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Baseline Values of the SCAT in Mexican Football Association Players

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Abstract

Introduction: Recently, there has been increasing cases of sports-related concussion. Individuals with this kind of injury may develop acute or chronic symptoms that may affect their health and athletic performance. Therefore, the main objective of this study was to determine the baseline scores in all domains of the Sport Concussion Assessment Tool (SCAT) among Mexican football association players.

Materials and Methods: Four-hundred and seven football players with a mean age of 16.3 years were interviewed about the presence of concussion in the past 12 months and then assessed with the SCAT.

Results: Three-hundred and thirty (81.1%) football players trained from 6 to 12 hours per week and 77 (18.9%) trained from 13 to 18 hours per week. One-hundred and nineteen (29.2%) athletes had consistently been involved in football for 6 to 24 months, and 288 (70.8%) athletes had been involved for longer than 24 months. In the past 12 months, the prevalence of concussion was 5.4%. According to the SCAT, 32 out of 407 (7.9%) participants made orientation errors, 227 out of 407 (55.8%) participants made errors in immediate memory, 377 out of 407 (92.6%) participants made errors in concentration, 366 out of 407 (89.9%) participants made errors in balance tests, and 309 out of 407 (75.9%) football players made delayed memory errors. The overall average of the SCAT was 86.6. Participants with an antecedent of concussion scored significantly lower ($P < 0.05$) on the SCAT total score than those without an antecedent of concussion.

Discussion: These results show that athletes who are in good health presented variable or negative results at baseline in the SCAT. Therefore, it is proposed the application of the SCAT to athletes to obtain baseline assessments and thus these values can be helpful for interpreting post-injury test scores.

Keywords

Concussion in Sports, Physical Evaluation, Football Players

Introduction

The problems in consciousness due to sports-related brain injury have increased dramatically in recent years. According to a report by the Center for Disease Control of the United States (US), between 2001 to 2005 US emergency departments received approximately 207,830 patients with traumatic brain injury related to sports and recreation activities [1]. It has been estimated that approximately 1.6 to 3.8 million sports-related brain injuries occur each year[2,3]. Head injuries mainly occur in contact sports such as football, rugby, football association (soccer), boxing, wrestling, lacrosse, basketball and hockey [1,2,4,5]. The symptoms and signs may occur immediately after the accident or minutes, hours, days or weeks after the injury [6-10]. Loss of consciousness is uncommon and occurs in less than 10% of sports-related brain injuries [6-11]. A concussion has been defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces [9,11]. It was further reported that the majority (80 to 90%) of concussions resolve in a short time (7 to 10 days), although the recovery time may be longer in children and adolescents. A complete neurological examination is recommended in athletes with a concussion, with special attention to speech, visual acuity, visual field, pupillary reaction, extraocular movements, muscle strength, postural stability, tendon reflexes, gait and finger-nose coordination, among other evaluations [8,9,11-13]. There are several tests to evaluate a state of concussion in athletes; however, there is no gold standard. The Sport Concussion Assessment Tool (SCAT) is a convenient standard test for the evaluation and documentation of symptoms and signs of concussion [9,11,14]. There are reports on the utilisation of the SCAT in athletes. Two-hundred fourteen non-concussed high school athletes who participated in football, basketball, gymnastics, baseball, and softball were evaluated in an observational study [15]. The authors reported low scores onseveral of the subtests of the SCAT test, primarily on concentration and balance testing. Similarly, deficiencies or low scores in some of the subtests of the SCAT were found in another study that evaluated 1,134 athletes [16]. These previous reports recommend obtaining baseline scores on the SCAT test for every athlete during the preseason or at the beginning of each school cycle. Neither the Mexican government nor any Mexican sport society has issued or published a national policy statement for the evaluation and management of traumatic brain injury related to sports such as football. A unique feature of football is the use of the head to control the ball and this heading is in minor grade the responsible of concussions in football players [17]. There is no study about epidemiology of concussion and its impact on the health and/or physiological variables of Mexican football players. Therefore, following the international recommendations, the main objective of this study was to determine the prevalence of football-related concussion and to obtain the baseline scores in all domains of the SCAT test in Mexican football association (soccer) players.

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Materials and Methods

Sample, participant selection and methods

The study population was taken from the Sport Science and Football University (SSSU), a Mexican private educational institution that offers various levels of education (primary, secondary and tertiary education; bachelor, master and doctoral). The SSSU has implemented an academic-sport model, in which students participate in academic, sporting and cultural activities throughout the day. All students practice football, as well as other sports less frequently, participating in training from Monday to Saturday (2 to 4 hours per day). For analysis, athletes were divided into two groups according the hours of football practicing: a 12 hours group and the 13-24 hours group. Likewise, the total duration of participation in the sport was evaluated. For analysis, athletes were divided into two groups according the total months of football practicing: a 6-24 months group and the > 24 months group [18].

Athletes were interviewed to determine whether they had experienced any trauma indicative of concussion during their sport activities within the previous 12 months. The concussion antecedents were corroborated with the clinical records of the participants. Reported traumas were classified as mild, moderate and severe. Furthermore, athletes were excluded if they had ever sustained a concussion or head trauma by motor vehicle, falls, fights or recreational activities. A validated Spanish version of the SCAT test [14]was given to all students of the SSSU. The SCAT is a standardised method for evaluating injured athletes for concussion and may be used in young and older athletes [9,11,15,16]. In order to obtain baseline assessments prior to a possible concussion, the application of SCAT before starting the season is widely recommended [9,11,15,16].

The SCAT is divided into 9 sub-tests, each with its own score; the sum of the 9 sub-tests is 100 for a non-concussed person. The sub-tests are: symptoms (22 points), physical signs (2 points), Glasgow Coma Score (E + V + M) (15 points), balance assessment (30 points), coordination (1 point), orientation (5 points), immediate memory test (15 points), concentration (5 points) and delayed memory (5 points). In respect to symptoms, a lower symptom score means impairment. Failing or making mistakes in the sub-tests may result in a low score and may indicate a probable cognitive alteration caused by a concussion. Assessments were given by the investigators and/or by trained research medical doctors. The evaluations were conducted during the first semester of 2013. Students who met the following criteria were included: age of 13-22 years, male gender, conscious, football association (soccer) player, good health according to their clinical history and able to respond adequately or appropriately to medical staff questions. For analysis, athletes were divided into two groups: a 13-19-year age group (adolescents) and the 20-22-year age group (young adults) [19]. All participants agreed, with permission from their parents (they signed a letter of informed consent), to participate in the study. Students who exhibited cognitive alteration or motor disability at the time of evaluation were excluded. The Ethics and Investigation Committees approved the study protocol and the study was performed according to the guidelines delineated by the Declaration of Helsinki.

Data analysis

The results were analysed with the version 20 of the Statistical Package for Social Sciences (SPSS). Descriptive (absolute frequencies, proportions, means, standard deviations, etc.) and inferential statistics were calculated and are reported as mean ± standard deviation (SD). Four separate independent-samples *t*-tests, with age, history of concussion within 12 months, total duration of participation in the sport and daily time spent practicing the sport as dichotomous independent variables, were used to assess differences in the SCAT total score. The significance level was set at $P < 0.05$.

Results

Four-hundred and seven male football player students from the SSSU were included in the study, with an average age of 16.3 ± 2.2 years. Three-hundred and thirty (81.1%) athletes practiced or trained from 6 to 12 hours per week and 77 (18.9%) students practiced or trained from 13 to 18 hours per week. One-hundred and nineteen (29.2 %) athletes had consistently been involved in football for 6 to 24 months, and 288 (70.8 %) athletes had been involved for longer than 24 months.

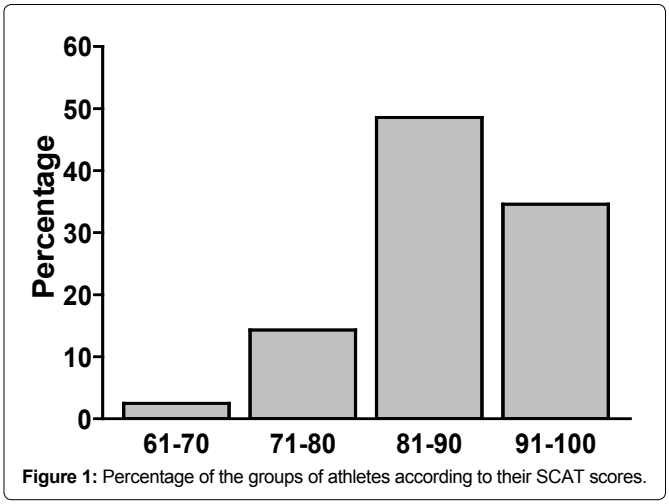

Figure 1: Percentage of the groups of athletes according to their SCAT scores.

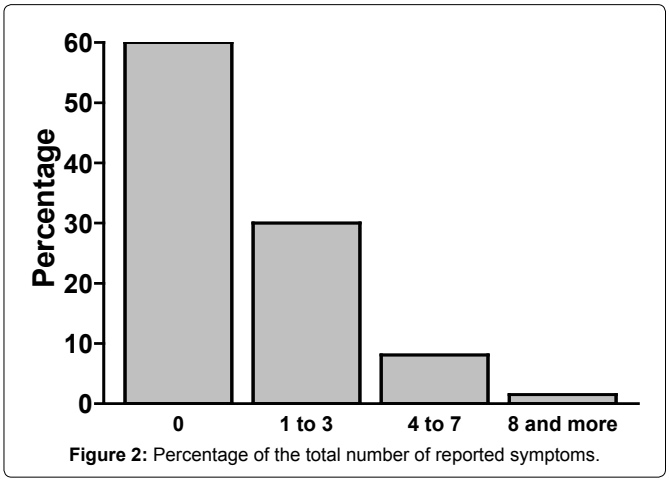

Figure 2: Percentage of the total number of reported symptoms.

History of concussion

According to the athletes' interviews, 22 (5.4%) had suffered trauma in the head region (face, neck, forehead, temple or mandible) that suggested the presence of concussion. Of the 22 athletes, 8 (36.4 %) reported the trauma as mild, 12 (54.5 %) reported it as moderate and 2 (9.1 %) reported it as severe.

Assessments SCAT2

Total test score

The overall test average was 86.8 ± 6.9 (with a minimum score of 64 and a maximum of 100). Figure 1 shows the final total score percentages obtained by the athletes. Athletes with an antecedent of concussion scored significantly lower ($P < 0.05$) on the SCAT total score than those without an antecedent of concussion (Table 1). Results and statistical analysis of the total score according to age groups, hours per week and months of practicing the sport are shown in table 1 and table 2.

Symptoms score

Of all the participants, 161 (37.0 %) had one or more of the symptoms described by the SCAT test, with an average of 1.0 symptom per athlete. Figure 2 shows the frequency in the number of symptoms reported by athletes, with a minimum of zero and a maximum of 14 symptoms. The 5 most common symptoms were: "Fatigue or low energy" in 75 (18.4%) athletes, "Drowsiness" in 56

Table 1: Sport Concussion Assessment Tool (SCAT) total and component scores by age group and concussion history

		Age groups		Background of concussion	
	Total	13 - 19 Years Mean, s	≥ 20 Years Mean, s	No Mean, s	Yes Mean, s
SCAT	86.8 ± 6.9	86.9 ± 6.9	84.8 ± 6.2	87.0 ± 6.9	83.6 ± 6.4*
Symptom Evaluation	21.0 ± 1.8	21.0 ± 1.8	21.3 ± 1.7	21.1 ± 1.7	19.6 ± 2.9*
Orientation	4.9 ± 0.3	4.9 ± 0.3	4.8 ± 0.5*	4.9 ± 0.3	4.8 ± 0.5*
Immediate memory	13.5 ± 2.0	13.5 ± 2.0	13.2 ± 1.9	13.4 ± 1.9	13.9 ± 2.5
Concentration	2.8 ± 1.2	2.8 ± 1.2	3.0 ± 1.0	2.8 ± 1.2	2.5 ± 1.2
Delayed recall score	3.5 ± 1.2	3.6 ± 1.2	2.9 ± 1.1*	3.5 ± 1.2	3.4 ± 1.3
SAC	24.7 ± 2.8	24.8 ± 2.8	24.0 ± 2.8	24.7 ± 2.8	24.5 ± 3.5
Balance examination	23.1 ± 5.7	23.2 ± 5.7	21.5 ± 5.7	23.2 ± 5.8	21.6 ± 4.7
Double leg stance	0.8 ± 2.0	0.7 ± 1.9*	1.8 ± 2.6	0.8 ± 2.0	0.4 ± 0.8
Single leg stance	3.6 ± 2.9	3.6 ± 2.9	3.7 ± 2.5	3.6 ± 2.8	4.3 ± 3.1
Tandem stance	2.5 ± 2.7	2.4 ± 2.7	3.1 ± 2.4	2.4 ± 2.6	3.3 ± 3.5
Coordination examination	0.98 ± 0.1	0.98 ± 0.1	1.0 ± 0.0	0.98 ± 0.12	0.91 ± 0.29*

*Significantly different from values of the same line $P<0.05$. Results of the double leg stance, single leg stance and tandem stance tests are presented as the mean of the number of errors. Standardised Assessment of Concussion (SAC).

Table 2: Sport Concussion Assessment Tool (SCAT) total and component scores by hours/week dedicated to the sport and total duration of participation in the sport.

	Total	From 6 to 12 hours/week Mean, s	From 13 to 18 hours/week Mean, s	From 6 to 24 months Mean, s	More than 24 months Mean, s
SCAT-2	86.6 ± 7.2	87.2 ± 6.7	85.1 ± 7.5*	84.8 ± 6.9	87.6 ± 6.7*
Symptom Evaluation	20.1 ± 1.8	21.1 ± 1.7	20.5 ± 2.1*	20.9 ± 1.7	21.0 ± 1.8
Orientation	4.9 ± 0.3	4.9 ± 0.3	4.9 ± 0.4	4.8 ± 0.5	4.9 ± 0.3*
Immediate memory	13.4 ± 2.0	13.4 ± 2.0	13.6 ± 1.6	13.5 ± 2.0	13.4 ± 1.9
Concentration	2.8 ± 1.2	2.9 ± 1.1	2.6 ± 1.3	2.7 ± 1.2	2.9 ± 1.1
Delayed recall score	3.5 ± 1.2	3.6 ± 1.2	3.1 ± 1.3*	3.8 ± 1.0	3.4 ± 1.3*
SAC	24.7 ± 2.9	24.8 ± 2.9	24.3 ± 2.7	24.9 ± 2.7	24.7 ± 2.9
Balance examination	23.1 ± 5.7	23.3 ± 5.5	22.3 ± 6.4	21.1 ± 5.9	23.9 ± 5.4*
Double leg stance	0.8 ± 2.0	0.8 ± 2.0	1.0 ± 1.9	1.5 ± 2.5	0.5 ± 1.6*
Single leg stance	3.6 ± 2.9	3.5 ± 2.7	3.9 ± 3.5	4.3 ± 2.8	3.3 ± 2.9*
Tandem stance	2.5 ± 2.7	2.4 ± 2.6	2.8 ± 3.1	3.1 ± 2.7	2.2 ± 2.6*
Coordination examination	0.98 ± 0.1	0.98 ± 0.14	0.99 ± 0.11	0.98 ± 0.13	0.98 ± 0.14

*Significantly different from values of the same line $P < 0.05$. Results of the double leg stance, single leg stance and tandem stance tests are presented as the mean of the number of errors. Standardised Assessment of Concussion (SAC).

(13.8%) athletes, "Difficulty concentrating" in 53 (13.0%) athletes, "Difficulty remembering" in 45 (11.1%) participants and "Neck pain" in 41 (10.1%) athletes. The average score for this test was 21.0 ± 1.8. Results and statistical analysis of the symptoms according to age groups, antecedent of concussion, hours per week and months of practicing the sport are shown in table 1 and table 2.

Rating of physical signs and Glasgow Coma Score (E + V + M)

In this section all were assigned a rating of 2 (the maximum) for physical signs and 15 (the maximum) for the Glasgow Coma Score.

Orientation rating

In this test, 375 (92.1%) athletes completed the entire test. The mean score of the test was 4.9 ± 0.3 points. Table 1 and Table 2 show the mean scores achieved on this test by age group, antecedent of concussion, hours per week dedicated to the sport and the total duration of participation in the sport.

Immediate memory test

In this section, 180 (44.2%) athletes completed the test without any error (maximum score of 15 points) and 227 (55.8%) athletes made 1 to 10 errors. Table 1 and Table 2 show the mean scores achieved on this test.

Concentration test

In this test, only 30 (7.4%) athletes completed the entire test without error (maximum score of 5 points), and 377 (92.6%) participants made 1 to 5 errors. Table 1 and Table 2 show the mean scores obtained from this subtest.

Delayed memory test

In this section, 98 (24.1%) athletes completed the test without error (maximum score of 5 points) and 309 (75.9%) athletes made 1 to 5 errors. Table 1 and Table 2 show the mean scores obtained from this subtest.

Standardised Assessment of Concussion (SAC)

The mean score for the SAC (orientation, immediate memory, concentration and delayed recall) was 24.7± 2.8. Post hoc analysis of the total SAC score found no significant difference when analysed by age groups, antecedent of concussion, hours per week dedicated to the sport and the total duration of participation in the sport (Table 1 and Table 2).

Balance assessment rating

Only 41(10.1%) athletes evaluated made no error when completing the three subtests (double-leg stance, single-leg stance and tandem stance) (maximum score 30 points). The average scores for the complete test and the three subtests are shown in table 1 and table 2.

Rating coordination

In this test, only 8 (2.0%) athletes failed the test. Table 1 and Table 2 show the mean scores obtained from this subtest.

Discussion

Whilst a concussion is a common event it is a poorly-reported injury in the sport world [5,20,21]. This is mainly due to the lack

of understanding of the impact of the problem, social and personal pressure to continue playing or practicing the sport and the probable economic impact [20,22]. Recently, there has been increasing interest in this type of injury, as a small number of individuals have developed chronic or long-term symptoms. This is especially common in cases of repetitive concussion or moderate traumatic brain injury, which have reportedly caused at least 17% of individuals to develop chronic traumatic encephalopathy [23,24]. Head injuries have been and continue to be a concern for the football community. A unique feature of football is the use of the head to control, pass and shoot the soccer ball. Additionally, the use of the head to change the direction of the ball and score goals is a key skill that increases the risk for a variety of head injuries, including bruises, lacerations, fractures and concussions [17]. In the present study, it was found a 5.4% prevalence of concussion in the past 12 months. This prevalence was slightly lower than the 8% of football players with a concussion in a six-year evaluation of FIFA competitions [25] and was considerably lower than the prevalence of 28.5% reported in another study, in which 137 soccer players who competed in the Olympic sports Festival in the USA in 1993 were evaluated [26]. These differences are probably due to the different levels and requirements of competition. Therefore, it is also necessary to observe more closely the football players during their sports activities.

For several years, attempts have been made to obtain tools to quickly and effectively evaluate the cases of sports-related concussion. In this sense, the SCAT was created and recommended for its application before starting the season, in order to obtain baseline assessments prior to a possible concussion. Our study showed that virtually all tests had negative results in our athletes. Specifically, 37.0% of our athletes had minimal symptoms and over 89.9% of athletes had abnormalities on balance. Additionally, the SCAT mean final score of our participants was slightly lower (86.8 ± 6.9) than the scores of 89 ± 6 and 88.3 ± 6.8 reported by other authors [15,16]. In agreement with other studies, it was found that athletes with the antecedent of concussion scored significantly lower on the symptoms, orientation, coordination and total SCAT score [16,27] than participants with no concussion history.

In our study, the 13-19 year age group scored better on the orientation test and the delayed recall test than the 20-22 year age group ($P < 0.05$). In our study, the prevalence of concussion was determined within the last 12 months. It has been demonstrated that concussion frequencies trended upward throughout the time of practicing the sport as well as with increasing age [28]. Therefore, it is probable that this age group (20-22 year olds) has practiced the sport for more years than younger athletes; consequently, it is plausible that this age group has received more concussions. More research on this point, in order to give more support to this possibility, is necessary. These athletes were not aware that they had suffered a concussion, which is a very common occurrence in sports. For example, one study evaluated 328 football and 201 soccer players to determine the number of concussions experienced during the previous full year of football or soccer participation [29]. In this study, 70.4% of the football players and 62.7% of the soccer players had experienced symptoms of a concussion during the previous year and only 23.4% of the concussed football players and 19.8% of the concussed soccer players were aware that they had suffered a concussion[29]. Therefore, a limitation of our study was the short time (12 months) of concussion history evaluated. It is suggested to investigate the occurrence of concussion in a two or three year time-span.

It is widely demonstrated that the maintenance of balance is complex and is influenced by several sensorimotor functions, including muscular strength, proprioception, and the visual and vestibular sensory system [30]. Several studies have shown that strength training of the ankles and/or lower limbs correlates with postural stability and functional tests [31,32]. In the current study, it was observed that participants who had practiced in their sport consistently for 6 to 24 months scored significantly lower ($P < 0.05$) on the SCAT test than those who have practiced for over 24 months. This difference was mainly supported by higher scores on the balance and orientation tests (Table 2). Various investigations have demonstrated the health benefits associated with physical activity during adolescence [33,34]. Likewise, preceding investigations suggested that motor expertise is positively associated with physical activity levels[35]. The longer training duration of those who practiced for over 24 months likely produced an improvement on the balance tests. This last argument is supported by findings that have demonstrated that long-term strength training programmes improve the postural control in football players [19,36,37]. It is important to note that athletes with a concussion history achieved a lower score on the balance test than those without a concussion antecedent. However, this difference was not statistically significant ($P > 0.05$). In this last case, it is probable that the balance problems are partially due to proprioception or visual problems caused by the concussion antecedents [3,4,6,21,23]. Therefore, more research is needed to explain the factors affecting the balance in such athletes.

Among clinical evaluations of the SCAT, measurement of coordination is of particular interest in neuromuscular disorders secondary to disease or a concussion. Coordination is defined as the capacity to execute a controlled movement with accuracy and rapidity [38]. Coordination requires the appropriate activation of muscles with temporal and spatial components [39]. In the current study, 8 (2.0%) athletes failed the coordination test: 2 participants with and 6 without a history of concussion. Our result is lower than the10% of athletes that were not able to successfully complete the coordination test evaluated by Jinguji et al. [15]. Curiously, 100% of a sample of 1,134 high school athletes was able to complete the coordination test in the study by Valovich McLeod et al. [16], who believed that this result occurred because all participants were healthy. This last statement was not true in the current study and in the study by Jinguji et al. [15]. It is necessary to evaluate in more detail the clinical cases of dysmetria found in the application of the SCAT.

As mentioned previously, SCAT3 is now a new standardised tool recommended for evaluating injured athletes for concussion and is suggested for athletes aged 13 years and older [11]. The tandem gait test was included in the SCAT3 and this is an early important test in the case of concussion. The tandem gait is used to evaluate patients with truncal ataxia caused by damage to the cerebellar vermis or associated pathways [40]. These patients will have particular difficulty with the tandem gait test because they tend to have a wide-based, unsteady gait and become more unsteady when attempting to keep their feet close together. Our study was realized before the concrete publication of SCAT3 [11], therefore SCAT2 was applied to the participants. Consequently, a small weakness in our study was the lack of results of the tandem gait test. However, this small limitation does not diminish the relevance of our results.

Other limitations of our study include the lack of consecutive subjects and the analysis of subjects with and without concussion lumped together. Likewise, it is necessary to administer the SCAT at different times after a head injury.

Conclusions

Our results show that athletes who are in good health presented variable or negative results at baseline in the SCAT. Thus, we strongly propose that medical professionals apply the SCAT test to athletes to obtain baseline assessments. These values can be helpful for interpreting post-injury test scores.

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