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INJURY PREVALENCE AND FUNCTIONAL MOVEMENT SCREEN™ SCORES IN YOUNG FOOTBALL PLAYERS

Simoné CONLEY & Leon LATEGAN
Department of Sport and Movement Studies, Faculty of Health Sciences, University of Johannesburg, Johannesburg, Rep. of South Africa

ABSTRACT

The high rate of injury in football is indicative of the importance of injury prevention, especially in young football players. The primary aim of this study was to investigate the prevalence of musculoskeletal injuries over one 12-month period in junior male South African football players, attending a local football academy. The functional movement ability of the players was evaluated using FMS™ testing. The possible correlation between football injuries in this group and pre-season FMS™ scores was investigated. One hundred and nineteen (119) players participated. This study adopted a quantitative descriptive research approach. A questionnaire was used to record injuries that occurred in the previous 12 months. The Functional Movement Screen™ (FMS™) was used to assess the functional movement patterns of the players. The relationship between previous injury and FMS™ score was analysed and the confidence level was set at $p<0.05$. There was a high prevalence (88.2%) of injuries within this group. Lower-limb injuries were the most common (78.3%) and most injuries occurred at the knee joint (42%). The mean FMS™ score was 12.9±1.56, which was lower than that of similar groups tested. There was no significant correlation between previous injury and FMS™ score.

***Keywords*:** Football; Functional movement screen; Injury; Prevention; Soccer.

INTRODUCTION

Football participation at all levels carries some degree of injury risk. Several researchers have reported on the incidence, cost and causes of football injuries (Price *et al*., 2004; Azubuike & Okojie, 2008; Ekstrand *et al*., 2009). Youth football players may suffer a comparable number of injuries to those of adult players (Emery, 2003; Price *et al*., 2004; Jacobs & Van den Berg, 2012), but some sources noted that they might suffer from more injuries than adult players (Peterson *et al*., 2000; Pfirrmann *et al*., 2016).

The incidence of injury in football is high. Azubuike and Okojie (2008) reported that 81.6% of male football players sustained an injury during one competitive season. The average injury rate reported in male football ranged between 0.40 injuries per player per season (Price *et al*., 2004) to 2.0 injuries per player per season (Woods *et al*., 2003). Furthermore, the overall incidence of injury ranged between 8.0 and 13.4 injuries per 1000 playing hours, with most injuries occurring during matches (Ekstrand *et al*., 2009; Calligeris *et al*., 2015). The high rate of injury in football is indicative of the importance of injury prevention, particularly in young football players (Woods *et al*., 2003).

Injuries may be caused by both intrinsic (faulty biomechanics, muscle imbalance or lack of adequate flexibility and previous injury) and extrinsic factors (unequal playing surface, weather conditions or faulty equipment) (Hootman, 2002), as well as hereditary factors. According to Maffey and Emery (2006), addressing risk factors, such as muscle imbalance, inflexibility and muscular weakness could possibly reduce the incidence of injuries. However, Kiesel *et al*. (2007) proposed that evaluating risk factors in an isolated manner does not take into account how the athlete performs the functional movements required for sport, and thus a more functional approach to injury prevention was needed.

Similar to adult football players (Azubuike & Okojie, 2008; Ekstrand *et al*., 2009; Calligeris *et al*., 2015), most football injuries in the youth occur in the lower limb, with the ankle, knee and thigh being the most affected sites (Pfirrmann *et al*., 2016). Although the scientific evidence in support of injury prevention techniques and strategies is largely lacking, some evidence does exist in support of using certain tools and strategies to prevent lower-limb injuries in sport. The Fédération Internationale de Football Association (FIFA) '11+' injury-prevention programme and the Prevent Injury, Enhance Performance (PEP) programme developed by the Santa Monica Orthopaedic and Sports Medicine Research Foundation have both been proven to be effective in preventing and limiting injuries in youth football (Dallinga *et al*., 2012).

The Functional Movement Screen^{TM} (FMS^{TM}) method developed by Cook (2003) has previously been evaluated for its use in predicting musculoskeletal injury risk in male high school athletes (Smith *et al*., 2017), male and female high school athletes (Bardenett *et al*., 2015), male football players (Kiesel *et al*., 2007), male junior hockey players (Dossa *et al*., 2014), male firefighters (Butler *et al*., 2013) and in military recruits (Lisman *et al*., 2013). FMS^{TM} involves evaluating range of motion, core strength and muscular imbalances by means of seven different movement patterns involving the upper and lower extremities, as well as the trunk.

According to Cook (2003), an FMS^{TM} score of 15 or less indicated a high risk of injury, while others reported that an FMS^{TM} score of 14 or less was the cut-off point for injury risk (Kiesel *et al*., 2007; Chorba *et al*., 2010). Although some researchers believe that FMS^{TM} is not effective in predicting either traumatic or overuse sports injuries in adult (Dorrel *et al*., 2015) and youth athletes (Abraham *et al*., 2015; Bardenett *et al*., 2015; Smith *et al*., 2017), the data concerning its use in youth athletes is not saturated. In addition, the critical or cut-off values for injury risk were developed using predominantly adult populations.

PURPOSE OF STUDY

Surveillance data on football injuries and FMS^{TM} scores in junior male football players (younger than 19 years) is largely lacking in South Africa. Thus, the primary aim of this study was to investigate the prevalence of musculoskeletal injuries over a full season in junior male South African football players attending a local football academy. The two secondary aims were to evaluate the players' functional movement abilities using FMS^{TM} testing and to investigate the possible relationship between football injuries in this group and their FMS^{TM} scores.

METHODOLOGY

Research design

This study adopted a descriptive and retrospective quantitative research design. Following full disclosure and a comprehensive information session, the participants aged 18 years signed an informed consent form and the participants younger than 18 years signed a child assent form. The coaches of the players acted as guardians (since all the players were residing at the academy and not at home) and they also signed an informed consent form on behalf of each participant younger than 18 years. The participants, guided by the principle researcher, subsequently completed a retrospective injury questionnaire on the injuries they sustained in the previous 12 months. Only participants who were injury-free at the time of the study (n=119) underwent functional movement screening using the FMS™ method.

Participants

The sample for this study included 119 elite youth development football players from a national youth academy (talented football players, between the ages of 13 and 19, are drafted into the academy by coaches and scouts on an annual basis from all over the country and they reside on the premises of the academy for 11 months per year, while also attending school). The sample included representation from each of the nine provinces of South Africa and the participants' ages ranged from 13 to 19 years (Table 1).

***Table 1*. DISTRIBUTION OF PARTICIPANTS ACCORDING TO PROVINCE**

Province	n	%
Free State	15	12.6
Gauteng	43	36.1
Kwa-Zulu Natal	11	9.2
Western Cape	8	6.7
North West	17	14.3
Limpopo	12	10.1
Northern Cape	7	5.9
Eastern Cape	4	3.4
Mpumalanga	2	1.7

To be included in the study, all players were required to be injury-free and actively participating in training and matches at the Academy at the time of the study. Players who were currently injured or ill or not partaking in football training or competition were excluded from the study.

All participants in the study were informed of the requirements, risks and benefits of the study prior to commencing with any testing. They were invited to give their informed consent or child assent for taking part in the study, as well as to be video-recorded. The Academy gave consent for the study to be undertaken on-site and the coaches, who acted as guardians, gave permission for children younger than 18 years to participate. Since many of the players were from rural areas and since the majority of their parents were not reachable by electronic media (e-mail), their coaches acted as their guardians while they attended the Academy.

Ethical clearance for the study was obtained from the Research Ethics Committee of the University of Johannesburg (AEC No: 27/07/2012). Players' identities were protected through using unique identifying numbers instead of their names and all video recordings were kept under lock and key. Participants took part voluntarily and were allowed to withdraw at any stage if they so wished without fear of reprisal.

Data collection procedures

Each participant completed a demographic information sheet that captured age, playing position and province of origin. Since medical records pertaining to musculoskeletal injuries were not available to the current researchers, a previously developed injury-recall questionnaire (Conley, 2015) was used to obtain information on the injuries that players had sustained over the previous 12-month period.

A football injury was defined as an event that occurred during training or playing a football match that resulted in the player leaving that training session or match and if the player missed a subsequent training session or match (Fuller *et al*., 2006; Azubuike & Okojie, 2008; Ekstrand *et al*., 2009; Ani *et al*., 2015; Calligeris *et al*., 2015).

However, injuries not related to football were excluded, as was any absence due to illness. In addition, lacerations and other minor injuries that did not prevent a player from training or competing were not recorded as an injury. In addition to completing the injury-recall questionnaire, participants were interviewed by the principle researcher to confirm the injury sustained, the exact site of the injury and the cause of the injury ('contact' or 'non-contact').

Height was measured to the nearest 0.01m using a standard stadiometer and body weight was measured to the nearest 0.1kg using a standard portable scale (Seca Medical Scales and Measuring Systems, Germany, Hamburg, 22089).

The FMS^{TM} tool developed by Cook (2003) was utilised to evaluate functional movement patterns of each player. The FMS^{TM} method (when scored in real time or using video analysis) has fair to excellent inter-rater reliability (Kiesel *et al*., 2007; Schneiders *et al*., 2011), although some researchers do not agree with this (Dorrel *et al*., 2015). Participants were requested to wear shorts only during the FMS^{TM} testing.

The following seven functional movement patterns were performed in order: deep squat, hurdle step (bilateral), in-line lunge (bilateral), shoulder mobility (bilateral), active straight leg raise (bilateral), push-up for trunk stability and rotary stability (bilateral). The performance in each movement pattern was rated using the scoring system developed by Cook (2003). The maximum score obtainable is three (3), the minimum score is one (1) and a score of zero (0) indicates pain during the test. All participants who reported pain during any of the seven FMS^{TM} tests were excluded from the study and referred for further medical attention. Thus, a total possible maximum score for the FMS^{TM} test was 21 and the minimum total score possible, was seven (7).

The test performance of each participant was video-recorded from the anterior and lateral views (4 metres from the participant at a height of 1 metre) using two commercially available video cameras (Sony HDR CX100, Japan). Two independent evaluators graded each movement in accordance with the prescribed criteria (Cook *et al*.; 2006a, Cook *et al*., 2006b). If the two evaluators differed on a participant's score, the final score was obtained through consensus. Where a test involved both the left and the right sides, the lower score of the two sides was recorded and used for calculating the overall FMS^{TM} score.

Data analysis

Only total FMS^{TM} score was used for analysis. The injury data was divided into three different sites: lower-limb, upper-limb and spine/trunk injuries. The injuries that occurred at the different joints (hip, knee, ankle, etc.) were also noted. In addition, players were required to separate the cause of injury in terms of 'contact' or 'non-contact'. The data obtained from this study was analysed using IBM SPSS software (version 22.0). Descriptive statistics were performed to obtain the means, minimums, maximums and standard deviation for FMS^{TM} scores.

Cross-tabulation analysis was done to establish whether there was a significant relationship or correlation between the predictor variable (total FMS^{TM} score) and the response (injury prevalence – 'yes' or 'no'). When performing a comparison of the FMS^{TM} scores of the injured and non-injured groups, Kolmogorov–Smirnov and Shapiro–Wilk tests were performed for normality. Levene's test for equality of variances was conducted, with equal variance and normality assumed. The confidence level was set at $p<0.05$.

RESULTS

The participants' ages were distributed between 13 and 19 years and the mean age was 15.29±1.49 years. The mean body mass was 50.23±11.34kg and the mean height was 1.60±0.174m. The mean Body Mass Index (BMI) was 19.35±2.33kg/m^2 (Table 2). Of the 119 participants, 11 were goalkeepers, 32 were defenders, 39 were midfielders, 19 were wings and 18 were strikers. Thus, the participants consisted of a representative sample of all the football playing positions.

***Table 2*. DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS**

Characteristics	Mean±SD	Minimum	Maximum
Age (years)	15.29±1.49	13.00	19.00
Weight (kg)	50.23±11.34	26.70	91.90
Height (m)	1.60±0.17	1.30	1.89
BMI (kg/m^2)	19.35±2.33	12.35	25.72

There were a total of 123 injuries reported over the 12-month period by the 119 participants (88.2% prevalence). In addition, of the 105 injured players, 88 sustained only one injury, while 17 players sustained two injuries. Fourteen (14) players did not sustain an injury during the season in question. Injuries to the lower limb were the most common (78.3%), followed by the upper limb (19.2%) and spine area (5%) (Figure 1).

The three most common lower-limb injury sites were the knee (42%), the ankle (21%) and the groin (18%) regions (Figure 2). Non-contact injuries contributed to 44.5% of all injuries while 39.5% of injuries were due to contact and the cause of 16% of the injuries could not be recalled by the participants involved.

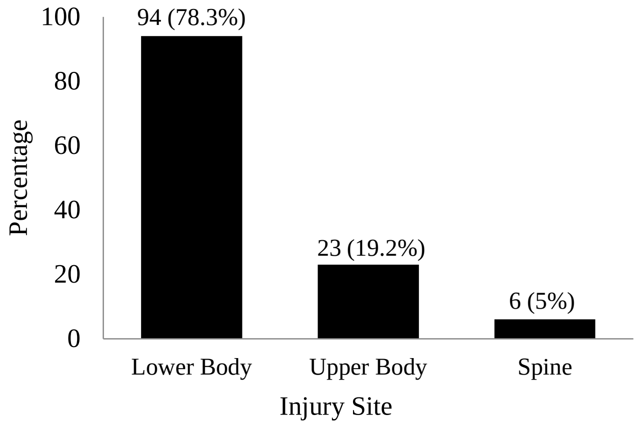

Figure 1. **INJURY SUSTAINED AT DIFFERENT BODY SITES**

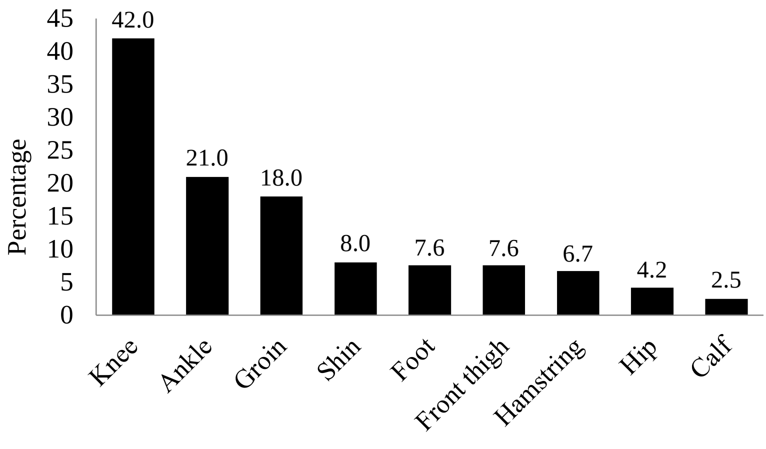

Figure 2. **DIFFERENT LOWER LIMB INJURIES**

The mean FMS^{TM} score for the group was 12.9±1.6 (Table 3). The mean FMS^{TM} score for injured players was 13.0±1.5 and the non-injured mean FMS^{TM} score was 12.6±1.8. There was no statistically significant difference between the FMS^{TM} scores of the injured and non-injured groups (p=0.36). The majority of the players (54.7%) achieved an FMS^{TM} score of between 11 and 13 and only 19 players (16%) achieved a score above 14, while only 5 players (4.2%) achieved a score of more than 15 (Figure 3). The highest score recorded was 16 and the lowest score was 10 (Table 3).

***Table 3*. FMS™ SCORES**

Participants	n	Mean±SD
Group	119	12.9±1.6
Injured	105	13.0±1.5
Non-injured	14	12.6±1.8

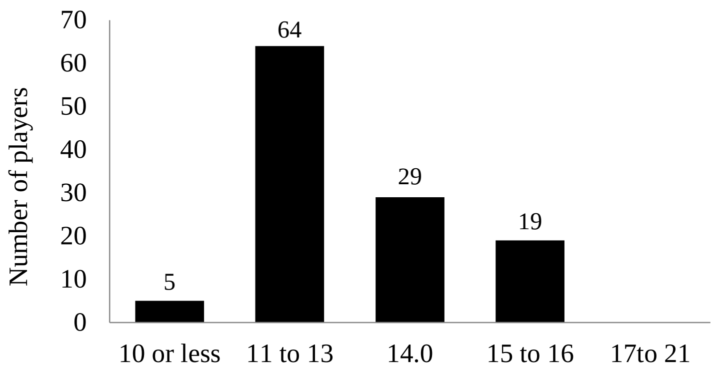

***Figure 3*. DISTRIBUTION OF FMS™ SCORES**

DISCUSSION

The main aim of the present study was to investigate the prevalence of football injuries in young football players. The two secondary aims were to evaluate functional movement abilities of the players using FMS™ testing and to investigate if a relationship existed between previous football injuries and FMS™ scores.

The current findings have to be evaluated against the specific demographic profile of the participants in the study. The mean age (15.3 years) is indicative of being in a rapid growth phase that is characterised by rapid increases in linear growth (stature) (Martini, 2001; Philippaerts *et al*., 2006) and possible transient decreases in muscle flexibility and whole-body coordination in some individuals. The decreased flexibility and lack of coordination could have attributed to the large number of injuries sustained and also to the low mean FMS™ score observed in the current study.

The FMS™ score of the participants of this current study were lower than the scores previously reported for young active individuals. Schneiders *et al*. (2011) reported an average FMS™ score of 15.7 in young active individuals and they found that only 31% of participants scored below 15. This is in contrast to the mean FMS™ score of this study of 12.9 and the fact that 95.8% of the participants scored below 15. The large discrepancy between the values of the current study and those from Schneiders *et al*. (2011) highlights the poor performance and thus the high risk of possible future injury in the current sample of players. This finding was supported by the large number of injuries reported in the previous season (88.2%).

In the present study, musculoskeletal injuries were common, with 88.2% of participants reporting an injury over the preceding 12-month period. This is in accordance with previous data emanating from Africa and Europe. Jacobs and Van den Berg (2012) reported an injury prevalence rate of 78% in elite male youth football players from 11 African countries, while Price *et al*. (2004) reported an injury occurrence rate of 79.7% in their sample of 38 junior English football clubs. This high rate of injury is a major cause for concern, as injuries may negatively impact the development, long-term health, maturation and future performance of these young football players.

Lower-limb injuries constituted 78.3% of all injuries, with the knee (42%), ankle (21%) and groin (18%) contributing to the majority of injuries reported in the present study. This finding is supported by reported research in football (Price *et al*., 2004; Jacobs & Van den Berg, 2012) that showed a high prevalence of lower-limb injuries. There was no significant difference ($p>0.05$) between the number of non-contact (44.5%) and contact injuries (39.5%) reported in the present study. However, Calligeris *et al*. (2015) reported 33% non-contact and 67% contact injuries among adult male players. This finding may indicate that young players may be at an increased risk of suffering a non-contact overuse injury, whereas adult players had a higher risk of contact injuries.

The mean FMS™ score of the current cohort was 12.9 and a total of 82.9% of players achieved scores of 14 or lower, while 95.8% of the current participants achieved FMS™ scores lower than 15. This is substantially lower than the FMS™ cut-off scores previously suggested (FMS≤14 or FMS≤15) (Cook, 2003; Maffey & Emery, 2006; Kiesel *et al*., 2007; Chorba *et al*., 2010). The lower FMS™ scores could stem from inadequate conditioning programmes or a lack of regular pre-participation evaluations of these players. Although the present study failed to establish a significant correlation between FMS™ score and injuries sustained over the last 12 months in young male football players, this finding may have been compromised by the uneven distribution of injured (n=105) versus non-injured (n=14) players.

The high prevalence of injuries and the low FMS™ scores in the young football players of the current study (compared to previous studies) may reflect the current state of affairs in South African youth football. Therefore, corrective exercises and preventative training may play an important role in reducing football injuries in this population. Furthermore, FMS™ testing may assist in identifying players who are at an increased risk of injury (a low FMS™ score). It is suggested that in future, medical and fitness staff should expand their pre-season screening protocols to include several important aspects to prevent possible injury, such as analysis of posture, gait, static flexibility, balance, muscle strength, agility, power and sport-specific skill execution.

Possible limitations of the current study are that no distinction was made between injuries sustained during either training or competition, that the severity of injuries (and thus the time lost to play) was not recorded, exposure in terms of football was not recorded, and that each separate FMS™ movement was not used for correlation to specific injuries. In addition, in utilising a retrospective methodology, recall bias was a limiting factor, since the participants were requested to recall all injuries they suffered in the previous 12 months, as no medical records were available. The retrospective methodology also raises the question whether FMS scores were lower due to previous injuries or whether the low FMS scores predicted the risk of future injury. Future researchers could investigate the possible correlation between individual FMS™ test items and specific injuries, like the correlation between poor performance in the squat and lower-limb injuries.

CONCLUSION

The present study reported a high prevalence rate of musculoskeletal injuries in the current sample of junior football players during a 12-month period. In addition, the current sample of junior football players exhibited low FMS™ scores compared to other similar populations from both Africa and Europe. There was no correlation between the FMS™ scores and injury prevalence in this group of players. Effective injury prevention strategies need to be implemented to try and reduce the high number of injuries in these participants. The deficits in functional movement patterns identified using FMS™ testing could potentially be used to design early intervention exercise programmes aimed at preventing future injuries.

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Corresponding author: Prof. Leon Lategan; **Email:**leonl@uj.ac.za

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