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ORIGINALIA

ACCEPTED: September 2015
PUBLISHED ONLINE: February 2016
DOI: 10.5960/dzsm.2015.200
Schroeder J, Wellmann K, Stein D, Braumann KM. The Functional Movement Screen for Injury Prediction in Male Amateur Football. Dtsch Z Sportmed. 2016; 67: 39-43.

The Functional Movement Screen for Injury Prediction in Male Amateur Football

Der Functional Movement Screen zur Verletzungsvorhersage im Männer-Amateurfußball

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Summary

- **Despite various research approaches,** there is still conflicting evidence as to the worthiness of injury prediction tools in football. This study was aiming at investigating
- correlations between injuries of amateur male football players and the results of a Functional Movement Screen (FMS). Using an observational design, ten amateur teams of the fifth and sixth division (Deutscher Fußball-Bund) were examined by means of FMS scores prior to a tenweek off- and main- season observation period (July to September 2013).
- **The assessment** included injuries and football exposure times during training and competition. Injury was defined as concerning the lower limb, and as non-contact with time loss of at least three days. After a drop-out of 56% (125 out of 221), 96 players could be analysed. We calculated a total exposure time of 1.770 hours (competition 289 h, training 1,481 h). We observed 10 injury incidents concerning 8 players, occurring exclusively during training. The according incidence was 6.8 injuries per 1.000 training hours.
- **There were no significant** differences between injured and uninjured players neither for any FMS item nor for the total score except for the hurdle step (Z=-2.059; p=0.040). Only the ratings for the hurdle step task and the injury state were correlated significantly (rpbis=0.209; p=0.041). Even if taking into account some experimental limitations, we conclude that the FMS does not allow a valid injury prediction in the field of amateur male football players.

Zusammenfassung

- **Im Fußball besteht keine Einigkeit** in der Bewertung der Aussagekraft unterschiedlicher Verfahren zur Verletzungsrisikoprognostik. Diese Arbeit hatte das Ziel, Zusammenhänge zwischen Ergebnissen im Functional Movement Screen (FMS) und dem Auftreten von Verletzungen im Herren-Amateurfußball zu evaluieren. In 10 Teams der 5. und 6. Liga (Deutscher Fußball-Bund) wurde zu Beginn einer 10-wöchigen Beobachtungsphase - 2 Wochen in der Vorbereitung direkt vor Saisonbeginn und in den ersten 8 Wochen der Saison 2013 eine FMS-Testung durchgeführt.
- **Im Beobachtungszeitraum** wurden die Expositionszeit und auftretende Verletzungen in Wettkampf und Training dokumentiert. Verletzungen waren definiert als non-contact Verletzung der unteren Extremität mit mindestens 3 Ausfalltagen. Nach einem drop-out von 56% (125 von 221) konnten die Daten von 96 Spielern berücksichtigt werden. Ermittelt wurden 1.770 Stunden Expositionszeit (Wettkampf 289 h, Training 1,481 h) und 10 Verletzungen - allesamt im Training - bei insgesamt 8 Spielern (1 Spieler mit 3 Verletzungen). Als korrespondierende Inzidenz wurden 6,8 Verletzungen pro 1.000 Trainingsstunden errechnet.
- **Weder im FMS-Gesamtergebnis,** noch in einzelnen Testaufgaben gab es signifikante Unterschiede zwischen verletzten und unverletzten Spielern, außer beim Hürdenschritt zu Gunsten der unverletzten Spieler (Z=2,059; p=0,040). Ein signifikanter Zusammenhang zwischen dem Auftreten von Verletzungen und den FMS-Testleistungen lag wiederum nur für die Aufgabe Hürdenschritt vor (rpbis=0,209; p=0,041).
- **Anhand** dieser Studie ist ein Zusammenhang zwischen dem FMS-Test und einem erhöhten Verletzungsrisiko nicht anzunehmen, auch wenn aufgrund methodischer Limitationen eine abschließende Beurteilung nicht möglich ist.

KEY WORDS:
Football, Functional Movement Screen, Injury Prediction

SCHLÜSSELWÖRTER:
Fußball, Functional Movement Screen, Verletzungsvorhersage

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Introduction

Evidence for injury prediction by means of football specific parameters, screening tools or questionnaires is not yet sufficiently established. A systematic review from 2012 (3) reported football associated injury risk factors identified earlier, e.g. anthropometrics, team-specific items like changes of coaches or clubs, and athletic performance or pre-injury (5, 7, 10-12). Another systematic review focussing on football specific demands extracted key risk factors (previous injury, fatigue, muscle imbalance) and widely used screening tests (Functional Movement Screen, questionnaires, isokinetic muscle testing) (16).

The Functional Movement Screen (FMS) is a test battery consisting of seven items (Fig. 1), examining coordination, flexibility, and trunk stabilisation ›

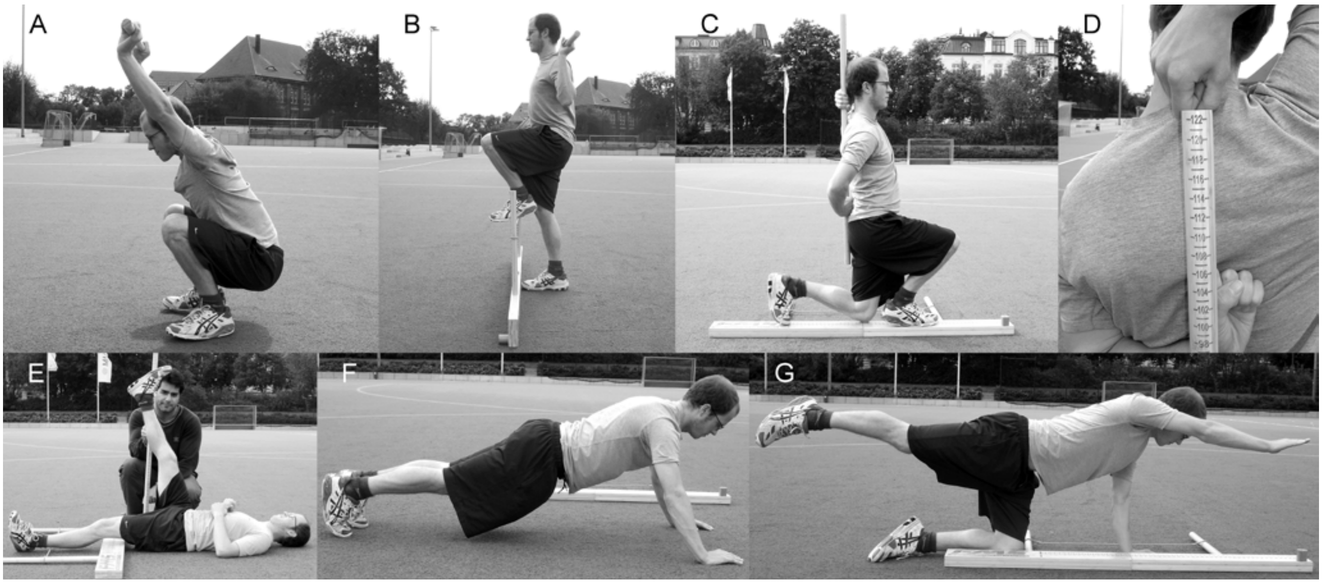

Figure 1

FMS-Items – Deep Squat (A), Hurdle Step (B), Inline Lunge (C), Shoulder Mobility (D), Active Straight Leg Raising (E), Trunk Stability Push-UP (F), and Rotary Stability (G) – all in correct execution.

capacities by means of expert ratings. Although the FMS was developed in the field of physiotherapists aiming at identifying disturbed coordination patterns based on single items execution deficits, it was evaluated in the field of North American College Football intending to use the composite score as injury risk prediction tool. Composite test scores of 14 points or less out of maximally 21 points were identified to be associated with an increased injury risk (14). For maximal predictive power, an FMS score equal or less than 14 points combined with a history of previous injury provided the greatest indicator of future injury risk in several sports, e.g. female football, male or female rugby, and swimming/diving (9). But – providing conflicting evidence – these positive experiences could not be confirmed in all fields of sports, e.g. (ice) hockey (4).

For the European professional football, first experiences were published in 2012 as a conference paper, only (19). Seeking for high-level papers, McCall and collaborates (16) found no articles providing the FMS to be able to identify professional male football players at injury risk. For amateur male football players, findings are still lacking. Apart from the composite score, recently published findings revealed injury specific differences in single FMS items in Hungarian elite male football players (22).

This paper aimed at assessing FMS composite and single item scores to analyse correlations with injury incidences in amateur male football players.

Methods

Study Design

This investigation was conducted as an observational study in the football season 2013/14. Prior to the monitoring of exposure and occurring injuries, a functional diagnosis tool (FMS) was used to assess probably disturbed coordination patterns.

Subjects

As inclusion criterion, all observed teams should belong to the fifth and sixth division organised in the Deutscher Fußball-Bund (DFB), which included the amateur state of all participating male football players. Teams had to have 2-3 training units per week. Managers and players were informed about study goals, diagnostic tools, and monitoring details and agreed to participate.

The investigation started with 10 teams including 221 players. Due to a drop-out of 56% (n=125), only 96 male players (age: 23.7 ±3.5 years; height: 1.82 ±0.07 m; weight: 79.9 ±7.7 kg) could be included and monitored completely (Fig. 2).

FMS-Screening Tool

The FMS (Functional Movement Systems Inc., Chatham, VA, USA) was created as a field test tool with minimal needs of equipment to test coordination, trunk stability and flexibility in seven tasks related to frequently observed neuromuscular problems associated with the risk of injury (14): Deep Squat, Hurdle Step, Inline Lunge, Active Straight Leg Raise (ASLR), Shoulder Mobility, Trunk Stability Push-Up (TSP), and Rotary Stability (Fig. 1).

Every task could achieve maximally 3 points in case of an excellent execution, 2 points showing minor deficits, 1 point for a poor execution, and no point, if pain was reported. Reliability for the total score (ICC=0.92) was evaluated earlier (17). In early studies, Kiesel and colleagues (14) reported sensitivity (54%) and specificity (91%) coefficients promoting validity for injury risk prediction abilities for a cut-off FMS composite score of 14 points in the field of College Football players; more than 14 points were called a 'good pattern', 14 points or less a 'poor pattern', respectively. However, later investigations could not confirm validity of this cut-off point (1, 4). Furthermore, internal consistency for the seven tasks was found to be poor (Cronbach's alpha=0.58), and the seven items loaded on more than one factor explaining only 47.3% of the total variance (15).

Examiners in the present study were skilled, well experienced and certified to distinguish correct from poor executions (16). Pre-injury clearing and the FMS testing took place directly before the observation period.

Monitoring

The observation interval was covering ten weeks – two weeks off-season just before the start of season (July 2013) and eight weeks from season start to the end of September.

The assessment protocol collected injuries (counts) and times of presence and absence of all players during the observation period separately for training (rounded for 30 minutes' increments) and competition (rounded for 5 minutes' increments). Injury incidence was calculated as the ratio of the exposure time divided by the number of injuries, and then transformed into counts per 1,000 hours.

An injury was counted, if training or competition had to be quitted for the actual day and a following time-loss of at least three days. Due to the regular training frequency of two or three units per week, a shorter time-loss was not noted. Injury was defined as non-contact injuries of the lower limb (muscles, tendons, bones, and joints) including the hip and the groin without superficial skin lesions. 'Paper and pencil' documentation was executed by assistant coaches. Collected data were transferred monthly to the study conductors.

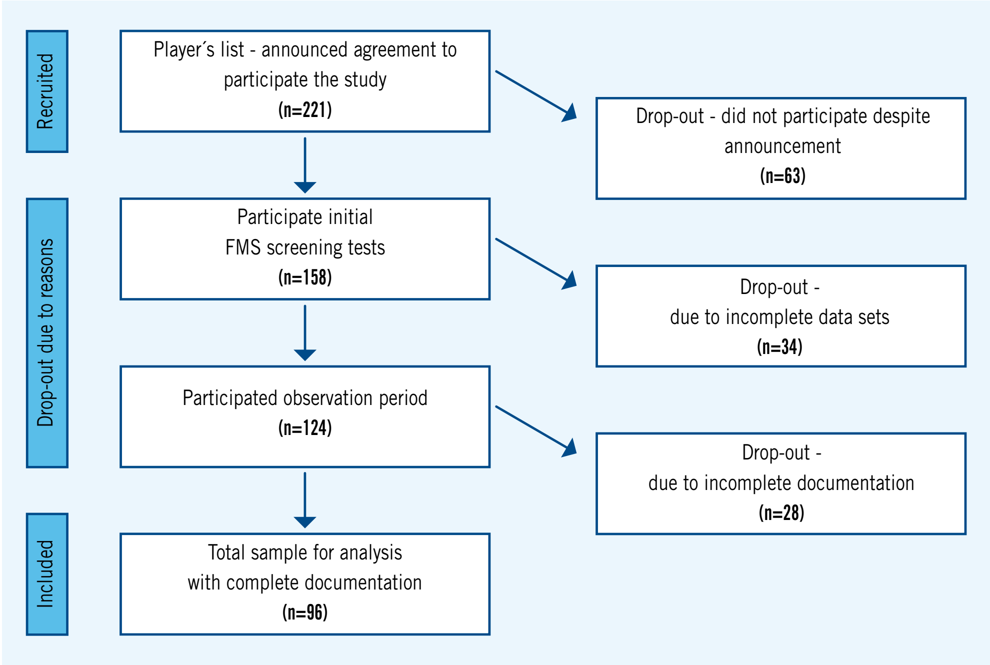

Figure 2
Drop-out rate and causes.

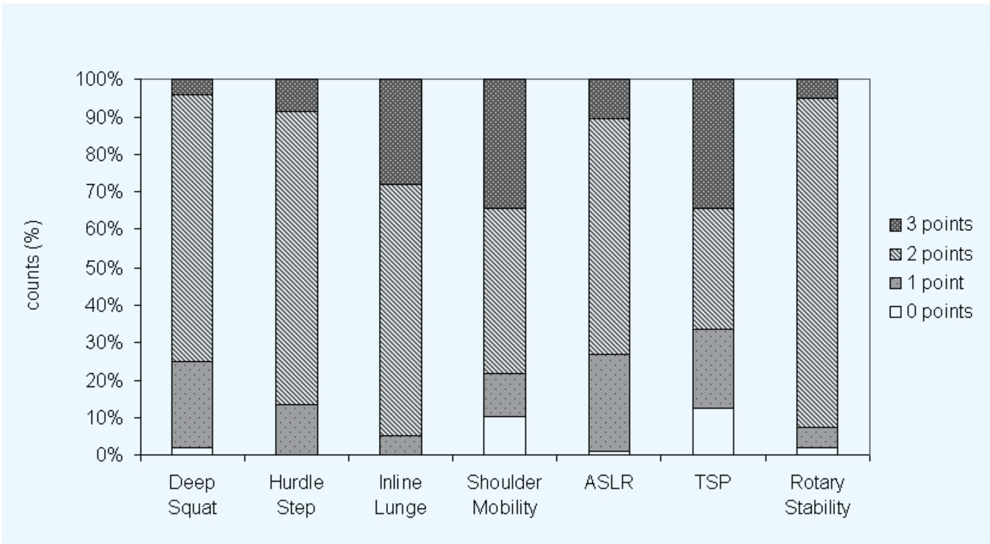

Figure 3
Relative frequencies of ratings (0-1, 2, 3 points) for the seven FMS items. ASLR=Active Straight Leg Rising, TSP=Trunk Stability Push-Up.

Statistics

Cases of injury were assessed as frequencies. The FMS score values were treated as scaled data (mean ±SD). The point biserial correlation (rpbis) was calculated to analyse associations between injury and FMS scores. Differences between samples – injured vs. uninjured players and dropped-out vs. remaining players – were tested by means of the non-parametric Mann/Whitney U-test. Significance was accepted at a level of p≤0.05.

Results

Starting with 221 players, there was a drop-out of 56% in total (Fig. 2). 63 players dropped out, partly explained by the general pre-season situation, where players change to other teams or clubs. 158 persons participated at the start-up FMS-screening. 34 players dropped-out due to communication problems between coaches, teams, assistant coaches and study conductors. Additionally, the documentation of exposure time and injuries was incomplete for some players (n=28).

With respect to following analyses, we analysed FMS scores of the dropped-out (total score 13.7±2.3pts., n=63) and the remaining players (total score 13.6±2.1pts., n=96), but did not find any significant differences (p>.05) (Tab. 1).

Within the remaining sample, distribution of execution quality most frequently showed the 2-point execution rating for almost all items except for the 'Trunk Stability Push-Up' (TSP) and the 'Shoulder Mobility' test (Fig. 3).

A frequency analysis revealed a 'good pattern' FMS result for 36% (35 out of 96 players), while 64% (61 out of 96) showed a 'poor pattern' total score relative to a cut-off value of ≤14 points.

The documentation revealed a total exposure time of 1,770 hours covering 289 competition hours and 1.481 training hours. Accordingly, we noted 10 injuries (4x groin, 4x adductor muscles, 1x calf muscles, and 1x ankle sprain), but none of them happening during competition. Injury incidence was ›

Table 1

FMS results for dropped-out players and the remaining sample being monitored after drop-out, the comparison of uninjured and injured players (mean±SD) within this sample, and the point biserial correlation (rpbis)between injury state and FMS scores. *=significant correlation coefficient (p≤0.05); ASLR=Active Straight Leg Rising, TSP=Trunk Stability Push-Up, rpbis=point biserial correlation, #=meaning players FMS-tested prior to observation interval and dropped out afterwards for reasons, ##=meaning players with FMS remaining after drop-out being observed completely and analyzed for injury incidence.

	TOTAL SCORE	DEEP SQUAT	HURDLE STEP	INLINE LUNGE	SHOULDER MOBILITY	ASLR	TSP	ROTARY STABILITY
Dropped-out #	13.7	1.9	2.0	2.2	2.1	1.8	1.9	2.0
(n=63)	±2.5	±0.6	±0.5	±0.7	±1.0	±0.7	±1.0	±0.4
Not dropped-out ##	13.6	1.8	1.9	2.2	2.0	1.8	1.9	2.0
(n=96)	±2.1	±0.6	±0.5	±0.5	±0.9	±0.6	±1.0	±0.4
Z (U-test)	-0.503	-1.940	-0.843	-0.643	-1.041	-0.436	-0.390	-0.231
p (U-test)	0.615	0.052	0.399	0.520	0.298	0.663	0.697	0.817
Uninjured	13.7	1.8	2.0	2.2	2.1	1.8	1.9	2.0
(n=88)	±2.0	±0.6	±0.5	±0.5	±0.9	±0.6	±1.0	±0.5
Injured	13.0	2.0	1.6	2.4	1.6	1.9	1.5	2.0
(n=8)	±2.4	±0.0	±0.5	±0.5	±1.1	±0.6	±1.2	±0.0
Z (U-test)	-0.890	-1.333	-2.059	-0.779	-1.270	-0.216	-1.026	-0.185
p (U-test)	0.373	0.182	0.040	0.436	0.204	0.829	0.305	0.853
r_{pbis}	0.093	0.126	0.209*	0.083	0.128	0.026	0.114	0.029
p (r_{pbis})	0.367	0.222	0.041	0.422	0.215	0.804	0.269	0.778

calculated as 5.6 injuries per 1,000 hours, if referring to the total exposure time (competition and training). But referring exclusively to training exposure time, we found 6.8 injuries per 1,000 hours.

As one player suffered from three injuries (groin and adductor muscles), there were only eight injured persons being compared to 88 uninjured players. Uninjured players were better in the 'Hurdle Step' task than injured players (uninjured 2.0±0.5 points vs. injured 1.6±0.5 points; Z=-2.059, p=0.040). Accordingly, the correlation between injury state and the FMS Hurdle Step results was significant (rpbis=0.209, p=0.041). Apart from this, there were neither significant differences nor correlations in any other FMS result (Tab.1).

Discussion

We found no association between the FMS composite score and the injury state (rpbis=0.093, p=0.367), but a significant correlation for the 'Hurdle Step' task (rpbis=0.209; p=0.041), although uninjured and injured players differed merely (0.4 points) (Tab. 1), what was in line with recently published studies concluding that single FMS items could be helpful for injury prediction rather than the composite score (2, 15).

The 'Hurdle Step' task was found to be associated specifically with ankle injuries in elite-level male professional football players (22). An association, we cannot confirm in our study, where only one out of ten injuries concerned the ankle joint.

Previous studies in the field of amateur and professional football players covering one or more complete football seasons reported injury incidents during training varying from 4.1 to 11.2 injuries per 1,000 hours (6, 18). As all ten counts of injuries in the present study were noted exclusively for the training exposure time, the resulting injury incidence of 6.8 injuries per 1,000 training hours appeared to be comparable, although we observed ten weeks only and used a differing injury definition and documentation protocol. We cannot explain why there was no injury noted for competition hours in our study. In general, injury incidence is known to be higher during competition (27.5 to 44.6 injuries per 1,000 h) compared to training hours (6, 18).

The present results of the FMS composite score (13.6±2.1 points) as well as the ratio of 'poor' (64%) and 'good' (36%) pattern players merely differed from those of elite male football professionals (14.3±2.2 points, 'poor pattern' 60%, 'good pattern' 40%) (19). Composite score means of amateur and elite players were close to the 14 points cut-off value, and were lower than those assessed for healthy but untrained people (14.1±2.9 points to 15.7±1.9 points) (1). But in general, methodological weaknesses of the FMS screening tool emphasized by Frost and colleagues should be considered (8). The test scale resolution of only 4 stages ranging from 0 to 3 points, which were leading to some ambiguous reliability coefficients in single test items (17), might offer statistical weaknesses. Beardsley and Contreras concluded: "The FMS seems to have some degree of predictive ability for identifying athletes who are at an increased risk for injury. However, a poor score on the FMS does not preclude athletes from competing at the highest level. Nor does it differentiate between athletes of differing abilities" (1). They found a lacking validity in several respects. Using the cut-off of 14 points may mislead up to 38% of people to false injury risk information (1). Injury history should be taken into account as a reasonable confounder affecting FMS scores (2, 9).

Limitations

In fact, our results are limited due to the drop-out rate of more than fifty percent leading to a remaining sample size of 96 players and the uncertainty about probable injuries within the group of the dropped-out players. Obviously, the motivation was high in the beginning, but comparable to earlier investigations, compliance and adherence were fading away in the time course of monitoring (20, 21). Furthermore, the chosen definition of injury, the according time loss and the documentation setting affected our results for injury incidences providing problems for comparisons with other investigations (13). Probably, ceiling effects also affected our FMS results, when all players of a complete team had to be judged one after the other, although testers were certified and experienced.

Conclusion

Even if taking into account some experimental limitations, we conclude that the FMS does not allow a valid injury prediction in the field of amateur male football players.

With respect to experiences with different kinds of sports and confounding pre-injury effects, a fixed cut-off criterion of 14 points or less indicating increased injury risk is problematic. "More attention should be paid to the score of each task rather than the sum score when we interpret the functional movement screen scores" (15).

Conflict of Interest

The authors have no conflict of interest.

Remark

FMS is a registred trademark of Gray Cook (FunctionalMovement.com).

References

(1) **BEARDSLEY C, CONTRERAS B.** The Functional Movement Screen: a review. Strength Condit J. 2014; 36: 72-80. doi:10.1519/SSC.0000000000000074

(2) **CHIMERA NJ, SMITH CA, WARREN M.** Injury history, sex, and performance on the Functional Movement Screen and Y Balance Test. J Athl Train. 2015; 50: 475-485. doi:10.4085/1062-6050-49.6.02

(3) **DALLINGA JM, BENJAMINSE A, LEMMINK KA.** Which Screening Tools can predict injury to the lower extremities in team sports? A systematic Review. Sports Med. 2012; 42: 791-815. doi:10.1007/BF03262295

(4) **DOSSA K, CASHMAN G, HOWITT S, WEST B, MURRAY N.** Can injury in major junior hockey players be predicted by a pre-season functional movement screen – a prospective cohort study. J Can Chiropr Assoc. 2014; 58: 421-427.

(5) **DVORAK J, JUNGE A, CHOMIAK J, GRAF-BAUMANN T, PETERSON L, RÖSCH D, HODGSON R.** Risk factor analysis for injuries in Football players. Possibilities for a prevention program. Am J Sports Med. 2000; 28: 69-74.

(6) **EKSTRAND J, HÄGGLUND M, WALDÉN M.** Injury incidence and injury patterns in professional football: the UEFA injury study. Br J Sports Med. 2011; 45: 553-558. doi:10.1136/bjsm.2009.060582

(7) **ENGEBRETSEN AH, MYKLEBUST G, HOLME I, ENGEBRETSEN L, BAHR R.** Intrinsic risk factors for hamstring injuries among male soccer players: a prospective cohort study. Am J Sports Med. 2010; 38: 1147-1153. doi:10.1177/0363546509358381

(8) **FROST DM, BEACH TAC, CALLAGHAN JP, MCGILL S.** Using the Functional Movement Screen (TM) to evaluate the effectiveness of training. J Strength Cond Res. 2012; 26: 1620-1630.

(9) **GARRISON M, WESTRICK R, JOHNSON MR, BENENSON J.** Association between the Functional Movement Screen and injury development in college athletes. Int J Sports Phys Ther. 2015; 10: 21-28.

(10) **GRIBBLE PA, HERTEL J, DENEGAR CR, BUCKLEY WE.** The effects of fatigue and chronic ankle instability on dynamic postural control. J Athl Train. 2004; 39: 321-329.

(11) **HÄGGLUND M, WALDÉN M, EKSTRAND J.** Previous injury as a risk factor for injuries in elite football: a prospective study over two consecutive seasons. Br J Sports Med. 2006; 40: 767-772. doi:10.1136/bjsm.2006.026609

(12) **HÄGGLUND M, WALDÉN M, EKSTRAND J.** Risk factors for lower extremity muscle injury in professional soccer: the UEFA Injury Study. Am J Sports Med. 2013; 41: 327-335. doi:10.1177/0363546512470634

(13) **JUNGE A, DVORAK J.** Influence of definition and data collection on the incidence of injuries in Football. Am J Sports Med. 2000; 28: S40-S46.

(14) **KIESEL K, PLISKY PJ, VOIGHT ML.** Can serious injury in professional football be predicted by a preseason functional movement screen?. N Am J Sports Phys Ther. 2007; 2: 147-158.

(15) **LI Y, WANG X, CHEN X, DAI B.** Exploratory factor analysis of the functional movement screen in elite athletes. J Sports Sci. 2015; 33: 1166-1172. doi:10.1080/02640414.2014.986505

(16) **MCCALL A, CARLING C, DAVISON M, NEDELEC M, LE GALL F, BERTHOIN S, DUPONT G.** Injury risk factors, screening tests and preventative strategies: a systematic review of the evidence that underpins the perception and practices of 44 football (soccer) teams from various premier leagues. Br J Sports Med. 2015; 0: 1-8. doi:10.1136/bjsports-2014-094104.

(17) **ONATE JA, DEWEY T, KOLLOCK RO, THOMAS KS, VAN LUNEN BL, DEMAIO M, RINGLEB SI.** Real-time intersession and interrater reliability of the Functional Movement Screen. J Strength Cond Res. 2012; 26: 408-415. doi:10.1519/JSC.0b013e318220e6fa

(18) **PETERSON L, JUNGE A, CHOMIAK J, GRAF-BAUMANN T, DVORAK J.** Incidence of Football injuries and complaints in different age groups and skill-level groups. Am J Sports Med. 2000; 28: S51-S57.

(19) **SCHMIDTLEIN O, KELLER M, KURZ E.** Asymmetric FMS patterns in Germany's Bundesliga soccer players. Poster session presented at: 3rd World Conference on Science and Soccer; May 15-15, 2012; Ghent, Belgium.

(20) **SOLIGARD T, NILSTAD A, STEFFEN K, MYKLEBUST G, HOLME I, DVORAK J, BAHR R, ANDERSEN TE.** Compliance with a comprehensive warm-up programme to prevent injuries in youth football. Br J Sports Med. 2010; 44: 787-793. doi:10.1136/bjsm.2009.070672

(21) **STEFFEN K, MEEUWISSE WH, ROMITI M, KANG J, MCKAY C, BIZZINI M, DVORAK J, FINCH C, MYKLEBUST G, EMERY CA.** Evaluation of how different implementation strategies of an injury prevention programme (FIFA 11+) impact team adherence and injury risk in Canadian female youth football players: a cluster-randomised trial. Br J Sports Med. 2013; 47: 480-487. doi:10.1136/bjsports-2012-091887

(22) **ZALAI D, PANICS G, BOBAK P, CSAKI I, HAMAR P.** Quality of functional movement patterns and injury examination in elite-level male professional football players. Acta Physiol Hung. 2015; 102: 34-42. doi:10.1556/APhysiol.101.2014.010