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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

Introduction

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

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

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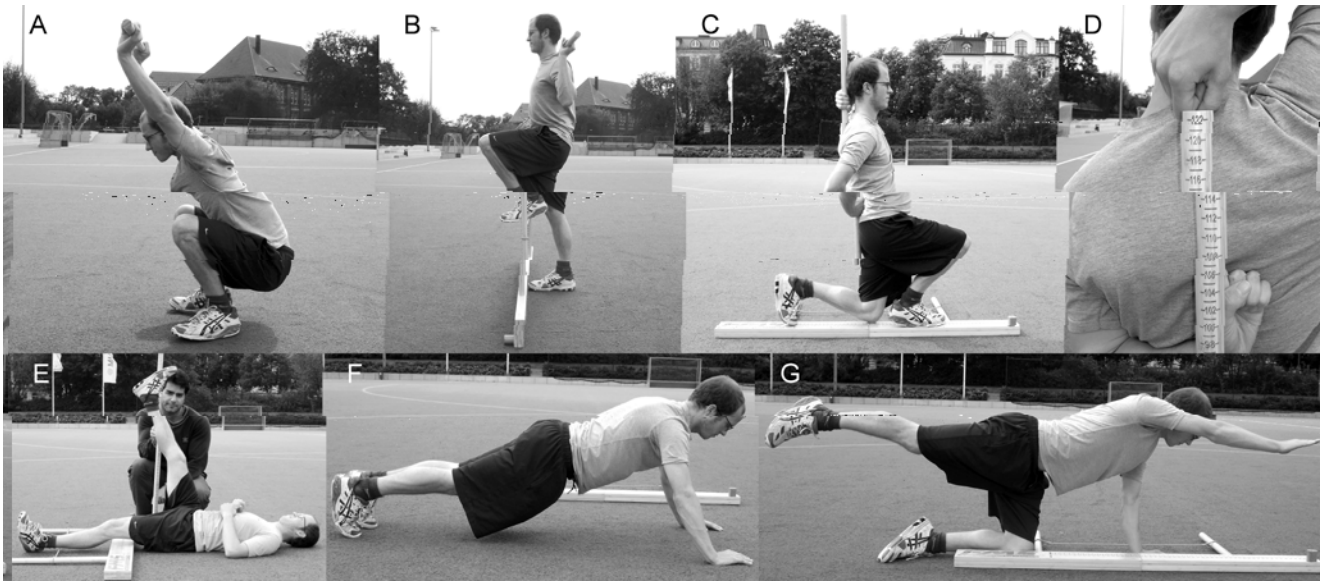

Figure 1

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 eld of physiotherapists aiming at identifying disturbed coordination patterns based on single items execution de cits, it was evaluated in the eld 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 identi ed 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 con icting evidence – these positive experiences could not be con rmed in all elds of sports, e.g. (ice) hockey (4).

For the European professional football, rst 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, ndings are still lacking. Apart from the composite score, recently published ndings revealed injury speci c differences in single FMS items in Hungarian elite male football players (22).

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

Methods

Study Design

is 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 fth 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.

e 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

e FMS (Functional Movement Systems Inc., Chatham, VA, USA) was created as a eld test tool with minimal needs of equipment to test coordination, trunk stability and exibility 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 de cits, 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 speci city (91%) coe cients promoting validity for injury risk prediction abilities for a cut-o FMS composite score of 14 points in the eld 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 con rm validity of this cut-o 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 certi ed to distinguish correct from poor executions (16). Pre-injury clearing and the FMS testing took place directly before the observation period.

Monitoring

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

e 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 de ned as non-contact injuries of the lower limb (muscles, tendons, bones, and joints) including the hip and the groin without super cial skin lesions. 'Paper and pencil' documentation was executed by assistant coaches. Collected data were transferred monthly to the study conductors.

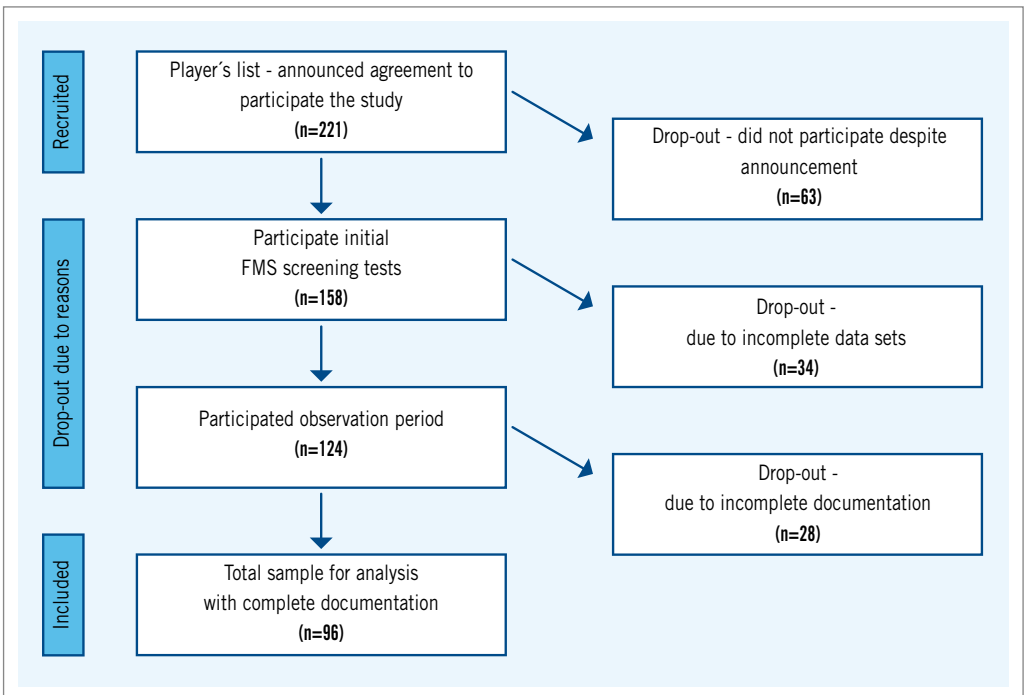

Figure 2

Drop-out rate and causes.

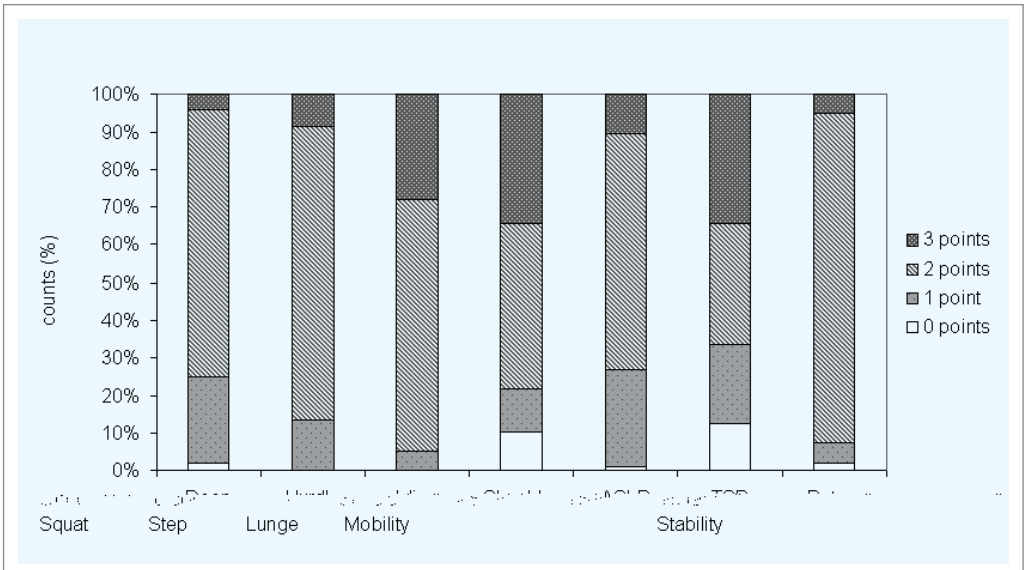

Figure 3

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. e FMS score values were treated as scaled data (mean ±SD). e point biserial correlation (rpbis) was calculated to analyse associations between injury and FMS scores. Di erences between samples – injured vs. uninjured players and dropped-out vs. remaining players – were tested by means of the non-parametric Mann/Whitney U-test. Signi cance was accepted at a level of $p \leq 0.05$.

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 nd any signi cant di erences ($p>.05$) (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-o value of ≤14 points.

e 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 su ered 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 signi cant (rpbis=0.209, p=0.041). Apart from this, there were neither signi cant di erences 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 signi cant correlation for the 'Hurdle Step' task (rpbis=0.209; p=0.041), although uninjured and injured players di ered 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).

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

Previous studies in the eld 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 di ering injury de nition 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).

e 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 di ered 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-o 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). e test scale resolution of only 4 stages ranging from 0 to 3 points, which were leading to some ambiguous reliability coe cients in single test items (17), might o er statistical weaknesses. Beardsley and Contreras concluded: " e 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 di erentiate between athletes of di ering abilities" (1). ey found a lacking validity in several respects. Using the cut-o 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 a ecting FMS scores (2, 9).

Limitations

In fact, our results are limited due to the drop-out rate of more than fty 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 de nition of injury, the according time loss and the documentation setting a ected our results for injury incidences providing problems for comparisons with other investigations (13). Probably, ceiling e ects also a ected our FMS results, when all players of a complete team had to be judged one after the other, although testers were certi ed 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 eld of amateur male football players.

With respect to experiences with di erent kinds of sports and confounding pre-injury e ects, a xed cut-o 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).

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