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ORIGINAL ARTICLE

The 9+ screening test score does not predict injuries in elite floorball players

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We aimed to examine whether the 9+ screening test score could predict injuries in elite floorball players. Eighty-four elite floorball players participated in the study. At baseline, two physiotherapists assessed the participants using the 9+ screening test. The test score reflects strength, stability, mobility, and functional movement pattern with an emphasis on the lower body and core. Injuries that occurred the following season (2013/2014) were recorded by medical staff, coaches, and/or self-reported by the players. Overall, there was no relationship between the 9+ screening test score and injury risk (OR = 0.96 per SD lower test score, $P = .84$). We, therefore, conclude that the 9+ screening test is not suited for overall injury risk prediction in elite floorball players. Whether the test may be used to predict risk of certain injury types more strongly related to inadequate mobility and strength (eg, muscle ruptures or strains) warrants further investigation.

KEYWORDS
floorball, functional movement, screening test, team sports

1 | INTRODUCTION

Floorball was founded and developed in Sweden, and Sweden remains the nation with the largest number of players (about 116 000 licensed players),[1] followed by Finland (about 65 000 licensed players).[2] Floorball is a fast-paced sport with many quick turns; it, thus, places a large amount of strain on players' muscles and joints, and contusions are common due to accidental body contact during play.[3] Injury rates have been reported at 21 per 1000 game hours in top level international tournaments[3] and 27 per 1000 game hours in junior leagues,[4] whereas there is less risk associated with pre-season activities and training.[4–7] Several studies report a female predominance in total injury rate,[4,5,8,9] seemingly due to an overrepresentation of particularly knee and ankle injuries.[4–6,10] Both acute and overuse injuries are prevalent and constitute, for example, muscle strains, ankle sprains, contusions and eye injuries.[3–5,9–12] As may be expected, floorball players sustain more injuries than age-matched controls,[10] and rank number 13 in acute injury incidence among 35 popular sports in Sweden.[8] The financial cost of these injuries are sometimes significant,[13] but prevention is primarily warranted to avoid suffering, decline in individual and team performance, and involuntary absence from play.

The most effective injury prevention is likely to be achieved from a multi-angled approach, where among others, protective equipment (such as protective eyewear or ankle support), stricter rule enforcement, fair play initiatives,

and neuromuscular control programs may produce additive results.[9]

The present study build on the neuromuscular control aspect, where weaknesses such as reduced strength, balance, or non-functional movement patterns may contribute to risk of acute injuries.[14,15] Further aspects, such as decreased range of motion, anatomical asymmetries, and a lack of good core stability might also predispose for overuse injuries.[16,17] Testing for neuromuscular control, range of motion, asymmetries, and core stability may therefore potentially enable identification of injury-prone players. By assessing factors such as asymmetries or functional movement patterns, several screening tests have been developed for this purpose.[18–20] However, none of these tests have been validated in the floorball setting, and only one instrument, the functional movement screen (FMS), seems to have good inter- and intra-rater reliability.[21,22]

Investigators of a study in soccer, volleyball, and basketball players suggested injury-prone players may be identified by the FMS, thereby enabling early preventive measures.[23] In relation to the FMS, the 9+ screening test includes additional lower body exercises, theoretically making it more relevant to use in the floorball context. The previous version, 9 test screening test, has been found to have good inter- and intra-rater reliability.[24] Validations studies for the newer 9+ test are scarce,[25] and validation outcomes are likely to be sport specific.

The purpose of this study was to examine whether injuries in elite floorball players, occurring during the following season, could be predicted by 9+ screening test scores. Our primary hypothesis was that the total injury frequency would be greater among players with low 9+ test scores. If confirmed, this would enable targeted prevention in individuals with elevated injury risk.

2 | MATERIALS AND METHODS

2.1 | Subjects

Initially, 94 players (54 males, 40 females) from five elite floorball teams (three teams playing in the Swedish Super League (SSL) and two teams from the National Floorball High School (NFHS) participated voluntarily in the study. All teams were playing in two highest floorball series in Sweden and most of the NFHS players were also part of the junior national team. Players who were injured during baseline testing period (n = 5) or were unable to complete injury registration (n = 3) were excluded. Two players asked to be excluded for personal reasons. The final sample thus comprised 84 players (47 males and 37 females). Sixty-one were recruited from the SSL-teams and 23 were recruited from the NFHS. Physical characteristics of the players are shown in Table 1. Before participation, the players were informed of potential pros and cons of the investigation and all signed an institutionally approved informed consent document. For players under the age of 18, a parental or guardian signed consent was obtained. The study was approved by the Regional Ethical Review Board in Umeå and was conducted in accordance with ethical principles of the Declaration of Helsinki.

2.2 | Procedures

Within one month of the first games of the 2013/2014 season, all players were assessed by one of two physiotherapists using the 9+ screening test, which consists of 11 exercises: squat, one-legged squat, Norwegian one-legged squat, in line lunge active hip flexion, straight leg raise, push-up, diagonal lift, seated rotation, functional shoulder mobility, and drop jump. On each of exercises, the players will get one to three points depending on movement quality. To get three points, the movement should be almost perfect according to the manual; to get two points, the player should perform the exercise with only a small amount of compensatory movements. One point is given, if the player is unable to perform the exercise or performs the exercise with large compensatory movements. Players who experience pain during a test will get zero points on that test. The 9+ screening test also includes three additional exercises: the modified Thomas test, back extension, and the apprehension test. Two of them do not affect the total score while a positive apprehension test gives zero points on the shoulder mobility test regardless of the initial result on the test. The maximum score for the whole test battery is 33 points. A detailed description of the individual test elements may be found as Supplementary material.

TABLE 1 Baseline characteristics of the study participants

Characteristic	All players (n = 84)	Males (n = 47)	Females (n = 37)
Mean age, years (range)	21.0 ± 4.2 (16-33)	22.0 ± 4.6 (16-33)	19.8 ± 3.1 (16-27)
Height (cm), SD	175.1 ± 9.1	180.5 ± 6.8	168.2 ± 6.6
Weight (kg), SD	69.9 ± 10.4	75.3 ± 8.6	63.1 ± 8.4
9+ screening score, SD (range)	21.5 ± 3.2 (14-30)	20.7 ± 3.0 (14-27)	22.2 ± 3.1 (14-30)

The two physiotherapists who evaluated the tests both had experience in physiotherapy, sports medicine, and in working with floorball players. Before study start, they completed a standardized training course learning how to perform and evaluate the 9+ screening test. After the course, their scoring was found to have good intra- and interrater reliability.

Injuries during the same season were registered by medical staff and/or coaches and self-reported by players. For this study, an injury was defined as one that prohibited a player from participating in or completing a practice or a game. A participating physiotherapist obtained information from the team coach or medical staff when a participating player was injured using the Textalk web survey program.[26] For every injury, the physiotherapist sent a standard self-reported injury card to the injured player by e-mail. The injury card was based on a similar card used by the Union of European Football Associations Champions League[27] with the questions modified to be suitable for floorball.

Injuries were grouped based on diagnosis (ligament injury/sprain, muscle rupture/strain, contusion injury, unspecified overuse injury, luxation/subluxation, fracture, meniscus injury, concussion, compartment injury, plica syndrome, and testicular torsion) and were recorded as either traumatic or caused by overuse.

2.3 | Statistical analysis

The 9+ test is intended to be applicable to both males and females and all participants were therefore analyzed as one group. Data were analyzed using SPSS software (version 21.0 for Windows; IBM Corporation). The independent-sample *t*-test was used to compare means in the baseline characteristics between injured and uninjured players. The relationship between 9+ test scores and prospective injuries was assessed using bivariate logistic regression. The test scores were approximately normally distributed and odds ratios (OR) are presented per standard deviation (SD, ie, 3.2 points) lower test score. A $P < .05$ was considered statistically significant.

3 | RESULTS

During the 2013/2014 season, 45 of the 84 (54%) participating players were injured at least once. The most common injuries were traumatic muscle ruptures/sprains and ligament injuries/strains. Knees and ankles/feet were the most commonly injured body parts. Frequency of the various injuries is presented in Figure 1. There were no statistical differences in physical characteristics when comparing players with and without prospective injuries ($P > .05$ for age, sex, height, and weight). There was no difference in baseline 9+ test scores in players who later sustained injuries compared to those who remained injury- free (OR = 0.96, $P = .84$, mean score 21.5 for both groups).

The total points in 9+ screening test for all study participants are shown in Figure 2. Players who sustained muscle ruptures or strains (n = 8) had a tendency toward lower 9+ screening scores than the rest of the study cohort (OR = 2.23, $P = .06$, mean score 19.4 compared to 21.7), whereas the other types of injuries (Figure 1) were not associated with the 9+ test score. The 9+ score did not predict traumatic injuries (OR = 1.01, $P = .97$), but a tendency toward lower test scores in subjects who sustained overuse injuries was noted (OR = 1.78, $P = .09$, mean score 20.0 versus 21.7).

Most injuries affected the lower limbs, but the total score of the 5 tests elements reflecting lower body characteristics, did, similar to the total 9+ test score, not predict total injury risk (OR = 1.17, $P = .50$).

4 | DISCUSSION

We hypothesized that the 9+ screening battery could distinguish injury-prone and non-injury-prone floorball players. However, we did not find support for our hypotheses as there were no differences in test scores between prospectively injured and uninjured players. These findings are in line with a recent study in male soccer players, in which the authors found no relation between +9 test score and future injuries.[25]

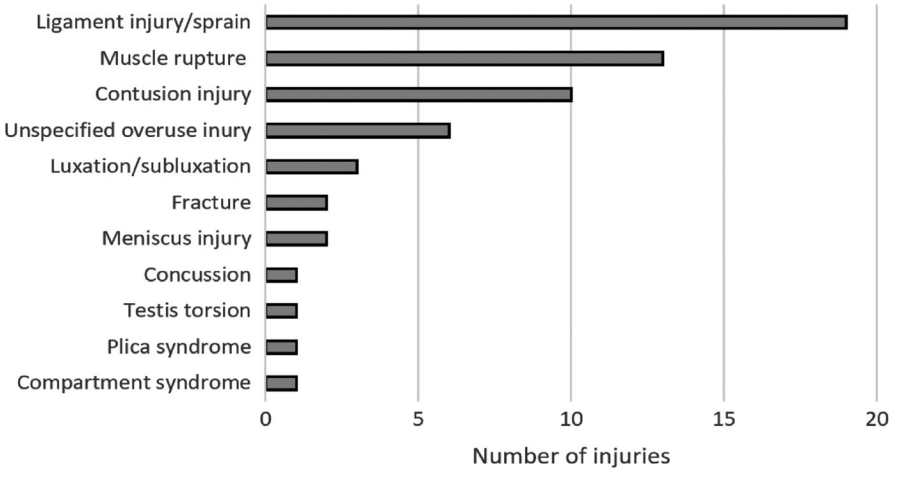

FIGURE 1 Frequency of injuries among study participants during the season of 2013/2014

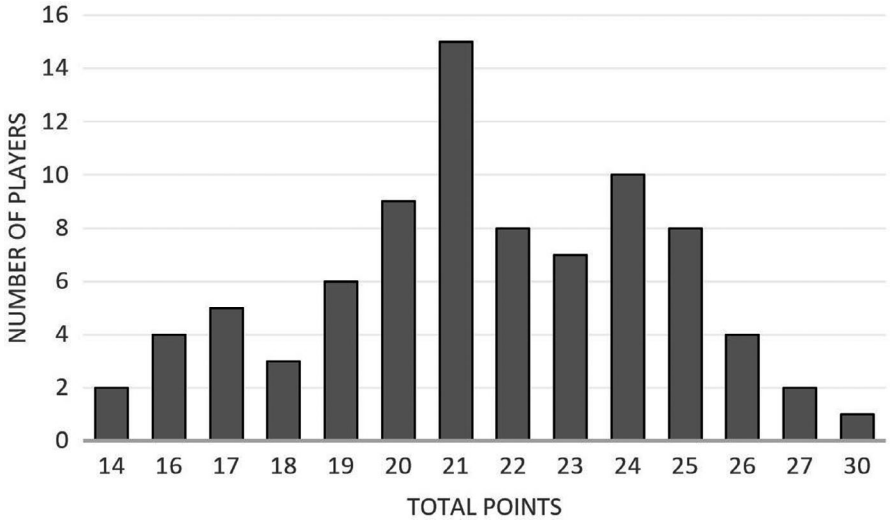

FIGURE 2 Total points in 9+ screening test for all study participants

The 11 exercises of the 9+ screening battery aim to reflect strength, stability, mobility, and functional movement pattern with an emphasis on the lower body and core. A majority of the 84 participating players were injured during the follow-up period, and as in previous studies,[3-7] most of them sustained lower extremity injuries. Neither the total 9+ screening test scores nor the scores from the lower body test elements predicted overall injury risk. It is possible that there simply is no link between the underlying qualities that the 9+ screening test measures and injury risk. It could also be that the test score is only relevant to certain types of injuries (in particular strains and overuse injuries). In this study cohort, a large part of the sustained of injuries were traumatic. As a substantial part of acute injuries are sustained during close contact encounters,[3] they may be more closely related to an aggressive mindset[28] or possibly chance rather than functional physical characteristics.

In secondary analyzes, players who sustained muscle ruptures or strains had a tendency toward lower 9+ test scores at baseline. This could be a chance finding but could also indicate that players who have inadequate mobility, stability, or neuromuscular control, reduced strength/balance, or non-functional movement patterns may be at an increased risk of these injury types.[14,15] This would be in line with previous studies showing that inadequate neuromuscular control or a non-functional movement pattern may contribute to acute injuries and that decreased range of motion, anatomical asymmetries, reduced neuromuscular control, and a lack of good core stability may increase the risk of overuse injuries.[16,17] However, as this was not a pre-specified hypotheses, and only one out of several secondary analyses, the relationship between 9+ test scores and muscle ruptures and strains would need verification in a separate cohort before definitive conclusions can be drawn.

This study has several limitations. The small samples of female (n = 37) and male (n = 47) floorball players hindered separate analyses by sex. We can, therefore, not assess whether the test would be better suited for male or female players. In addition, the study included only high level floorball players, and the results may not be generalizable to floorball players at lower levels, or to athletes in other sports.

The 9+ test score was only measured at baseline and the test score may vary over time.[29] Inability to capture test score variance through repeated measurement may have attenuated a potential relation to prospective injuries.

Total training and game time is likely to affect total injury frequency and was not measured in the present study. A low total time exposure may weaken statistical power; however, we saw no indications that the season of follow-up differed from other seasons with regard to overall practice and game time. Notably, individual variance in training and game time shouldn´t confound the relationship between 9+ test score and injuries, as prospective time of exposure do not influence the a priori +9 test score.

5 | CONCLUSION

Successful injury prevention reduces players´ suffering, improves results, and is likely to economically beneficial for floorball clubs. A valid and reliable screening test would make the work of teams' medical staff more effective. Sadly, findings from this study do not support the use of the 9+ screening test as a mean of overall injury prediction. Whether certain types of injuries may be predicted by the test warrants further investigation.

6 | PERSPECTIVES

Targeting specific prevention to high injury risk individuals may improve team and individual overall performance. Identifying these individuals requires reliable and valid risk estimations tools which are likely to be sport specific. In this study, the

pre-season 9+ screening test score failed to discriminate injury-prone elite floorball players, and the test should consequently not be used for such purposes. Regrettably, a valid injury prediction test for floorball players is still lacking.

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CONFLICT OF INTEREST

The authors report no conflicts of interest.

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REFERENCES

1. Federation SF. 2019. https://www.innebandy.se/om-svensk-innebandy/i-dag-och-i-framtiden/licenser-foreningar-2019/
2. Federation FF. 2019. https://salibandy.fi/salibandy-info/lajiesittely/tunnusluvut/
3. Pasanen K, Bruun M, Vasankari T, Nurminen M, Frey WO. Injuries during the international floorball tournaments from 2012 to 2015. *BMJ Open Sport Exerc Med*. 2016;2(1):e000217.
4. Pasanen K, Hietamo J, Vasankari T, et al. Acute injuries in finnish junior floorball league players. *J Sci Med Sport*. 2018;21(3):268-273.
5. Tranaeus U, Gotesson E, Werner S. Injury profile in Swedish elite floorball. *Sports Health*. 2016;8(3):224-229.
6. Pasanen K, Parkkari J, Kannus P, et al. Injury risk in female floorball: a prospective one-season follow-up. *Scand J Med Sci Sports*. 2008;18(1):49-54.
7. Engel J, Kälin M, Rogan S. Verletzungen im Unihockey – Eine Fragebogenerhebung bei Schweizer-Nationalliga-A-Unihockey-Spielern. *Sportverletz Sportschaden*. 2019;33(01):36-42.
8. Aman M, Forssblad M, Henriksson-Larsen K. Incidence and severity of reported acute sports injuries in 35 sports using insurance registry data. *Scand J Med Sci Sports*. 2016;26(4):451-462.
9. Aman M, Forssblad M, Larsen K. National injury prevention measures in team sports should focus on knee, head, and severe upper limb injuries. *Knee Surg Sports Traumatol Arthrosc*. 2019;27(3):1000-1008.
10. Tervo T, Nyström H, Nordström A. Injuries in Swedish floorball players: a nationwide matched cohort study. *Cogent Medicine*. 2019;6:1-9
11. Bro T, Ghosh F. Floorball-related eye injuries: the impact of protective eyewear. *Scand J Med Sci Sports*. 2017;27(4):430-434.
12. Beischer S, Augustsson SR. Lower extremity injuries in young floorball players: a prospective study on overuse injuries. *Open Sports Sci J*. 2016;9:135-142.
13. Tranaeus U, Heintz E, Johnson U, Forssblad M, Werner S. Injuries in Swedish floorball: a cost analysis. *Scand J Med Sci Sports*. 2017;27(5):508-513.
14. Lehance C, Binet J, Bury T, Croisier JL. Muscular strength, functional performances and injury risk in professional and junior elite soccer players. *Scand J Med Sci Sports*. 2009;19(2):243-251.
15. Zazulak B, Cholewicki J, Reeves NP. Neuromuscular control of trunk stability: clinical implications for sports injury prevention. *J Am Acad Orthop Surg*. 2008;16(9):497-505.
16. Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM. Core stability measures as risk factors for lower extremity injury in athletes. *Med Sci Sports Exerc*. 2004;36(6):926-934.
17. De Blaiser C, De Ridder R, Willems T, Vanden Bossche L, Danneels L, Roosen P. Impaired core stability as a risk factor for the development of lower extremity overuse injuries: a prospective cohort study. *Am J Sports Med*. 2019;47(7):1713-1721.
18. Cook G, Burton L, Hoogenboom B. Pre-participation screening: the use of fundamental movements as an assessment of function-part 1. *N Am J Sports Phys Ther*. 2006;1(2):62-72.
19. Cook G, Burton L, Hoogenboom B. Pre-participation screening: the use of fundamental movements as an assessment of function-part 2. *N Am J Sports Phys Ther*. 2006;1(3):132-139.
20. Mottram S, Comerford M. A new perspective on risk assessment. *Phys Ther Sport*. 2008;9(1):40-51.
21. Minick KI, Kiesel KB, Burton L, Taylor A, Plisky P, Butler RJ. Interrater reliability of the functional movement screen. *J Strength Cond Res*. 2010;24(2):479-486.
22. Onate JA, Dewey T, Kollock RO, et al. Real-time intersession and interrater reliability of the functional movement screen. *J Strength Cond Res*. 2012;26(2):408-415.
23. Chorba RS, Chorba DJ, Bouillon LE, Overmyer CA, Landis JA. Use of a functional movement screening tool to determine injury risk in female collegiate athletes. *N Am J Sports Phys Ther*. 2010;5(2):47-54.
24. Frohm A, Heijne A, Kowalski J, Svensson P, Myklebust G. A nine-test screening battery for athletes: a reliability study. *Scand J Med Sci Sports*. 2012;22(3):306-315.
25. Bakken A, Targett S, Bere T, et al. The functional movement test 9+ is a poor screening test for lower extremity injuries in professional male football players: a 2-year prospective cohort study. *Br J Sports Med*. 2018;52(16):1047-1053.
26. Texttalk. 2019. https://www.textalk.se/produkter/websurvey/
27. Walden M, Hagglund M, Ekstrand J. UEFA champions league study: a prospective study of injuries in professional football during the 2001–2002 season. *Br J Sports Med*. 2005;39(8):542-546.
28. Junge A, Dvorak J, Rosch D, Graf-Baumann T, Chomiak J, Peterson L. Psychological and sport-specific characteristics of football players. *Am J Sports Med*. 2000;28(5 Suppl):S22-28.
29. Bakken A, Targett S, Bere T, et al. Interseason variability of a functional movement test, the 9+ screening battery, in professional male football players. *Br J Sports Med*. 2017;51(14):1081-1086.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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