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Br J Sports Med published online November 3, 2010

doi: 10.1136/bjism.2010.075093

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Are skilled players at greater risk of injury in female youth football?

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Accepted 5 September 2010

ABSTRACT

Background Knowledge of skill-related risk factors for injury in football is limited.

Objective To investigate whether there is an association between football skills and risk of injury in football.

Study Design Prospective cohort study of the incidence of injuries and a retrospective evaluation of the players' skill-level.

Methods Exposure and injuries were registered prospectively in 82 of 125 football teams (1665 of 2540 female Norwegian amateur players aged 13–17 years) throughout one football season (March–October 2007). A standardised questionnaire designed to assess the football skills of each player was completed by the coaches after the season.

Results Across the different skill attributes, the injury incidence in the high-skilled players varied from 4.4 to 4.9 injuries per 1000 player hours, compared to 2.8 to 4.0 injuries per 1000 player hours in the low-skilled players. Players skilled at ball receiving, passing and shooting, heading, tackling, decision-making when in ball possession or in defence and physically strong players were at significantly greater risk of sustaining any injury, an acute injury and a contact injury than their less skilled teammates (rate ratio: 1.50–3.19, all $p < 0.05$).

Conclusions Players with high levels of football skill were at greater risk of sustaining injuries than their less skilled teammates.

INTRODUCTION

The number of female youth footballers (soccer players) has increased rapidly during the last decade, and there are already more than 2.9 million registered players worldwide.¹ Young female players incur from 8.3 to 22.4 injuries per 1000 match hours and from 1.1 to 4.6 injuries per 1000 training hours,^{2–5} and acute, lower extremity injuries dominate. Players with a history of previous injury have an increased risk of recurrences,^{3,6} perhaps because they return too early and without sufficient rehabilitation. Furthermore, debilitating long-term health consequences have been reported after ankle and knee sprains.^{7,8} As injuries can cause early retirement and limit future physical activity, it has also been argued that they may have an additional negative effect on future health.⁹

Injuries can to a great extent be reduced by taking significant risk factors into consideration and implementing injury prevention strategies.^{10,11} Still, a general trend in football is that little is done to minimise injuries, while technical, tactical and physiological skills are honed carefully.¹² This is somewhat counterintuitive, as football

performance is highly dependent on remaining injury free.^{13,14}

Although the relationship between the skill attributes underpinning performance in football and injury risk is largely unknown,^{3,15–20} there are indications from male football that skilled players may be at greater risk of injury than their less skilled counterparts.^{19,20} One suggestion is that skilled players are more likely to be in ball possession, and therefore are more exposed to tackles and other duels. In young female players, however, the only study available reported no association between the risk of injury and physiological attributes such as dynamic balance, vertical jump height or endurance.³ Nonetheless, more documentation is needed, in particular regarding the influence of technical and tactical football skills, which to date remains unexplored in female youth football.

The aim of this study was to investigate whether there are any associations between technical, tactical and physiological skill attributes in football and risk of injury in young female players.

METHODS

This study is based on data from a cluster-randomised controlled trial on young female footballers examining the injury-preventive effect of a comprehensive warm-up programme (The 11+). The design, intervention programme and main results have been reported.¹¹ This investigation included a prospective registration of the incidence of injuries and a retrospective evaluation of the skill level of players.

The study was approved by the Regional Committee for Medical Research Ethics, South-Eastern Norway Regional Health Authority, Norway. Informed consent was obtained from the players and their parents.

Participants

Of the 181 teams organised in the girls' 15- and 16-year amateur leagues in the south, east and middle regional districts of the Norwegian Football Association, 125 teams entered the randomised controlled trial. To be included in the current study, however, teams were required to have recorded injuries and exposure for the complete 2007 season (figure 1).

Recording and reporting of injuries and exposure

The coaches reported injuries and individual player participation prospectively, on a weekly basis. One physical therapist and one medical

student called every injured player to assess detailed aspects of the injury based on a standardised injury questionnaire.²¹ These injury recorders were given specific training on the protocols for injury classification and injury definitions (table 1) before the start of the injury recording period.

Recording of football skills

A standardised questionnaire designed to assess the football skills of each individual player compared to the rest of the team was mailed or emailed to the coach of each team 2 months after the end of the season 2007. The coach completed one questionnaire for each player. The skill assessment included 12 technical, tactical and physiological attributes. The technical attributes comprised ball receiving, passing and shooting (precision, power), heading (power and timing), dribbling and tackling. The tactical attributes comprised decision-making when the player had ball possession, decision-making when the team, but not the player, had ball possession (offensive decisions), and decision-making when the opposing team had ball possession (defensive decisions). The physiological attributes comprised endurance, speed/agility, strength (football-specific strength) and coordination/balance. The coach categorised each player into four quartiles; weakest, below average, above average or best. This was done separately for each of the 12 skill attributes.

Statistical methods

The quartiles of skill-level were merged into two groups consisting of high- and low-skilled players. We used χ^2 tests to compare the distribution of players in these two groups for all 12 attributes with Bonferroni p values correction to $0.05/12 = 0.00417$. Furthermore, we used χ^2 tests to examine whether there were any relationships between the players' skill-level across the 12 skill attributes. In each test the players were classified in terms of whether they were equally assessed in two skill attributes. This resulted in 66 tests with Bonferroni p values correction to $0.05/66 = 0.00076$. Unpaired two-sample t tests were used to compare the match exposure time of the

players with high and low skill in each attribute. To avoid bias related to absence from training and matches due to injury only uninjured players were included in this analysis. These analyses were conducted in SPSS (SPSS for Windows 15.0; SPSS, Chicago, Illinois, USA).

To estimate the relation between skill level and risk of injury we used a Cox regression model with the robust calculation method of the variance-covariance matrix,²³ taking the cluster randomisation by clubs into account. Rate ratios (RRs) were tested with Wald test. These analyses were conducted in STATA (STATA 10.0; Stata Corporation, Lakeway Drive, Texas, USA, 2007). Players in the low-skill group were used as the reference group. Interaction between group allocation (intervention or control) and skill level for each of the 12 attributes was tested with a z test, using the results from the Cox regression model with injuries overall as the dependent variable. No significant interaction was found (all $p > 0.20$) and the two groups were merged. The injury incidence was calculated based on the number of injuries during the study period divided by the sum of exposure time expressed in player hours of match, training or in total. Descriptive data on players' injury incidence and skill-level were calculated by means with 95% CIs. Two tailed p values < 0.05 were regarded as significant.

RESULTS

Of the 82 teams entering, 56 teams completed the study (68%, 1034 players). The overall exposure to football was 61 295 h (21 893 h of matches, 39 402 h of training). Two-hundred and two players sustained 259 injuries (167 match injuries, 89 training injuries). Of these, 203 (78%) were acute injuries and 56 (22%) overuse injuries. The majority of all injuries occurred to the lower extremity ($n=219$; 85%). In terms of injury mechanisms, there were 133 (51%) contact injuries and 115 (44%) non-contact injuries. For 11 (5%) of the injuries the mechanism was unknown.

The distribution of players rated as high skilled and low skilled was skewed (table 2); for 11 of 12 skill attributes a

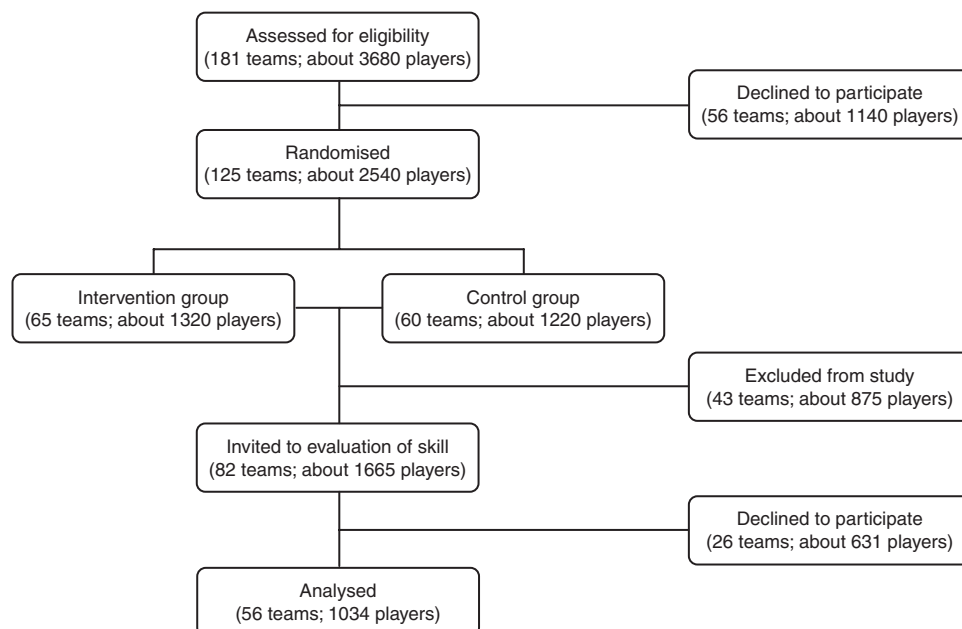


Figure 1 Flow of team clusters and players throughout the study.

majority (56–71%) was rated as highly skilled. There was a significant relationship between how the players were rated across all 12 attributes (all $p < 0.000001$). Each player's level of skill in one attribute was in 63–84% of the cases identical to the same player's skill level in other attributes.

In all skill attributes the highly skilled players had significantly higher match exposure than players with low skill level (all $p < 0.00001$). For all attributes, except speed/agility, the skilled players also had higher exposure to training (all $p < 0.001$). In players who were assessed as highly skilled across all of the attributes ($n=203$) the average match exposure was 104% higher than in players with low skill level across all attributes ($n=71$; $p < 0.001$).

Football skills and risk of injury

The injury incidence among highly skilled players varied from 4.4 to 4.9 injuries per 1000 player hours. By contrast, players with low skill level sustained 2.8–4.0 injuries per 1000 player hours. Table 3 shows the relative risk of injury in high-skilled players compared to low-skilled players.

The players with good ball-receiving technique were at greater risk of injuries overall, acute injuries and contact injuries than the players with poor receiving technique (table 3). Players who were highly skilled in passing and shooting, heading and tackling had significantly higher risk of injuries overall, injuries to the lower extremity, acute injuries and contact injuries than the players with low skill level in these attributes. Furthermore, players with good dribbling technique were at higher risk of contact injuries compared to players with poor dribbling technique.

Table 1 Operational definitions used in the recording of injury

Reportable injury ²²	An injury occurred during a scheduled match or training session, causing the player to be unable to fully take part in the next match or training session
Player	A player was entered into the study if she was registered by the coach on the club roster as participating for the club's team competing in the 15- or 16-year divisions
Return to participation	The player was defined as injured until she was fully fit to take part in all types of training and matches
Type of injury	Acute – injury with sudden onset associated with known trauma Overuse – injury with gradual onset without known trauma Contact – injury resulting from contact with another player Non-contact – injury occurring without contact with another player

The players who made good tactical decisions in defence experienced a significantly higher risk of all the tested injury outcomes compared to players who made poor defensive decisions. Correspondingly, players who made good decisions when in possession of the ball were at higher risk of injuries overall, injuries to the lower extremity, acute injuries and contact injuries than the players who displayed poor decision-making when in ball possession.

Regarding the physiological attributes, the most distinctive finding was that physically strong players experienced a higher risk of injuries overall, injuries to the lower extremity, acute injuries and contact injuries compared to physically weaker players.

DISCUSSION

The main finding of this cohort study was that the players with good football skills were at greater risk of injury than their less skilled teammates. In particular, the risk of sustaining contact injuries was high among skilled players. The increased injury risk was most evident in players with high technical and tactical skills and in physically strong players.

Football skills and risk of injury

The data on the relationship between football skills and risk of injury in football are equivocal.^{3 15–20} In youth football, Emery *et al*³ found no association between the risk of injury and the dynamic balance, vertical jump height, and endurance of female and male players 12–18 years of age. In male youth football, Le Gall *et al*¹⁹ reported no difference in the overall risk of injury between players acquiring a professional contract and those who did not. Yet, a higher risk of moderate and major injuries was found in the non-professionals, while the professionals sustained more injuries to the lower extremity, contusions to the lower leg, minor injuries and re-injuries. The latter results are supported by Severino *et al*,²⁰ who in 11- to 12-year-old males found that injured players were better at ball juggling, dribbling, agility and anaerobic performance.

It is difficult to suggest reasons for the higher risk of injury in the skilled players compared with their less skilled teammates. Previously, it has been argued that technically skilled players may be less injury-prone due to their ability to efficiently control and pass the ball before being challenged by the opposing player.²⁴ Likewise, tactically skilled players

Table 2 Number of players (%) categorised as high skill and low skill

	Players with low skill	Players with high skill	Missing	p-Value
Technical attributes				
Ball receiving	413 (39.9%)	621 (60.1%)	–	<0.001
Passing and shooting (precision, power)	351 (33.9%)	683 (66.1%)	–	<0.001
Heading (timing, power)	531 (51.4%)	501 (48.5%)	1 (0.1%)	0.367
Dribbling	447 (43.2%)	582 (56.3%)	5 (0.5%)	<0.001
Tackling	351 (33.9%)	679 (65.7%)	4 (0.4%)	<0.001
Tactical attributes. Decision-making when				
in ball possession (offensive)	371 (35.9%)	662 (64.0%)	1 (0.1%)	<0.001
not in ball possession (offensive)	434 (42.0%)	592 (57.3%)	8 (0.8%)	<0.001
in defence	410 (39.7%)	612 (59.2%)	12 (1.2%)	<0.001
Physiological attributes				
Endurance	391 (37.8%)	643 (62.2%)	–	<0.001
Speed/agility	393 (38.0%)	639 (61.8%)	2 (0.2%)	<0.001
Strength (football specific strength)	313 (30.3%)	720 (69.6%)	1 (0.1%)	<0.001
Coordination/balance	300 (29.0%)	734 (71.0%)	–	<0.001

Table 3 Relative risk of injury in high-skilled players compared to low-skilled players

	Injuries overall	Lower extremity injuries	Acute injuries	Overuse injuries	Contact injuries	Non-contact injuries
Technical attributes						
Ball receiving	1.55 (1.04 to 2.31)*	1.48 (1.00 to 2.19)	1.64 (1.06 to 2.53)*	1.23 (0.68 to 2.25)	3.19 (1.91 to 5.32)**	0.96 (0.58 to 1.58)
Passing and shooting (precision, power)	1.82 (1.26 to 2.63)**	1.64 (1.13 to 2.38)**	1.99 (1.31 to 3.03)**	1.34 (0.72 to 2.49)	3.13 (1.83 to 5.35)**	1.10 (0.74 to 1.64)
Heading (timing, power)	1.50 (1.13 to 2.00)**	1.56 (1.14 to 2.14)**	1.53 (1.11 to 2.11)**	1.17 (0.62 to 2.21)	1.77 (1.25 to 2.50)**	1.24 (0.82 to 1.87)
Dribbling	1.27 (0.91 to 1.77)	1.32 (0.94 to 1.86)	1.23 (0.86 to 1.75)	1.61 (0.91 to 2.85)	2.10 (1.37 to 3.22)**	0.93 (0.59 to 1.46)
Tackling	1.70 (1.18 to 2.45)**	1.68 (1.13 to 2.49)*	1.83 (1.22 to 2.73)**	1.48 (0.73 to 3.00)	2.37 (1.42 to 3.97)**	1.18 (0.79 to 1.78)
Tactical attributes. Decision-making when						
in ball possession (offensive)	1.62 (1.08 to 2.45)*	1.55 (1.01 to 2.36)*	1.66 (1.03 to 2.67)*	1.29 (0.71 to 2.37)	3.12 (1.63 to 5.97)**	0.95 (0.62 to 1.45)
not in ball possession (offensive)	1.30 (0.92 to 1.85)	1.33 (0.93 to 1.91)	1.41 (0.98 to 2.03)	0.95 (0.53 to 1.73)	2.07 (1.34 to 3.20)**	0.93 (0.62 to 1.40)
in defence	1.81 (1.23 to 2.65)**	1.84 (1.20 to 2.84)**	1.79 (1.17 to 2.73)**	1.96 (1.02 to 3.78)*	1.95 (1.19 to 3.18)**	1.62 (1.01 to 2.61)*
Physiological attributes						
Endurance	1.18 (0.84 to 1.66)	1.28 (0.91 to 1.80)	1.21 (0.83 to 1.76)	1.09 (0.57 to 2.08)	1.45 (0.90 to 2.34)	0.89 (0.56 to 1.43)
Speed/agility	1.21 (0.90 to 1.61)	1.36 (1.00 to 1.85)*	1.22 (0.89 to 1.67)	1.02 (0.59 to 1.77)	1.24 (0.82 to 1.89)	1.12 (0.77 to 1.64)
Strength (football specific strength)	1.62 (1.18 to 2.22)**	1.57 (1.13 to 2.17)**	1.72 (1.22 to 2.44)**	1.46 (0.73 to 2.92)	2.15 (1.34 to 3.44)**	1.25 (0.86 to 1.82)
Coordination/balance	1.19 (0.79 to 1.79)	1.21 (0.79 to 1.86)	1.32 (0.88 to 1.99)	0.82 (0.42 to 1.59)	1.65 (1.04 to 2.63)*	0.92 (0.53 to 1.57)

Values are rate ratios with 95% CIs. Rate ratios calculated from Cox model according to method of Lin and Wei.²³

* $p < 0.05$, ** $p < 0.01$.

may be protected from injury, because they possess the ability to recognise potentially hazardous situations before they occur, and thus avoid them.²⁵ Although these theories intuitively seem valid, they do not account for the fact that skilled players have more ball possession and consequently are more exposed to tackles and other duels.^{19 25 26} This rationale is reflected by our findings; players skilled in ball receiving, passing and shooting, and decision-making when in ball possession, experienced a threefold risk of contact injury. In our analyses, we have corrected for exposure, estimated as the number of hours of match and training exposure. In this way, the fact that skilled players are more likely to be selected for games has been adjusted for. However, highly skilled players are most likely also more involved in the game, more prone to tackles and foul play, and hence, at greater risk of injury than their less skilled counterparts. Although generally not feasible in youth football, notational analysis tools²⁷ provide the opportunity to record whether skilled players are more involved in game situations that entail a higher risk of injury, such as tackles.

Previously, it has been shown that the risk of injury in young female amateur players increases by 12% for every successive year of participation in organised football.⁶ Moreover, previous injuries, as well as symptoms from previous injuries, make the player more susceptible to re-injuries.^{3 6 28} Although these factors were not recorded in the current study, one possible scenario is that compared to their less skilled teammates, the skilled players not only played more football during the season but also started playing football at an earlier age. Furthermore, key players may experience higher external pressure or be more motivated to quickly return to play after an injury. Inadequate rehabilitation and premature return to play may increase the risk of exacerbations or re-injuries²⁹ and may thus lead to a higher injury risk in skilled players.

Methodological considerations

In this study exposure was recorded individually, and not on a team basis. Individual exposure takes censorship into account, such as abbreviated lengths of follow-up for reasons other than injury (eg, illness, moving, quitting the sport).³⁰ Furthermore, we adjusted the analyses for playing time which

can vary greatly among players. The individual exposure demonstrated that the high-skilled players had a higher match and training exposure than their less skilled teammates. However, since match exposure was a dichotomous variable (participation yes/no), it remains possible that the low-skilled players not only played fewer matches but also were on the field for a lower proportion of the match. This may have led to an overestimation of match exposure and an underestimation of injury risk among the low-skilled players.

Injury recorders, who were blinded to group allocation, interviewed the injured players based on a standardised injury questionnaire as soon as possible after the weekly registration form was received. Even so, there is a possibility that injuries may have been overlooked by the coaches. However, given the individual activity logs kept by the coaches and the time-loss injury definition,²² we think it is unlikely that injuries would go unreported. Thus, our method should ensure good reliability and validity of the injury and exposure data.

The main limitation of the study is that the recording of skills was conducted retrospectively, 2 months after the recording of injuries was completed. This may add uncertainty as to whether a player's level of skill is a possible cause or a consequence of the injury,³⁰ and may be a limitation if the skill assessment of the coach was influenced by his/her knowledge of the player's injury status. However, we believe this to be unlikely, as the purpose of the assessment they were asked to make was not explicitly linked to the study purpose. There is also an obvious advantage of recording the level of skill retrospectively; it allows for an overall assessment of the players' performance throughout the course of a complete season. Nevertheless, skill is not a static variable and potential change in the different skill attributes of the players during the season was not accounted for. In future studies, it would be advisable to measure the skills before the injuries occur and follow-up with prospective repeated assessments throughout the season.

Another limitation is that the skill assessment approach was not validated. In future studies, the use of established tests for passing,^{31 32} shooting,³² dribbling³³ and physical performance^{34–36} should be considered. Nevertheless, football is a complex sport where performance is determined by a wide range of technical, tactical and physiological skill attributes.

It is questionable whether performance in football can be assessed strictly using objective testing,³⁷ and the qualitative assessment of a coach can therefore be useful.

The majority of the coaches were volunteers such as parents and their level of education and experience as football coaches was not recorded. Different interpretations of the skill attributes may have affected the inter-rater reliability of the skill assessment. Furthermore, a test–retest procedure of the coaches' skill assessment would have been useful to evaluate the intra-rater reliability. However, 84% of the players were assessed equally in ball receiving and dribbling; two technical skill attributes assumed to be related. By contrast, only 63% of the players were assessed equally in the less-related skill attributes heading technique and speed/agility. This exemplifies our findings of a consistent logical relation between attributes, which strengthens the reliability of the coaches' skill assessment.

Half of the players performed an injury prevention programme throughout the study. The risk of injuries overall, overuse injuries and severe injuries was reduced in these players.¹¹ However, this did not bias the current results, as no interaction was found between the implementation of the injury prevention programme and the association between the players' level of skill and their injury risk.

Implications

Considering the limited knowledge about football skills as a potential injury risk factor in football, our findings need to be confirmed by subsequent studies in youth football, as well as in adult cohorts. Furthermore, by implementing actual game play measures (match statistics) in future research we can ascertain whether skilled players actually are more involved in game situations that entail a higher risk of injury. The disproportionate high risk of contact injuries in players who excel in youth football does in any case seem to warrant injury prevention to focus more on the injuries occurring from tackles and contact situations. Stricter interpretation of the fair play rules and better refereeing may be important means to protect the 'Messis' and 'Martas'³⁸ of tomorrow from career-ending injuries and allow them to hone their skills throughout adolescence to achieve their optimal potential in adulthood. Previously proposed measures to prevent contact injuries include modification and enforcement of the Laws of the Game, the referees' interpretation of the rules, as well as the coaches' and players' attitudes towards fair play and high-risk game situations.^{39–42} To our knowledge, no risk factor studies or preventive measures specifically aimed at contact injuries have been implemented in female youth football. However, it has been shown in international female tournaments that the decision of the referee does not reflect the injury risk of sliding-in tackle.⁴³ Thus, it seems unreasonable to expect referees on a lower level to make correct decisions based on a subjective judgment of injury risk.

The current results also suggest that skill level should be addressed as a possible confounder in studies on other risk factors for injury. However, because skill level was registered in relation to the skill level of teammates, our findings might not be valid within populations consisting of multiple teams or leagues. Teams in female youth football are often characterised by large variations in skill level, larger than on the senior level and in male football. Thus, we do not know if the results can be generalised to both sexes or other age groups.

What is already known on this topic

- ▶ Football performance is composed of an admixture of technical, tactical, physiological, psychological, psychosocial and anthropometric factors.
- ▶ Knowledge of how these factors influence the injury risk in football is limited.

What this study adds

- ▶ Players with good technical, tactical and physiological football skills may be at greater risk of injury than their less skilled teammates.
- ▶ Subsequent studies are needed to determine whether stricter enforcement of the Laws of the Game and modification of coaches' and players' attitudes towards fair play and high-risk game situations are required.

CONCLUSION

Players with good football skills were at greater risk of injury than their less skilled teammates. The increased injury risk was most evident not only in the players with high technical and tactical skills but also in physically strong players. Players skilled in these attributes were generally more susceptible to injuries overall, lower extremity injuries, acute injuries and contact injuries.

Acknowledgements We thank the project assistants (Birgitte Lauersen, Ellen Blom, Olav Kristianslund, Agneth Nilstad and Tone Wigemyr), the coaches and the players who participated in this study.

Funding This study was supported by grants from the FIFA Medical Assessment and Research Centre. The Oslo Sports Trauma Research Center has been established at the Norwegian School of Sport Sciences through generous grants from the Royal Norwegian Ministry of Culture, the South-Eastern Norway Regional Health Authority, the International Olympic Committee, the Norwegian Olympic Committee and Confederation of Sport, and Norsk Tipping AS.

Competing interests None.

Ethics approval This study was conducted with the approval of the Regional Committee for Medical Research Ethics, South-Eastern Norway Regional Health Authority, Norway.

Provenance and peer review Not commissioned; externally peer reviewed.

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