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Still poorly adopted in male professional football: but teams that used the Nordic Hamstring Exercise in team training had fewer hamstring injuries – a retrospective survey of 17 teams of the UEFA Elite Club Injury Study during the 2020–2021 season

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ABSTRACT

Objectives The primary objective was to study the adoption of the NHE programme in European football teams in the 2020/21 season and to compare it to the previous study. A second objective was to compare hamstring injury rates between teams that used the NHE programme in the team training and teams that used the NHE only for players with previous or current hamstring injuries.

Methods Data about the implementation of the NHE programme and injury rates were included for 17 teams participating in the Elite Club Injury Study during the 2020/2021 season.

Results One team (6%) used the full original NHE programme, and another four teams used it for all or most players in the team (team training group, n=5). Eleven teams used NHE only for players with a previous or current hamstring injury (individual training group), and one team did not use NHE. The team training group had fewer hamstring injuries (5 vs 11 per team, p=0.008) and a lower injury burden (12 vs 35 lay-off days per 1000 hours, p=0.003) than the individual training group.

Conclusion Similar to previous reports, low adoption of the NHE programme was seen in the 2020/2021 season. The low adoption rate (13%) relates to the number of teams fully or partly using NHE programmes. Teams that used NHE for the whole team or most players had a lower hamstring injury burden than teams that used NHE only for individual players.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Hamstring injury is the most common injury subtype in male professional football players.
⇒ The Nordic Hamstring Exercise (NHE) programme has been reported to reduce acute and recurrent hamstring injuries in football.
⇒ The NHE programme does not seem to have been widely adopted in men's professional football in Europe.

WHAT THIS STUDY ADDS

⇒ The attitudes regarding the NHE programme among the medical staff were generally positive.
⇒ The implementation of the full NHE programme among teams was low.
⇒ Teams that used the NHE in their team training for all or most players had lower match hamstring injury rates, less severe injuries and lower recurrence rates than teams that only used the NHE for individual players with a history of hamstring injury or current hamstring injury.
⇒ None of the teams reported that the NHE programme would be the only hamstring prevention measure in the future for their team.

INTRODUCTION

Hamstring injury is the most common injury subtype in male professional football players.[1–3] As part of the Union of European Football Associations (UEFA) Elite Club Injury Study (ECIS), we have previously reported that hamstring injuries constitute 12%–26% of all time-loss injuries.[1–3] Around 20%–22% of players sustain at least one hamstring injury during a season,[2] and a team with a 25-player squad can typically expect six to seven hamstring injuries each season.[1–3] Additionally, recurrences within the same season are common and constitute 13%–18% of all hamstring injuries.[2 4]

The Nordic Hamstring Exercise (NHE) programme has been reported to reduce acute hamstring injuries in football by 50%–70%,[5–8] and recurrent injuries by 86%.[5]

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our findings showed that teams that implemented NHE in team training and used it with most players had fewer hamstring injuries than teams that only used the NHE for individual players with a current injury or a history of a hamstring injury.

⇒ A key point for medical staff is to convince the coaches about the benefits of using the NHE in the team training for most players. The results from this study might be helpful since it provides clear practical information.

⇒ Teams that implemented NHE in team training had 100 fewer injury absence days per team and season on average.

A recent meta-analysis found the same point estimate as van Dyk *et al*[8] but both authors pointed out that the expectations around what this might result in in practice should be tempered, since there is a large amount of variability in the data.[9] A problem when interpreting the literature is that the NHE programme has not been widely adopted in men's professional football in Europe. In 2015, a study on the implementation of the NHE programme in top-level football in Europe 2012–2014 (32 clubs in the ECIS participated) showed a low adoption and implementation of the NHE programme, with only a few teams (13%) using the NHE programme fully or partly.[10]

The primary objective of this study was to study the reach, effectiveness, adoption, implementation and maintenance (RE-AIM) of the NHE programme in ECIS teams in the 2020–2021 season and compare it to the situation previously described for 2012–2014. A second objective was to compare the incidence and burden of hamstring injuries between teams that used the full or modified NHE programme in the team training during the 2020–2021 season and teams that used the NHE only for players with previous hamstring injuries or in the rehabilitation of hamstring injuries.

MATERIAL AND METHODS

This is an observational cohort study with prospectively collected injury data and retrospectively collected questionnaire data in the ECIS.

Study participants

Out of the 32 teams that qualified for the UEFA Champions League group stage in the 2020/2021 season, 19 participated in the ECIS. One team delivered data for only 5 months of the season and was excluded from this survey. Eighteen teams delivered complete data for the whole season and were invited to participate in the survey. One of these 18 invited teams did not answer the questionnaire and was excluded. The remaining 17 teams represent 11 countries (4 teams from England, 3 from Germany, 2 from Italy and 1 each from Spain, Portugal, France, Russia, The Netherlands, Belgium, Ukraine and Hungary).

Exposure and injury data collection

The 2020/2021 season started in July 2020 and ended in May 2021. The overall methodology for the definitions and data collection procedures in the cohort has been described in detail previously.[11–13] Teams assigned a contact person (a member of the medical staff) who was responsible for registering data. Contact persons were given a manual that provided study methods and operational definitions used in the study (table 1). Teams were requested to provide the study group with exposure and injury data each month. Members of the study group reviewed all data to ensure that it complied with the study protocol. If any missing or unclear data were identified during this review process, immediate feedback was sent to the contact person to complete or correct the data.

The survey questionnaire

A questionnaire addressing key issues related to the RE-AIM of the NHE programme was the basis of the survey,[14] as for the original NHE survey 2012–2014.[10] The questionnaire included a description of the NHE and the protocol with the initial programme (the 10-week progression model) and the weekly maintenance programme (one session each week).[15] We used the same survey structure for the 2020/21 season but added a few questions about using any modified NHE programme (box 1).

We contacted each club via email to the club representative nominated as the individual responsible for the

Table 1 Operational definitions

Training session	Team training that involved physical activity under the supervision of the coaching staff
Match	Competitive or friendly match against another team
Injury	Any physical complaint sustained by a player that resulted from a football match or football training and led to the player being unable to take full part in future football training or match play
Hamstring injury	An acute onset distraction injury or gradual onset injury to the hamstring muscle group
Recurrent injury	Injury of the same type and at the same site as an index injury occurring previously during the same season
Early recurrence	Recurrent injury that occurs within 2 months after return to full participation from the index injury
Injury incidence	No of injuries per 1000 player hours ((Σ injuries/Σ exposure hours)×1000)
Injury burden	No of lay-off days per 1000 player hours ((Σ lay-off days/Σ exposure hours)×1000)

Box 1 Survey questions (response options and reach, effectiveness, adoption, implementation and maintenance framework domains are shown in parenthesis)

⇒ Are you familiar with the Nordic Hamstring Exercise programme aimed at reducing hamstring injuries? (Yes; No) (Reach)
⇒ Have you used the complete original Nordic Hamstring Exercise programme (the 10-week progression as suggested by Mjølsnes et al. SJMSS 2004) in your first team squad at the start of season 2020–21? Choose one option: (Yes, the complete 10 week programme; Yes, but only for 7–9 weeks; Yes, but only for 5–6 weeks; Yes, but only for 4 weeks or less; No, not at all) (Adoption)
⇒ With which players in your first team squad, did you use the original Nordic Hamstring Exercise programme during the 2020–21 season? (All players from the first team squad; Players with a history of hamstring injury only; No players; Other selection criteria (if yes, please describe your selection criteria)) (Adoption)
⇒ How many players in your first team squad completed the initial Nordic Hamstring Exercise programme (the complete 10 week programme) during the season 2020–21? (>75% of players; 50% to 74%; 25% to 49%; Less than 25%) (Implementation)
⇒ Have you used a weekly maintenance programme with the Nordic Hamstring Exercise programme (one session each week as suggested by Petersen *et al*. AJSM 2011) in your first team squad during season 2020–21? Choose one option: (Yes, every week; Yes, most weeks; Yes, but sporadically; No, not at all) (Adoption)
⇒ With which players in your first team squad did you use the weekly maintenance programme during the 2020–21 season? Choose one option: (All players from the first team squad; Players with a history of hamstring injury only; No players; Other selection criteria (if yes, please describe your selection criteria)) (Adoption)
⇒ How many players in your first team squad completed the weekly maintenance programme during the 2020–21 season? Choose one option: (>75% of players; 50%–74%; 25%–49%; Less than 25%) (Implementation)
⇒ *Have you used any other (modified) Nordic Hamstring Exercise protocol with your first team squad at the start of the 2020–2021 season? (No; Yes, please describe the protocol used in your team) (Adoption)
⇒ *Have you used the previously described modified Nordic Hamstring Exercise protocol in your first team squad during the competitive 2020–21 season? Choose one option: (Yes, every week; Yes, most weeks; Yes, but sporadically; No, not at all) (Adoption)
⇒ *With which players in your first team squad did you use the described modified Nordic Hamstring Exercise protocol during the 2020–21 competitive season? Choose one option: (All players from the first team squad; Players with a history of hamstring injury only; No players; Other selection criteria (if yes, please describe your selection criteria)) (Adoption)
⇒ *How many players in your first team squad completed the previously described modified Nordic Hamstring Exercise protocol during the 2020–21 season? Choose one option: (>75% of players; 50%–74%; 25%–49%; Less than 25%) (Implementation)
⇒ Have you experienced any complaints about the Nordic Hamstring Exercise programme from players in your first team squad during the 2020–21 season? Choose one option: (Many; More than a few; A few; No complaints) (Effectiveness)
⇒ How satisfied are you with the Nordic Hamstring Exercise programme in your first team squad? (Very dissatisfied; Dissatisfied; Indifferent; Satisfied; Very satisfied) (Effectiveness)

Continued

Box 1 Continued

⇒ With regard to the Nordic Hamstring Exercise programme, please let us know how you agree or disagree with each of the following statements: (1) It reduces injuries; (2) It makes more players available for team selection; (3) Players can return to play sooner after injury; (4) It reduces re-injuries; (5) It's really easy to get players to do the programme; (6) The players really like the programme and see its value; (7) It causes muscle soreness in players; (8) It increases sprint speed and acceleration; (9) It. Increases hamstring muscle strength. (Fully agree; Partly agree; Indifferent; Partly disagree; Fully disagree) (Effectiveness)
⇒ Do you intend to use the Nordic Hamstring Exercise programme for your first team squad in the future? (Yes; No; We have not thought about it yet) (Maintenance)
⇒ Which hamstring injury prevention strategy for your first team squad do you intend to use in the future? (Nordic Hamstring Exercise programme is the only strategy we will use in the future; Nordic Hamstring Exercise programme is part of, but not the only strategy we will use in the future; We will have a hamstring injury prevention strategy, but the Nordic Hamstring Exercise programme is NOT part of this; We will not have a hamstring injury prevention strategy in the future; We have not thought about it yet). (Maintenance)
⇒ Did your first team squad use any specific exercises/exercise programmes other than the Nordic Hamstring Exercise programme to prevent hamstring injuries in the 2020–21 season? (Yes; No) If yes, please describe. (Adoption)

* Additional questions in the 2020/21 survey not included in the previous 2012–2014 survey.

club's participation in the injury surveillance programme. In most cases, the club representative was the first team physician or physical therapist. The representatives were informed that the questionnaire aimed to evaluate if the NHE programme is being used, how it is used and if other preventive measures are used in conjunction with or instead of the NHE. After consenting to participate in the study, they were provided access to the questionnaire using online survey software (SurveyMonkey, California, USA).

The questionnaire was distributed in December 2021. The survey software distributed automatic reminders after three, seven and ten days, after which two teams were contacted by email with an additional reminder.

Patient and public involvement

This study was done without patient (player) involvement; patients (players) were not invited to comment on the study design or contribute to this document's drafting.

Equity, diversity and inclusion

This study was conducted on male professional football players only. A women's ECIS was launched in July 2017 in collaboration with the UEFA with similar data collection on hamstring injuries. Results from this study will be presented in the future.

Data analyses

Based on their questionnaire responses, teams were classified as compliant with the NHE programme if

they reported having used the (full or modified) NHE programme in the team training on >75% of players (team training group).[10] In contrast, teams were classified as partly compliant if they reported having used the NHE programme only for players with previous hamstring injuries or in the rehabilitation of hamstring injuries (individual training group).

Injury incidence was calculated as the number of injuries per 1000 hours and described with a 95% CI. Comparisons of incidences were made using a rate ratio (RR) with 95% CI and tested for statistical significance using Z-statistics. The injury burden was calculated as the number of lay-off days per 1000 hours. Exposure hours in matches, the number of injuries per team/season, injury burden, and total lay-off days are described as means (with SD) of the participating teams and independent sample Student's t-test were used for between-group comparisons. Exposure hours in training and total exposure hours are described as medians with IQR and compared between groups with Mann-Whitney U test since these variables were not normally distributed. Analyses were two sided, and the significance level was set at $p<0.05$.

RESULTS

In total, 17 out of the 18 invited teams answered the questionnaire (response rate of 94%). Reach was excellent; all 17 teams reported that they were familiar with the NHE programme. Similar to the 2012–2014 study, the adoption and implementation of the NHE programme, with an initial 10-week progression followed by a weekly maintenance programme during the rest of the season, was low; only one team (6%) was compliant with the original NHE programme.

Team training group: one team reported having used the complete NHE programme as intended with an initial 10-week progression followed by a weekly maintenance programme during the rest of the season. Two teams were partly compliant in that they used the NHE programme for less than ten weeks initially but used the maintenance programme in the team training for the rest of the season. Another two teams were partly compliant in that they used the maintenance programme in the team training for the rest of the season but did not use the NHE programme during the initial ten weeks of the season. Individual training group: 11 teams (65%) used it only for players with a history of hamstring injury or rehabilitation of new hamstring injuries. One team did not use the NHE at all during the season. Table 2 summarises the survey responses from the teams regarding the adoption and maintenance of the NHE programme.

Satisfaction with and future use of the NHE

Eleven teams (65%) reported that they were satisfied or very satisfied with the NHE (four in the team training group and seven in the individual training group). None of the teams reported that the NHE programme would be the only hamstring prevention measure in the future for their team, but 15 clubs (88%) reported that the NHE would be a part of the hamstring injury prevention strategy. A large number of teams reported being indifferent to various statements describing potential benefits

Table 2 Survey responses for adoption and maintenance in teams in which all players performed the Nordic hamstring exercise (NHE) (n=5) and teams in which only some players performed NHE (n=11)

	Team training (n=5)	Individual training (n=11)
Use of the initial NHE progression at the start of the season	Yes (n=3)	Yes (n=8)
Use of the initial NHE progression, which players	All players (n=3)	Only previous hamstring injury (n=7), Other selection criteria (n=1)
Use of the initial NHE progression, proportion of squad	>75% (n=2); <25% (n=1)	<25% (n=8)
Use of the weekly NHE maintenance protocol during the season	Most/every week (n=5)	Most/every week (n=4); Sporadically/unknown (n=6)
Use of the weekly NHE maintenance protocol, which players	All players (n=5)	Only previous hamstring injury (n=9); Other selection (n=1)
Use of the weekly NHE maintenance protocol, proportion of squad	>75% (n=5)	25%–74% (n=3); <25% (n=7)
Use of any other (modified) NHE protocol at the start of the season	Yes (n=2)	Yes (n=7)
Use of modified NHE protocol during the season	Most/every week (n=2)	Most/every week (n=4); Sporadically/unknown (n=3)
Use of modified NHE protocol, which players	All players (n=2)	Only previous HSI (n=6); Other selection (n=1)
Use of modified NHE protocol, the proportion of first team squad	>75% (n=2)	Yes (n=8)

Table 3 Exposure and hamstring injury data in teams in which all players performed the Nordic hamstring exercise (NHE) (n=5) and teams in which only some players performed NHE (n=11)

	Team training (n=5)	Individual training (n=11)	P value
Training exposure hours, median (IQR)	4710 (4535 to 4860)	4785 (3513 to 4863)	0.743
Match exposure hours, mean (SD)	1030 (162)	1024 (110)	0.925
Total exposure hours, median (IQR)	5722 (5648–5742)	5742 (4515–5972)	0.827
Training hamstring injuries, mean (SD)	3 (2)	4 (2)	0.336
Match hamstring injuries, mean (SD)	2 (1)	7 (3)	0.005
Total hamstring injuries, mean (SD)	5 (2)	11 (4)	0.008
Hamstring injury burden, mean (SD)	12 (4)	35 (14)	0.003
Lay-off days following training hamstring injuries, mean (SD)	29 (20)	82 (44)	0.024
Lay-off days following match hamstring injuries, mean (SD)	38 (14)	103 (47)	0.011
Lay-off days absence following all hamstring injuries, mean (SD)	67 (26)	184 (69)	0.003

Data are presented as team averages with corresponding SD for normally distributed variables and as medians with IQR for non-normally distributed variables.
Hamstring injury burden is expressed as the number of lay-off days per 1 000 player hours.

and problems associated with the NHE programme. The majority was positive.

Complaints

Out of the 16 teams that used the NHE in the team or individual training, 13 (81%) reported complaints from players using the NHE. Twelve of these 13 teams (92%) reported a few complaints from players, and 1 team reported more than a few complaints. The majority of complaints were about muscle stiffness or soreness after training sessions.

Exposure and injury data

Exposure and injury data are reported only for the 16 teams that had used the NHE in the team or individual training during the season. The team training group reported a total of 28 004 hours of exposure (22 853 training hours and 51 151 match hours) with a total of 27 hamstring injury occurrences (15 in training and 12 in matches) while the individual training group reported a total of 58 401 exposure hours (47 141 training hours and 11 260 match hours) with a total of 119 hamstring injury occurrences (46 in training and 73 in matches). Table 3 shows the exposure, injury and lay-off data with between-group comparisons. Exposure hours for training and matches were almost identical for the two groups. There was no difference between the two groups in the mean number of training hamstring injuries, but the mean number of match hamstring injuries and total hamstring injuries were significantly lower in the team training group. The mean total number of hamstring injuries was less than half (5 vs 11 injuries, p=0.008), and the injury burden was around one-third (12 vs 35 lay-off days per 1000 hours, p=0.003) in the team training group compared with the individual training group. Figure 1 shows the team ranking for total hamstring injury burden from lowest to highest. Teams in the team training group were ranked in places 1–4 and 6 out of the 16 teams based on total injury burden. The team training group had, on average, 67 lay-off days following hamstring injuries during the 2020/2021 seasons compared with 184 lay-off days in the individual training group.

Table 4 shows injury incidence data with between-group comparisons. There was no difference between the groups in training hamstring injury incidence, but the match hamstring incidence was significantly lower (64%) in the team training group with an RR of 0.36 (95% CI 0.20 to 0.66). The recurrence rate of hamstring injuries in the team training group was 20% (0.1 vs 0.4) of the rate in the individual training group.

DISCUSSION

The principal finding of the current study was the low adoption and implementation of the full NHE programme among teams, even lower than what was reported in the 2012–2014 seasons. Noteworthy was the discrepancy between the positive attitude to the NHE among the medical staff and the low implementation

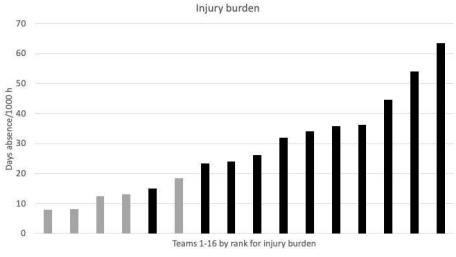

Figure 1 Team ranking for total hamstring injury burden shown for teams in the team training group (grey bars) and teams in the individual training group (black bars).

Table 4 Comparison of hamstring injury incidences between teams in which all players performed the Nordic hamstring exercise (NHE) (n=5) and teams in which only some players performed NHE (n=11)

	Team training (n=5)	Individual training (n=11)	Rate ratio	P value
Training hamstring injury incidence, injuries/1000 hours (95% CI)	0.7 (0.4 to 1.1)	1.0 (0.7 to 1.3)	0.67 (0.38 to 1.20)	0.182
Match hamstring injury incidence, injuries/1000 hours (95% CI)	2.3 (1.3 to 4.1)	6.5 (5.2 to 8.2)	0.36 (0.20 to 0.66)	0.001
Hamstring injury recurrence incidence, injuries/1000 hours (95% CI)	0.1 (0.0 to 0.3)	0.4 (0.3 to 0.6)	0.19 (0.04 to 0.70)	0.025

of the exercise in the teams. The second main finding was that teams that used the NHE in their team training had significantly lower match hamstring injury rates, less severe injuries and lower recurrence rates than teams that only used the NHE for individual players with a history of a hamstring injury.

Can we explain why the implementation of the NHE is low despite the positive attitude of medical staff?

The positive attitude of team medical staff towards the NHE is understandable since there are well designed controlled studies showing that the NHE programme effectively reduces injuries.[5 6] Our study highlights the difficulty with applying an intervention in a controlled vs a clinical environment. Preventive measures proven highly efficacious in clinical trials do not necessarily work in real life on the football field.[2 16 17] These measures have to be successfully implemented in the club, but if the players, coaches and officials are not motivated to use the measures, then the preventive efforts will fail.[18]

There are many potential barriers to implementing preventive measures at the club level. First, the coaching staff usually decide on training content and coaches might not always be prepared to devote training time to preventive programmes.[2 19] Coaches may be concerned about a lack of football specificity or the validity of the suggested preventive measures from the club medical staff since many coaches want the training sessions to mimic actions during matches.[20] Second, lack of time for recovery might be another obstacle. Most professional clubs have a very congested playing calendar with multiple days and nights of travelling.[2 21 22] A tight schedule has a negative effect on the injury situation and the availability of players for training sessions, with increased muscle injury rates found in periods of match congestion.[23] Consequently, coaches could be reluctant to include any time-consuming preventive measures in their regular team training schedule. Third, another obstacle might be negative opinions from players. The majority (81%) of teams using the NHE in this study reported complaints from players, mainly in the form of muscle soreness or stiffness.

Can we explain why NHE seems to reduce hamstring injuries and recurrences effectively?

A main finding in this study is that the hamstring injury rate was significantly lower in teams that implemented the NHE in the ordinary team training and used it for all team players compared with teams with non-use or only individual use of the NHE. An explanation could be that the players understand that the exercise is important if included in team training. Further, the coaches will supervise the exercise session and take action if it is not done with seriousness and quality.

Can we explain why teams that used the NHE in team training had a lower incidence of hamstring injuries at matches only?

The incidence of hamstring injuries at matches was only one-third in the team group compared with the individual training group while the difference between groups were not as profound (and statistically non-significant) for the incidence in training. This difference is most likely explained by the difference in high-intensity actions between training and matches. Most teams have two matches a week during the competitive season, and the training sessions between matches are often focused on recovery, with few opportunities to have high-intensity training sessions. During recovery sessions, the high-intensity actions are fewer, meaning less risk of hamstring injuries and, in turn, less effect of hamstring prevention programmes.

How can our findings be of practical value for players, clinicians and clubs?

A key for medical staff is to convince the coaches about the benefits of using the NHE in the team training. The results from this study might be helpful since it provides clear practical information. Our findings indicate that teams that implemented NHE in team training and used it with most players had fewer hamstring injuries than teams that only used the NHE for individual players with current or a history of a hamstring injury. We acknowledge that the generalisability of our findings outside of the study cohort is uncertain although a previous study on top-tier clubs in Norway showed similar adoption rates as in the ECIS clubs,[10] and preventive efficacy of the NHE has mainly been documented in subelite teams.[5–8]

Player availability is a key indicator for team performance,[24] and absence due to hamstring injuries is a big problem for most teams. Our study shows that teams that implemented NHE in team training had a lower injury burden 100 days fewer injury absence days per team and season on average.

Future improvements

Bahr *et al*[10] reported 83% of teams as non-compliant to the original NHE programme, as suggested by Mjølsnes *et al*.[15] This study found 94% non-compliant. The current study indicates that positive benefits were also seen from a modified NHE programme as long as the NHE is included in the team training for most players.

We suggest three areas of possible improvements be evaluated in future studies:

- Get the coaches on board. Decision-makers (eg, coaches and managers) could play important roles in injury prevention and be decisive for the overall injury situation in a club.[2] The coaches decide the content of training sessions and the load on players. Medical staff can only realise suggestions for preventative training implementation across the whole team if the coach and coaching staffs are positive about the suggestions.

Establish the minimum effective dose. As pointed out by Bahr *et al*,[10] we do not know the NHE programme's minimum effective dose.[10] The current study indicates that even a modified programme might work if used by all or the majority of players in the team and used primarily as a maintenance programme once a week throughout the whole season. The obvious question from coaches to medical staff might be: What is the minimum time that we need to devote to the NHE in our team to reduce our hamstring injury incidence significantly? There are some indications from the Australian football where Presland *et al*[25] found that 2 sets of 4 per week maintain the architectural adaptations (provided they had the 6 weeks of building up strength start of the season). This could be a good starting point for clinicians.

- Widen the horizon and look at alternative risk factors. Injuries are multifactorial. Preventive strategies targeting player-related risk factors may not, on their own, be sufficient to reduce injury rates at the top-level significantly.[2 26] Alternative risk factors need to be investigated to determine whether there is an association with injury rates and to provide guidance on the most appropriate preventive measures to be adopted.[27] We have studied some risk factors suggested by chief medical officers of the clubs participating in the ECIS to contribute to injury risk, and we have found associations between overall injury rates (not specifically hamstrings injuries) and the leadership style of the head coach,[27] the quality of the internal communication within a team,[28] and during periods of match congestion.[22] It is likely that a better understanding of how these risk factors may be associated with injuries could help us reduce hamstring injury rates even further.

Methodological considerations

The study is limited by a relatively small sample size and the short observation period. It would have been beneficial to have a study over several consecutive seasons to establish a more robust association between NHE use and hamstring injury rates, that is, being less likely to be influenced by seasonal flukes in injury occurrences or changes in training practices. Another limitation is the lack of detailed information about the teams' training practices, including strength training sessions and general conditioning or individual training performed by players outside the team. This is especially important as part of the study period was atypical due to the COVID-19 pandemic restart of league play in Europe. However, in a separate study, we found neither any apparent differences in the percentages of muscle injuries between the pandemic 2020 and the previous 5 years nor between the different periods (prelockdown, lockdown and restart) of 2020.[29] On the other hand, another recent, but smaller, study on 84 male elite players from three Belgian teams identified a fivefold higher muscle strain injury rate in players with COVID-19 infection, in particular within the first month of football resumption.[30] To date, there are no hamstring-specific data published and this need to be explored in future studies. Finally, as this is a descriptive ecological study, we cannot infer any causality between NHE use and injury rates since teams may have differed in other aspects of importance for hamstring injury occurrence (confounding factors) unknown to us.

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Contributors JE was responsible for the conception of the study. The survey questions were reviewed by JE, HB, MH and MW. JE distributed the survey, and responses were collected by JE and MD. HB conducted the analyses, which were planned and checked with JE. JE wrote the first draft, which was critically revised by HB, MW, MH and MD. All authors contributed to the interpretation of findings and approved the final manuscript. JE is the study guarantor.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study protocol was approved by the UEFA Football Development Division and the UEFA Medical Committee.ID 09/14 exempted this study. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

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