BMJ Open Sport & Exercise Medicine

Real-world implementation of the Copenhagen Adduction Exercise: what do football teams modify and why?

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To cite: Dalen-Lorentsen T, O'Brien J, Harøy J. Real-world implementation of the Copenhagen Adduction Exercise: what do football teams modify and why? *BMJ Open Sport & Exercise Medicine* 2024;**10**:e001982. doi:10.1136/bmjsem-2024-001982

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/bmjsem-2024-001982).

Accepted 18 July 2024

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ABSTRACT

Objectives To evaluate the use and modification of the Copenhagen Adduction Exercise in football (soccer) teams, including the reasons for modification and alternate injury-prevention strategies.

Methods In this cross-sectional study, staff members from a convenience sample of 50 male elite, academy and amateur football teams in Norway, Germany and Austria completed an online questionnaire focussing on the implementation of the Copenhagen Adduction Exercise. Fourteen of the staff members also completed an interview.

Results Forty-two teams (84%) reported using the Copenhagen Adduction Exercise, but the majority (65%) had modified the original programme. Modifications included changes to sets, repetitions, progressions and frequency and were particularly common among elite teams. The main reasons for modifications were managing overall player load, experiences and beliefs and individualisation. Despite modifications, all teams followed the basic principles of the original programme.

Conclusion The adoption of the Copenhagen Adduction Exercise by football teams is high, but the vast majority of teams modify the programme. Despite these modifications, the basic principles of the programme are maintained.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Copenhagen adduction exercises reduce the risk of groin problems in football players.
⇒ Despite widespread adoption, teams frequently modify the original protocol.
⇒ Little is known about the nature of these modifications, the reasons behind them, and any alternate strategies that teams employ.

WHAT THIS STUDY ADDS

⇒ The majority of teams modified the original protocol but still upheld its basic principles.
⇒ A wide range of reasons for modifications were identified, along with alternate exercises and preventive strategies.
⇒ This adds to the current understanding of the real-world injury-prevention landscape.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The findings can guide the development of future injury-prevention programmes with a better fit for real-work implementation contexts.
⇒ Research identifying the core intervention components (eg, content and dose) of adductor strengthening programmes is needed.

INTRODUCTION

Injuries are a significant problem in sports and can result in lost progress, reduced participation and, in the worst case, athletes quitting their sports altogether.[1–8] As a result, researchers worldwide have placed great emphasis on developing preventive training and warm-up programmes to reduce the incidence of injuries. Randomised-controlled trials (RCT) have demonstrated the efficacy of various injury-prevention programmes and exercises, such as the 11+,[9] Adductor Strengthening Programme (ASP),[10] Nordic hamstring exercise[11] and Oslo Sports Trauma Research Center (OSTRC) shoulder injury prevention programme.[12]

However, the considerable challenges in successfully implementing these preventive measures under real-world conditions are well documented.[13–15] Multiple studies have demonstrated low adherence to evidence-based programmes across a range of sports and settings.[14 16 17] Only 17% of elite male football teams[14] and 3% of amateur teams[17] adhered to the Nordic hamstring exercise, while only 29% of elite handball coaches adhered to the OSTRC shoulder injury prevention programme.[16] These low figures are impacted by how adherence is defined and measured.[18 19] While several sports injury prevention studies have employed the Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) framework[20] to evaluate adherence and other implementation issues,[16 17 21 22] most analyses only consider teams' use of the programme in its original (RCT) form. Despite low adherence to efficacious programmes in their original form, it is well documented that teams frequently modify injury-prevention exercises with the

aim of improving their fit to the specific implementation context.[21 23] When these modifications and the reasons behind them are not considered, an incomplete picture of real-world injury-prevention efforts can result.[20 24]

One example of an efficacious injury-prevention intervention is the Copenhagen Adduction Exercise (CA; part of the ASP). It was designed to impact the most modifiable risk factor for groin pain, reduced hip adduction strength.[10] The protocol is based on general strength principles, with a progressive increase in training volume and the goal of enhancing hip adduction strength.[25] Under RCT conditions, the programme demonstrated a significant reduction in the risk of groin problems[10] and achieved favourable results for the domains reach (100%),[21] adoption (100%)[21] and maintenance (68–97%)[21 22] in the RE-AIM framework. However, there were significant challenges with adherence (termed 'Implementation' in RE-AIM), which describes the extent to which an intervention is performed as originally intended.[20] Only 46%[22] of the athletes and 10%[21] of the programme deliverers (eg, physiotherapists) reported carrying out the programme exactly as described in the original protocol. Despite this, modified forms of the programme were common,[21] aligning with previous research findings of teams employing modified or alternate injury-prevention exercises.[14 23 26 27]

Modifying efficacious interventions carries the risk of jeopardising their fidelity.[28 29] Real-world implementation often requires a delicate balance between the need to adjust the intervention to the context in which it is implemented and the need to maintain the core components that make the intervention effective. This has been referred to as the fidelity-adaptation dilemma.[28 29] Currently, there is a paucity of knowledge on exactly how teams modify evidence-based injury-prevention programmes, their reasons for doing so, and the degree to which teams' modifications uphold the core components of the original programme. The extent to which these factors vary across different football playing levels (eg, elite, academy and amateur) and settings (eg, different countries and regions) is also unknown. This information is essential for guiding the development and implementation of future programmes, which are both adaptable to different implementation contexts while preserving fidelity.

Therefore, the primary objective of this study was to investigate the real-world use and modification of the Copenhagen Adduction Exercise among European football (soccer) teams, including the extent to which any modifications maintain the original programme's basic principles. Additional goals were to comprehensively analyse the reasons for programme modifications, along with evaluating alternate preventive exercises and strategies employed by teams.

METHODS

The participants were a convenience sample of staff members involved in the design and delivery of preventive exercise programmes in elite (first or second national division), academy or amateur male football teams. The staff members were predominantly physiotherapists and strength and conditioning (S&C) coaches in the case of elite and academy teams, while at the amateur level (in the absence of the above-mentioned roles), football coaches or players were responsible for delivering injury prevention exercises. Only one staff member participated per team.

Based on their knowledge and experience of the specific implementation context, the authors exercised their judgement regarding the necessary sample size to achieve the study aims.[30]

The aim was to recruit 25 participants from Norway, where pioneering research on the Copenhagen Adduction Exercise was performed, and a further 25 from Germany and Austria. Furthermore, participants from a range of playing levels (elite, academy and amateur) were targeted, providing a range of different implementation contexts. All participants were recruited through the authors' professional networks.

Data collection included an online questionnaire (online supplemental material S1) for all participants and a semistructured telephone interview (online supplemental material S2) for a subgroup of participants. A mixed-methods approach was employed, combining quantitative (eg, frequency of programme modifications) and qualitative (eg, reasons for modifications) data within a pragmatic paradigm.[31] The pragmatic approach embraces multiple methods and focusses on addressing real-world issues by exploring the interactions between individuals with lived experience and their specific environments.[31] The real-world, practical focus of this paradigm aligns closely with this study's goals. The qualitative methodology employed a general inductive approach[32 33] with latent coding.

Questionnaire

The authors developed an online questionnaire focusing on the awareness, use and modification of the Copenhagen Adduction Exercise, including the associated reasons. The questionnaire was developed in English, Norwegian and German using the QuenchTec Survey Builder by Walr, London, UK. The theoretical foundations of the questionnaire were drawn from the Health Action Process Approach (HAPA) model[34] and RE-AIM framework,[20] in particular the implementation dimension of RE-AIM. The content was also influenced by previous studies[21 22] and the experience of the authors. The questionnaire was piloted on six participants before further refinement and revision. The study was approved by the Norwegian Centre for Research Data (839602).

Semistructured interviews

Additionally, a random sample of 14 participants who reported modifying the Copenhagen Adduction Exercise and consented to an interview were contacted by one of the researchers for a telephone interview. The

semistructured interview was based on the FRAME framework for evaluating adaptations to evidence-based programmes[35] and focused on programme modifications, along with alternate injury prevention exercises and strategies. The interview aimed to gather more detailed information than was possible from a questionnaire alone. Two researchers (JO'B and JH) conducted the interviews. Both were sports physiotherapists with over 15 years of experience, including experience in the specific context of football and the prevention and management of hip and groin injuries. In seven (50%) of the interviews, the researcher knew the participant from previous research or clinical collaboration.

Coding process

Free-text answers from surveys and interviews were coded in a systematic four-step process[23 36]:

1. Two researchers (JO'B and JH) independently coded the interviews and survey answers from six randomly selected participants, following established methods outlined by Tolley *et al*[36] (data immersion, inductive code generation, testing and revision). The two researchers then met to discuss their findings, identify common codes and revise and refine codes until a consensus was reached on an initial code book. To align with the study's aims, all codes were categorised as follows:
   - Why is the original exercise (not) performed?
   - Why is the exercise modified?
   - Which other hip adduction strength exercises are performed?
   - Why are these exercises performed?
   - What other injury prevention strategies are used?
   - Why are these other strategies used?
   - Other
2. The codebook was presented to a third researcher (TDL), and all researchers reviewed, refined, reduced or merged codes until a consensus was reached.
3. One researcher (JO'B) applied the revised codebook to the fee-text answers (interviews and surveys) of all 50 participants, including adding and further refining codes.
4. All three researchers reviewed the final codebook (online supplemental material), and further minor changes were made to the code terminology and categorisation. Code frequency was calculated as the absolute number and proportion of the 50 participants for whom the code was identified. Codes identified in both the survey and interview from the same participant were only counted once.

Equity, diversity and inclusion statement

This study was limited to male football players, as it focused on the real-world implementation of an efficacious intervention, the Copenhagen Adduction Exercise, which has only demonstrated efficacy in male players. A recent RCT, including female players, found no effect of the intervention. Within this restraint, the study purposely sampled teams from three different countries and from a range of football settings, including youth and amateur teams with limited resources and players from marginalised groups. The three authors were from two different countries, two different professions and from early and mid-career contexts, but were not gender-balanced or from marginalised groups. As outlined in the limitation section, there is a need for further research on the efficacy of the Copenhagen Adduction Exercise across different genders, playing levels and settings, along with further implementation research across diverse football contexts.

RESULTS

Participants (n=50) were recruited from elite teams (n=19), amateur teams (n=19) and academies (n=12) located in Norway (n=23), Austria (n=15) and Germany (n=12).

Awareness and use of the exercise

84% (n=42) of all participants were aware of the Copenhagen Adduction Exercise. The remaining 16% (n=8) were all from Austrian amateur teams and were excluded from further questions. Participants reported initially learning about the exercise through conferences or courses (37%, n=15), scientific journals (34%, n=14), colleagues (n=17%, n=7), websites (5% n=2), social media (5%, n=2) and smartphone apps (2%, n=1).

Of the 42 teams who were aware of the Copenhagen Adduction Exercise, 14 (33%) used it in its original form, 28 (65%) in a modified form and one (2%) did not use it (figure 1). All participants who used a modified version of the programme reported adhering to the basic principles of the programme.

Modification of the exercise

All components of the programme underwent modifications in both the preseason and regular season. An overview of these modifications is presented in figure 2. Elite teams reported the highest frequency of modifications.

Reasons for use, modifications and other preventive strategies

The coding of free-text answers from the questionnaires and interviews identified 54 different codes in seven categories. 15 of the 54 codes (28%) were only identified in interviews, while one code (2%) was only identified in the survey. The full codebook, including definitions and code frequency, is provided in online supplemental table S3. Additionally, table 1 summarises the most frequently reported codes (identified by ≥15% of participants). The most frequently reported reason for modifying the programme was to manage the overall load. This included only progressing exercises to a certain threshold and reducing the intensity and volume of exercises prior to football, with the aim of avoiding fatigue (see online supplemental table S3). Participants frequently reported

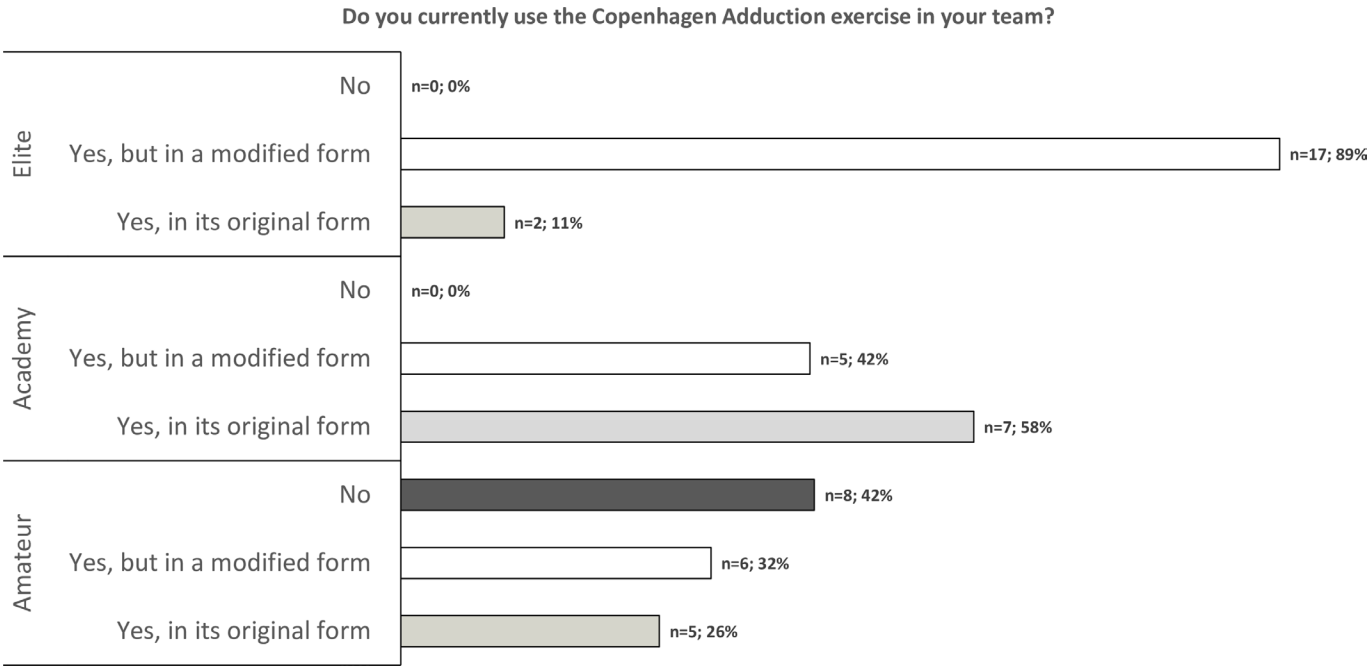

Figure 1 Proportion of teams using the original or modified form of Copenhagen Adduction exercise grouped on different levels of play.

sessions per week, sets and repetitions as a range (eg, 1–2 sessions with 2–3 sets and 8–10 repetitions), along with context-specific adaptations (eg, lower volume/intensity before football sessions) and individualised player programmes. This made pooling of the data on sessions, sets and repetitions difficult. The use of alternate adductor strengthening exercises was common, particularly hip adduction in standing with a cable or resistance band, which was reported by over a third of participants (table 1). None of the modified programmes retained the original level 1 exercise (side-lying and open-chain hip adduction), but isometric exercises such as the adductor squeeze against a ball or ForceFrame (26%), isometric Copenhagen Adduction (16%) and isometric side planks (6%) were reported as alternate low-load exercises (see table 1 and online supplemental table S3).

92% (n=39) replied that they were planning to use the programme in the following season; the remaining 8% (n=3) answered that they didn't know.

Contribution of interview data

In addition to identifying 15 additional codes, the interviews (n=14) significantly impacted the frequency of codes and assisted in clarifying the descriptions of certain exercises and strategies reported in the survey. The online supplemental table S3) provides a breakdown of code frequency from surveys and interviews, in addition to the total code frequency reported in table 1 above. The interviews also provided additional information on the staff member(s) involved in delivering the programme. 11 (79%) reported strength and conditioning coach(es),

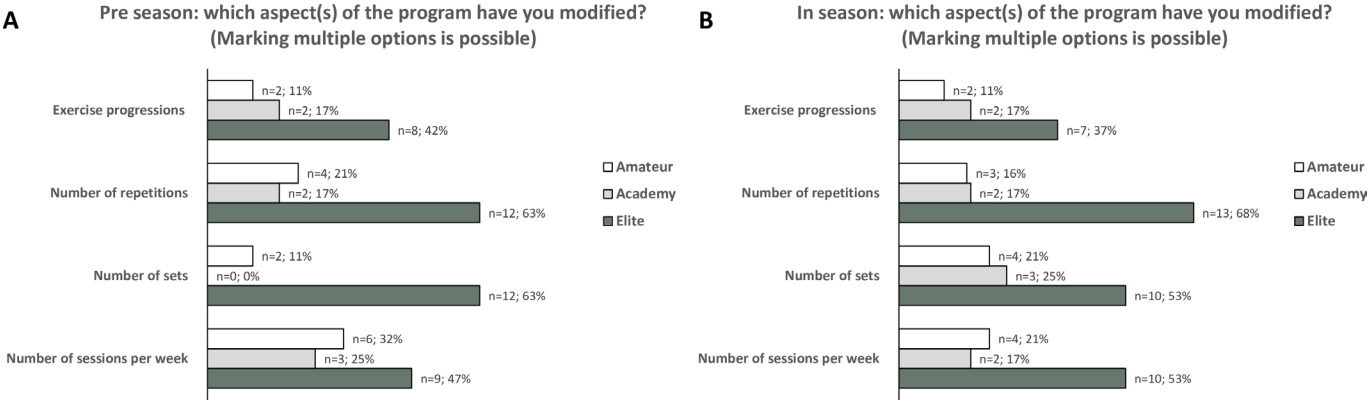

Figure 2 Illustrate the aspects of the original program that the teams modified during the pre-season (A) and in-season (B), distributed across the categorised elite-, academy- and amateur teams.

Table 1 The reasons for football teams (n=50) using and modifying the Copenhagen Adduction Exercise and other preventive strategies*

Category	Code	Description*	Count	Frequency
Why is the original exercise (not) performed?	Previous experience	Staff members perform the exercise based on previous experience in other clubs and/or seasons.	23	46%
	Practicality	Staff members perform the exercise because it is easy to implement and modify, and no equipment is required.	15	30%
	Evidence base	The exercise is performed based on scientific evidence from journals and conferences.	8	16%
Why is it modified?	Overall load	The volume and intensity of the exercise are modified based on the overall physical and psychological load on players.	21	42%
	Experiences and beliefs	Staff members modify the programme based on their experiences from previous seasons/clubs. Players' experiences and beliefs are considered.	15	30%
	Individualisation	The exercise is modified to better fit player's age, strength profile and experience with the exercise.	14	28%
	Injury and symptoms	The programme progressions are modified to reduce (perceived) injury risk and in response to symptoms.	12	24%
	Variation and progression	Strength and conditioning training is periodised across the season, with different foci in different training phases and a variety of exercises.	8	16%
Which other strength exercises are performed?	Hip Adduction Cable Pull	Resisted hip adduction in single-leg stand with cable or resistance band.	19	38%
	Squeeze	Isometric hip adduction in supine against a ball or ForceFrame device.	13	26%
	Lateral Lunges	Lateral lunges in various angles.	9	18%
Why are these exercises performed?	Comprehensiveness	A multifactorial approach with a range of exercises is considered important.	14	28%
	Football specificity	Exercises replicating kicking and change of direction are performed in standing positions.	8	16%
Which other strategies are used?	Load management	Monitoring and managing local tissue load and total player load.	23	46%
	General strength	Includes hip and trunk strengthening, squats and straight lunges.	15	30%
	Range-of-movement	Active/passive interventions aimed at improving hip/lumbar spine range of movement.	14	28%
Why are these other strategies used?	Comprehensiveness	Strength is one of several interventions and Copenhagen Hip Adduction is one of several strengthening exercises.	13	26%
Other*				

*See online supplemental material for the full list of categories and codes. Only codes with a frequency of ≥15% are included in this summary.

10 (71%) physiotherapist(s), 2 (14%) players and 1 (7%) football coach.

DISCUSSION

This cross-sectional study investigated the use and modification of the Copenhagen Adduction Exercise in 50 European football teams. The main finding was that despite the low use of the original exercise protocol, the use of the programme in a modified form was high, and teams still maintained the original programme's basic principles. The study also identified a range of reasons for programme modifications, along with alternate exercises and other preventive strategies which teams use under real-world conditions. The findings have implications for the development of future injury-prevention programmes in both football and other team sports.

How do teams use the CA exercise?

All of the participants who knew the CA exercise (84%) reported using the exercise in either the original or modified form. Over a quarter (26%) of amateur teams and over one-half (58%) of academy teams reported using the original programme, in comparison to just 11% of elite teams. One potential explanation is the elite teams' increased staff numbers and more extensive facilities, along with more professional performance and injury-prevention strategies. The high reach and adoption of the CA exercise, in either its original or modified form, supports previous findings.[21] The main reported reasons

for using the exercise were staff members' previous experience, along with the programme's practicality and evidence base. The lack of awareness of the programme among amateur Austrian teams highlights the need for increased dissemination efforts in this particular implementation context.

What do teams modify and why?

In line with previously published studies involving both players and staff members,[21 22] participants in the present study frequently reported modifying the original CA exercise protocol. The most frequently reported reasons were to manage the overall player load (42%), reflect the experiences and beliefs of staff and players (30%) and tailor the programme to individual player profiles (24%). These findings, specific to the CA exercise, align with previously established implementation facilitators for injury-prevention exercises in football.[23 26] Teams modify efficacious programmes to increase their fit to the specific implementation context.[23 26] Programmes that are adaptable to different training locations, formats and goals, along with containing adequate individualisation, variation and progression, will facilitate adoption and adherence under real-world conditions.[23 27] However, the impact of these modifications, either positive or negative, on the fidelity of the CA exercise is unknown.

Several studies have documented the positive strength effect of the CA, ranging from 1% to 40%, with variations in protocols.[37–42] In terms of groin injury rates, several have been evaluated, with results ranging from no effect to a 41% injury risk reduction.[10] The optimal dosage of CA to maximise its effectiveness in reducing groin injury rates remains unknown.[39] Accordingly, defining an adequate level of adherence is also difficult. If the definition of adherence is limited to teams performing the original programme, adherence to the CA exercise in the current study was low, especially for the elite teams. However, if the definition embraces modified versions of the programme that still maintain the basic principles, adherence in the current study was very high. We defined the basic principles or 'core components'[29] of the CA programme to align with general strength principles, with a progressive increase in training volume and the goal of enhancing hip adduction strength.[25] However, there is currently no research evidence to support this definition. Comparing the effects of different programmes on adductor muscle strength, muscle architecture and hip and groin injury rates are important areas for future research.[43] The fidelity-adaptation dilemma remains a challenge in sports medicine, health promotion and other fields.[28 29]

Other strategies

This study identified several alternate preventive exercises (eg, Adduction Cable Pull and Squeeze) and preventive strategies (eg, load management and general strengthening) employed by teams. Analysis of the reasons for these strategies highlights a multifactorial and comprehensive approach to injury prevention, aligning with previous findings in football.[44 45] As emphasised by the participants in this study, the CA exercise is just one of several important strengthening exercises, and strength is just one of several important injury-prevention strategies.

Limitations

In the absence of a standardised approach to determining adequate sample size in qualitative research,[30] the authors exercised their qualified judgement. The high repetition of codes and themes relating to the reasons for using and modifying the CA exercise suggests that saturation was reached. All participants were recruited through the authors' professional networks, which may have impacted the study findings. However, it is possible that a larger or more diverse sample (eg, including teams from other countries and continents) would have identified additional factors.

As the core intervention components and minimal effective dosage of the Adductor Strength Exercise have not been determined, the extent to which the teams' programme modifications negatively impact the injury-prevention effect of the intervention is unknown.

The questionnaires used were tested in a small pilot study, and we cannot be certain all the participants understood the questions and interpreted them correctly. The questionnaires were developed in English and then translated by the authors into Norwegian and German. The authors are not certified translators but are subject matter experts, which added to the questionnaire's face validity.

Not all participants were interviewed due to pragmatic reasons, including the author's time capacity and the goal of completing the study within one football season. One-third of all participants did not agree to be interviewed. The interviewers' pre-existing relationships with some of the participants may have influenced the interaction and data. As 28% of codes were only identified in interviews, our findings support the use of interviews in addition to the online survey. The generalisability of the study is limited by the fact that it only included male football players from three European countries. Consequently, the applicability of the findings to other populations and contexts remains uncertain. Future research should explore both the efficacy of the Copenhagen Adduction Exercise across different genders, playing levels and settings, as well as the intervention's real-world impact across diverse football contexts.

Clinical implications

The results suggest the need for context-specific implementation strategies. For example, awareness of the evidence-based CA exercise among amateur Austrian teams was low, indicating the need for dissemination efforts in this context. In other settings, where teams frequently modify the programme, the key challenge is finding the balance between maintaining fidelity

and adapting to the specific implementation context. The insights in this study, from a range of teams and settings, can inform practitioners navigating the fidelity-adaptation dilemma.

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Acknowledgements The authors acknowledge the participants in the study for their time and effort.

Contributors All authors contributed equally in the planning of the study, the data collection, the analysis and the drafting of the manuscript. TDL is the guarantor for the work.

Funding The Oslo Sports Trauma Research Centre 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 IOC, the Norwegian Olympic Committee, and Confederation of Sport and Norsk Tipping AS.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. The regional ethics board and the university ethics board have expressed that studies like these are exempt from the national laws of health research and should not apply for ethical approval. The study has been approved by the Norwegian Centre for Research Data. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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