Research Square

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Risk factors and symptoms associated with cardiovascular disease in female elite hockey players allowed bodychecking

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Abstract

Background

Cardiac screening is recommended for athletes aged ≥ 16 to prevent sport-related sudden cardiac death (SCD), but overall adherence to these recommendations among many team sport associations in Sweden remains low.

Aims

This study aims to investigate cardiovascular risk factors and symptoms in elite hockey players in the Swedish Women's Hockey League (SDHL).

Methods

All 225 registered SDHL players were invited to participate; 159 (71%) accepted to participate and were included in the study. During the season 2023–2024, the included players answered a questionnaire regarding cardiac symptoms and family history of cardiac diseases.

Results

The mean age was 24 ± 5 years. Cardiac symptoms were reported by 11% (n = 18) of the study participants and 36% (n = 57) reported a family history of cardiovascular disease. Among the players, 7% (n = 11) had a parent or sibling with diabetes, 26% (n = 42) with hypertension and 11% (n = 17) with cardiac disease. Four players (3%) had a first-degree relative with sudden cardiac death. Previous cardiac arrhythmia was reported in 4% (n = 7) by the players, 5% (n = 8) had experienced chest pain, and 11% (n = 16) had experienced an episode of syncope. In addition, 1% (n = 1) of the players had coronary artery disease, 1% (n = 1) hypertension and 3% (n = 4) diabetes.

Conclusions

A significant number of female elite hockey players presented with symptoms and/or a family history of cardiovascular disease. Our findings support the use of pre-participation screening in female elite hockey players to identify athletes at risk of adverse cardiac events.

Trial registration:

https://clinicaltrials.gov/study/NCT06351618?cond=ice%20hockey%20female&viewType=Card&rank=4 (ID: NCT06351618) Registered on: 2023-12-01

Key points

• Approximately one tenth of the female elite hockey players in the Swedish Women's Hockey League reported cardiac symptoms, and more than one third of the players reported a family history of cardiovascular disease.

• The most reported symptoms were syncope (11%) and chest pain (5%), while the most frequent hereditary risk factor was hypertension (26%) in a first-degree relative.

• Systematic cardiac screening, including ECG, may be warranted in female ice hockey players, particularly given the increased physical demands following the introduction of body checking.

Introduction

Sudden cardiac death (SCD) in athletes is a rare but devastating event, often occurring without prior symptoms in individuals perceived as being in peak physical condition. The estimated incidence ranges from 0.2 to 6.8 per 100,000 athletes annually, with substantial variability influenced by age, ethnicity, and sporting discipline (1). Even if the incidence is relatively low, competitive young athletes have an up to 4.5-fold increase in incidence rate compared to recreational athletes of the same age (2). This has been attributed to the fact that intense physical activity can trigger cardiac events due to physiological stressors during exercise such as hyponatremia, hyperthermia, and dehydration (3).

In athletes under 35 years of age, SCD is often linked to congenital or hereditary cardiovascular disorders, including coronary artery abnormality, hypertrophic and arrhythmogenic cardiomyopathy, as well as inherited channelopathies such as long QT syndrome and Brugada syndrome (4, 5). These conditions are often asymptomatic, with sudden cardiac arrest (SCA) or SCD being the first manifestation. However, many of these individuals can be identified through pre-participation cardiovascular screening, which has been shown to reduce the incidence of exercise-related SCA and SCD (6, 7).

In Sweden, national guidelines recommend that all elite athletes undergo regular cardiovascular screening from the age of 16. This screening should include a resting ECG, a standardized questionnaire on symptoms and family history, and a physical examination (8). These recommendations align with international guidelines for cardiac screening in elite athletes (9, 10, 11). However, the overall adherence to these screening recommendations in Sweden remains low among athletes at both the elite and recreational levels, with significant variation observed among athletes depending on sex, sport, and level of competition. The low adherence may partly be attributed to limited financial resources in many teams, where sport and performance-related priorities often outweigh medical considerations. It has also been questioned whether cardiovascular pre-participation screening is relevant and cost-effective in female athletes as the prevalence of SCA and SCD are significantly lower in females than in males (12, 13).

Despite the existence of both national and international guidelines, there is currently no mandatory pre-competition cardiac screening in place for many athletes, including those in the Swedish Women's Hockey League (SDHL). Ice hockey is characterized by short bursts of high-intensity, intermittent activity that frequently elevates the heart rate above 85% of the athlete's maximum (14). In 2022, SDHL became the first women's league globally to permit body checking, likely increasing both physical and cardiovascular demands as well as the risk of trauma to the chest. While rare, blunt chest trauma from body checks or puck impact can also cause SCA through commotio cordis, a mechanically induced arrhythmia (15). As female participation and physical intensity in ice hockey rise, it is increasingly important to address different health risks, including cardiovascular ones, to improve preventive measures. This study aims to investigate risk factors and symptoms associated with cardiovascular disease in female elite ice hockey players in SDHL who are allowed bodychecking.

Method

The present study is part of the broader research project *"Women's Ice Hockey Injury Study"* which aims to investigate injury incidence, prevalence and contributing risk factors among elite female ice hockey players in SDHL. A detailed description of the study method has been presented in a previous study (16). The SDHL consists of 10 teams, each comprising approximately 20–25 players. Prior to the 2023/2024 season, all 225 athletes registered in the league were invited to participate in the research project. Email invitations were distributed using contact information provided by team sports managers. While representatives from both the league and individual clubs supported the study (e.g., by facilitating communication), they did not have access to the data, nor were they involved in the data analysis.

Each invitation email included detailed written information about the purpose of the study, the procedures involved, potential risks and benefits and ethical aspects. The participants received a link to an online survey, available in both Swedish and English. The questionnaire has been used and validated in previous studies within the same research project and is described in detail elsewhere (16, 17, 18, 19, 20). The items used in the present study is presented in detail in Appendix 1. Participation was voluntary, with the possibility to decline or withdraw at any stage without providing a reason. All respondents provided written informed consent before proceeding to the survey.

In total, 159 players (71% response rate) chose to participate and were directed to the web-based questionnaire. The survey collected information on date of birth, height, weight, playing position, country of birth, tobacco, alcohol and medical use. Age was calculated as the time difference between birth date and date of filling in the questionnaire. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$. The survey also collected information on family history of cardiovascular conditions including diabetes, hypertension, cardiac disease and SCD as well as the participants' own history of cardiovascular symptoms and diagnoses, including diabetes, hypertension, arrhythmia, coronary artery disease, hyperlipidemia, ICD/Pacemaker, chest pain and syncope. The study adhered to the Declaration of Helsinki, was approved by the Swedish Ethical Review Authority (Dnr: 2023-06114-01) and registered at ClinicalTrials.gov (ID: NCT06351618). We used SPSS (version 18.0, SPSS Inc., Chicago, IL, USA) for

statistical analysis. Descriptive statistics are presented as mean± standard deviations (SD) or numbers (n) and percentage (%).

Results

Descriptive statistics of the study population are presented in Table 1. In the whole study population, 11 (7%) had a parent or sibling with diabetes, 42 (26%) a parent or sibling with hypertension and 17 (11%) a parent or sibling with a cardiac disease. Four participants (3%) had a parent or sibling who died in a SCD and 16 participants (10%) had two or more types of heredity. The total number of participants with self-reported heredity was 57 (36%). Seven (4%) study participants declared that they had experienced an episode(s) of cardiac arrhythmia/irregular heartbeat, 8 (5%) had experienced chest pain and 16 (11%) had experienced syncope (Table 2). Two participants (1%) reported two or more cardiac symptoms. The total number of participants with cardiac symptoms was 18 (11%).

Table 1
Descriptive statistics of the study population (n = 159)

Age (years)	**24 ± 5**	
Body weight (kg)	68 ± 6.7	
Body height (cm)	169 ± 6	
Body mass index (BMI)	24 ± 2	
Player position		
	Goalkeeper	18 (11)
	Defensemen	53 (33)
	Forwards	85 (54)
	Missing	3 (2)
Country of birth		
	Scandinavia (Sweden, Norway, Denmark, Finland)	113 (71)
	North America	13 (8)
	Czechoslovakia	11 (7)
	Other European country	13 (8)
	Asia (Russia or Japan)	3 (2)
	Missing	6 (4)
Smoking status		
	Yes	0 (0)
	No	154 (97)
	Missing	5 (3)
Alcohol use		
	Never	46 (29)
	Less than 1 standard glass per week	98 (62)
	1–2 standard glasses per week	10 (6)
	3–9 standard glasses per week or more	0 (0)
	Missing	5 (3)
Snus use		

Age (years)	**24 ± 5**	
	Yes	23 (15)
	Yes, sometimes	7 (4)
	No, never	124 (78)
	Missing	5 (3)
Regular medication use		
	Yes	31 (20)
	No	119 (75)
	Missing	9 (5)

Table 2
The prevalence of cardiac risk factors and symptoms in 159 elite ice hockey players in the Swedish Women's Ice Hockey League SDHL. Data is presented as n (%).

Heredity				
Do you have a parent or sibling with any of the following conditions or diseases?				
	Yes	*No*	*Do not know*	*Missing*
Diabetes	11 (7)	137 (86)	2 (1)	9 (6)
Hypertension	42 (26)	94 (59)	14 (9)	9 (6)
Cardiac Disease	17 (11)	126 (79)	7 (4)	9 (6)
Sudden Cardiac Death	4 (3)	140 (88)	6 (3)	9 (6)
Symtoms				
Do you currently have, or have you previously had, any of the following diseases, symptoms, or conditions?				
	Yes	*No*	*Do not know*	*Missing*
Diabetes	4 (3)	146 (91)	0 (0)	9 (6)
Hypertension	1 (1)	149 (93)	0 (0)	9 (6)
Arrythmia	7 (4)	143 (90)	0 (0)	9 (6)
Coronary Artery Disease	1 (1)	149 (94)	0 (0)	9 (6)
Hyperlipidemia	0 (0)	150 (94)	0 (0)	9 (6)
ICD/Pacemaker	0 (0)	150 (94)	0 (0)	9 (6)
Chest pain	8 (5)	142 (89)	0 (0)	9 (6)
Syncope	16 (10)	134 (84)	0 (0)	9 (6)

Discussion

This study shows a notable prevalence of cardiovascular risk factors and symptoms among female elite ice hockey players in the Swedish Women's Hockey League (SDHL), where body checking recently has been introduced. Despite being a relatively young and seemingly healthy athletic population, a considerable proportion of the players reported a positive family history of cardiovascular diseases, most notably hypertension (26%) and cardiac disease (11%), as well as sudden cardiac death (3%). Additionally, a non-negligible number of athletes reported having experienced symptoms that may be indicative of underlying cardiac pathology, including arrhythmia (4%), chest pain (5%), and syncope (11%).

These findings are particularly concerning given the well-established association between family history and the risk of SCA or SCD, as shown in prior studies (21). The relatively high prevalence of syncope is a concern as syncope has been repeatedly identified as a red flag symptom for underlying arrhythmic disorders and as a possible predictor of future SCA/SCD events in athletes (22, 23).

Moreover, elite ice hockey imposes substantial physiological demands on the cardiovascular system due to its high-intensity, intermittent nature, with players frequently reaching > 85% of their maximum heart rate. The recent introduction of body checking in the SDHL likely increases both the cardiovascular and physical demands, potentially raising the risk of both exercise-induced and trauma-related cardiac events.

Previous research supports the importance of cardiovascular screening in elite athletes, since implementation of cardiac screening programs has been associated with a significant reduction in incidence of SCD in young athletes (24). In line with our results, a recent study (25) found that 3.4% of female elite ice hockey players were diagnosed with conditions associated with an elevated risk of SCD —supporting the relevance of screening in this specific athletic population (7). Although the incidence of sport-related SCD is higher among males than females (12), the rapid expansion of women's ice hockey, combined with the findings of this study indicating that many elite female ice hockey players exhibit cardiac symptoms despite the absence of mandatory pre-competition cardiac screening in the SDHL, highlights a significant area for improvement in athlete health policy.

Furthermore, a recent epidemiological study conducted in Quebec, Canada reported that ice hockey had the highest participation-based rate of SCD among elite sports, with an incidence of 0.19 per 100,000 athletes per year (26). Although this rate remains low, the potential severity of a single fatal event, in a highly visible setting, reinforces the value of proactive prevention measures.

Strengths and limitations

This study has several strengths. First, the high participation rate among a unique cohort of female ice hockey players competing in a league where bodychecking is allowed adds new significant knowledge. The study is also addressing the existing research gap regarding cardiovascular screening, symptoms, and risk factors among female athletes—a field that has traditionally focused on male athletes. Moreover, the inclusion of players from all teams in the SDHL strengthens the representativeness and generalizability of the findings to other female ice hockey leagues including those who do not allow bodychecking.

However, the study also has several limitations. The reliance on self-reported data introduces potential recall bias, especially for subjective symptoms such as arrhythmia or chest pain. In addition, symptoms and heredity may have been underreported if the players identify themselves as being very healthy. It is also unknown whether the reported symptoms occurred in connection with exercise or not. The absence of objective diagnostic tools, such as ECG or echocardiography, further restricts the ability to confirm

potential underlying cardiac conditions and/or diseases. Nonetheless, the study's novelty provides a valuable foundation for future research on cardiovascular health and screening practices among female ice hockey players as well as female athletes within other contact sports.

Conclusions

The findings of this study suggest a need for systematic pre-participation cardiac screening among female elite ice hockey players, particularly in leagues like the SDHL, where recent rule changes, such as the introduction of body checking, have increased the sport's physical demands. Future research should evaluate the value of including physical examinations and electrocardiography (ECG) as part of standardized pre-participation screening programs.

Declarations

Acknowledgements

None.

Author contributions

AL is the primary investigator of the research project and planned the study, performed the data analysis, and redacted the manuscript; MFT contributed to the design of the study, and assisted in writing the manuscript; ES contributed to the writing of the manuscript, and AG contributed to the statistical analysis and KS to the writing of the manuscript and as a senior advisor to the intellectual content. All authors reviewed the manuscript.

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Conflict of interest

The authors declare no competing interests.

Ethical approval and consent to participate

All respondents provided written informed consent before proceeding to the survey.

Data availability declaration

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request. Data are located in controlled

access data storage at Lund University.

Ethics declaration

All procedures involving human participants were conducted following the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Participation in the study was entirely voluntary, with assurances of anonymity and confidentiality upheld throughout the research process. Before data collection, all participants provided informed consent through a digital consent form. The study adhered to the Declaration of Helsinki, was approved by the Swedish Ethical Review Authority (Dnr: 2023-06114-01) and registered at ClinicalTrials.gov (ID: NCT06351618).

Consent for publication

All participants provided written informed consent to participate in the study and consented to the publication on a group level.

Data Availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

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Supplementary Files

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- Appendix1.docx