ACTA UNIVERSITATIS GOTHOBURGENSIS
GOTHENBURG STUDIES IN EDUCATIONAL SCIENCES 493

Interdisciplinary research and youth sport injury

Developing methodological insights

Solveig E. S. Hausken-Sutter

UNIVERSITY OF GOTHENBURG

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Abstract

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Recognising sport injuries as complex phenomena has urged calls for alternative research approaches to better understand their causes. Instead of adhering to traditional research approaches only, scholars advocate for a methodological pluralism, incorporating both qualitative and quantitative methods and integrating knowledge from different disciplines. Such integrated approaches offer a more comprehensive understanding of sport injuries by addressing their multifaceted and intricate nature. While integrated research approaches in sport science are gaining momentum, their focus has primarily centred on adult athlete health. However, given the prevalence of youth sport injuries and their significant consequences, it is necessary to develop effective approaches for studying them. Moreover, there is a lack of best practices for how to integrate methods and knowledge from different disciplines in youth sport injury research. Addressing these gaps is crucial for informing comprehensive injury prevention interventions.

The overall aim of this thesis is to explore and explain the methodological insights that can be gained from conducting interdisciplinary youth sport injury research. Three research questions guide the thesis:

1) What is the base of existing disciplinary knowledge on youth sport injuries and how does this knowledge shape the understanding of youth sport injuries?
2) What contextual and methodological issues are important to consider in interdisciplinary youth sport injury research?
3) How can qualitative and quantitative youth sport injury data be integrated in an interdisciplinary research process?

The thesis incorporates four journal papers and presents these in the following framework text embedding the conducted research papers into a broader theoretical perspective. The four central papers are: a research protocol paper, a narrative review of literature, a paper describing the adaption and application of a questionnaire to youth football players, and a methodological paper focusing on the integration of qualitative and quantitative youth sport injury data as part of an interdisciplinary research process. All of these papers were developed within the interdisciplinary research project 'Injury-free children and adolescents: Towards better practice in Swedish football (FIT project)'.

The thesis has generated three broad insights that correspond to the research questions. First, existing knowledge on youth sport injuries stems from several fields, including biomedicine, sport psychology and sport sociology, underscoring the complex and interdisciplinary nature of youth sport injuries. Second, contextual factors significantly impact youth sport injuries, making it necessary for future researchers to account for these influences when developing research tools and addressing ethical concerns during the interdisciplinary research process. Third, integration of qualitative and quantitative youth sport injury data is facilitated through a three-stage procedure that enables common ground, a comparison of different types of data, and dialogue across disciplinary boundaries.

Overall, the thesis showcases three vital components crucial to interdisciplinary research: Synthesisation, contextualisation, and integration. The thesis also highlights the need for further exploration of interdisciplinary practices' possibilities and limitations related to integration and their application in developing complex injury prevention interventions.

Svensk sammanfatning

Idrottsskador är komplexa och kräver alternativa forskningsmetoder för att bättre förstå orsakerna. Forskare förespråkar metodologisk pluralism, vilket innebär att använda både kvalitativa och kvantitativa metoder samt integrera kunskap från olika discipliner. Ett sådant integrerat tillvägagångssätt ger en mer omfattande förståelse av idrottsskador genom att bemöta deras mångsidiga och invecklade natur.

Användningen av integrerade forskningsmetoder ökar inom idrottsforskning, men fokus ligger främst på vuxna idrottares hälsa. På grund av hög prevalens och alvarliga konsekvenser så är det väsentligt att även utveckla effektiva metoder för att undersöka idrottsskador hos ungdomar. Det finns även en brist på tillvägagångssätt för att integrera metoder och kunskap från olika discipliner i forskning om ungdomars idrottsskador. Att adressera dessa kunskapsluckor är avgörande för att klargöra hur skadeförebyggande insatser kan implementeras effektivt.

Det övergripande syftet med denna doktorsavhandling är att utforska och förklara de metodologiska insikter som kan erhållas genom att bedriva tvärvetenskaplig idrottsskadeforskning. Tre forskningsfrågor vägleder avhandlingen:

1) Vilken befintlig disciplinär kunskap finns om idrottsskador hos ungdomar och hur formar denna kunskap vår förståelse av fenomenet?
2) Vilka kontextuella och metodologiska frågor är viktiga att beakta i tvärvetenskaplig forskning om idrottsskador hos ungdomar?
3) Hur kan kvalitativa och kvantitativa data om idrottsskador hos ungdomar integreras i en tvärvetenskaplig forskningsprocess?

Avhandlingen omfattar fyra vetenskapliga artiklar som placeras i ett bredare teoretiskt sammanhang. De fyra artiklarna är: ett forskningsprotokoll, en narrativ litteraturöversikt, en artikel som beskriver anpassningen och tillämpningen av ett frågeformulär till unga fotbollsspelare, samt en artikel som fokuserar på integrering av kvalitativa och kvantitativa data om idrottsskador som en del av en tvärvetenskaplig forskningsprocess. Dessa artiklar har utvecklats inom forskningsprojektet 'Skadefri barn- och ungdomsidrott: Mot en bättre praktik för svensk fotboll (FIT-projektet)'.

Avhandlingen har genererat tre övergripande insikter som kan relateras till forskningsfrågorna. För det första kommer befintlig kunskap om idrottsskador

hos ungdomar från flera olika områden, såsom biomedicin, idrottspsykologi och idrottssociologi, vilket understryker den komplexa och tvärvetenskapliga karaktären hos idrottsskador. För det andra påverkar kontextuella faktorer idrottsskador hos ungdomar avsevärt, vilket gör det nödvändigt för framtida forskare att beakta dessa faktorer i utvecklingen av forskningsmetoder och vid hantering av etiska problem under den tvärvetenskapliga forskningsprocessen. För det tredje underlättas integrationen av kvalitativa och kvantitativa data genom en procedur som möjliggör gemensam grund, en jämförelse av olika typer av data och disciplinöverskridande diskussioner.

Sammanfattningsvis demonstrerar avhandlingen tre viktiga komponenter som är avgörande för tvärvetenskaplig forskning: syntetisering, kontextualisering och integrering. Avhandlingen belyser också behovet av ytterligare förståelse av den tvärvetenskapliga forskningens möjligheter och begränsningar relaterade till integration och deras tillämpning vid utveckling av komplexa skadeförebyggande interventioner.

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List of original papers

The following papers were written during my time as a doctoral researcher:

I. **Hausken, S. E. S.,** Barker-Ruchti, N., Schubring, A., & Grau, S. (2018). Injury-free children and adolescents: towards better practice in Swedish football (FIT project). *Research Ideas and Outcomes, 4,* e30729. https://doi.org/10.3897/rio.4.e30729

II. **Hausken-Sutter, S. E.,** Pringle, R., Schubring, A., Grau, S., & Barker-Ruchti, N. (2021a). Youth sport injury research: a narrative review and the potential of interdisciplinarity. *BMJ Open Sport & Exercise Medicine, 7*(1), e000933. http://dx.doi.org/10.1136/bmjsem-2020-000933

Correction: This article has been corrected since it was first published. The funding statement was missing in the published version which has been reinstated. https://doi.org/10.1136/bmjsem-2020-000933corr1

III. **Hausken-Sutter, S. E.,** Schubring, A., Grau, S., Boije af Gennäs, K., & Barker-Ruchti, N. (2021b). Methodological implications of adapting and applying a web-based questionnaire on health problems to adolescent football players. *BMC Medical Research Methodology, 21(*252), 1-11. https://doi.org/10.1186/s12874-021-01406-7

IV. **Hausken-Sutter, S. E.,** Boije af Gennäs, K., Schubring, A., Grau, S., Jungmalm, J., & Barker-Ruchti, N. (2023). Interdisciplinary sport injury research and the integration of qualitative and quantitative data. *BMC Medical Research Methodology, 23*(110), 2-9. https://doi.org/10.1186/s12874-023-01929-1

My contributions for each of the four papers

Paper I: Design of the paper, drafting and writing the paper as a first author, leading the writing process together with co-authors, submission (corresponding author), and revision.

Paper II: Conceptualisation and design of the paper, drafting and writing the paper as first author, leading the writing process together with co-authors, reviewing all literature, leading the analysis process, synthesising findings in the literature review, submission (corresponding author), and revision.

Paper III: Conceptualisation and design of the paper, data collection and processing, analysing and interpretation of data, drafting and writing the paper as first author, leading the writing process together with co-authors submission (corresponding author), and revision.

Paper IV: Design of the paper, data collection and processing, analysing and interpretation of the data, drafting and writing the paper as first author, leading the writing process together with co-authors, submission (corresponding author), and revision.

Preface

> "Borders? I have never seen one. But I have heard they exists in the minds of some people."
>
> - Thor Heyerdahl

The above quote on *borders* is printed on a red cup that sits on my desk, a relic from my current office. While I am unaware of the backstory behind the text printed on the cup, I recall a moment in 2021 when I sipped my morning coffee from it and found a connection to my research. Thor Heyerdahl was a Norwegian adventurer and ethnographer famous for his voyages across oceans, which served to demonstrate the potential for contact between ancient people separated by vast distances. Though I may not relate to Heyerdahl's adventure of crossing the oceans, my research presented in this thesis similarly highlights the possibility of promoting connections between distinct scientific disciplines. However, before I go any deeper into the topic of borders, or as I will refer to them throughout this thesis, boundaries, I find it necessary to provide some context, and I begin with my personal journey towards obtaining my PhD. Ever since I was 11 years old, when I filled out answers to questions in the memory books of school friends about my goals for adulthood, conducting research consistently ranked among my top three choices. Alongside dreams of becoming a football player (a passion I pursued from ages 8 to 16) or working with animals, the fascination of 'doing research' intrigued me. It was the notion of becoming an 'expert' in a specific field that particularly resonated with me. I envisioned myself as one of those esteemed experts invited to share insights on television news segments: "And now, we turn to Professor Hausken, who will enlighten us on this critical topic that demands greater understanding." Despite my shyness, I believed that possessing extensive knowledge in a particular area would grant me the confidence to speak with authority and clarity.

My early interest in sport, health, and health promotion led me to question why people make the choices they make in relation to health and what influence peoples' choices have on their health behaviours. These questions drew me to the fields of psychology and sociology. In 2009, I earned my bachelor's degree in social

sciences with a specialisation in psychology and sociology from the Norwegian University of Science and Technology (NTNU), Trondheim. I enjoyed the combination of psychology and sociology as they illuminated different aspects of human health behaviour. I therefore did my master's degree in health and social psychology at the University of Oslo. While I did take courses in qualitative methods during my bachelor's and master's programs, the majority of the courses offered focused on quantitative research. Furthermore, many students and teachers approached their research using quantitative methodologies. Consequently, a quantitative approach to research was something that I carried into my next role as a research assistant.

After my master's, I became a research assistant in Mona Bjelland's postdoctoral project 'Family & Dietary habits (F&D)' at the Department of Nutrition, Institute of Basic Medical Sciences, University of Oslo. In this role, I worked with quantitative data and contributed to the development of a family and dietary habits-questionnaire (Bjelland et al., 2014; Hausken et al., 2019). Due to positive experiences from my time as a research assistant, I decided to pursue a PhD.

On the 3rd of January 2017, I took up a PhD position in the research project 'Injury-free children and adolescents: 'Towards better practice in Swedish football (FIT project)' at the Department of Food and Nutrition, and Sport Science, University of Gothenburg. I was drawn to the project's emphasis on preventing injuries among youth athletes and its commitment to promote individual health and well-being. In my role within the FIT project, I became familiar with sport injuries from various scientific perspectives including biomechanics, sport psychology, sport sociology, and sport coaching. To prepare for this role, I explored literature from diverse fields and attended courses in biomechanics to understand biomedical testing and qualitative methods to conduct observations and interviews effectively.

By exploring diverse disciplinary literature, conducting the FIT project's studies, completing coursework, and collaborating with researchers from different fields, I gained insights into how researchers' contexts – cultural, social, political, and others – shape their research traditions, values, practices, norms, and methodologies. However, it became challenging to navigate these differences and to manage the various aspects of the FIT project without addressing the integrative process. I also recognised an absence of practical interdisciplinary research examples despite longstanding calls for holistic approaches. Thus, I chose to focus on the *interdisciplinary research process* in youth sport injury in my research. In addition

to a growing interest in various research approaches, this decision was prompted by feedback that urged me to delineate my research from the FIT project and demonstrate my contribution to sport science and sport injury research. As I was situated within an interdisciplinary context, this effort proved challenging, echoing the sentiments of interdisciplinarian William H. Newell (2007) that interdisciplinary study is unconventional in academia and requires constant adaptation and ongoing learning.

Introduction

Sport science research has generated important knowledge concerning the prevention, causes and origins of sport injuries over the past years. Much of this knowledge has originated from monodisciplinary research approaches, where the perspective taken is limited to a single subdiscipline of sport science, and the research methods employed are either qualitative or quantitative (Burwitz et al., 1994; Woods et al., 2021). For the purpose of this thesis, a discipline is understood as a branch of learning or body of knowledge, typically studied in higher education, requiring specialised learning (Repko et al., 2020). Traditional disciplines in sport science include sport psychology, sport sociology, and sport medicine. Although monodisciplinary research approaches have generated a wealth of important knowledge on sport injuries, scholars have claimed that this research is simplistic and reductionist (Bekker, 2019; Bittencourt et al., 2016; Burwitz et al., 1994). At the heart of this criticism is the argument that such approaches oversimplify the multifactorial and complex nature of sport injuries. They do not consider the intricate interrelationship between the athlete and the context in which an injury occurs.

As a response to this criticism, the conceptualisation of athletes as complex systems that adapt, stabilise, and change in relation to their context has gained increased momentum recently in sport injury research, particularly in the field of sport and exercise medicine (Bekker & Clark, 2016; Bittencourt et al., 2016; Salmon & McLean, 2020). Rather than employing linear approaches and one-size-fit-all solutions, many sport and exercise medicine researchers now acknowledge the importance of individually tailored intervention strategies for athletes that account for their unique situations and contexts. For example, athletes' active decision-making (Edouard et al., 2022) and lived experiences are now being emphasised as significant contextual factors influencing sport injuries (Monsonís et al., 2021). Moreover, injury prevention initiatives are co-created with end users (e.g., athletes, coaches, sport organisations) (Ageberg et al., 2024; Fagher et al., 2022). Recent research has also incorporated a gendered environmental lens to better understand how gender can operate as a contextual factor influencing anterior cruciate ligament (ACL) injury in female athletes (Parsons et al., 2021).

Finally, the concept of methodological pluralism, i.e., the integration of qualitative and quantitative methods, has been emphasised as a significant strategy forward (Bekker, 2019). Indeed, incorporating qualitative methodologies can shed light on the dynamic and complex relationship between individual performance, biology, and the broader social and cultural context in which youth athletes operate. This has been demonstrated by several social scientific studies (e.g., Bjørndal & Rognland, 2018; Malcom, 2006; Schubring & Thiel, 2014b).

The importance of understanding the athlete as a *whole* person, who interacts with and is influenced by their context (including sporting culture, coaches, training methods) has also been stressed by the International Olympic Committee (IOC) in relation to injury prevention among *youth* athletes (Bergeron et al., 2015; Bergeron et al., 2022). Injuries in youth athletes can have many severe negative consequences that include, but are not limited to, drop out from sport and poor health (Bakken, 2019; Persson et al., 2020). In sum, there is an increasing awareness that research can provide stakeholders with up-to-date knowledge that addresses the multiple dimensions of sport injuries to develop healthy, capable, and resilient young athletes (Bergeron et al., 2015).

Although the research landscape is changing and there has been a greater recognition of the benefits of integrated, contextually oriented sport injury research, many current discussions take place at the theoretical level. Examples of *applied* interdisciplinary research are thus scarce. Several scholars argue that the reasons for this lack of applied research are related to the many challenges of conducting integrated research. For example, several scholars emphasise challenges of receiving funding and publishing integrated research (Buekers et al., 2017; Campbell, 2005). Furthermore, there are differences between research traditions related to philosophical assumptions. These differences can lead to misunderstandings, communication issues, and difficulties in integrating disciplinary knowledge, theory, and research methods in practice (Bracken & Oughton, 2006; Lunde et al., 2012; Thorpe et al., 2022). Recently, some sport science scholars from New Zealand have attempted to overcome such obstacles by considering the problem of athlete health using a holistic and integrated approach (Schofield et al., 2020). Their work is both promising and inspiring as well as helpful for my own research, especially considering how they collect and compare quantitative measures of low energy availability (LEA) with qualitative interview data on athletes while working across disciplines.

Against this background, this thesis specifically focuses on the *process of conducting interdisciplinary youth sport injury research*. The interdisciplinary process of this

thesis is conducted by sport science scholars from different disciplines working together with a single interdisciplinarian (me) to integrate disciplinary knowledge and qualitative and quantitative research techniques and data throughout the research process. The main reason for employing such an approach is to generate a more comprehensive understanding of youth sport injuries, which can subsequently enhance injury prevention strategies and promote athlete health and well-being.

Aim and research questions

The overall aim of this thesis is to explore and explain the methodological insights that can be gained by conducting interdisciplinary youth sport injury research. Three research questions guide the thesis:

1) What is the base of existing disciplinary knowledge on youth sport injuries and how does this knowledge shape the understanding of youth sport injuries?
2) What contextual and methodological issues are important to consider in interdisciplinary youth sport injury research?
3) How can qualitative and quantitative youth sport injury data be integrated in an interdisciplinary research process?

To achieve this goal and to answer the three research questions, I draw from research conducted in the project 'Injury-free children and adolescents: 'Towards better practice in Swedish football (FIT project)' within which I have conducted my research and been employed as a PhD student. I will also draw from the four papers cited earlier.

Research context

This thesis is written within the field of sport science, which is, according to the University of Gothenburg's web site: "…a third-cycle subject focussing on sport, exercise and physical activity applying a multidisciplinary perspective" (University of Gothenburg, 2021). A 'multidisciplinary perspective' implies that sport is a complex phenomenon that needs to be studied from different disciplines with different approaches to generate knowledge of the 'whole'. This thesis and the FIT project more generally, can be understood in accordance with the abovementioned description of sport science. However, researchers studying the issue of *sport injuries* over the last years, particularly PhD students at the University of Gothenburg,

have mainly employed monodisciplinary approaches and used quantitative research techniques (e.g., Augustsson, 2009; Desai, 2021; Jungmalm, 2021; Lundberg, 2021; Lundblad, 2019). This thesis therefore represents an alternative way to study sport injuries in youth football players that aims to complement already established approaches.

The FIT project

The FIT project was initiated and created based on a call for research on health and performance in child/youth sport by the Swedish Research Council for Sport Science (CIF). CIF specified that the research should be interdisciplinary and comprehensive. An application was made for a PhD fellowship in 2015. This fellowship received funding and my PhD position started in 2017. The project received ethical approval from the regional ethical review board in Gothenburg on 18 October 2017 (Dnr 815-17).

The FIT project was designed as a longitudinal prospective study conducted at the Department of Food and Nutrition, and Sport Science, University of Gothenburg (GU), Sweden. The project's overarching research purpose was to provide evidence-based interdisciplinary injury prevention strategies. In providing this evidence, the research attempted to produce a comprehensive and integrated picture of injury aetiology in a sample of male and female Swedish youth football players aged 10 to 19. The research team consisted of five scholars, four from biomechanics, sport medicine, sociology, and sport coaching, and me, with a background in health and social psychology. The FIT project's disciplinary perspectives were biomedical (biomechanics, sport medicine) and sociological (sport sociology, sport coaching).

The FIT project involved four sub-studies:

1) A prospective questionnaire study using the Oslo Sport Trauma Research Center Questionnaire on Health Problems, OSTRC-H (Clarsen et al., 2014) to record incidence and prevalence of health problems in youth football players over a five-month period.
2) A one-time biomedical testing battery involving clinical examination, isometric strength measurements, running analysis and knee stability.
3) Observations of training sessions of youth football players and their coaches.
4) Interviews with youth football players and coaches.

More information on the four sub-studies can be found in paper I (Hausken et al., 2018). During my PhD student employment, I was involved in all aspects of the FIT project, which included writing the application for ethics approval, project preparation, development and testing of methods, recruitment of research participants, implementation of the four sub-studies, data management, and data analysis. Figure 1 visualises the timeline of the FIT project's four studies as well as my PhD research.

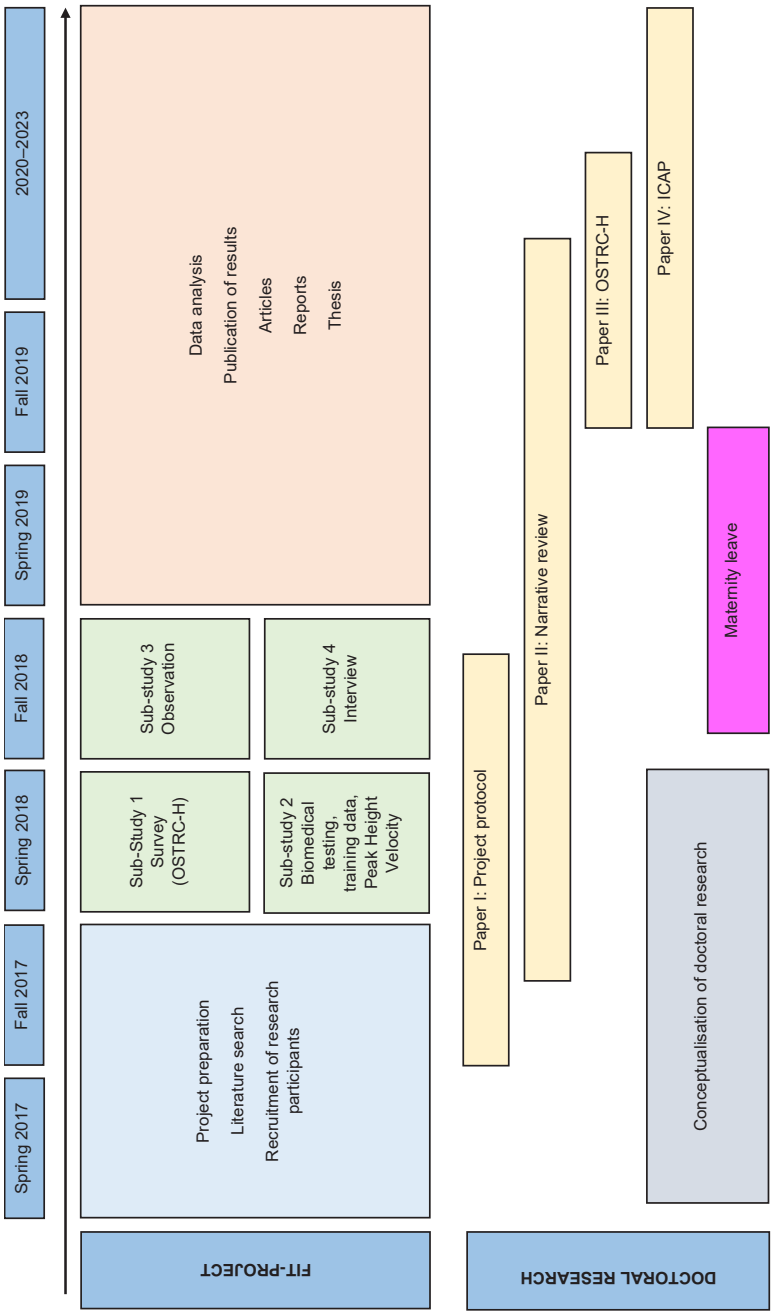

Figure 1 Overview of the FIT project, my involvement in the project and the development of papers I-IV.

Paper I was written before all sub-studies of the FIT project were conducted and serves as a project protocol for the FIT project and as a contextual background for the three following papers. Paper II presents a narrative review of youth sport injury research to support the proposition of an interdisciplinary research process. Paper III includes data from sub-study 1 but focuses on methodological implications. Paper IV relates to the process of integrating data from the four sub-studies. The four papers are also described in more detail in the chapter named 'Methodological approach'.

Outline of the thesis

The following chapter, 'Background', provides a picture of the field of sport science and specifically, an understanding and appreciation of the relevance of interdisciplinarity in youth sport injury research. This is followed by a chapter that describes the thesis' theoretical and conceptual framework, which is grounded in the concepts of complexity and interdisciplinarity. Next, a chapter describes the methodological approach employed for this thesis. Furthermore, this chapter accomplishes two tasks: 1) positions the thesis and me as a researcher in the field of sport science; and 2) outlines the different strategies that I have applied to be able to explore and explain methodological insights that can be gained by conducting interdisciplinary youth sport injury research. The chapter named 'Findings' presents the thesis' main insights in relation to the three research questions and my papers. Findings from paper II correspond to research question 1 regarding disciplinary knowledge on youth sport injuries. Findings from paper III correspond to research question 2 regarding contextual and methodological issues. Finally, findings from paper IV correspond to research question 3 regarding the integration of qualitative and quantitative youth sport injury data. In the next chapter, 'Discussion', I discuss the insights gained from addressing the three research questions. The final chapter, 'Conclusion', summarises the thesis, and highlights key contributions, implications, and offers final reflections.

Background – setting the scene

In their book *Introduction to interdisciplinary studies*, Repko et al. (2020, p. 28) assert that "understanding why things are the way they are is foundational to learning." Examining the past is crucial because it shapes the present. Exploring historical contexts fosters critical thinking, deepens comprehension, and encourages inquiry, curiosity, and a holistic perspective, all of which are essential for addressing complex issues (Repko et al., 2020). While the following discussion does not aim to provide a definitive analysis or a comprehensive overview of the evolution of sport science research and its sub-disciplines, nor an exhaustive summary of the existing models, frameworks, and theories employed in sport injury research, it does provide a valuable context for this thesis. These sections aim to shed light on how sport science knowledge has been shaped by disciplinary approaches to phenomena specific to sport, such as sport injuries.

Sport science – a brief overview

During the late 19th and early 20th century, scientific disciplines emerged, driven by the belief that disciplines were the primary means to organise and classify areas of knowledge (Stichweh, 2001). Specialisation within these disciplines was celebrated as a positive progression, which shifted scholarly expectations from possessing broad knowledge of the world to acquiring deep expertise in specific domains (Repko et al., 2020). This trend marked a departure from the notion of a unified scientific approach. As disciplines flourished, so did the formation of scientific communities, where members assumed the role of gatekeepers for their respective fields, providing specialised training that provided prestige (Repko et al., 2012; Stichweh, 2001). Academic journals at this time initially aimed for broad international coverage but gradually encouraged separate disciplinary dialogues, leading to increased specialisation in their research fields (Repko et al., 2020). Consequently, as publication formats became more stringent, disciplines grew increasingly isolated from one another, a process exacerbated by heightened competition for university resources (Repko et al., 2020).

As the scientific disciplines were becoming more specialised, the study of sport gained traction (Loland & McNamee, 2017). Educational institutions, particularly in Europe and the US, began to establish sports teams, competitions, and intercollegiate leagues that broadened the focus of physical education to include team sports like football, baseball, cricket, and track and field (Lewis, 1970). Throughout the 20th century, sports and athletics became increasingly integrated into academia, and this led to the emergence of sport as an academic discipline, often known as 'sport science', particularly in Europe (Loland & McNamee, 2017). In the US, the term 'kinesiology' became commonly used to refer to human movement and physical activity. First introduced by a Swedish scholar in the 19th century, kinesiology was used in physical education settings to denote movement analysis (Renson, 2002). In the 1960s and 1970s, the study of human movement and physical activity, particularly with a focus on biomechanics (mechanical kinesiology), was central to the field, while the scholarship in the humanities was largely marginalised (Newell, 2021; Renson, 2002). The field at that time was an amalgamation of related disciplines, each specialised in studying different aspects of human movement and physical activity, such as physiology, psychology, biomechanics, and physical education pedagogy (Renson, 2002). Consequently, the scientific approach to human movement and physical activity during this period was predominantly reductionist (Newell, 2021). By the 1990s, concerns arose about the field's overspecialisation and fragmentation, which prompted several integrative efforts, including a refinement of the field (Renson, 2002). Today, there are growing signs of kinesiology, particularly in the US, being considered an interdisciplinary field, where the integration of various disciplines is a standard practice in the fast-paced, competitive research environment (Newell, 2021).

In Sweden and other Scandinavian countries, the rise of *sport science* as a field occurred around the mid- to late 1970s, slightly later than in countries like the US and Germany (Eliasson, 2014). During this period, sport science encompassed various scientific disciplines, such as exercise physiology, anatomy, biomechanics, kinesiology, pedagogy, history, sociology, and physical education (Eliasson, 2014; Loland, 2000; Woods et al., 2021).

In Sweden and Scandinavia, the term 'sport' (or 'idrott' in Swedish) is inclusive and encompasses not only competitive activities and intense physical exertion but also outdoor and exercise activities (Eliasson, 2014). The complexity of sport is acknowledged in these regions, prompting collaboration across various disciplines to establish a robust and scientifically anchored knowledge base (Eliasson, 2014). Consequently, the field of sport science, or 'idrottsvetenskap' in Swedish, differs

somewhat from international counterparts, where it is often rooted in a biological and natural scientific understanding. Instead, sport science in Sweden and Scandinavia can be understood as *interdisciplinary* in nature and is often approached with a social lens (Larsson, 2018).

This interdisciplinary and social understanding is evident in the approach taken by academic institutions in the region. For example, Örebro University defines sport science as: "...an interdisciplinary subject and as the study of physical activity undertaken with the goal of promoting physical and mental health, recreation, competition, performance, and aesthetic experience" (Örebro University, 2023). Similarly, Malmö University's Department of Sport Science "offers a broad range of courses and programmes in an interdisciplinary environment, with sports at the core" (Malmö University, 2024). Moreover, the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway, situates sport science within the Department of Sociology and Political Sciences, highlighting the social scientific aspect of sports and physical activity. This Scandinavian emphasis on adopting a social scientific approach to sports and recognising the interdisciplinary nature of the field can be seen as an enabling factor that led to the FIT project at the University of Gothenburg being funded.

While sport science is commonly viewed as an interdisciplinary *field* encompassing different disciplines spanning both the natural and social sciences, it is crucial to acknowledge the diverse research approaches applied to sport-specific phenomena like sport injuries. Larsson (2013) identifies three prevalent approaches within sport science: monodisciplinary, multidisciplinary, and interdisciplinary. These approaches have significantly shaped the evolution of sport science at Swedish universities (Larsson, 2013). Monodisciplinary approaches involve research conducted from the perspective of individual scientific disciplines, each with its own theories and methodologies (Burwitz et al., 1994; Eliasson, 2014). Moreover, although not without exceptions, monodisciplinary research approaches tend to apply either qualitative or quantitative research techniques. Loland (2000) suggests that while monodisciplinary approaches aim to establish a unified understanding of sport to bolster the academic identity of sport science, they risk exclusivity and may impede scientific rigor and clarity.

Multidisciplinary approaches typically entail collaboration among scholars from various disciplines within a shared project. However, these approaches often lack integration, with researchers working parallel and apart from each other rather than integrating knowledge, methods, or findings (Burwitz et al., 1994; Phoenix et

al., 2013). According to Larsson (2013), interdisciplinary approaches in Swedish sport science are based on the idea that various subject areas, such as physiology, sports pedagogy, and sports history, can each offer unique perspectives on a phenomenon. For example, health can be examined through physiological, neuroscientific, psychological, and educational lenses. In research, this approach requires the integration of information from different subdisciplines of sport science, which can result in a stronger collaboration between them.

Despite their success, monodisciplinary and multidisciplinary approaches have been criticised for hindering integration and collaboration across disciplines (Burwitz et al., 1994; Loland, 2000). Larsson (2013) therefore suggests that these disciplinary 'silos' have led to a limited understanding of research methodologies across different areas. Moreover, Repko et al. (2020) argue that a focus on disciplines influences departmental curriculum decisions and personnel hiring and promotion, favouring those aligned with disciplinary norms. According to Woods et al. (2021), sport science is characterised by silo-approaches, which is reinforced by specialised scientific journals that establish boundaries around specific disciplines. Furthermore, as Campbell (2005) emphasises, editorial boards, often composed of experts from particular disciplines, act as gatekeepers, which can pose challenges for reviewing articles outside their areas of expertise. This specialisation may lead to biases that favours research aligned with the editors' expertise, potentially neglecting, or undervaluing interdisciplinary work. Encouraging diversity on editorial boards could, according to Dada et al., (2022), foster integrated research and enable journals to adapt to emerging trends, remaining at the forefront of their fields.

The specialisation and tendency toward monodisciplinarity in the field of sport science have faced critisism for adopting a reductionist approach to the understanding of sport-specific issues (Bekker, 2019; Burwitz et al., 1994) and for fostering "confined and insular thinking" (Woods et al., 2021, p. 2). Nevertheless, it is important to acknowledge the valuable insights produced by these disciplinary approaches. For instance, with relevance to the topic of this thesis, sport medicine has yielded effective interventions that mitigate the risk of prevalent and severe sport injuries (Arnason et al., 2008; Olsen et al., 2005; Soligard et al., 2008). Additionally, sport psychologists have developed various psychological models for assessing sport injury risk and facilitating rehabilitation, offering valuable tools for athletes and injury prevention (Santi & Pietrantoni, 2013). Finally, sport sociological research has contextualised injury risk and strive to influence practices and policies within the sports industry to create safer and more equitable

environments for athletes (Bjørndal et al., 2017; Spaaij & Schulenkorf, 2014). As will be further discussed in the 'Theoretical and conceptual framework'-chapter, incorporating such disciplinary knowledge is fundamental to the interdisciplinary research process, and highlight the benefits of specialised expertise. Against this background, I now turn to research on sport injuries.

Sport injury research

While discussions and concerns about sport injuries have persisted in society and literature since ancient Greece (Nomikos et al., 2010), the initial systematic approaches to understanding sport injuries emerged in the 1960s and 1970s (Hackfort & Kleinert, 2007). During this period, it became increasingly recognised, both in Europe and elsewhere, that participation in sports could lead not only to positive health outcomes but also to negative consequences, such as injuries (van Mechelen et al., 1992). Consequently, organisations like the World Health Organization (WHO) and the Council of Europe began to advocate for preventive strategies to reduce sport injuries (van Mechelen et al., 1992). Researchers also directed their efforts toward injury prevention, treatment, and rehabilitation from different disciplinary perspectives. In this work, identifying risk factors and mechanisms was, and remains, a crucial initial step before the development, implementation, and evaluation of injury prevention interventions (Finch, 2006; van Mechelen et al., 1992).

From the 1980s to the 2000s, research on sport injuries continued to expand, focusing on comprehending the biomechanics, causes, and risk factors across various sports. Moreover, perhaps correlated with the rise in sport injuries and the escalating demands on athletic performance (Hackfort & Kleinert, 2007), there was a continuous progression in research methodologies and analytical tools, along with the formulation of significant disciplinary models of injury causation. Notably, within the field of sport psychology, Andersen and Williams' (1988; also see Williams & Andersen, 1998) stress-related model for sport injury causation gained prominence, influencing subsequent research in sport injury psychology. In the field of sport medicine, an early model of sport injury causation was put forward by Meeuwisse in 1994 who advocated for a multifactorial approach to assessing injury causation that accounted for both intrinsic and extrinsic risk factors (Meeuwisse, 1994). Meeuwisse et al. (2007) revised this model in 2007, emphasizing a more dynamic approach to injury development rather than a linear one. Another pertinent framework worth mentioning is the Translating Research

into Injury Prevention Practice (TRIPP) framework (Finch, 2006), which relates to implementation research and underscores the importance of ensuring that prevention strategies are adopted in practice. The TRIPP framework outlines six stages of essential steps in establishing the evidence base for injury prevention. Furthermore, scholars have underscored the significance of documenting overuse injuries and health issues among athletes. This led to the development of new methodologies for recording such concerns, such as the Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC-O) and the Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H), updated as the OSTRC-O2 and the OSTRC-H2 in 2020 (Clarsen et al., 2020). Finally, the field of sport sociology has significantly contributed to youth sport injury research, particularly by examining how interpersonal and contextual factors influence youth athletes' experiences of risk and injury (e.g., Cavallerio et al., Nixon, 1993). For instance, Malcom's (2006) ethnographic study highlights how young girls learn to conform to expectations of ignoring injury and pain due to a sport specific socialisation process.

The importance of researching injuries in *youth* athletes has been recognised. In this context, youth sport injury research has gained momentum in the 1970s, mainly focusing on establishing injury rates, type, and severity in youth (e.g., Nilsson & Roaas, 1978; Sullivan et al., 1980; Zito, 1983). Recently, the International Olympic Committee (IOC) presented recommendations for developing healthy, resilient, and capable youth athletes emphasising the need to address injury rates and prevention in youth sport (Bergeron et al., 2015). In the context of youth football (aged 10-19), research across various disciplines such as biomedicine, sport psychology, and sport sociology has highlighted the significant problem of injuries (Ivarsson et al., 2019; Johnson & Ivarsson, 2011; Jones et al., 2019; Robles-Palazón et al., 2021; Åman et al., 2016). Notably, injury rates tend to spike during periods of rapid growth and maturation (Read et al., 2018; van der Sluis et al., 2014; Wik, 2021). Research indicates an overall incidence rate of 5.7 injuries per 1000 hours in male and 6.77 injuries per 1000 hours in female football players under 19 years of age (Robles-Palazón et al., 2021). These figures are notably higher compared to other youth team sports like handball (Olsen et al., 2006), basketball (Longo et al., 2012), and volleyball (Bere et al., 2015). Moreover, studies demonstrate that injury incidences, particularly during matches, tend to rise with age (Faude et al., 2013), with male and female football players aged 15 to 17 years experiencing particularly high rates (Söderman et al., 2001).

The concerns about the high injury rate in youth football are twofold: First, injuries sustained during youth can influence the onset of injuries later in an athlete's career (Steffen, Myklebust, Andersen, et al., 2008; Wangensteen et al., 2016). Second, injuries at the child and youth sport levels may lead to drop-out from sports among children and adolescents, which can negatively impact lifelong physical activity and wellbeing (Persson et al., 2020; Maffulli et al., 2010; Whittaker et al., 2017). Given that football is the most popular sport among children and adolescents in several European and Scandinavian countries (Emmonds et al., 2021; Riksidrottsförbundet, 2021), the prevention of injuries in youth football remains a crucial area of research.

This brief overview illustrates the historical prevalence of monodisciplinary research approaches in sport injury research, which have yielded valuable insights into injury development among youth athletes. Furthermore, research conducted within the different disciplines differ in their choices of theory, methodology and research techniques when studying sport injuries. Importantly, different paradigmatic approaches[1] also significantly shape how a specific discipline employs certain methodologies and research techniques. For example, biomedical researchers usually base their assumptions on a positivistic view, which entails an understanding of sport injuries as objective realities that can be understood through the application of quantitative methods. Examples of how current youth sport injury research relates to different paradigms are presented in paper II and the 'Findings'-chapter.

In response to contemporary calls for methodological pluralism and integrated research in sport injury research, relying only on disciplinary knowledge and monodisciplinary approaches has proven to be inadequate, however. Such approaches tend to concentrate on limited aspects of the athlete, thereby overlooking the complex interactions between individuals, the physical and social environment (Wiese-Bjornstal, 2010).

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[1] Paradigms are philosophical frameworks or belief systems of a scientific field, based on ontological, epistemological, and methodological assumptions (Lincoln et al., 2011). Three established research paradigms commonly shape sport injury research: positivism, postpositivism, and interpretivism. Ontology deals with the nature of reality and existence, questioning whether reality is external and identifiable or socially constructed and subjective (Morgan, 2007). Epistemology relates to ways of knowing reality and involves how researchers engage with that reality (Phoenix et al., 2013). Methodology includes the selection of design, data collection techniques, data analysis procedures, and the philosophical underpinnings that inform the research (McMeekin et al., 2020).

Theoretical and conceptual framework

This thesis draws from the concepts of complexity and interdisciplinarity. Considering the diverse interpretations and applications of complexity and interdisciplinarity among scholars and projects, I will explore and outline these in this chapter, also illustrating their utilisation in my research. Initially, a brief introduction is provided to complexity, both in general and within the domain of sport science/sport injury research.

Complexity

The concept of *complexity* has gained attention in sport injury research in the last decade and there are several publications that emphasise the need to address the complexity of sport injuries (e.g., Bekker, 2019; Bittencourt et al., 2016; Edouard & Ford, 2020). Interdisciplinarian Newell (2001, p. 1) argues that "the nature of complex systems provides a rationale for interdisciplinary study". To better appreciate this argument, some key tenets of complex systems are important to understand. Here, I use the example of an athlete as a complex system. Based on current sport injury literature that emphasises complexity, understanding an athlete as a complex system entails an understanding of the athlete as someone who adapts and changes based on the dynamic interactions and the collective influence of social and cultural factors (Bekker & Clark, 2016; Edouard & Ford, 2020; Parsons et al., 2021). The ability to adapt and change differ from simple and complicated systems (Bekker, 2019), and for complex systems, three key tenets are important to understand: nonlinearity, improbability, and local knowledge.

Nonlinearity. Central to understanding complex systems, is the notion of *nonlinearity*. Nonlinearity implies that A plus B does not necessarily equal C. For example, a weak muscle (A) plus psychological stress (B) does not necessarily result in an injury (C), even though research has found associations between muscle weakness and stress as individual risk factors (e.g., Ridder et al., 2017; Steffen et al., 2009). A complex system, such as an athlete, consists of physical components (e.g., muscles, cells) and contextual components (e.g., sports club, coach, teammates, family), for

example. The relationship between these components is nonlinear, meaning that small changes to one part of the system, for example the athletes' football technique, can lead to possibly unexpected changes in other parts of the system. In other words, the combined effect is not automatically the sum of the separate effects (Byrne, 2001). In an interdisciplinary research process, the different disciplines provide an understanding of how the various components operate within and around the athlete. But further, an interdisciplinary process generates insights into the nonlinear interactions between the components and what they produce together (Newell, 2001).

Improbability. Second, since this nonlinearity gives rise to unexpected behaviour of the athlete, or in other words, since an athlete can spontaneously modify her behaviour to accommodate unexpected changes such as pain, it is difficult to make predictions. Thus, the *improbability* of effects can be the only expected outcome (Bekker, 2017; Newell, 2001). The same is true for an interdisciplinary research process that, for example, integrates knowledge and/or methods to develop more effective injury prevention interventions. According to Newell (2001, p. 22), an intervention that is developed on the basis of an interdisciplinary process "can propose a modest intervention that turns out to produce large and unexpected results", which may differ greatly from what was planned and predicted from the outset. The emphasis placed on improbability and complexity reflects the recently increased focus on the need for developing and evaluating complex interventions and complexity-informed research in sport science and health research. Skivington et al. (2021, p. 21), for example, emphasises how a complex intervention generate outcomes that are dependent on "exogenous factors, including the characteristics of recipients, and/or the context or system within which it is implemented". Certainly, the improbability of effect due to complexity needs to be considered. Furthermore, interdisciplinary scholars argue that by using interdisciplinary approaches, a more effective basis for action can be achieved as well as innovative and original insights into complex problems (Newell, 2007; Spaaij, 2014).

Local knowledge. The third key tenet is the importance of *local knowledge*, or knowledge of specific parts of the system that give rise to the system's behaviour. Newell (2001) argues that this tenet is typically overlooked in attempts to understand complex systems. Translated to sport injury research, an athlete can, for example, be stressed about an upcoming exam at school and get injured right before the exam. The researcher measuring the athlete's stress levels at that point in time might conclude that exam-stress caused the injury. A closer examination of other components in the athlete's context by applying 'local knowledge' may, however,

show that the coach had changed her behaviour towards the athlete, which also affected the athlete's stress and the injury's aetiology. Local knowledge is here understood as disciplinary and contextual knowledge, thus emphasising the importance of drawing from different disciplinary knowledge in an interdisciplinary process when researching sport injuries.

The three complexity tenets – *nonlinearity, improbability*, and *local knowledge* – provide a way of thinking about sport injuries *and* the interdisciplinary research process. Unlike simple or complicated understandings of sport injuries and mono- or multidisciplinary approaches, which may oversimplify the issue, a complex understanding and interdisciplinary approach emphasises uncovering, examining, and influencing the nonlinear interactions between different components. This perspective suggests that it is crucial to explore the interconnected nature of disciplinary knowledge in sport injury research.

Having described the key tenets of complexity, it is further important to 1) explain how the concept of complexity relates to current sport injury research and 2) show how and where my research contributes to the current discussions about complexity.

Complexity and sport injury research

As noted, the idea that sport injuries are complex is gaining momentum. Sport injury research is witnessing what can be called a complexity turn, with researchers stressing the need to approach sport injuries in new and alternative ways (Bolling et al., 2018; Edouard & Ford, 2020; Parsons et al., 2021). There is, however, considerable variation in the ways that scholars define, understand, and approach complexity. In general, three different understandings of and approaches to complexity are employed in current sport injury research.

The first, and what might seem as a prominent approach to complexity in sport science and sport injury research, is the application of complex statistical models and computer-based simulations such as the Agent-Based Modelling (ABM) and Systems Dynamics (SD) modelling (Bittencourt et al., 2016; Hulme et al., 2019a; Hulme et al., 2019b). Such models and simulations are computer-based. The ABM, for example, is used to theoretically observe and explore the mechanism(s) by which collective behaviour among, for example, athletes and coaches, gives rise to rates of sport injuries. SD modelling is used to identify and simulate the effect of different interventions. According to Hulme and colleagues (2019a, p. 1510), such computational and modelling approaches move sport injury research towards "a

theoretically driven computational modelling paradigm that can complement traditional statistical regression analyses." These scholars emphasise the use of quantitative and statistical methods common in the natural sciences. One result, however, is that the approach is limited in recognising the importance of athletes' interactions within contexts and hence, ignores the significance of sociocultural conditions that other scholars have identified as relevant (Bolling et al., 2018; Ivarsson et al., 2019; Parsons et al., 2021).

The second approach integrates qualitative methods and adopts a sociocultural perspective to address the complexity of sport injuries (Bekker et al., 2020; Verhagen & Bolling, 2018; Wiese-Bjornstal, 2010). Advocates of this approach argue that qualitative methods offer valuable insights into the contextual factors surrounding injuries and their prevention (Bolling et al., 2018; Monsonís et al., 2021; Parsons et al., 2021). These methods may involve engaging athletes in dialogue to highlight their perspectives and experiences (Bolling, 2019). The potential of qualitative methods in sport science and sport injury research has gained recognition, with some scholars noting a shift towards greater legitimacy and acceptance of qualitative research and interdisciplinary practices within sport studies, a shift that encourages innovation and creativity (Evans et al., 2021). Qualitative methods have been utilised to explore significant aspects such as growth and maturation in youth athletes (Schubring & Thiel, 2014a; Verhagen & Bolling, 2018). However, it is also acknowledged that relying only on qualitative methods may overlook important aspects of sport injury aetiology. Sociologist Thorpe (2014, p. 667) reflects upon the divide between the biological and social in relation to exercise and female reproductive hormones, writing that: …" there is nothing quite like surgery or time in a hospital ward to remind us of the complex processes operating inside our bodies, beyond our sociological gaze".

The third approach relates to the concept of *methodological pluralism* (Bekker, 2019). Bekker (2019, p. 80) criticises the first quantitative and statistical understanding of complexity, proposing that it overemphasises "the epistemological questions of how multifactorialism is accounted for and… [underemphasises] the ontological considerations and assumptions we make about the world". In Bekker's view, this situation reflects a dissonance between how complexity is understood and applied to sport injury research. Bekker (2019) therefore suggests that complexity be used as a framework for injury prevention research to formulate other types of research questions. This framework should facilitate methodological pluralism, or the application of both qualitative and quantitative methods. According to Bekker (personal communication, May 2020), methodological pluralism is

equivalent to interdisciplinarity as applied by the FIT project and in my thesis. By applying *methodological pluralism* as a third approach to complexity, researchers could aim – as I do with this thesis – to produce a more comprehensive understanding of a phenomenon by drawing from and integrating existing disciplinary knowledge and methods. Certainly, methodological pluralism, as suggested by Bekker (2019) and interdisciplinarity, as previously called for by Burwitz et al. (1994) in the 1990s and recently also suggested by Parson et al. (2021), have the potential to account for context. They also can aim to integrate knowledge from various disciplines across research paradigms. It is here, in the third approach to complexity that my thesis contributes to sport injury research by exploring and explaining the process of conducting interdisciplinary youth sport injury research. In the following, an introduction to interdisciplinarity is provided.

Interdisciplinarity

Scholars describe that the interest in interdisciplinarity began to develop once the disciplines were established at the end of the 19th and the start of the 20th century (Klein & Frodeman, 2017; Repko et al., 2020). As a counterbalance to the specialisation and separation of the disciplines, students in Western universities, particularly in the US, demanded more holistic education and science (Repko et al., 2020; Sokolova, 2013). Protests led to multiple 'waves' of interdisciplinarity, which involved the establishment of different interdisciplinary programs (e.g., women's studies and environmental studies) and non-profit organisations. These programs and organisations were dedicated to advance integrated research, as well as new fields of research and interdisciplinary curricula intended to promote integration across the disciplines (Klein & Frodeman, 2017). In the 1970s, interdisciplinary studies successfully solidified their position as a scientific field in the US, primarily due to the efforts of pioneering analysts of interdisicplinarians William H. Newell and Julie Klein. To demonstrate and clarify the essence and application of interdisciplinarity, the non-profit organisation Association for Integrative Studies (AIS) was established in 1979 (Repko et al., 2020), renamed in 2013 to the Association for Interdisciplinary Studies.

According to Burwitz et al. (1994), there have been signs of support for interdisciplinarity within the sport science and sport injury community since the 1980s from a range of individuals from the subdisciplines of sport psychology, exercise physiology, biomechanics, and sport sociology (e.g., Gould, 1982; Maguire, 1991). For instance, sport psychologist Gould (1982) underscored in the 1980s the ne-

cessity of employing diverse methods to advance knowledge in the field, highlighting sport injuries as complex phenomena influenced by numerous internal and external factors.

Despite early calls for interdisciplinarity in sport science and sport injury research, interdisciplinary studies focusing on athletes were slow to develop, however (Burwitz et al., 1994). Recently, Sokolova (2013, p. 1) has suggested that "in the presence of unprecedented social and environmental challenges we might be witnessing something that Klein (1990, p. 54) refers to as 'quiet revolutions', whereby our understanding of science, its function and methodology is rapidly changing". The landscape does indeed appear to be changing, also for sport science and sport injury research. Some funding agencies in the Nordic countries are attempting to facilitate more interdisciplinary research. For instance, the Swedish Research Council for Sport Science (CIF) made a call for interdisciplinary research in 2014; as a result, the FIT project was developed in which this doctoral thesis was written. Related to research on sport injuries, The Research Council of Norway issued a call for large-scale interdisciplinary research projects in 2020, resulting in funding for the ongoing interdisciplinary sport injury research project 'Preventing injuries in youth sport through an interdisciplinary and theory-based approach' at the Norwegian School of Sport Sciences. A final example outside of the Nordic countries can be found in New Zealand (Schofield et al., 2020; Thorpe et al., 2019). Thorpe and colleagues aim to understand the complexities of sportswomen's experiences of low energy availability (LEA) and relative energy deficiency in sport (RED-S) by adopting an integrative approach. In sum, interest in integration and interdisciplinarity is (again) growing, both in Scandinavia as well as internationally. To date, however, no convincing interdisciplinary *procedures* for *sport injury research* have been developed.

Due to this lack of established interdisciplinary procedures in sport injury research, I have in my research turned to this very field of interdisciplinary studies. In this research I have especially focused on contributions by Newell (2006, 2007), Klein (2004; 2017), and Repko et al. (2020) who have significantly shaped interdisciplinary research over the past four decades. Their work provides a definition of interdisciplinarity and a framework for operationalisation of the interdisciplinary research process which is relevant and suitable to both research and the study of sport injuries.

For Newell (2007, p. 247), interdisciplinarity is "an effective approach to decision making regarding individual complex systems". The approach outlines certain assumptions about how to deal with complexity through a system-based

process. Elaborating on this definition, Klein and Newell (1997) define interdisciplinarity as:

> …a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession... [interdisciplinary research] draws on disciplinary perspectives and integrates their insights through construction of a more comprehensive perspective. (p. 3)

Based on Klein and Newell's (1997) definition above, interdisciplinarity is in this thesis understood as a research process that recognises and appreciates multiple scientific perspectives from both the natural and social sciences, and that values the integration of disciplinary youth sport injury knowledge. Further, the interdisciplinary research process involves decisions and strategies about how to integrate different disciplinary knowledge and scientific methods to gain a more comprehensive understanding of the complex issue of sport injuries.

My understanding of interdisciplinarity might resemble a *transdisciplinary* approach that some sport scientists have recently called for and applied in their research (Thorpe et al., 2022). Transdisciplinarity is understood as an approach where researchers move *in-between* disciplinary boundaries, *step out* and try to create something *new* (Woods et al., 2021) and *transcendence* is a key term as opposed to *integration* (Klein, 2017). Although there are some similarities to an interdisciplinary approach, those who advocate transdisciplinarity in sport science emphasise that the aim is to *transcend* disciplinary concepts, terminology, and methods to create a higher-level framework or theory (Phoenix et al., 2013; Thorpe et al., 2020; Woods et al., 2021). Thus, transdisciplinary research involves a constant re-organisation of knowledge, where the disciplinary lines are blurred, as opposed to interdisciplinary research where scholars aim to draw from the disciplinary knowledge (Woods et al., 2021). Transdisciplinarity can also be understood as a *dialogue* between a group of scholars and scientists from different disciplines addressing shared concerns and topics which can lead to new models, concepts, and strategies (Thorpe et al., 2022). Often, transdisciplinary research also includes practitioners and stakeholders from outside of academia. However, this was not the case in the FIT project or my thesis.

Parts of the interdisciplinary research approach may also seem familiar to scholars conducting *mixed methods* research in, for example, health research and sport psychology (e.g., Fetters et al., 2013; O'Cathain et al., 2007). Mixed methods research does often aim to integrate qualitative and quantitative research techniques and data to gain a broader and deeper understanding, and to generate

unique insights into multifaceted phenomena (Fetters et al., 2013; Johnson et al., 2007; Onwuegbuzie & Johnson, 2006). However, as discussed in paper IV (Hausken-Sutter et al., 2023), the type of interdisciplinarity undertaken in my thesis differs from mixed methods research approach in its attempt to consider *ontological* and *epistemological* differences between disciplinary approaches and between disciplinarians in an interdisciplinary team (i.e., interparadigmatic interdisciplinarity). Ontological and epistemological differences in interdisciplinary teams that work across research paradigms can result in problematic power relationships, language barriers, and misunderstandings that complicate the integration of knowledge, methods, and data (Bracken & Oughton, 2006; Lunde et al., 2012; Thorpe et al., 2022). Such onto-epistemological differences in interparadigmatic teams have received sparse attention in the practice of mixed methods research (O'Cathain et al., 2008; Ryba et al., 2022; Sale et al., 2002; Sparkes, 2015). Although I have drawn inspiration from various articles on mixed methods research, I have not opted to incorporate the term mixed methods into my research.

Existing interdisciplinary research projects in sport science and sport injury research are conducted by teams of scholars and not by single researchers (e.g., Lunde et al., 2012; Thorpe et al., 2022; Thorpe et al., 2019; Thorpe et al., 2020). Therefore, questions about the kinds of issues that can emerge in collaborative situations and how teams can deal with such issues are important to explore. However, the interdisciplinary scholars I mainly focus on in my research largely eschew issues concerning teamwork. Instead, they refer to the single researcher, i.e., 'The interdisciplinarian (Newell, 2006, 2007; Repko et al., 2012; Szostak, 2012). Newell's (2007, p. 247) rationale for focusing on the individual researcher is to avoid "mudd[ying] our understanding of interdisciplinarity" due to the "additional layer of challenges" teamwork generates. Yet, these additional layers entail exactly the ontological and epistemological differences that I understand as crucial for interdisciplinary teams. It is therefore questionable if these interdisciplinary scholars' operationalisation of interdisciplinarity can be applied to interdisciplinary *teams* and to the interparadigmatic context where I have conducted my research (i.e., the FIT project). Therefore, I also turn to sport science literature that contains reflections on, and practical experiences of, working across disciplinary and paradigmatic boundaries to better understand issues that can emerge in a team and how to deal with such issues (Heather et al., 2021; Schofield et al., 2020; Thorpe et al., 2022; Thorpe et al., 2020). Drawing from this research has helped me to better understand and deal with the 'muddiness' of interdisciplinarity that I have experienced as an interdisciplinary PhD student. Paper II in particular, explores

paradigmatic assumptions related to ontology and epistemology in disciplinary and interdisciplinary sport injury research.

Conceptualising the interdisciplinary research process

Interdisciplinary scholars such as Newell (2006, 2007), Repko et al. (2020) and Szostak (2012) propose a seemingly straightforward process in which conducting interdisciplinary research includes several steps. Although the proposed steps differ slightly between these scholars, they draw from each other's works and are similar in their content. Furterhmore, these scholars argue that the steps align with established principles of interdisciplinary research, offering a rationale for widely accepted best practices among interdisciplinarians (Newell, 2007; Repko et al., 2020). Despite the aforementioned criticism regarding Newell and colleagues' focus on the single interdisciplinarian, my thesis primarily draws on Newell's (2001, 2006, 2007) work on conceptualising the interdisciplinary research process. Although I have not carried out all the steps, I find many of Newell's steps relevant to my own research journey. Newell (2006, 2007) splits the interdisciplinary process into two parts: 1) Drawing from disciplinary perspectives, and 2) Integrating their insights through construction of a more comprehensive understanding. Table 1 outlines the two parts and their respective research steps as outlined by Newell (2006, 2007).

Table 1. The steps in the interdisciplinary research process by Newell (2006, 2007).

1) Drawing on disciplinary perspectives
• Defining the problem • Determining relevant disciplines • Developing a working command of the relevant concepts, theories, and methods of each discipline • Gathering all relevant disciplinary knowledge • Studying the problem from the perspective of each discipline • Generating disciplinary insights into the problem.
2) Integrating their insights through construction of a more comprehensive understanding
• Identifying conflicts in insights • Evaluating assumptions and concepts in the context of the specific problem • Resolving conflicts by working towards a common vocabulary and set of assumptions • Creating common ground • Constructing a new understanding of the problem • Producing a model (metaphor, theme) that captures the new understanding • Testing the understanding by attempting to solve the problem.

It is important to understand that although Newell's (2006, 2007) steps are outlined in a linear order, the process is iterative as well as complex. Some steps may overlap or might not be conducted at all (Newell, 2006, 2007; Repko et al., 2020). The iterative nature of the interdisciplinary process is also stressed by Szostak (2012, p. 7) and he therefore encourages researchers to "revisit earlier steps as they perform later steps, alter the question as new information is uncovered, embrace additional theories and methods as the limits of the first ones chosen become apparent, and so on". The concept of iteration is also relevant for this research as the process of reviewing and critically analysing disciplinary literature, conceptualising my research, and structuring the thesis has been an evolving process. Therefore, while I have chosen to present this thesis and its insights in a rather traditional, linear fashion, the research process has been far from linear.

Methodological approach

This chapter aims to: 1) outline the methodological and ethical assumptions and principles underpinning my thesis, and 2) describe the strategies applied to address the three research questions and achieve the thesis' aim. This also involves outlining the designs of my four papers. Regarding ethics, I particularly draw from Balsamo's (2017) chapter on ethics in interdisciplinary research when addressing ethical considerations concerning the intricacies of interdisciplinary collaboration and the incorporation of diverse perspectives and knowledge.

Methodological and ethical considerations

Positioning of thesis

My approach to exploring and explaining methodological insights gained from interdisciplinary youth sport injury research aligns in several aspects with social constructivism. According to Lincoln et al. (2011), social constructivism understands meaning and social reality as subjectively constructed, allowing for multiple social realities. For example, the understanding of what it means to experience and recover from a sport injury is understood and shaped by each athlete's unique cultural, social, and personal context. An athlete can, for example, see an injury as a setback that needs immediate medical attention and a structured recovery plan to return to peak performance, while another athlete might include more emotional and social dimensions in her understanding and recovery plan. This means that meaning and social reality are shaped in various ways and are never definite. Meaning making and learning are seen as ongoing processes, with individuals' perspectives continually evolving (Lincoln et al., 2011). This perspective aligns with my view of myself and my team members as active co-producers of youth sport injury knowledge throughout the interdisciplinary research process, including our collaboration with the four sub-studies and the writing and publishing of papers I-IV.

Social constructivism has to be seen in stark contrast to views that consider knowledge as a discovery of objective reality (i.e., positivism/postpositivism).

Instead, social constructivism emphases the role of human agency and social processes in shaping our understanding of the world (Lincoln et al., 2011; Phoenix et al., 2013). However, it can be debated whether this positioning aligns with some underlying assumptions of interdisciplinarity and the FIT project outlined in this thesis. For instance, interdisciplinarity often assumes that methodological pluralism can tell a more complete and 'truer' story of sport injury aetiology than single-disciplinary insights and research techniques. Similarly, the aim of the FIT project was to produce evidence-based recommendations on how injuries can be prevented (Hausken et al., 2018). These recommendations should be based on the data generated through the four sub-studies. The project thus seeks to uncover some kind of 'truth' based on the diverse data collected. The idea of developing 'truths,' however, aligns more with a realist or post-positivist perspective, where, for example, an injury is viewed as an objective reality that can be measured and known (Phoenix et al., 2013). There are notable similarities between interdisciplinarity and a realist or post-positivist perspective, particularly in their shared pursuit of a comprehensive and often empirically based understanding of a complex phenomenon through the integration of rigorous methods from multiple disciplines (Newell, 2007; Phoenix et al., 2013; Piggot et al., 2020). Nevertheless, social constructivism involves an element of understanding and reconstructing knowledge which aligns more closely with my thesis. Clarifying my positioning in the context of interdisciplinary research, much like the study of sport injuries, is complex and warrants further reflection and discussion beyond the scope of this thesis. However, the following paragraphs aim to further outline my positioning and the strategies I have employed.

A personal positioning in-between disciplines

Interdisciplinary researchers often find themselves navigating through disciplinary boundaries. While there were no significant challenges in respecting the paradigmatic boundaries within the FIT project's team, I found it challenging to navigate and effectively communicate the 'space in between' (Welch, 2018) the project. Drawing on my experiences from various disciplinary perspectives during my bachelor's and master's studies, as well as my role as a research assistant, influenced how I positioned myself in this interdisciplinary context. For instance, my familiarity with frameworks, methodologies, and theories from various disciplines such as sociology, psychology, social psychology, and nutrition proved beneficial. It allowed me to quickly embrace my role in-between disciplines and to appreciate

the diverse perspectives and methodologies while crossing disciplinary boundaries. However, entering the field of sport science also required me to acquire an understanding of its fundamental concepts, theories, and terminology through extensive literature review across different disciplines. Additionally, I frequently encountered the challenge of defining my positioning within the field, as I often received feedback questioning where I truly 'belonged'. While this in-between positioning can sometimes feel like unclaimed territory, I have tried make it my own, akin to inhabiting a boundary space (Fleming, 2013). Engaging in interdisciplinary discourse, I explored different disciplinary approaches, scrutinised my choices of inclusion and exclusion, and adapted my writing style to suit different journal expectations. Though challenging, these experiences, guided by ethical research principles such as intellectual humility, flexibility, and generosity, as outlined by Balsamo (2017), expanded my research horizons. While the FIT project's structured approach to addressing youth sport injuries presented its challenges, it also offered opportunities for reflection on the interdisciplinary research process and the journey of doing interdisciplinary research as a PhD student (e.g., Amran & Ibrahim, 2012; Lindvig, 2018).

Reflexivity as a philosophical strategy

In my research, I employ reflexivity as a philosophical strategy, particularly in writing this thesis. Reflexivity is a key element in interdisciplinary research, and it requires a continuous awareness and critical examination of my own background, biases, assumptions, and experiences, alongside those evident in the work of others (Berger, 2015; Folkes, 2022; Repko et al., 2020). This practice demands conscious reflection on my role and position concerning the research subject, methodology, and broader research context. Furthermore, I needed to reflect how the interdisciplinary approach enhanced the comprehension of sport injuries.

As discussed earlier, reflexivity starts with recognising and acknowledging my own perspective and positioning. Furthermore, it played an important role in integrating my research into a cohesive framework. To support this process, I maintained a diary or log, documenting my work, thoughts, and discussions related to both the FIT project and my doctoral research. These notes served as a valuable tool for documenting my research journey, allowing me to reflect on the rationale behind decisions and track the evolution of my thoughts.

Scholars have referred to this type of log as 'reflexive diary' or 'reflexive journal' and have claimed that this can be a valuable tool in prompting insights into a

variety of decisions taken in research (Markula & Silk, 2011; Nadin & Cassell, 2006). Keeping a diary is something that resonated with me, and I ended up with a word document containing notes from the last seven years of my PhD journey. While these notes are not utilised as empirical data, they have been instrumental in shaping my findings throughout my PhD journey. Moreover, revisiting these notes proved especially beneficial during the challenges posed by the COVID-19 pandemic, providing a space for reflection when face-to-face interactions with supervisors and fellow PhD students were limited.

To illustrate how the log notes contribute to my reflexive strategy, I share two excerpts from the document. These 'reflexive moments' (Subramani, 2019) highlight various methodological implications and are excerpts that I deemed particularly relevant, as they demanded careful reflection. The first excerpt is from my meeting notes following a discussion with my main supervisor regarding my papers and the potential direction of my thesis. The thoughts recorded at that moment reflect my attempt to delineate my thesis further from the FIT project and toward my growing interest in complexity, interdisciplinarity, and methodology.

Excerpt 1

> With regards to Bittencourt (2016) and Bekker (2019): then it is of no use to conduct analysis on single risk factors. For example, we do not need more of this research, if I were to write a biomechanical paper on sub-study 2. I can thus argue that in MY thesis I did not mean to apply the biomechanical data separately because injury development is so complex that we need complex solutions. We must move away from risk factors to risk patterns recognition. These thoughts relate to focusing on paper 2 (narrative review) and paper 4 (ICAP)! (Personal meeting notes November 4, 2019)

The first excerpt from my log relates to an attempt at positioning myself, my papers, and my thesis, resulting in a decision to focus more on the aspects of integration of knowledge, methods, and data across disciplinary boundaries rather than publishing four separate papers related to the FIT project's four sub-studies.

The second excerpt is taken from my notes after a meeting with Richard Pringle, Professor in sport sociology, health, and physical education, who examines socio-cultural and pedagogical issues associated with injuries and pain (e.g., Pringle & Falcous, 2018). I met with Richard during my research stay at Monash University, Melbourne, and we worked together on paper II. Excerpt 2 shows how I continued to try and make sense of complexity in relation to interdisciplinarity during my stay abroad.

Excerpt 2

> What is the difference between the call for complexity in injury research and the call for interdisciplinarity? Could interdisciplinarity be the "method" for how to do complexity research? Because nobody really says *how* to bring complexity in, and it sounds like you need to work across paradigms and/or fields to be able to capture the complexity. You can't sit in your bubble and just include more questions on your survey. (Personal notes, November 2019)

Excerpt two relates to my decision of drawing more from complexity in relation to *interparadigmatic* interdisciplinarity in my thesis as these two seemed to be closely related. I also found interdisciplinarity to be a fascinating and valuable strategy that could deal with the complexity of sport injuries through, for example, drawing from different knowledge and theories from different paradigms, instead of 'just' adding more questions on a survey.

In sum, this reflexive practice has been important in my thesis, distinguishing it from many traditional Swedish sport injury research theses that are often empirically driven and that are based on one type of empirical data. This thesis therefore breaks from established conventions by exploring and explaining the insights that can be gained from the *process* of conducting youth sport injury research.

Integration as a methodological strategy

Integration is a key concept in interdisciplinary research and has been argued to be the most challenging aspect (Newell, 2001). Nonetheless, this thesis integrates disciplinary knowledge and qualitative as well as quantitative youth sport injury data. This integration is firstly achieved by critically reading and rereading disciplinary literature on youth sport injury research and mapping and synthesising the diverse literature in paper II (Repko et al., 2020). By developing and piloting an Interdisciplinary Case Analysis Procedure (ICAP), the integration process is further put into practice. The ICAP will be described specifically in relation to paper IV.

Interdisciplinary scholars contend that integration involves a *cognitive process* of critically assessing disciplinary insights and establishing common ground, with *process* referring to the cognitive activities inherent in interdisciplinary thinking (Repko et al., 2020). When identified, conflicts between disciplinary insights are neither aimed to be resolved nor dismissed but rather to be reduced (Newell, 2007). Conflicts are thus anticipated and embraced in the pursuit of creating a more comprehensive and integrated understanding that combines more elements that any single disciplinary insight (Repko et al., 2020). Some mixed methods

scholars perceive these conflicts negatively, suggesting that integrating methods across paradigms or combining qualitative and quantitative approaches is impractical or incompatible due to differing philosophical assumptions. (Onwuegbuzie & Johnson, 2006; Sparkes, 2015). However, integration in this thesis is not just about bringing together different types of data. Rather, integration is understood as a process that recognises that ontology and epistemology and the underlying paradigmatic assumptions of research traditions and qualitative and quantitative research techniques matter. These considerations are important in interdisciplinary research as they shape the researcher's standpoint, understanding of knowledge, and approach to reconciling conflicting values that are encountered (Lincoln, 2010,). Integration, therefore, serves as a convergence point where these differences meet to bring together various facets of research – people, data, methods, and theories – while always trying to keep in mind what is being left out (Hägerstrand, 1984). Finally, the process of integration can vary in its ambition. For instance, integration can involve transdisciplinary work that develops consistent and coherent conceptual theories and explanations related to sport science phenomena, as suggested by Thorpe et al. (2020, 2023). In this thesis however, integration focuses more on the acceptance and mutual understanding of various forms of knowledge and how they can collectively contribute to a more comprehensive understanding of youth sport injuries. Therefore, this approach to integration may offer more applied and clinical value compared to deep conceptual integration.

Nevertheless, integration has its challenges, particularly in an interdisciplinary team, and requires the cultivation of certain ethical virtues. For the FIT team, successful integration and collaboration required the embodiment of specific moral behaviours. These virtues encompassed acknowledging others' contributions, maintaining confidence in one's own work, practicing humility and flexibility in perspective shifts, and upholding intellectual integrity (Balsamo, 2017). Moreover, fostering self-awareness regarding disciplinary biases and assumptions did promote effective communication and mutual understanding within the FIT teams.

Design of papers I-IV

This thesis consists of four papers: a research protocol paper of the FIT project, a narrative review of literature, a paper describing the adaption and application of a questionnaire for youth football players, and a methodological paper focusing on

the integration of qualitative and quantitative youth sport injury data as part of an interdisciplinary process. All publications were developed within the interdisciplinary research project 'Injury-free children and adolescents: Towards better practice in Swedish football (FIT project)'. The first paper presents the design of the FIT project while the remaining three papers are based on three different study designs and methods reflecting the three different research questions. In the following, I outline each of the four papers.

Paper I

Paper I serves as a research protocol of the project 'Injury-free children and adolescents: Towards better practice in Swedish football (FIT project)' within which I have conducted my research. The purpose of the protocol was to provide an overview of existing knowledge on injury risk factors in youth sport, justify the need for interdisciplinary and context-driven knowledge, and present and outline the FIT project's research methodology. Paper I was based on the application sent to the Swedish Research Council for Sport Science (CIF) for a PhD fellowship in 2015. The purpose of developing this application into a paper was twofold: first, to provide easy access to the interdisciplinary research methodology of the FIT project for other researchers, and second, to establish a reference point for my subsequent papers in which I describe the contextual background of my studies. Through collaborative discussions with the co-authors, we simplified the language from the original application and adjusted the research procedure outlined therein. For example, I incorporated additional research and references into the paragraph on existing knowledge on injury risk factors as well as added additional information about the two different questionnaires developed by the Oslo Sport Trauma Research Center (OSTRC) (the OSTRC-O and the OSTRC-H). Furthermore, the inclusion of floorball and handball as sports were reconsidered and ultimately excluded. This exclusion was mainly due to recruitment problems and challenges related to the planned statistical analysis. Also, after having reviewed literature from the three different sports during my first months as a PhD student, we realised how the inclusion of three different types of sports would be time consuming and challenging for both the project and for me as a PhD student. Additionally, I contributed with the inclusion of a detailed time plan, which offers the readers with a comprehensive understanding of the research context outlined in my thesis.

Paper II

Paper II is a narrative review of current youth sport injury literature from the disciplines of biomedicine, sport psychology, and sport sociology and helps to address research question 1. The purpose of the paper was to advance existing youth sport injury aetiology scholarship by considering and outlining an interdisciplinary research process for the complex nature of youth sport injury aetiology. Paper II was initiated early in my doctoral research to establish a robust knowledge foundation for my research. Paper II also became an important part for the FIT project as it enabled the team to create common ground before and during the conduction of the four sub-studies.

The conceptualisation of paper II began in the spring 2017, when I presented and discussed my research with the Sports Coaching and Physical Education (SCoPE) research group, of which I am still a member. During these discussions, I received valuable feedback on search terms and the importance of using relevant key words. Richard Pringle further contributed to the conceptualisation of paper II during my research stay at Monash University, Melbourne, in the autumn of 2019. Additionally, Richard Pringle introduced me to Holly Thorpe, Professor of sport sociology, who provided insights into the challenges of working across disciplinary boundaries. Although I had started a first draft in 2018, a new draft focusing on complexity in relation to interdisciplinarity, using a narrative review approach, was initiated by me during my stay in Melbourne.

In this thesis, paper II helps to address research question 1: What is the base of existing disciplinary knowledge on youth sport injuries and how does this knowledge shape the understanding of youth sport injuries? I decided to apply a narrative review approach as I found it appropriate due to its flexibility in accommodating various types of evidence, as suggested by Mays et al. (2005). Additionally, this method allows for a comprehensive synthesis of previously published literature, offering a broad perspective on the topic (Green et al., 2006). Furthermore, narrative reviews enable critical analysis of complex bodies of literature, as acknowledged by Collins and Fauser (2005). Unlike systematic reviews, which focus on answering narrow, predefined questions, narrative reviews aim to synthesise findings across the literature (Mays et al., 2005; Pollock & Berge, 2017).

Method of paper II

I conducted the literature search between January 2017 and May 2020. I first searched for literature across the databases PubMed, Scopus, PsycINFO and Web

of Science. The following search terms were entered within each search engine: 'youth', 'adolescent', 'injury', 'risk', 'biomedicine', 'biomechanics', 'clinical', 'psychological', 'cultural', 'sociocultural', 'coach', 'education', 'training', 'puberty', 'growth', 'maturation', 'norms', and 'knowledge'. These terms were combined with four terms relating to sport ('training', football', 'soccer' and 'sport) using the 'AND' operator. After the initial searches, I performed: a) title screening, b) abstract screening, and c) a full-text screening. Secondly, I conducted a cited reference search of articles identified through the first search strategy. This secondary search method allowed me to uncover relevant publications and to expand the scope of my review. Included articles focused on youth football players between 10 – 19 years of age and sport injury prevention and/or injury risk factors. I excluded articles focusing on older or younger athletes as well as articles focusing on other aspects than sport injury prevention and/or injury risk factors. However, the initial search revealed a lack of sociological youth football injury research. Thus, to better cover the field of sport sociology in relation to injury research, we decided to broaden the search to also include articles focusing on different sports and age groups within the discipline of sport sociology, which identified sociological research in biathlon, figure skating, rhythmic gymnastics, rugby, and softball.

Analysis of the literature

For the in-depth analytical reading of the literature, Braun et al.'s (2016) thematic analytical approach served as reference point as it enables flexibility across ontological and epistemological positions and is a robust method for scholars working in teams across disciplinary contexts (Braun et al., 2016). Moreover, thematic analysis enables the search for themes or patterns in the data and for describing and interpreting the meaning of those.

My analysis of the literature was exploratory, involving an attempt to understand the different disciplinary knowledge on youth sport injury through three steps. While the steps may appear linear, the analysis process was iterative and reflexive. Throughout this process, I engaged in dialogue with the co-authors to facilitate interpretations and develop a deeper understanding.

In step 1, I worked inductively coding the literature without trying to fit it into a pre-existing frame or analytical preconception (Bendassolli, 2013; Braun & Clarke, 2006). I sorted the articles by the type of journal they were published in and the authors' affiliation as scientific journals in sport science tends to focus on specific disciplinary approaches (Campbell, 2005; Woods et al., 2021). I then divided the literature into three disciplines: biomedicine, sport psychology, and

sport sociology. Determining relevant disciplines to study the problem is one of the early decisions made in the interdisciplinary research process according to Newell (2006, 2007).

In step 2, I worked deductively, relying on predefined categories from step 1 when rereading and making sense of the literature. I produced initial *codes* based on the literature, such as 'viewing the body as a machine', and 'athletes need expert treatment'. These codes identified features of the literature that were relevant for the aim of step 2, which was to identify the disciplines' pre-understanding of youth sport injuries (Braun & Clarke, 2006). The codes were produced based on key differences between the articles, which I outline in the findings.

In step 3, three analytical areas were delineated based on findings from step 2: Underlying paradigmatic assumptions, ontology, and epistemology. Following discussions at a scientific conference (Hausken-Sutter et al., 2018), discussions with co-authors, and analysis of the literature, the identified themes were categorised under three leading paradigms for youth sport injury research: positivism, post-positivism, and interpretivism. The underlying paradigmatic assumptions of each discipline were identified and synthesised into a table (see 'Findings', Table 3). This synthesis of literature and interdisciplinary knowledge can, as suggested by Phoenix et al. (2013, p. 220), enhance understanding and awareness within the research field, offering a path to transcend debates concerning the "right or wrong ways of approaching research".

Paper III

After I had gained a comprehensive understanding of sport injuries as well as sport injury research through conceptualising and writing paper II, the FIT project and my doctoral research moved towards the practical part of the interdisciplinary research process, which included conducting the four sub-studies and applying qualitative and quantitative research techniques. Work from the FIT project's sub-study 1 (questionnaire study) resulted in paper III, which is a methodological paper that aims to outline and discuss the adaption and application process of using the Oslo Sport Trauma Research Centre Questionnaire on Health Problems (OSTRC-H) with youth Swedish football players.

Writing an empirical paper based on sub-study 1 was included in the original FIT project's research protocol and my PhD publication plan. Due to my positive experience with a questionnaire study during my time as a research assistant, I was supportive of incorporating this paper into my thesis. Consequently, I initiated the

first draft in spring 2021, based on sub-study 1. Initially, the FIT project intended to use the Oslo Sports Trauma Research Center Overuse Injury Questionnaire (OSTRC-O) (Clarsen et al., 2013). However, during my review of sport injury literature, I came across the OSTRC-H (Clarsen et al., 2014), which had been recently employed with youth athletes by other scholars (Moseid et al., 2018; Pluim et al., 2016). In one of our regular team meetings, Natalie Barker-Ructhi and I proposed switching from OSTRC-O to OSTRC-H after discussing both questionnaires with the FIT team. We chose the OSTRC-H because it was better suited for recording injuries in heterogeneous groups of athletes prone to various injuries and health issues. Additionally, the OSTRC-H was more comprehensive, encompassing questions about health-related matters. This decision was influenced by insights gained from the narrative literature review; for example, based on our reading of sociological literature, it was important to consider the context and the interdisciplinary nature of the FIT project where scholars applied qualitative methodology. In summary, paper III contributes to addressing research question 2: What contextual and methodological issues are important to consider in interdisciplinary youth sport injury research?

Methods of paper III

In its original form, the OSTRC-H consists of four key questions about participation in sports, training volume, performance, and symptoms of health problems during the past 7 days (Clarsen et al., 2014). Subsequent questions allow the respondents to report whether the problem they have referred to is an illness or an injury. In case of an injury, respondents can register the area of the body in which it is located, and in the case of an illness, they can select major symptoms. The questionnaire was originally developed based on adult athletes and no Swedish validated version for youth athletes existed at that time.

The questionnaire study of paper III targeted all eligible football players between 10- and 19-years old attending two football schools in Gothenburg (N=499). The recruitment and enrolment process is visualised in Hausken et al. (2018), Figure 1, page 7. Of the 499 players invited to take part, 174 agreed to participate in the questionnaire study and signed written informed consent forms (parents signed for participants under 15 years). Players were included regardless of whether they had present or previous injuries or health problems. In total, 59 players dropped out during the study, which resulted in a final sample of 115 players. The remaining participants' age ranged from 10 to 19 years (M=14.7, SD=2.8) with 37 female and 78 male players.

The adaption process of the questionnaire for the youth football players in the FIT project included a slightly modified back-translation method to translate the questionnaire, which is explained in Hausken-Sutter et al. (2021b). I translated the Norwegian version into Swedish. We further pre-tested the questionnaire on a target population conducting cognitive interviews to determine its face validity and to evaluate its online delivery (Beaton et al., 2000; Wild et al., 2005). Following the pre-test, all authors of paper III discussed the questionnaire and additional changes were made based on these discussions.

The application process included a web-based version of the Swedish OSTRC-H. The questionnaire was sent out once a week over 23 weeks to 115 adolescent football players. Throughout these 23 weeks, we visited the schools to encourage participants to complete the questionnaire and to investigate the reasons behind the low and inconsistent response rate. Finally, I calculated the response rate and the prevalence of health problems over 23 weeks and developed the tables and figures for paper III. Findings from the adaption and application process are described under 'Findings'.

Paper IV

Based on the FIT project's protocol, paper IV was initially planned as a case study (Yin, 2014) exploring key injury risk factors in youth Swedish football players from a holistic approach. The interdisciplinary data analysis was outlined to involve the creation of *portfolios* as in an integrated excel document (Hausken et al., 2018). The portfolios would include results/analytical comments from each of the four sub-studies and annotations made by the research team that would then be mapped as per Wiese-Bjornstal's (2010) biopsychosocial sport injury risk profile. To generate an integrated understanding of youth sport injury aetiology, the FIT team would then discuss the integrated picture each portfolio (i.e., each case) generated (Hausken et al., 2018). The project plan did not, however, specify *how* this process should occur, or what elements needed to be included. Through my reading of literature during my early time as a PhD student, I also realised that there was a lack of available procedures at that time as most literature revolved around the *challenges* of integrating such data (e.g., Lunde et al., 2012; Sale et al., 2002; Sparkes, 2015) rather than on solutions for how this could be done. Therefore, the FIT project's team members and I saw a need to develop a procedure for *how* to integrate qualitative and quantitative sport injury data that suited the FIT project's interdisciplinary context.

The conceptualisation of paper IV gained momentum in spring 2020, especially after I attended a meeting at the School of Health Sciences, Örebro University, with Richard Tinning, Professor of pedagogy and physical education. Tinning gave a lecture on the concept of 'knowledge silos' (Kretchmar, 2008), interdisciplinarity and the compatibility (or incompatibility) of different paradigms. Together with my supervisor, we discussed paper IV in relation to the FIT project's process and how the paper could generate an understanding of the complexity of sport injury aetiology as well as the research process. After discussions with the other co-authors, the conceptualisation of paper IV shifted to focus more on the process of integration rather than on the key injury risk factors in youth players, which was initially its focus. Hence, a first draft of paper IV was initiated by me during spring 2021.

The purpose of paper IV is twofold: first, to introduce an interdisciplinary case analysis procedure (ICAP) and second, to offer an example for future interdisciplinary sport injury research. In doing so, paper IV addresses research question 3: How can qualitative and quantitative youth sport injury data be integrated in an interdisciplinary research process? To align with my thesis, I decided to adopt Klein and Newell's (1997) definition of interdisciplinary research in paper IV. Hence, the paper states that integration is not a linear process but rather requires analytical reasoning and creative thinking due to the iterative and complex nature of interdisciplinary research. The paper elucidates how the ICAP was developed within the FIT project through three key stages: 1) creation of common ground, 2) comparing qualitative and quantitative data, and 3) team meeting and discussion. These stages are further described in more detail under 'Findings'.

Taken together, the four papers included in this thesis take different approaches to youth sport injuries. While the provided insights into the *whole* interdisciplinary research process are limited to some extent, it is possible to generate methodological insights that demonstrate the practice of interdisciplinary youth sport injury research by bringing them together in the 'Findings'. Based on this, we can furthermore argue for and justify a range of appropriate methodologies valuable in this research area.

Findings

The aim of my thesis was to explore and explain the methodological insights that can be gained by conducting interdisciplinary youth sport injury research. Three research questions have guided this thesis:

1) What is the base of existing disciplinary knowledge on youth sport injuries and how does this knowledge shape the understanding of youth sport injuries?
2) What contextual and methodological issues are important to consider in interdisciplinary youth sport injury research?
3) How can qualitative and quantitative youth sport injury data be integrated in an interdisciplinary research process?

In this chapter, I present the findings in relation to the research questions.

The base of existing knowledge on youth sport injury

By reading and rereading literature in three steps, I have been able to address research question 1. Step 1 identifies and outlines the key disciplines and what the literature says about these disciplines, a pivotal aspect in the interdisciplinary research process as outlined by Newell (2007). Step 2 unveils pre-understandings of sport injuries and step 3 shows the underlying paradigmatic assumptions found in the literature (paper II).

The key disciplines and what the literature says about these disciplines

Unsurprisingly, the type of journal often reflects the disciplinary perspective that the authors adopted. Thus, the literature could be divided into three key disciplines of sport injury research: *biomedicine* (which included sport and exercise medicine, biomechanics, sport physiology), *sport psychology*, and *sport sociology*. Of the 32 articles included in the review, 14 were categorised as biomedical. All biomedical articles, employed quantiative methods, the most common approach being the use of

questionnaires (De Ridder et al., 2017; Padua et al., 2015; Steffen, Myklebust, Andersen, et al., 2008). Additionally, methods such as assessing movement performance during functional tasks, like the single leg jump (Read et al., 2018), and evaluating biological maturity (van der Sluis et al., 2014; Wik et al., 2020) were frequently used. These were often used in conjunction with questionnaires (De Ridder et al., 2017; Padua et al., 2015; Venturelli et al., 2011).

Moreover, several studies investigated the effectiveness of interventions and programs such as the FIFA 11+ and Knee Control, designed to mitigate injuries and re-injury risks (Hägglund et al., 2007; Soligard et al., 2008; Steffen, Myklebust, Olsen, et al., 2008; Thompson et al., 2017; Waldén et al., 2012). Furthermore, some research delved into injury incidence and patterns over time to offer insights for future injury prevention strategies (Olsen et al., 2006; Walden et al., 2005). Collectively, the themes addressed in the reviewed biomedical studies included risk factors, method assessments, and preventive measures concerning youth sport injuries.

The second prominent discipline in sport injury research is sport psychology. Out of the 32 articles reviewed, eight were categorised under sport psychology. Many of these studies employed quantitative methods such as questionnaires (Brink et al., 2010; Ivarsson et al., 2014; Johnson & Ivarsson, 2011; Schwebel et al., 2007; Steffen et al., 2009), while one study used qualitative interviews (Ivarsson et al., 2019) to investigate risk factors for sport injuries. These studies shed light on various risk factors contributing to sport injuries: these include every-daily hassles, such as family issues, personal responsibilities, and work relationships, (Ivarsson et al., 2014), sociocultural norms, expectations regarding overtraining, the pressure on athletes to play despite being unfit (Ivarsson et al., 2019), as well as physical and psychological stress (Brink et al., 2010; Johnson & Ivarsson, 2011; Steffen et al., 2009). Additionally, sport psychology has developed several psychosocially oriented injury prevention strategies, often based on the stress and athletic injury model by Andersen and Williams (1988; 1998).

In summary, the themes explored in the sport psychology studies centred on understanding the psychological and sociocultural factors influencing injury risk, as well as the development of preventive measures within the disicpline of sport psychology.

In the discipline of sport sociology, fewer studies have focused on injuries in *youth* athletes compared to biomedical and sport psychological research. Therefore, I expanded the scope to include studies on adult athletes as well. Out of the 32 articles reviewed, 10 fell under this category. Sport sociologists typically utilised

qualitative methods such as participant observations (Barker-Ruchti, 2008; Malcom, 2006), interviews (Barker-Ruchti & Schubring, 2016; Fenton & Pitter, 2010; Johnson, 2011; Roderick et al., 2000; Schubring & Thiel, 2014a), a combination of these methods (Cavallerio et al., 2016; Schubring & Thiel, 2014b), and personal narratives (Kuhlin et al., 2019). These studies have revealed how the relationship between coaches and athletes can influence injuries by shaping the identities and experiences of those they coach, often leading athletes to push through pain and injury (Barker-Ruchti & Schubring, 2016; Kuhlin et al., 2019). Additionally, some research has highlighted how the socialisation processes of young athletes into competitive sports and the sport ethic can lead to a 'glorification of pain,' where athletes learn to adapt and behave in ways that compromise their health (Malcom, 2006; Fenton & Pitter, 2010).

In summary, the themes explored in sociological studies focus on understanding the sociocultural aspects of sport, including coach-athlete dynamics and the impact of the sport-specific socialisation on athletes' behaviour. By employing qualitative methodologies, sport sociology contributes with contextual insights to sport injury research, considering individual, sociocultural, and environmental factors. This literature addresses criticisms of contemporary sport injury research strategies as being simplistic and reductionist, which several scholars have put forward (Bekker, 2019; Benjaminse & Verhagen, 2021; Bittencourt et al., 2016; Burwitz et al., 1994; Thorpe et al., 2020). However, there remains limited integration of sport sociological knowledge on youth sport injury research within specific contexts.

Taken together, step 1 included determining the relevant disciplines in order to find out how these contribute to the understanding of youth sport injuries. This is central in the interdisciplinary research process as outlined by Newell (2007). Furthermore, step 1 also included exploring the problem from each disciplinary perspective; this generates disciplinary insights and a 'general feel' for each perspective. This step is crucial for the interdisciplinarian in the early interdisciplinary research process (Newell, 2006).

Pre-understanding of sport injuries

Step 2 involved going deeper into the literature on sport injuries by examining the underlying assumptions of the involved disciplines (Newell, 2006). I identified three main differences among the articles related to their pre-understandings. First, authors used a variation of terms to describe their research, the target population,

and the motivations for injury prevention. In their examination of interdisciplinary research, Bracken and Oughton (2006) likened these differences in language to *dialects*. In the analysed texts, these dialects were evident in how authors conceptualised the athlete, or what I interpreted as the body. The body was portrayed as a multifaceted entity that could be understood and analysed through various lenses (e.g., physical, psychological, sociological). Thus, I further explored the theme of *body perspective*.

Second, there were discrepancies in how authors defined injuries, ranging from specific to nonspecific definitions. I termed this theme the *injury perspective*. Last, the authors' responses to these questions were influenced by the research methodologies they adopted. This constituted the third theme of my analysis. *Methodology*, in this context, refers to the practical guidance or tools that shape researchers' approaches to their studies and are grounded in particular philosophical or contextual frameworks characterised by certain assumptions (Kallio et al., 2016; McMeekin et al., 2020). Table 2 summarises the pre-understandings of the three disciplines according to the body perspective, the injury perspective, and the methodology perspective.

Table 2. Key disciplines of sport injury research and differences in body perspective, injury perspective and research methodology.

	Biomedical sport injury research	Psychological sport injury research	Sociological sport injury research
Body perspective	• Body as machine • Modifiable • Normative • Body in center of focus	• Body as a machine • Modifiable, but together with the mind • Physical body less in the center	• Body as a social product • Embodied • Athlete seen in context
Injury perspective	• Specific • Related to individual physical factors • Needs expert treatment	• Specific • Related to individual psychological factors • Needs expert treatment together with the mind	• Not specific • Related to factors outside of the physical body • Injury part of a story
Methodology	• Quantitative – physical testing • Injury registration – self reported, medical experts • Medical theory – descriptive	• Quantitative – questionnaires • Injury registration – self reported, medical experts • Psychological theories – descriptive	• Qualitative – interviews, observations • No injury registration • Social/sociological theory – prescriptive

The biomedical research I explored adopts a mechanistic perspective of the body, conceptualising it as being similar to a machine that requires screening to identify potential physical risk factors for injuries (Padua et al., 2015; Ridder et al., 2017; Steffen, Myklebust, Andersen, et al., 2008; Thompson et al., 2017; Venturelli et al., 2011; Walden et al., 2005). The language used in these articles describes the athlete in mechanical and reductionist terms, viewing them as entities that need to be taken apart and examined individually. For instance, in the conclusion of one article, de Ridder et al. (2017, p. 410) states: "Reduced hip extension muscle strength is an independent risk factor for lateral ankle sprains in male youth soccer players." The authors also stress that athletes' bodies can be modified, often with physical exercises and early screening:

> Ideally, one would want to use movement screening programs that identify individuals at risk for ACL injury as young as possible to allow time for preventive training to correct high-risk movement patterns before the peak ages for ACL injury risk (age range, 15 to 18 years). (Padua et al., 2015, p. 595)

In the biomedical articles, the body perspective is normative, as it adheres to a standard healthy body against which other bodies are considered to be at risk or injury-prone. By emphasising a physical and mechanical understanding of the body, the perspective on injuries becomes restricted, with the pre-underdstanding of an injury being specific and identifiable within the physical body. Biomedical research tends to narrow the aetiology of sport injuries by employing quantitative research methods grounded in general medical theory. This approach aims to establish causal relationships between an injury and physical deficits within the body.

The sport psychological research I explored also adopts a mechanical perspective on the physical body but incorporates considerations of the mind as an important factor (Brink et al., 2010; Ivarsson et al., 2014; Johnson & Ivarsson, 2011; Schwebel et al., 2007; Steffen et al., 2009). Sport psychologists emphasise the reciprocal relationship between the mind and body, suggesting that both can influence each other. Therefore, understanding both the mind and body is crucial for predicting injury outcomes from a psychological standpoint. Some scholars, for instance, demonstrate that a combination of physical stress (measured by factors such as training duration and perceived exertion) along with psychosocial stress and recovery play a vital role in injury and illness aetiology among youth football players (Brink et al., 2010). Others focus on psychological factors only and find that traits such as somatic anxiety, life event stress, mistrust, and ineffective coping mechanisms can account for 23% of injury occurrences in youth soccer players (Johnson & Ivarsson, 2011). In articles employing quantitative research techniques, the dialects are similar to those in biomedicine, with a mechanical and reductionist approach that breaks down the athlete into psychological traits requiring exploration and monitoring. For example:

> Based on the results of this study, trainers, coaches, and medical staff may consider monitoring the duration of training and matches and the psychosocial recovery–stress state, and possibly also the training load, monotony and strain of each player. (Brink et al., 2010, p. 814)

Some sport psychology researchers applying qualitative methods emphasise that the athlete has to be seen as a person in a specific context and, therefore, consider how sociocultural factors can influence the athlete's thoughts and feelings, for example:

> We recommend that players, coaches, and members of the medical teams work together to formulate norms and rules that facilitate adaptive behaviours, both related to training load and return after injuries. Developing a positive sociocultural environment will, possibly, decrease the risk of players experiencing excessive fatigue or anxiety. (Ivarsson et al., 2019, p. 642)

Nevertheless, the overarching aim of this work is still to identify risk factors and causal relationships in relation to injury, with the only difference being that the risk factors are psychosocial instead of only psychological. And as in the biomedical articles, the injury is pre-understood as a specific physical deficit in the body that should be diagnosed and looked after by experts.

Sociological researchers approach the body as a social construct, emphasising its embodiment of cultural norms and values (Cavallerio et al., 2016; Fenton & Pitter, 2010; Johnson & Ivarsson, 2011; Malcom, 2006; Roderick et al., 2000; Schubring & Thiel, 2014a). For instance, Cavallerio et al. (2016) investigated how cultural norms and values surrounding winning and performance were internalised and embodied by young rhythmic gymnasts, leading them to exhibit attitudes and behaviours associated with mental toughness, such as participating despite injury and pain. Similarly, other scholars have examined how social pressure and the normalisation of playing through pain are ingrained within sporting cultures (Fenton & Pitter, 2010; Malcom, 2006). In sociological research, the physical body is not at the centre of the researchers' focus. Instead, the focus is on the athlete in their social and situational context. Injuries are not narrowly defined by their anatomical location or rehabilitation process; instead, they are viewed as part of a broader narrative. Sociologists are more interested in understanding the contextual factors that influence injury causation, rather than presenting injuries in a linear fashion, as this example by Roderick et al. (2000) shows:

> Our data indicate that incurring an injury has a number of well-understood meanings for players and it is clear that the meanings associated with risk, pain and injury, as well as the status of players who are unable to play because of injury, can only be fully understood by locating these shared meanings within the network of social relations characteristic of professional football. (p. 177)

Sport sociologists frequently employs qualitative research methods such as interviews and observations. These studies delve into athletes' first-hand experiences and interpretations of concepts like injury and pain, shedding light on their perspectives. Additionally, these studies often include insights from various individuals involved in the athletes' experiences, such as coaches, parents, and others within

the sports context. Furthermore, researchers in sport sociology rely on social and sociological theories to inform their work. These theories, while not empirical in nature, provide frameworks for understanding social phenomena. For instance, applying Pierre Bourdieu's theory can elucidate how social factors, such as sport-specific body ideals and early selection practices, contribute to growth issues in young athletes, leading to pain and injury (Schubring & Thiel, 2014a).

Underlying paradigmatic assumptions

The third and final step of reviewing and analysing the literature included identifying conflicts in the underlying assumptions based on findings from step 2 (i.e., the body perspective, injury perspective and methodology). Identifying conflicts in disciplinary insights is a significant aspect of the integration part of the interdisciplinary process (Newell, 2007). These underlying assumptions were evaluated in the context of sport injuries and were found to be related to ontology, epistemology, and methodology. Bringing them together in Table 3 creates a visual understanding and synthesis of biomedical, psychological, and sociological sport injury research with a focus on 'state of the art', 'reality/truth', 'nature of knowledge', 'research approach', 'research methodology and data analyses', and 'paradigm' (Hausken-Sutter et al., 2021a). Taken together, this synthesis establishes a common ground and a more comprehensive understanding of sport injuries based on the included literature (Newell, 2007).

Table 3. Underlying assumptions of (youth) sport injury research.

	Biomedical research	Psychological research	Sociological research
State of the art	Injury is specific epidemiological/physical damage to tissue/muscles/bones Injury aetiology is a result of the accumulating effect of internal/external risk factors Injury aetiology is a result of complex interactions of multiple components in and around the athlete (complexity approach) Injury aetiology is explained/theorised in models and frameworks Injury prevention is possible through interventions that target the physical body, mind and environment		Injury is interpreted by athletes and researchers Injury can be explained/understood by examining sociocultural context Injury aetiology is a (non-linear) process Injury aetiology is explained and understood through conceptualization & theorisation Injury prevention is possible through education and adapting sociocultural conditions
Reality/truth	Injury is an objective reality Injury aetiology can be measured and studied	Injury is an objective reality Injury aetiology can be measured and studied, but never fully grasped	Injury is a socially constructed reality Injury aetiology is constructed intersubjectively trough the meanings and understandings relative to sociocultural context
Nature of knowledge	Injury aetiology knowledge is objective To generate injury aetiology knowledge, researchers detach themselves from athletes and context	Injury aetiology knowledge is approximate To generate injury aetiology knowledge, researchers keep interactions with athletes and context minimal	Injury aetiology knowledge is socially constructed To generate injury aetiology knowledge, researchers interact with athletes and context to construct knowledge
Research approach	Monodisciplinary Multidisciplinary Complexity (biomedical/positivist research, no empirical data yet)		Monodisciplinary Multidisciplinary
Research methodology and data analysis	Experimental-manipulative methodology Falsification principle Mathematical & statistical techniques Deductive reasoning & generalization Quantitative methods (mostly physical testing in laboratories, questionnaires & registration of injuries & training volume) Qualitative methods (psychology/post-positivist: mostly interviews)		Naturalistic methodology Interpretive science in search of meaning and understanding of injury aetiology Interpretive analysis techniques Inductive reasoning and social relevance Qualitative method (mostly interviews & observations)
Paradigm	Positivism	Positivism/Post-positivism	Interpretivism

Table 3. Adapted from Hausken-Sutter et al. (2021a, p. 3).

It is important to note that the reviewed sport injury research did not always fit neatly into a specific paradigm. In fact, some of the research overlapped and the paradigmatic boundaries were at times blurred. There are also different opinions about the definition of paradigm and what that entails in terms of choice of methods, ontology, and epistemology (e.g., Sale et al., 2002; Weed, 2009). In addition, scholars who are at home in the same scientific discipline or who apply similar methods to study identical issues can differ in their philosophies and approaches (Barbour, 1998; Poucher et al., 2020). For this reason, categorisation should be seen as a heuristic that helps to understand the whole body of literature on sport injuries, rather than a classification system that can be used to label specific examples of research.

Collectively, these three steps of reviewing literature facilitated a comprehensive understanding of youth sport injuries as a unified yet dynamic phenomenon including physical, biological, psychological, and contextual dimensions.

Important contextual and methodological considerations in interdisciplinary research

Research question 2 concerns contextual and methodological issues encountered when conducting interdisciplinary youth sport injury research. Interdisciplinary scholars often stress the importance of paying careful attention to how, for example, concepts, theories, and ideas may vary in meaning when employed by different disciplines addressing the same problem (Newell, 2007; Repko et al., 2020). However, interdisciplinary scholars primarily explore the theoretical dimensions of such contextualisation without detailing its practical and empirical application. To address research question 2, I therefore rely on insights gained from conducting a quantitative questionnaire study in the FIT project and from the process of writing and disseminating paper III in the interdisciplinary context of the FIT project. These insights underscore the significance of accounting for both the participants' context and the interdisciplinary environment in which the research is situated.

Considering the participants' context in interdisciplinary research

Adapting and using the OSTRC-H with Swedish youth football players shows the importance of considering the participants' context, i.e., their 'language', school,

and training environment, when developing tools to gather quantitative data on injuries in youth football players.

Adaption of the OSTRC-H

Before implementing the OSTRC-H, it needed to be adapted, piloted, and used with youth football players sampled for the FIT project. The adaption was necessary as the questionnaire was originally developed for adult athletes. Piloting it with youth football players required considerable language adaptions. We piloted the questionnaire with a group of adolescents to get feedback on specific words and concepts that are used in the questionnaire such as 'injury' in the first question: 'Have you had any difficulties participating in normal training and competition due to an injury, illness or other health problems during the past week?'. The FIT project had an injury definition based on Fuller et al. (2006), who defines and injury as:

> Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities. An injury that results in a player receiving medical attention is referred to as a "medical attention" injury, and an injury that results in a player being unable to take a full part in future football training or match play as a "time loss" injury. (p. 193)

However, the adolescents in the pilot study were unsure of what constituted an injury, and their understanding and interpretation of the concept sometimes diverged from the definition used in the FIT project. We therefore engaged with the research participants and their context through school visits during the first weeks of implementation. We discussed with both the teachers and the players the content of the questionnaire and what the concepts of health problems, illness, and injuries meant for them and for our project.

Application of the OSTRC-H

Another contextual challenge arose with regard to ensuring high response rates. Participants were asked to complete the OSTRC-H weekly for a period of 23 weeks; this presented challenges. The FIT team implemented various strategies to tackle this issue, including regular visits to schools throughout the study to maintain communication with players, teachers, parents, and coaches.

The data demonstrate that the response rate increased in the weeks during and/or after visiting the schools in weeks 3, 9, 13, 16 and 20 (see Figure 2), although overall, the response rate was decreasing over time (Figure 2). By talking to

participants during school visits, we also found that the response rate was lower during holidays (weeks 7, 13 and 14) and when players had long term health problems (Hausken-Sutter et al., 2021b).

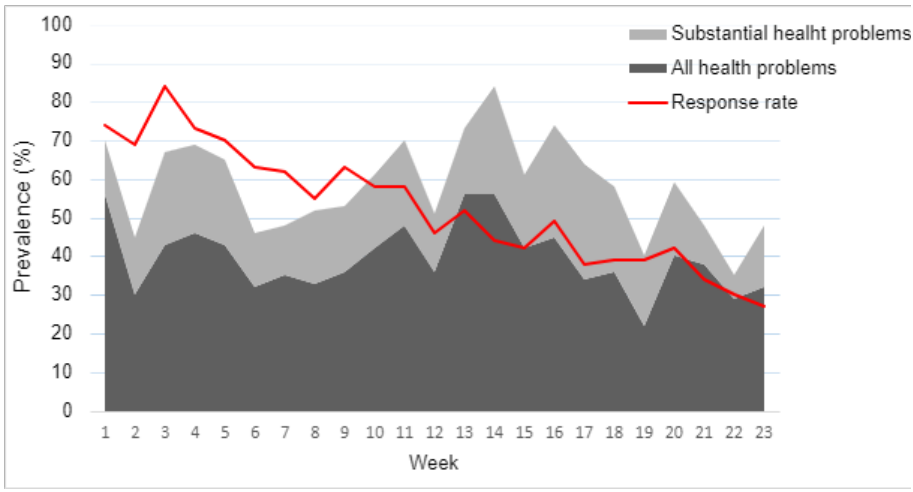

Figure 2. Response rate and weekly prevalence of health problems. Adapted from Hausken-Sutter et al. (2021b, p. 8).

Based on conversations with teachers and adolescents, we also found out that the adolescent groups aged 15 to 19 years gradually lost interest in completing the questionnaire. For adolescents aged 10 to 14 years, I was able to engage parents by email contact and phone calls, which resulted in a slightly higher response rate for this age group.

Twenty-five players answered comprehensibility questions that were added to the end of the questionnaire during the last week of registration. Although the response rate of the questionnaire in general was relatively low, the feedback on these questions was that overall, the players thought that the questionnaire was easy to understand and answer. These quantitative comprehensibility questions did, however, not provide us with any knowledge about what exactly was causing the low and unstable response rates. By taking these questions into consideration *together* with the adaption and application process as well as with conversations with the research participants, their parents, and teachers, we found that it was not the questionnaire itself that led to the low response rate, rather, it was influenced by various aspects such as the *context of the player's life* (i.e., holidays, health problems,

lack of interests) and the *research context,* i.e., the need for closer follow up from the FIT team.

Considering the interdisciplinary context in which the research is conducted

The process of designing and writing paper III based on a quantitative questionnaire study in an interdisciplinary team provided insights into the importance of considering the interdisciplinary context when writing and publishing results from different studies. Originally, the scope of paper III was intended to centre on the players and injury development, involving numerous statistical analyses to examine the frequency, severity, and types of injuries. This aspect was important from the biomedical perspective. However, the experiences of translating and adapting the questionnaire to the youth football players demonstrated how vital it was to consider methodological issues in (interdisciplinary) youth sport injury research, such as ensuring the quality of the questionnaire and data through, for example, considering language and context. Moreover, earlier experiences from writing paper II (narrative review) had highlighted aspects such as underlying assumptions in disciplinary approaches and methods and the importance of considering the broader socio-cultural context in which research is situated (Lunde et al., 2012). Together with my growing interest in interdisciplinary methodology as a topic of this thesis, I thus needed to convince some members of the team to focus on a methodological aspect in paper III rather than statistical analysis. In the end, we agreed to focus on the *research process* in relation to methodological and contextual issues that can influence a questionnaire study and, in the FIT project's case, knowledge about youth sport injuries.

Integrating qualitative and quantitative data

Research question 3 addresses the important issue of how qualitative and quantitative youth sport injury data can be integrated in an interdisciplinary research process. To answer this question, I draw from findings from paper IV and the FIT project's process of integrating data from the four sub-studies.

According to Newell (2006, 2007), the final part of the interdisciplinary research process involves the integration of disciplinary insights. Integration according to Newell (2006, 2007) relates to identifying conflicts between disciplines, evaluating disciplinary assumptions, resolving the conflicts, and creating a

common ground and a more comprehensive understanding of the investigated problem. A common ground and a more comprehensive understanding were achieved by addressing research question 1, i.e., through critically reviewing and analysing literature, identifying underlying assumptions, and synthesising disciplinary knowledge (see table 2, 3, and paper II). For a team of sport science scholars, integration also involves the integration of qualitative and quantitative data, as exemplified in Lunde et al.'s (2012) and Schofield et al.'s (2021) research and discussed further by Sparkes (2015). The integration of qualitative and quantitative data was also something that the FIT project aimed to achieve after the application of the four sub-studies (Hausken et al., 2018).

After working with paper II and the four sub-studies, the FIT team members and I had learned how differences in underlying paradigmatic assumptions can influence decisions and that the interdisciplinary context of a project could influence the research process and complicate the integration of seemingly opposing data. These experiences were the foundation for the development of the interdisciplinary case analysis procedure (ICAP), which is both a practical *process* of integration as well as a *finding* that addresses research question 3.

The ICAP

The development and piloting of an interdisciplinary case analysis procedure (ICAP) was possible with the use of injury data from the FIT project's four sub-studies, (outlined in Hausken et al., 2018). The procedure includes three stages that are visualised in Figure 3: 1) creation of a comprehensive understanding; 2) collecting and comparing qualitative and quantitative data, and 3) team meeting and discussion.

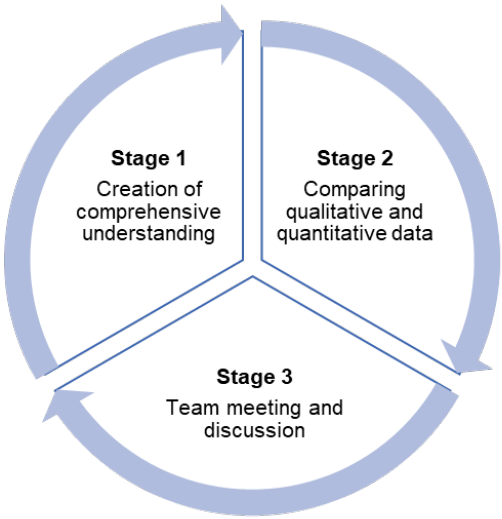

Figure 3. The three stages of the Interdisciplinary Case Analysis Procedure. Adapted from Hausken-Sutter et al. (2023, p. 6).

Stage 1 – creating a comprehensive understanding

In stage 1, researchers aim to establish a comprehensive understanding of the research problem by integrating insights from the various scientific disciplines involved in the project. This process involves fostering a common language among team members, acknowledging potential conflicts, appreciating, and reinforcing individual strengths, and recognising the diverse disciplinary knowledge contributed by each team members. To achieve this, disciplinarians are encouraged to embrace both/and thinking rather than either/or thinking, as advocated by Newell (2007).

In the context of the FIT project, this stage was realised through initiatives such as regular team meetings, thoroughly organised, and guided by the project leader to ensure inclusivity of language and consideration of all disciplinary perspectives. Additionally, team members engaged in reviewing literature beyond their expertise domains (Hausken-Sutter et al., 2021a). These efforts facilitated the development of a comprehensive understanding of youth sport injuries, enabling reflection on onto-epistemological differences within the team and in the broader sport injury research landscape. Furthermore, presenting the project in diverse academic and non-academic settings, including conferences and the participants' school environment, encouraged scholars to step out of their comfort zones, which facilitated learning across different contexts.

Stage 2 – comparing qualitative and quantitative data

In stage 2, the qualitative and quantitative data was brought together. Stage 2 began with an individual analysis of the qualitative and quantitative data according to their respective disciplinary data analysis methods and quality standards (e.g., thematic analysis for qualitative interview and observation-data; statistical procedures for biomedical data). Since the ICAP was a pilot, the focus was on a 14-year-old female football player that was chosen because her data was available from the project's four sub-studies. Second, the FIT team brought the analysed data together for comparison in a multilevel data catalogue in the form of an Excel document (see online material in Hausken-Sutter et al., 2023). Table 4 contains a simplified overview of the multilevel data catalogue from this female player.

Table 4. Stage 2 of the Interdisciplinary Case Analysis Procedure of a 14-year-old player.

Level 1	**Perspective**	**General**				**Biomedical**		**Sociological**	
Level 2	**Theme**	**Baseline information**			**Injury* information**	**Kinematics/ movement**	**Strength**	**Interview with player & coach**	**Observation of training sessions**
Level 3	**Type of data (examples)**	Age	Gender	Training	Diagnosis, duration, severity	Hip adduction range of motion (°)	Hip abduction / adduction ratio	Knowledge about injury and injury prevention	Communication between player and coach
Level 4	**Individual raw data (value or quote)**	14	Girl	7,5 hours of football training and 6 hours of handball training per week	Partial rupture left quadriceps, 3 weeks decreased or out of training	4,54	0,83	Athlete quote: *Injuries happen because of many different reasons. Mainly due to tough play.* Coach quote: *Injuries happen because they [players] might be untrained, or train too much*	The training context is relaxed; there is little interaction between the coach and the players
Level 5	**Group reference or code**	14,7 ±2,8	Girls			5,54 ± 2,10	0,86 ± 0,15	Injury related to tough play and overloading	Relaxed, laissez-faire coaching
Level 6	**Interpretation & evaluation**	Completed growth spurt, very high training volume (>10h); both football and handball			Overuse injury	Individual values are within 1 standard deviation (SD) of the mean value; e.g. no values outside of ± 1SD. (Reference group: females aged 14-19)		The complexity of sport injury development is not mentioned, coach and athlete mainly focus on training aspects	Lack of specific feedback and steering to achieve desired outcomes (i.e., injury prevention, effective training, desired learning)

Table 4. Adopted from Hausken-Sutter et al. (2023, p. 5).
**Injury was defined based on a consensus statement from Fuller et al. (2006, p. 193).*

In level 1, the multilevel data catalogue is divided into one biomedical (biomechanics, sport medicine) and one sociological (sociology, sport coaching) section, representing the FIT project's disciplinary perspectives. The purpose of level 2 is to show the different types of measurement and research methods that were employed under each disciplinary perspective. The columns in level 2 are divided into different research techniques (e.g., strength measurements; observation, interview). Level 3 specifies the type of data measured and generated for each of the themes. For example, for the strength theme, the hip abduction/adduction ratio is listed in separate columns. For the interview theme, topics such as 'knowledge about injury and injury prevention' are listed. Level 4 contains data excerpts to demonstrate the type of qualitative and quantitative data from the individual analyses of the injured football player. Qualitative data are represented in textual form (for example, quotes from the interview) while quantitative data are represented in numeric form (for example, results from the strength measurements). Level 5 shows the reference value for qualitative and quantitative data. For the former, codes were given through a qualitative thematic analysis procedure (Braun & Clarke, 2006). For the latter, individual biomedical data were calculated and compared to the mean values of one reference group 'females aged 14-19'. Finally, level 6 contains interpretations and evaluations of the qualitative and quantitative data in relation to reference values and literature. This interpretation and evaluation layer lays the most important groundwork for team discussion and continuation of data integration of stage 3.

Stage 3 – discussing the data

Stage 3 aims for researchers from various disciplines in an interdisciplinary project to convene and discuss the compiled qualitative and quantitative data. According to Newell (2007), the objective here is to achieve a balanced understanding among disciplinary perspectives without anyone dominating. The data in Table 4 was scrutinised to uncover behavioural patterns or relationships between different components influencing sport injuries. In the FIT project, this stage involved team discussions focusing on interpreting data related to the project's goal of understanding injuries comprehensively. Moderated by a researcher familiar with interdisciplinary research, the discussion followed a two-step process: first, each researcher presented interpretations of the analysis of data relevant to their disciplinary expertise. For example, I oversaw the data on growth and maturation (Peak Height Velocity). Second, the different perspectives and data were related to the 14-year-old female player's injury in a joint discussion. During each researcher's

statement of the analysed data, the other team members were invited to ask questions to enable a deeper understanding of the problem at hand (Szostak, 2012). Although the aim was to reach a consensus on the factors influencing the 14-year-old player's injury, time constraints limited the extent of integration due to the project's pilot nature and resource limitations. Given enough time and resources, the team discussion in stage 3 could, for example, have resulted in new models, concepts, or strategies to address youth sport injuries.

Discussion

In this chapter, I will discuss the insights derived from addressing the three research questions that guided my thesis:

1) What is the base of existing disciplinary knowledge on youth sport injuries and how does this knowledge shape the understanding of youth sport injuries?
2) What contextual and methodological issues are important to consider in interdisciplinary youth sport injury research?
3) How can qualitative and quantitative youth sport injury data be integrated in an interdisciplinary research process?

The insights are contextualised by referencing relevant literature and by drawing on experiences gained through my involvement in the FIT project.

The base of existing knowledge on youth sport injuries

In the following, I will discuss results from addressing research question 1. These insights are derived from the process of examining disciplinary literature on youth sport injuries.

First, I found a dominance of monodisciplinary research approaches and a lack of integration across the key disciplines of biomedicine, sport psychology, and sport sociology, as well as across dominant paradigms like positivism, postpositivsm and interpretivism. The dominance in monodisciplinarity and lack of integration can be attributed to the historical trajectory of specialisation and reductionism that has characterised both science and sport science (Eliasson, 2014; Repko et al., 2020; Woods et al., 2021). As discussed earlier, this emphasis on specialisation and compartmentalisation has led researchers to operate within silos, which is evident in youth sport injury research and reflected in the primary disciplines of biomedicine, sport psychology, and sport sociology. Similar to the broader field of sport science (Woods et al., 2021), youth sport injury research is primarily influenced by the natural sciences, which favour quantitative approaches framed by a positivist or post-positivist paradigm. This dominance is also evident in the lack of research I encountered on youth sport injuries from the interpretive

paradigm utilising qualitative methods. These findings underscore the general state of sport injury research, where scholars advocate for greater integration, particularly research that acknowledges the context through qualitative methodologies (Bekker et al., 2020; Truong et al., 2021). The same argument can be made for research on youth athletes. Athletic development is multifaceted, encompassing factors such as growth, maturation, specialisation, and the coach-athlete relationship, all of which vary over time and across different contexts (Bjørndal & Ronglan, 2021). Integrating sociocultural aspects and qualitative methodologies into this discourse certainly has the potential to facilitate the development of comprehensive interventions for injury prevention and sustainable sports practice in youth sport, aligning more closely with real-world settings (Ageberg et al., 2024; O'Cathain et al., 2019).

Second, and with specific relevance to research question 1, the narrative review revealed that disciplinary research is shaped by conflicts in paradigmatic underlying assumptions regarding the nature of injuries (ontology), methods of acquiring knowledge about injuries (epistemology), and approaches to researching sport injuries (methodology). These conflicts contribute to the lack of interparadigmatic youth sport injury research as outlined above. For instance, the reductionist ontology of biomedicine focuses its analysis on the athlete and the athlete's subsystems (e.g., cellular, molecular), aiming to dissect and understand an injury at a microscopic level (Woods et al., 2021). However, the ontological assumptions of biomedicine and sport psychology conflict with those of sport sociology and the interpretivist paradigm, which conceptualise an injury as a socially constructed phenomenon shaped by both the athlete and the researcher (Markula & Silk, 2011; Roderick et al., 2000). Unlike the positivist ontology, which emphasises analysis, the ontological perspective in sport sociology prioritises synthesis. Sociological researchers take a step back and weave together contextual factors to comprehend the phenomenon (Toohey et al., 2018; Woods et al., 2021).

Contradictions in ontological assumptions were also reflected in the disciplines' epistemological assumptions. Biomedical researchers tended to distance themselves from the athletes and the context they study, while sport sociology researchers tended to interact with the athletes and the context. For this reason, biomedical researchers favour quantitative research techniques such as questionnaires and physical testing (e.g., Ridder et al., 2017), whereas sport sociology researchers favour qualitative research techniques such as observations and interviews (e.g., Fenton & Pitter, 2010; Schubring & Thiel, 2014b). Insights into onto-epistemological contradictions were the result of analysis of literature

spanning three key disciplines in sport injury research. These insights would not have been possible without engaging with literature from diverse disciplines, similar to a boundary-crossing, transdisciplinary methodology, as highlighted by several scholars (Campbell, 2005; Clark & Thorpe, 2020; Thorpe et al., 2020). Certainly, "wrestling with unfamiliar literature" is recognised as a vital aspect of interdisciplinary success as it fosters a deeper understanding of perspectives outside one's own discipline (Campbell, 2005, p. 576). Specifically concerning this research, exploring literature from various disciplines prompted reflection on numerous ethical issues related to the diverse perspectives involved (Balsamo, 2019), which again opened opportunities for conversations across disciplinary boundaries.

In essence, addressing research question 1 show how the foundation of current knowledge on youth sport injuries originates from the disciplines of biomedicine, sport psychology, and sport sociology spanning three dominant paradigms: positivism, postpositivsm and interpretivism. Insights from these disciplines and paradigms brought together frame youth sport injury as complex and interdisciplinary, thus advocating for an interparadigmatic and interdisciplinary research approach. While these insights endorse the adoption of an integrated approach, the process of engaging with literature extends beyond mere compilation. It necessitates understanding and exploring the differences in assumptions; without such exploration, achieving a comprehensive synthesis of literature becomes challenging.

Important contextual and methodological considerations in interdisciplinary research

In the next step, I will discuss the gained insights from addressing research question 2, which were derived from the process of conducting the FIT project's sub-study 1. As explained before, this sub-study included the adaption and use of a questionnaire with Swedish youth football players in an interdisciplinary research context.

The OSTRC-H had been established as a valid and reliable tool in previous studies (Bailón-Cerezo et al., 2020; Jorgensen et al., 2016). However, within the interdisciplinary context of the FIT project, it was crucial to consider the participants' context when adapting and implementing the tool for youth football players. This adaptation involved aligning the language of the tool with the participants' linguistic preferences, a practice observed in some previous studies

(Bailon-Cerezo et al., 2020; Mashimo et al., 2020), although such adjustments have not been common in similar studies involving youth athletes. For the FIT project it was particularly important to align the questionnaire with the participant's understanding of the term 'injury', in accordance with the interdisciplinary approach emphasising multiple perspectives. For instance, young athletes' definition of injury differed from the FIT project's definition due to disparities between 'research language' and 'youth language'. This highlights the importance of considering the sociocultural context when defining concepts and developing tools, as it impacts data quality. Scholars, especially in sport injury prevention intervention research, emphasise the significance of accounting for end-users' context in the research process (Monsonis et al., 2021). Co-creating interventions with end-users, as argued by several scholars (Ageberg et al., 2024; Monsonis et al., 2021) enhances relevance, implementation, and sustainability. Concerning the injury definition and OSTRC-H usage in the FIT project, an alternative approach could have entailed integrating the youths' perspectives through qualitative methodology to establish a mutually agreed-upon definition. This collaborative effort would align with the principles of pluralism and integration, ensuring compatibility between the FIT project's interdisciplinary context and the perspectives of the youth athletes. Such an approach could potentially mitigate confusion surrounding certain questions during the initial registration weeks and enhance the relevance, significance, and applicability of the research outcomes across various research contexts and real-world settings. As highlighted by Bolling (2019, p. 111), engaging in conversation with athletes "brings participants' voices forward," which proved very crucial for refining the questionnaire and addressing the low and inconsistent response rates. Adapting tools, particularly questionnaires within interdisciplinary projects, requires a methodical approach involving thorough comprehension of the subject, pre-testing of the tool, and consideration of participants' contexts.

Recognising the necessity of tailoring tools to the context underscores the importance of early contextual consideration in the research process, as emphasised by various scholars (e.g., Bekker, 2019; Bekker & Clark, 2016; Bolling et al., 2018; Monsonís et al., 2021; Parsons et al., 2021). In hindsight, initiating the qualitative sub-studies (observations and interviews) before the quantitative sub-studies (questionnaire and biomedical testing) could have been beneficial for the FIT project. Insights from the qualitative studies could have provided FIT team members with a better understanding of the athletes and their context. This could have included important factors like the coach-athlete relationship and training environment, which are known to influence injuries (Ivarsson et al., 2019; Malcom,

2006). Equipped with this contextual knowledge from the outset, we could have more effectively customised the questionnaire for the youth athlete population, potentially increasing the response rates. Additionally, gaining a deeper understanding of the youth's context early in the research process could have been valuable during the 23-week registration period. Establishing a relationship with participants could have facilitated follow-up with those who missed responses or sustained injuries. Although this approach could have enhanced the FIT project's contextual understanding, it has to be mentioned in this context that research lacks clarity on the most effective sequence in this regard. For instance, some interdisciplinary studies have in fact benefited from conducting quantitative studies before qualitative ones (e.g., Thorpe et al., 2020).

In addition to considering the context of research participants, it is crucial to acknowledge unexpected insights during the interdisciplinary research process and to publish them, even if they were not part of the initial plan or the recommended established publishing protocol for interdisciplinary studies (Campbell, 2005). For instance, the interdisciplinary nature of the FIT project influenced the direction of this PhD thesis, leading to a focus on methodology and context in paper III, deviating from the originally intended emphasis on the frequency, severity, and types of injuries and health problems in youth football players. The change of focus for paper III did create tensions in the team as it was not part of the original publishing plan for the FIT project nor for my PhD research. Eventually, we agreed to go for a methodological focus as this decision aligned better with the available data and the overall theme of my thesis. Working in an interdisciplinary research project is a complex and iterative process, where new knowledge and insights continually emerge, requiring a flexible and adaptive approach. This ability to change perspectives, characterised as intellectual flexibility, aligns with one of the key ethical virtues outlined by Balsamo (2017). A recognition of the dynamic nature of interdisciplinarity therefore demands openness to unexpected findings and a willingness to adjust plans accordingly in the pursuit of valuable insights. Changing an established publishing protocol can, however, pose challenges, especially if the project is expected to produce specific outcomes based on a predefined plan. Therefore, it is crucial to communicate and report any changes during the project's development, especially to relevant funders, a step I had to undertake in the context of my PhD.

Disagreements or tensions arising during the research process are often linked to the composition of the team, particularly noteworthy when the team comprises scholars from both the natural and social sciences, as was the case for the FIT

project (Lunde et al., 2012). The FIT project utilised both qualitative and quantitative methods and was led by a social scientist. Having a social scientist as a project leader as well as including more scholars from the social sciences than the natural sciences may define the FIT project as being predominantly qualitative. This team configuration and project management approach seems to deviate from the conventional structure of interdisciplinary sport science projects, where the project tends to lean towards a quantitative focus (Lunde et al., 2012; Piggott et al., 2018). Consequently, interdisciplinary research can pose challenges for qualitative researchers, as emphasised by several scholars (Campbell, 2005; Wiltshire, 2018). What appears to be particularly challenging is that qualitative researchers in an interdisciplinary team often feel as though they must "justify their methods or fight for space to talk about their work within team meetings" (O'Cathain et al., 2008, pp. 1580-1581). As also experienced by Thorpe et al. (2020), these challenges relate to qualitative researchers' roles being 'tokenistic', meaning that they are included only to be able to label the project interdisciplinary when their actual contribution is limited (Campbell, 2005; Reich & Reich, 2006). Considering Johnson et al.'s (2007) claims on mixed methods research, these feelings and experiences can be understood as being part of a project that was dominated by quantitative research methods and perhaps more positivist in the understanding of and approach to athlete health. I personally did not experience the team meetings as being 'in favour' of one or the other methodological approaches. However, when presenting research from the FIT project and my thesis, I did experience feelings of 'tokenism' depending on the context I was situated in. For example, I experienced tensions and disagreements when I presented my work within my department, to the funders, and at scientific conferences, especially when I discussed the importance of context and a qualitative approach. Some scholars did not appear to understand or were critical of the need for interdisciplinarity and the concept of integration. Critical comments were often based on positivist and monodisciplinary understandings of sport injuries. These experiences can be related to what Thorpe et al. (2020, p. 371) refer to as "invisible walls" that are the result of "decades of agential cuts that have carved deep boundaries between [natural] science and social science ways of knowing athlete performance, health, and wellbeing". Newell (2007, p. 252) also touches upon this issue in his research and stresses that "some disciplines are more prestigious than others", and that prestige can "translate into more recognition in the larger culture". For instance, Sparkes (2015) highlighted the challenges inherent in mixed methods research, suggesting that the mixed approach may

encounter resistance within scientific fields like science, technology, engineering, and mathematics (positivist/post-positivist inquiry). Similarly, within the domain of sport science, there is a tendency to favour these traditional methodologies (Woods et al., 2021). Hence, scholars engaged in interdisciplinary research would benefit from recognising and understanding the boundaries that may inadvertently be reinforced.

In sum, understanding the sociocultural context of youth sport, school, and training environments is crucial to conducting interdisciplinary research on youth sport injuries. Methodological issues, such as fostering open communication for interdisciplinary collaboration and addressing ethical considerations, regardless of research techniques, are also vital for a successful collaboration. To enhance this communication and collaboration, team members should aim to learn and practise, and eventually embody ethical virtues such as generosity, humility, flexibility, and intellectual integrity (Balsamo, 2017). Embracing these virtues can lead to new insights that contribute to advancements in tools, methodologies, and knowledge in the field.

Integrating qualitative and quantitative data

Finally, I will discuss insights gained from addressing research question 3 in the following. These insights are based on the process of piloting an interdisciplinary case analysis procedure (ICAP) to integrate qualitative and quantitative data in the FIT project.

To facilitate the integration of qualitative and quantitative youth sport injury data in an interdisciplinary research process, it is crucial to initially consider the diverse disicplinary assumptions and their implications for data production. This consideration is significant for both individual researchers and interdisciplinary teams, especially for procedures like the ICAP, where subsequent data discussions and prioritisations will occur within the team. Having considered underlying ontological, epistemological, and methodological assumptions *before* the team meets for discussion can enable a more comprehensive understanding of the data. Therefore, establishing common ground and a comprehensive understanding as in stage 1 of the ICAP, is a vital initial step before data analysis and discussion. Newell (2007, p. 260) underscores the importance of early common ground creation, highlighting the objective as "not to remove tension between insights of different disciplines, but to reduce their conflict." Strategies like exploring literature beyond one's discipline, working with different concepts, venturing into unfamiliar

research areas, and conducting regular team meetings involving dialogue on disciplinary assumptions are crucial practices for mitigating conflicts and achieving common ground (Repko et al., 2020; Thorpe et al., 2020).

The FIT project did explore literature from diverse disciplines and engaged in studies beyond individual expertise, leading to the creation of the ICAP (Hausken-Sutter et al., 2023), a component not initially included in the original FIT project plan. Alongside the development and publication of paper II (Hausken-Sutter et al., 2021a), team members actively participated in sub-study 1 (questionnaire study) and conducted visits to the participants' schools. Engaging in research beyond one's comfort zone, through both literature review and hands-on research, fosters openness to alternative perspectives and aligns with ethical virtues such as intellectual flexibility, generosity, and humility, as highlighted by Balsamo (2017). As illustrated in Thorpe et al.'s (2020) project, venturing into research beyond individual areas of expertise gradually breaks down boundaries among team members.

Comparing qualitative and quantitative data in a multilevel data catalogue in stage 2 of the ICAP was a helpful way to visually show the data involved and laid a good foundation for the succeeding team discussions. The multilevel data catalogue was developed based on a method similar to what Richards et al. (2019) refer to as joint display in mixed methods research. According to Guetterman et al. (2015), who elaborate on mixed methods research, visual joint displays can facilitate integration. Visual joint displays can, according to these authors, "provide structure to discuss the integrated analysis and assist both researchers and readers in understanding how mixed methods provide new insights" (Guetterman et al., 2015, p. 554). Before piloting the ICAP, the FIT team members and myself included, were not familiar with the concept of joint display, which can be linked to our literature choices in stage 1 where we incorporated only a few articles on mixed methods. Moreover, as touched upon under 'Theoretical and conceptual framework', I decided early to not include the term mixed methods in my research. However, incorporating such literature in relation to paper IV could have enriched the development process of the ICAP in relation to the *data* and stage 2. Nevertheless, the multilevel data catalogue shows what an *interdisciplinary* research process of integrating data can look like, and it provided us with an innovative tool for the integrated team discussions in stage 3.

The discussion in stage 3 of the ICAP represents a learning process, and given ample time and resources, it can lead to innovative breakthroughs that advance the field of sport injury research. For example, stage 3 can lead to a comprehensive

understanding of the player's injury aetiology that can further inform injury prevention strategies. Additionally, it can facilitate the development of new concepts and theories, shaping future theoretical approaches to interdisciplinary youth sport injury research. However, productive interdisciplinary dialogue is time-consuming and mentally taxing, requiring significant effort from all participants (Newell, 2007). Building trust and understanding among team members is essential, as communication breakdowns can derail collaboration and hinder integration efforts (Bracken & Oughton, 2006; Campbell, 2005; Lunde et al., 2012). Involving an interdisciplinarian, as in the FIT project, can be advantageous because they can serve as a mediator, bridging disciplinary divides, fostering unity, and guiding the team towards effective knowledge production (Thorpe et al., 2020). Since the discussion in stage 3 of the ICAP provides only partial insights into an integrated practical outcome, further exploration is required to determine the extent to which key concepts and methodologies can be meaningfully translated across disciplinary and paradigmatic boundaries.

Taken together, the integration of qualitative and quantitative youth sport injury data can be achieved by using a three-stage procedure that enables common ground, a comparison of different types of data and dialogue across disciplinary boundaries. The process is complex and iterative, which underscores the importance of establishing common ground early. The ICAP served as a pilot, a crucial step toward the final stages of the interdisciplinary research process, as outlined by Newell (2007), which involves testing the more comprehensive understanding. To progress to this final step, further exploration is necessary to determine if such an analysis can be achieved while maintaining disciplinary integration. To advance our understanding of youth sport injuries, future research should also investigate whether an integrated and interparadigmatic understanding truly facilitates more effective actions, aligning with Newell's (2007) proposed steps of the interdisciplinary research process. Finally, it would be particularly intriguing to explore whether the integrated analysis can progress toward *transcending* disciplinary boundaries, resulting in "deeper and significantly richer insights into a complex phenomenon" (Woods et al., 2021, p. 9). Such a transdisciplinary approach could generate new and coherent conceptual, theoretical, and methodological innovations that would add to the academic challenge of deep integration on the conceptual level (Thorpe et al., 2020; Thorpe et al., 2023).

Conclusion

This thesis has generated three main insights with regard to the research questions guiding this thesis. First, the understanding of youth sport injuries is rooted in the disciplines of biomedicine, sport psychology, and sport sociology. These disciplines offer insights that portray youth sport injuries as a complex and interdisciplinary issue, advocating for an interdisciplinary approach. Second, it is important to consider participant's contextual factors, such as their language, school, and training environment when developing data-gathering tools for studying injuries in youth football players in an interdisciplinary project. Additionally, it is essential to address the interdisciplinary nature of the research along with ethical considerations throughout the research process. Third, qualitative and quantitative youth sport injury data can be integrated through a three-stage procedure that facilitates common ground, a comparison of different types of data, and dialogue across disciplinary boundaries.

In conclusion, these insights illuminate three vital components crucial to interdisciplinary research: synthesisation, contextualisation, and integration. Synthesisation involves combining information, concepts, theories, and methodologies from various disciplines to establish common ground and attain a comprehensive understanding of youth sport injuries. This process includes activities such as reviewing disciplinary literature, identifying patterns and connections among different types of data, generating new knowledge, and effectively communicating findings to both experts and non-experts. Clear communication is imperative for translating complex interdisciplinary research into practical solutions for real-world issues, such as developing complex interventions relevant to end-users.

Contextualisation revolves around placing research questions, issues, or phenomena within broader contexts to better understand youth sport injuries. This process involves considering the common ground and a comprehensive understanding of youth sport injuries when developing and applying tools and methods for studying them. Contextualisation requires acknowledging various perspectives that may influence or shape the research topic.

Integration, closely linked to synthesisation, is concerned with the extensive merging of knowledge, methodologiews, data, and insights from different disciplines to foster a comprehensive understanding of youth sport injuries. But integration goes beyond merely collating data; it is an ongoing process of contemplating disciplinary boundaries, engaging in dialogue, and stepping beyond one's comfort zone while maintaining methodological rigour.

Contributions

The thesis offers three significant contributions: First, it provides practical insights into interdisciplinary youth sport injury research, revealing some of the negotiations and decisions inherent in the research process. Unlike much interdisciplinary sport research that focuses on theoretical issues, this work advances the field by demonstrating interdisciplinary youth sport injury practice, building upon recent integrated sport science studies (e.g., Lunde et al., 2012; Schofield et al., 2020; Schofield et al., 2021; Thorpe et al., 2019; Thorpe et al., 2020) and offering guidance for future interdisciplinary research.

Second, the thesis confirms Newell's (2006; 2007) steps in the interdisciplinary research process, highlighting a cognitive and structured, yet iterative and flexible process guiding interdisciplinary research. Additionally, it extends Newell's model to the youth sport injury context, integrating both qualitative and quantitative data and addressing the onto-epistemological differences encountered by interdisciplinary teams. This expansion builds upon the work of Schofield et al., (2020; 2021), Thorpe et al., (2019; 2020) and Lunde et al. (2012).

Third, the thesis shows how the utilisation of an interdisciplinary approach deepens the understanding about sport injuries. The integration of literature and methods from various disciplines deepens the overall understanding of the issue, revealing its multifaceted nature. This synthesis unveils crucial disciplinary elements contributing to sport injuries and provides a holistic perspective, considering physical, psychological, environmental, and contextual factors. Therefore, through the interdisciplinary methodology of this PhD thesis, contextual influences on sport injury knowledge, including participant context, research tools, and environments, were explored and explained.

Implications

For researchers aiming to work in interdisciplinary research projects, I propose that it is important to:

- Design projects based on already developed interdisciplinary processes relevant for the problem to be studied. While sport scientists are starting to explore the practical aspects of interdisciplinary collaboration, they could benefit from exploring interdisciplinary literature beyond their field for inspiration and methodological development. Noteworthy works that I have found to be helpful include those by Newell (2006, 2007), Repko et al. (2020), Szostak (2012), Klein (2021; 2004; 1997), and Klein and Newell (1997).
- Conduct regular team meetings to foster mutual understanding of onto-epistemological and methodological assumptions. This creates an environment conducive to creativity and innovation through reflective discussions.
- Develop a clear project and publication plan yet do remain flexible and open to adjustments. Interdisciplinary research is iterative, and it often requires revisiting and re-evaluating previous steps as new knowledge emerges.
- Define clear roles for each team member and utilise their unique expertise to contribute to the project effectively. Ethical commitment to the research process is paramount, and team members do not need to be experts in every aspect but should contribute ethically.
- Encourage team members to explore unfamiliar territory. Encouraging team members to engage in both practical and cognitive aspects of the project can foster innovation and personal growth. Presenting research to diverse audiences, holding meetings in unconventional settings, and exploring literature from diverse disciplines can broaden scholars' perspectives.
- Appoint an interlocutor within the team. Having a team member skilled at navigating diverse perspectives and methodologies can facilitate communication, resolve misunderstandings, and move the research forward.
- Involve practitioners and stakeholders. Although involving practitioners adds complexity, it provides valuable real-world insights and enhances the applicability of the research findings.

- Be mindful of what is excluded. Balancing inclusivity with feasibility is crucial in interdisciplinary research. Documenting decisions and changes throughout the process helps maintain clarity and accountability.
- Maintain detailed records. Given the unpredictable nature of interdisciplinary research, maintaining thorough documentation helps to review and understand decisions and track changes.
- Embrace complexity. Interdisciplinary research, like youth sport injuries, is inherently complex. Embracing uncertainty and remaining open to emerging insights fosters resilience and growth within the research process.

Final reflections

By reflecting on *my* journey towards becoming an interdisciplinarian, I find myself still drawn to fundamental questions about human behavior and decision-making, albeit from a different perspective. Instead of focusing solely on health behaviour, my interests have shifted toward methodological inquiries, such as why scholars approach problems in certain ways and how their choices influence research outcomes and recommendations. While these questions will continue to guide my exploration, I realise that my path has not led me to become the kind of 'expert' I envisioned as a child. Today, I understand that expertise is not about knowing everything within a specific field, but rather about cultivating an awareness of what we leave out and continually evolving as scholars and individuals. As Hägerstrand (1984) emphasises, we must learn to recognise the limitations of our knowledge and embrace the ongoing process of learning and growth.

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Solveig E. S. Hausken-Sutter

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Youth sport injuries are recognised as complex phenomena, leading to calls for alternative research approaches such as the integration of qualitative and quantitative methods and different disciplinary knowledge. The overall aim of this thesis is to explore and explain the methodological insights that can be gained from conducting such interdisciplinary youth sport injury research.

The thesis' capstone text and four papers were developed within the interdisciplinary research project 'Injury-free children and adolescents: Towards better practice in Swedish football (FIT project)'.

The thesis has generated three broad insights: first, youth sport injury knowledge spans biomedicine, sport psychology, and sport sociology. Second, contextual factors significantly influence youth sport injuries, requiring careful consideration in research and ethical concerns. Third, integrating qualitative and quantitative data involves a three-stage process: establishing common ground, comparing qualitative and quantitative data, and fostering dialogue across disciplines. The thesis emphasizes three crucial components for interdisciplinary research: synthesis, contextualisation, and integration, highlighting the need for further exploration to develop effective injury prevention interventions.

Solveig Hausken-Sutter has a MSc in Health and social psychology. Her main research interests concern interdisciplinary research within the field of sport science.

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