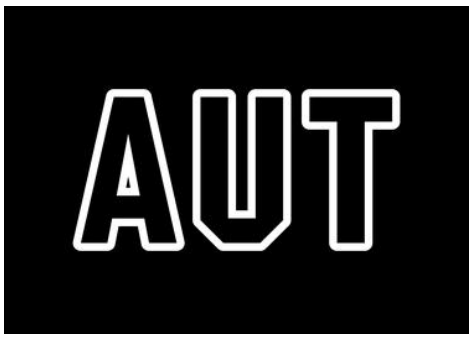

Injury Prevention in Futsal: An observational longitudinal prospective study to assess the influence of the modified FIFA “11+” injury prevention program.

Lubos Tomsovsky

A thesis submitted to Auckland University of Technology in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD)

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ABSTRACT

Futsal, a five-a-side version of the association football, has experienced significant growth globally, as well as in New Zealand (NZ). Due to the growing population of futsal players, the issue of safety has become more important. However, there has been little investigation regarding the effects of any injury-prevention measures in amateur futsal players. This thesis is, therefore, focused on the development of a novel injury-prevention warm-up programme and the evaluation of its effectiveness in NZ community futsal.

The first step in developing an effective, injury-prevention programme, was to understand the frequency of injuries and their characteristics in NZ community futsal. Data was collected from 420 teams of both genders and different age groups (junior, high school, adult) during a year-long futsal competition. A total of 131 injuries were sustained during 1723 matches, which is equivalent to an incidence rate (*IR*) of 11.4 injuries per 1000 player hours. Most injuries affected the lower extremity (56%), followed by head and neck (24%), and upper extremity (17%). The most common body parts injured were the ankle (25%), head (22%), and knee (17%). Most injuries occurred during contact situations (88%). Over half of the injuries (52%) stopped players finishing the match while 13% of injuries required medical attention.

Based on this injury data and the input from key stakeholders (coaches, players, sport medicine professionals), via two focus groups, a novel futsal-specific warm-up programme ("Futsal FastStart") was developed. The structure consisted of futsal-related movements adapted from the 11+ warm-up, previously shown to reduce injuries in football.

The effectiveness of the programme to reduce the risk of injuries in amateur players was assessed using a quasi-experimental study over the course of the 2019 futsal season (a total of 20 weeks). A total of 878 teams agreed to participate in the study. Teams in the intervention group (n=458 teams) were given information about the study and the implementation of the warm-up programme. Teams in the control group (n=420 teams) were asked to warm up via their usual routine. The intervention group had a significantly lower risk of contact injuries (incidence rate ratio (*IRR*)=0.68, p=0.035), especially injuries caused by contact with the ball (*IRR*=0.48, p=0.040). Subgroup analysis, based on adherence to the warm-up, revealed a significantly lower number of injuries overall (*IRR*=0.52, p=0.038) and lower extremity injuries (*IRR*=0.32, p=0.015) in teams with high adherence compared to teams with low adherence. Significantly fewer injuries overall

(*IRR*=0.50, *p*=0.041) were also found in the high adherence group compared to the intermediate adherence group.

Although the Futsal FastStart warm-up programme has not been found effective for preventing injuries overall, there were significantly fewer contact injuries that are common in amateur futsal. There is also preliminary evidence the warm-up could be effective in reducing injuries in community futsal players if adherence is high.

ACKNOWLEDGEMENTS

This part is dedicated to all the people, near and far, that have helped me and that I have met during this incredible journey from a boy growing up in a small village in the middle of the Czech Republic to an adult man pursuing his PhD on the other side of the world.

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Lastly, my thanks belong to New Zealand itself. It has changed my life forever; it has made me a better person and it will always be my second home. Kia ora, Aotearoa!

Thank you all, again.

ATTESTATION OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Luboš Tomšovský

25 September 2020

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CO-AUTHORED WORKS

Table 1 - Table of co-authored works.

Publication Reference (Chapter no.)		Authorship (%)
Chapter 2.	Tomsovsky L, Reid D, Whatman C, Fulcher M. Futsal: the nature of the game, injury epidemiology and injury prevention. A Narrative review. *New Zealand Journal of Sports Medicine* 2020;**47**(1):8-14.	LT: 85% DR: 5% CW: 5% MF: 5%
Chapter 3.	Tomsovsky L, Reid D, Whatman C, Fulcher M. Incidence and characteristics of injuries during an amateur futsal competition. *Journal of Science and Medicine in Sport*. Prepared for submission.	LT: 80% DR: 7.5% CW: 7.5% MF: 5%
Chapter 4.	Tomsovsky L, Reid D, Whatman C, Fulcher M, Walters S. Futsal FastStart; the development of a futsal-specific warm-up. *New Zealand Journal of Sports Medicine* 2020;**47**(1):15-19.	LT: 80% DR: 5% CW: 5% MF: 5% SW: 5%
Chapter 5.	Tomsovsky L, Reid D, Whatman C, Borotkanics R, Fulcher M. The effect of a neuromuscular warm-up on the injury rates in New Zealand recreational futsal players: a prospective cohort study. *Physical Therapy in Sport*. Prepared for submission.	LT: 80% DR: 5% CW: 5% RB: 5% MF: 5%

We, the undersigned, hereby agree to the percentages of participation to the chapters identified above:

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ETHICS APPROVALS

Two ethical approvals for the research were granted by the Auckland University of Technology Ethics Committee (AUTEC). The first one was granted on the 24th May 2018 for a period of three years:

- AUTEC 18/215 - Injury prevention in Futsal: An observational longitudinal prospective study to assess the influence of the modified FIFA 11+ injury prevention program (Appendix A and B).

And the second one was granted on the 30th October 2018 for a period of three years:

- AUTEC 18/379 - Injury prevention in futsal: A prospective study to assess the influence of the modified FIFA 11+ injury prevention programme (Appendix C and D).

CHAPTER 1: Introduction and Rationale

Futsal – the nature of the game

Futsal is a recent, fast-paced, dynamic sport derived from association football and widely played across the world[1]. Its name represents an abbreviation of the Spanish "*fútbol de salón"* (or colloquially "*fútbol sala*") or the Portuguese "*futebol de salão*"[2]. Both phrases can be translated as "hall football" or "indoor football"[2]. As the translation suggests, the game usually takes place indoors, but it can also be played outdoors[1]. Despite its short history, futsal has experienced significant growth globally. Due to the speed, non-stop flow of the game and plenty of goalmouth action, futsal has become attractive for both spectators and players[3]. The nature of the game puts an emphasis on an individual's technique, improvisation, creativity, footwork, agility and coordination[2, 4, 5]. Reduced space forces players to make decisions that require speed and quick reflexes[2, 3]. Due to these physical demands, high levels of physical and psychological preparation are considered important for all players[6, 7]. It has also been reported that the fundamentals of football can be learnt in futsal faster than anywhere else, which makes it an ideal sport for youth players[7, 8]. For all these reasons, futsal has been used more and more by traditional football players as a supplementary activity to improve their skills[4, 5, 8]. Several world-famous players reportedly developed their talents playing futsal (e.g. Pelé)[9, 10].

Futsal is a five-a-side game, including a goalkeeper, played on a flat and smooth pitch comprised of non-abrasive surfaces, preferably made of wood or artificial material (e.g., synthetic turf). The size of pitch differs for international and non-international matches; the dimensions for non-international matches are the minimum of 25 metres x 16 metres to maximum of 42 metres x 25 metres while the dimensions for international matches must be minimum of 38 metres x 20 metres to maximum of 42 metres x 25 metres[11]. However, the average size of pitch is 40 metres by 20 metres[12]. The size of goal is 3 metres by 2 metres and the game is played with a ball of a circumference of between 62cm and 64cm (corresponding to a football ball size 4) and a reduced bounce (the ball must not bounce lower than 50cm or higher than 65cm on the first rebound when dropped from a height of 2 metres). The ball can be played over a head-height and it is returned to play with a "kick in" (controlled by four seconds to re-start play). A game consists of two halves, each lasting 20 minutes. Matches are played to a "stopping clock", which means that the time stops every time the ball is out of play and in other rule-related situations (e.g., penalty kick, serious injury). Coaches can call one one-minute time-out each half to discuss tactics with the players. An unlimited number of substitutions may be made during a match.

A number of studies have suggested that the nature of game taxes both the anaerobic and aerobic metabolic pathways[13-15]. Compared to football players, the results of studies suggest that futsal players have higher values of the following variables; maximal heart rate (HR_{max}), the heart rate at the ventilatory threshold (HR_{VT}), the percentage of maximal heart rate *(%* HR_{max}), the maximum rate of oxygen consumption (VO_{2max}), oxygen consumption at the ventilatory threshold (VO_{2VT}), and the percentage of maximal oxygen consumption (*%* VO_{2max})[16]. From a biomechanical point of view, futsal is characterised by sudden changes of direction, quick accelerations and decelerations, and greater ground reaction forces compared to football[17].

A number of studies compared futsal and football in terms of physiological and physical demands, and these studies have found that both games require suitable aerobic power to maintain the high pace of play, especially due to the need for energy recovery between repeated sprints[18-20]. However, the intensity of game is much higher in futsal, which results in a consistent need for higher levels of anaerobic capacity, as most of the crucial moments of play last no longer than five seconds[19, 20]. Futsal is, therefore, considered an intermittent high-intensity game that requires substantial aerobic and anaerobic capacities, along with substantial muscular power of the lower extremities to compete at a high level[13, 14, 19, 21-23]. Despite some similarities with football, both games have significant differences that need to be considered when creating new training methods or developing injury prevention programmes[19].

Sport and regular physical activity reduce the risk of premature mortality in general and provide many health benefits, such as enhanced functioning of the cardiopulmonary and neuromuscular systems, improved mental health, and lower risk of obesity and diabetes mellitus[24-26]. However, sports participation also comes with considerable risk of injury for elite and sub-elite, as well as amateur, athletes[27] and futsal is no exception. Due to its growing popularity globally, with over 60 million players estimated to play futsal by the end of 2016, professionalisation of the sport, high physical and physiological demands on players, the nature of the game, and the playing environment, injuries are a growing concern and the issue of safety and injury prevention is becoming more important[5, 28-31].

Injury surveillance and injury definitions in sport

As injury surveillance is the first step in the injury prevention process, one must consider the definition of injury before incidence rates and severity can be evaluated in a given sport[32, 33]. Recently, there has been a consensus statement from the International Olympic Committee providing recommendations during injury surveillance to strengthen the consistency of data collection and research reporting of sports-related injuries[34]. The

statement provides a thorough guideline for planning and conducting research in the field of sports epidemiology in general. From this consensus an injury is classified as “Injury is tissue damage or other derangement of normal physical function due to participation in sports, resulting from rapid or repetitive transfer of kinetic energy“[34]. This is a very broad definition aimed to capture all injuries that might occur as result of sport. Within this overall definition are the concepts of any complaint, medical attention injuries and time loss injuries[34]. However, there are two areas of injury reporting requiring a specific, more detailed approach: the recording of subsequent injuries (multiple, recurrent, and exacerbations) and overuse injuries. The Subsequent Injury Categorisation (SIC) model was developed and found suitable to address recurrent, multiple, and exacerbation of injuries building on previous models proposed by Fuller et al. (2007) and Hamilton et al. (2011)[35-37]. In the case of overuse injuries, the Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC-O) was designed to improve the registration and characteristics of overuse injuries[38]. Since then, the questionnaire has been widely used in sports injury research and it has been found effective for improving the recording of sports-related injuries to a fuller extent[38, 39].

As futsal was derived from association football, previous studies focused on injury surveillance in futsal have used definitions that were first applied in football[5, 30, 31, 40-45]. In some of these earlier studies, a player was defined as injured if he was unable to participate in a training session or game[42-46]. However, it has been suggested this definition may not be appropriate for several reasons[46]. Firstly, the definition does not consider the frequency of trainings or matches and therefore may not identify significant differences between a player who trains daily and a player with 2-3 training sessions per week[46]. Secondly, an injured player can still attend a training session, but the definition does not consider possible modifications of the training programme for such a player[46]. Thirdly, the definition might be affected by other factors, such as availability of medical care or the importance of the game[46]. Another definition was proposed by the National Institute for Sports Health Care where a player was defined as injured if the injury resulted in one of the following consequences: 1) the amount or level of sports activity was reduced or limited, 2) there was a need for medical attention or treatment, and 3) an injury caused adverse social or economic effects[47]. Although this definition seems the most extensive, it was modified for football purposes to avoid the underestimation of mild injuries, and this resulted in injuries being defined as “any tissue damage caused by football regardless of subsequent absence from games or training sessions”[46]. This definition has also been used in several studies in futsal[44, 46].

However, more recent studies investigating football and futsal injury epidemiology have implemented the injury definition based on the consensus statement produced by the Injury Consensus Group (ICG) established under the auspices of the FIFA Medical Assessment and Research Centre (F-MARC)[48]. Based on this consensus an injury is defined as "any physical complaint sustained by a player that results from a football/futsal match or training session, irrespective of the need for medical attention or time-loss from football/futsal 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/futsal training session or match play as a ''time-loss'' injury"[48]. Although the reliability of such broad injury definitions has been found to be lower than other studies that have used "time-loss-only" injury definitions,[49] it has been suggested that it has the advantage of capturing the full spectrum of injuries[50]. This approach might be useful especially in the community-based environment, where the lack of sports medicine professionals present at matches could result in underreporting of the extent of injury in the case of "time-loss-only" injury definitions[51]. Although there are advantages and disadvantages of both injury definitions, research has demonstrated that the definition in any study should always be selected based on the context, purpose and methodology of the study, and epidemiological data should only be compared between studies with the same injury definition.

With respect to injury surveillance, there are two other important categories to consider: the severity of injury and exposure[48]. The exposure represents the time a player spends either playing matches or in training sessions[48]. It is usually expressed as a total number of hours, with training and game hours combined or presented separately. Exposure is mainly used to determine injury rates (i.e., incidence rates) which are generally expressed as the number of injuries per 1000 hours of player exposure[52]. This approach has been found useful and consistent in most epidemiological studies to improve comparability of the rates between different studies or sports[10, 33, 40-43, 45]. However, studies should always state if the exposure is based on matches only, training sessions only, or a combination of both, to avoid any misunderstanding when interpreting the results. The severity of injury is defined by the Injury Consensus Group[48] as "the number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training session and availability for match selection". Severity is usually rated by the number of days lost due to the injury: minor (0 days lost), mild (1-7 days lost), moderate (8-29 days lost), severe (≥30 days lost)[33, 42, 43].

Injuries in Futsal

Given it is a variation of football, the rate of futsal injuries has been compared to the rate in football. The rate of futsal injuries has been found to be slightly higher than the rate in football when the data was collected during the whole season (match and training injuries together)[30, 40, 53, 54]. With respect to tournaments, the rate of futsal injuries has been found to be up to three times higher than the rate in football[41, 42, 55]. Studies indicate that the lower limbs are the most common site of injuries in futsal contributing up to 88% of injuries followed by injuries to the head/neck area ranging from 2% to 22%, and injuries to the upper extremity accounting for 6-21%[30, 41, 43, 56, 57]. The ankle, knee and thigh are the specific areas of the body with the highest injury rates[30, 41, 43, 56, 57]. Most injuries are sustained in a contact situation (up to 70%), especially with another player (up to 90% of all contact injuries)[41-43, 56, 57]. Contusions, sprains, muscle and ligament injuries represent the most frequent pathologies[5, 30, 41-43]. Concussions are also shown to be more common among futsal players (when compared to traditional football)[30, 41, 54, 55, 58]. With respect to the severity of injuries, the results of studies have shown a trend toward less severe injuries in futsal (90% of injuries recovered within 7 days),[30, 41, 43, 56, 57] which is in contrast with football where higher rates of moderate and severe injuries have been reported[54]. A harder futsal ball, the smaller and harder surface of the futsal pitch, and the faster speed of the futsal game may result in a higher risk of collisions and injuries, which may account for the differences in the incidence rates between futsal and football. Although the incidence rates, severity, aetiology, and mechanisms of futsal injuries have been well described, most studies have focused on elite or sub-elite players[5, 30, 31, 41, 42]. The injury epidemiology in amateur futsal players, as well as the implementation and evaluation of preventive measures, have been poorly investigated.

Neuromuscular warm-up programmes

In general, a warm-up is considered as an introductory part of any training session or competitive event[59]. A warm-up can be broadly defined as an activity that "prepares the body for exercise"[60] or in a more detailed way as a "protocol specifically undertaken to prepare for the following physical activity"[61]. However, common warm-up routines usually only include general running and calisthenics followed by stretching[59]. Although such routines can satisfy psychological and physiological criteria of a warm-up such as an increase in body temperature, increase in blood flow to muscles, delivery of more oxygen to muscle cells, as well as decrease of stress and anxiety helping an athlete to focus on the upcoming activity, they have no effect on performance enhancement or injury prevention for the following activity[59, 61-63]. Therefore, the research has been lately focused on dynamic warm-up routines that activates proprioception and motor control, and thereby prepare the neuromuscular system for the upcoming physical activity[63].

Such systematic neuromuscular training programmes have been designed to improve body control and motor skills for sport-specific movements, enhance athletic performance and thereby improve lower extremity biomechanics and reduce the risk of injuries[61-63].

Neuromuscular warm-up programmes have been consistently shown to be effective in the prevention of risk of injuries across a broad range of research settings, designs, and sports[64-75]. Although most of these programmes have been designed for the sport-specific environment (football, basketball, rugby, handball, netball), their structure is very similar (11+ in football, PEP in football, RugbySmart in rugby, NetballSmart in netball, handball and basketball specific programmes)[64-75]. These programmes include exercises focused on dynamic stretching, strength and power, agility, jumping/landing skills, planting and cutting movements, and balance[64-75]. They have been evaluated regardless of the gender, age, and playing level, suggesting effective prevention of risk of injuries[64-75].

The results of studies have also found the uptake (compliance or adherence depending on the study design) of the warm-up programme among participants to be one of the key factors in successful injury prevention[64-77]. Given it is a variation of football, there is preliminary evidence the 11+, a validated, neuromuscular warm-up programme to prevent the risk of injuries in football, may be effective in an amateur futsal environment[56]. However, the use of the 11+ as a common warm-up in the community-based futsal may not be realistic. It has been shown that if a warm-up was not designed specifically to fit in the sport-related environment and it did not include enough sport-related activities, the uptake is likely to be low[76, 78, 79]. As coaches are considered key to maximising the uptake in community-based athletes,[80] including them in the development of such programmes has been promoted as important[79, 81, 82].

Injury-prevention frameworks

Developing injury prevention strategies in any sport is best done using a recognised framework. The Translating Research into Injury Prevention Practice framework, or TRIPP, is a well-known model for developing injury-prevention strategies[81]. It is built on a four-stage approach to sports injury prevention (Fig. 1, top four stages) proposed by van Mechelen and colleagues[32]. Compared to the model by van Mechelen, the TRIPP framework outlines a six-stage approach by adding two more stages to the original model (Fig. 1, bottom two stages).

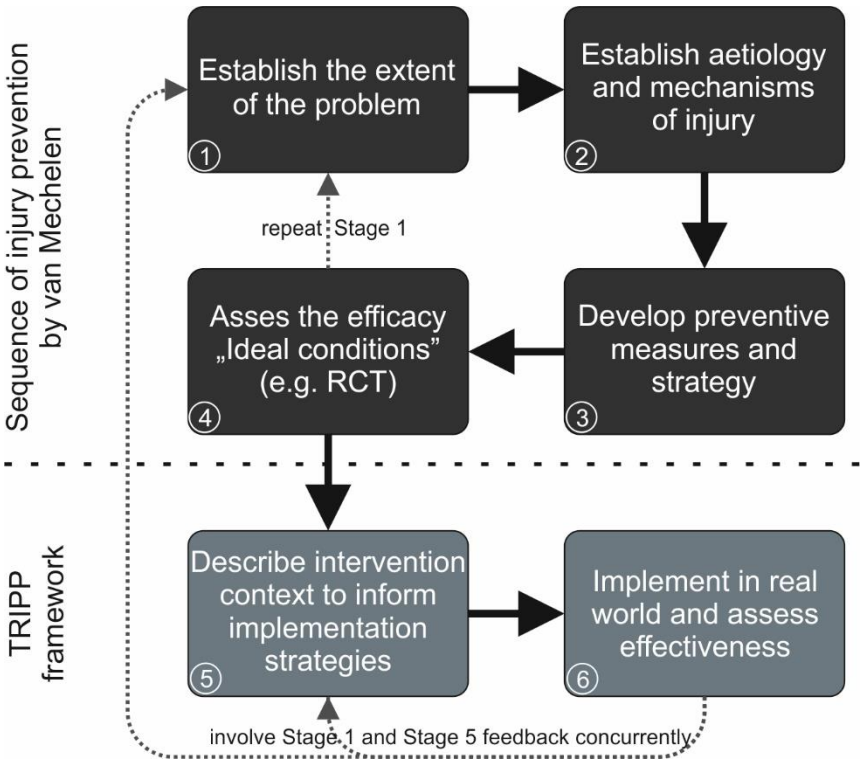

Figure 1 - The Translating Research into Injury Prevention Practice (TRIPP) framework[81] combined with the sequence of injury prevention proposed by van Mechelen[32].

The initial four stages of the TRIPP model overlap with the model by van Mechelen. Firstly, high-quality injury surveillance needs to be established to identify and describe the extent of the problem in terms of the incidence rates and severity of sports injuries[27, 32, 81]. The need for appropriate sports injury and exposure definitions are crucial during this stage[81]. The second stage focuses on the aetiology of why injuries occur and their mechanisms. The emphasis is put on a multifactorial approach to account for all the factors involved (both internal and external risk factors), as well as the inciting event (the injury situation)[27]. The injury mechanism itself for a particular injury type in a given sport needs to include the description of events that led to the injury situation (playing situation, players' behaviour), as well as the description of whole body and specific joint biomechanics leading up to injury[27, 81]. The third stage of the TRIPP model then uses information from both previous stages to develop specific injury-prevention measures and strategies. These need to be strongly guided by the second stage providing the identification of potential risks and protective factors for injuries in a given sport[81]. The fourth stage evaluates these measures and strategies under "ideal conditions" via the assessment of their efficacy to prevent the risk of injuries[81]. However, "ideal conditions" settings might also include controlled field-based studies, such as randomised controlled trials of interventions, because these are often conducted within an artificial environment with the injury-prevention measures delivered in a controlled and targeted way[32, 81]. Although such studies directly contribute to the better understanding of the efficacy of

injury-prevention measures under the “ideal conditions”, they might not lead to real-world sports injury prevention[81]. The TRIPP model, therefore, includes the fifth stage that is focused on the translation and implementation of the injury-prevention measures in the real-world context based on the outcomes of the previous efficacy research[81]. A better understanding of the knowledge and attitudes of key stakeholders (players, coaches, sports bodies) towards the rate, cause, mechanism, severity, and prevention of injuries is crucial for this stage and for the successful implementation of preventive measures in any sport[80-82]. The sixth and final stage then evaluates the effectiveness of the preventive measures and strategies implemented in the real-world context[81]. In other words, this stage combines the intervention found to be effective in TRIPP Stage 4 and it takes into account implementation cues and strategies identified in TRIPP Stage 5. The outcomes determine how effective given protective measures are in the sport-related environment to prevent the risk of injuries.

Purpose of the research

The overall purpose of this thesis was to develop a novel, futsal-specific, injury-prevention warm-up programme and to evaluate its effectiveness to reduce the risk of injuries in New Zealand amateur futsal players. Specifically, there were four sub-aims that formed the overall purpose:

1) Review the available evidence with respect to the game demands, injury epidemiology, and injury-prevention strategies in futsal.
2) Investigate the incidence rates, severity, and characteristics of injuries sustained during an amateur futsal season in New Zealand.
3) Develop a futsal-specific warm-up and implementation strategy for the New Zealand community-based futsal environment using the input from key stakeholders (players, coaches, sports medicine professionals).
4) Evaluate the effectiveness of a novel, futsal-specific, neuromuscular warm-up programme (“Futsal FastStart”) designed to reduce the risk of injuries in New Zealand amateur futsal players.

Significance of the research

The results of this thesis will be beneficial to three areas of injury research in New Zealand sport. Firstly, they will provide a more detailed picture of incidence rates in amateur futsal. Although there have been several studies focused on injury epidemiology in futsal, most of these have been in elite or sub-elite players[5, 30, 31, 41, 42]. To our knowledge, there have only been two studies involving amateur futsal players[56, 57].One of these studies did not have a focus on detailed reporting of injury epidemiology,[56] and the other study only involved youth players (under 21 years) during one tournament[57].

Therefore, the results of this part of the current study will provide a more detailed identification of the incidence rates, risk factors and mechanisms of injuries among New Zealand amateur futsal players of both genders and different age groups during a year-long futsal competition.

Secondly, the unique development of a novel, futsal-specific, injury-prevention warm-up programme will be then used as a cornerstone in designing and developing similar programmes in other similar sports. Although injury-prevention programmes have been shown to significantly reduce the risk of injuries and to enhance the performance of athletes,[64-68] the effectiveness has been found to be strongly dependent on the uptake (compliance or adherence depending on the study design) of the warm-up[70, 71, 76, 77, 83]. To improve both the protective effect and the uptake of players, it has been suggested a successful warm-up needs to meet three criteria[76, 79-82]. It needs to be implementable in the sport-specific environment, it needs to include sport-related activities, and it should involve coaches during its development as they play a key role in the delivery of the programme[80]. The results of this part of the study could provide a strategy to assist development and implementation of injury-prevention measures in other sports based on their unique environments.

Thirdly, the study will determine the effectiveness of a novel, futsal-specific warm-up programme to reduce the risk of injuries in amateur futsal. Although the efficacy or effectiveness (depending on the study design) of neuromuscular warm-up programmes has been investigated in both genders, in different age groups, and at different levels of competition,[64, 68, 70, 71] there is limited research focused on the effectiveness of these programmes in futsal. To our knowledge, there is only one study focused on the effectiveness of the 11+ to reduce the risk of injuries in amateur male adult futsal players[56]. The translation of these findings to the "real-world" community futsal environment may be limited due to the acknowledged difficulties implementing the 11+. Therefore, the results of this part of the thesis will evaluate the effectiveness and implementation of a novel, futsal-specific warm-up to reduce the rate of injuries in New Zealand amateur futsal players when the challenges of the community-based futsal environment are considered in the development of the programme.

Structure of the thesis

The thesis consists of six chapters and two main sections (Fig. 2). The theme of the first section is the game demands and injuries in futsal. Firstly, there is a narrative review of the physical and physiological demands of futsal, the incidence rates and severity of futsal injuries, and injury prevention in futsal (Chapter 2). Secondly, there is a chapter

describing the epidemiology of futsal injuries in the New Zealand community-based environment during a year-long futsal competition (Chapter 3). The theme of the second section (Chapters 4 and 5) is the development, implementation and evaluation of a futsal specific warm-up. Chapter 4 is focused on the development of a novel, futsal-specific, warm-up programme ("Futsal FastStart") using a focus group approach to improve both the protective effect and the adherence of players considering the challenges of the community-based futsal environment. Chapter 5 then evaluates the effectiveness of the warm-up to reduce the risk of injuries in amateur futsal players during a year-long competition. The final chapter of the thesis consists of a comprehensive overall discussion of the outcomes from each chapter, it derives main conclusions from them, and suggests future directions and practical implications of the findings (Chapter 6). Chapters 2 to 5 are written as manuscripts submitted to peer-reviewed journals and they were written in the format for the respective journal to which they were submitted. Chapter 2 and 4 have been published in the New Zealand Journal of Sports Medicine. Each chapter begins with a brief prelude that provides explicit links between the distinct chapters each of which form a sequential and cohesive thesis. Due to the manuscript format of thesis (Pathway 2, a thesis by publication), some repetition is expected between the chapters.

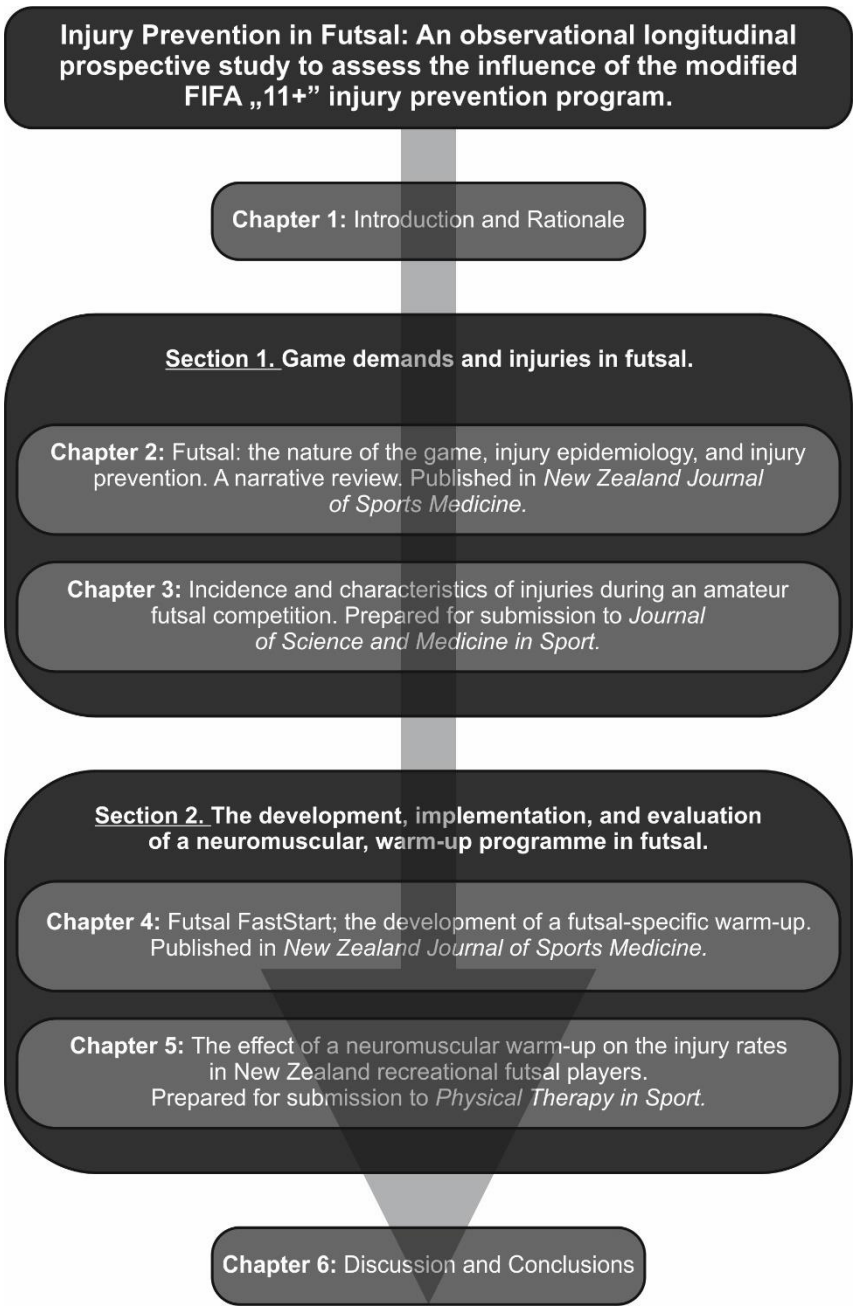

Figure 2 - An overview of the thesis structure.

SECTION 1: GAME DEMANDS AND INJURIES IN FUTSAL.

CHAPTER 2: Futsal: the nature of the game, injury epidemiology, and injury prevention. A narrative review.

This chapter contains the following paper published in the *New Zealand Journal of Sports Medicine.*

Reference

Tomsovsky L, Reid D, Whatman C, Fulcher M. Futsal: the nature of the game, injury epidemiology and injury prevention. A Narrative review. *New Zealand Journal of Sports Medicine* 2020;**47**(1):8-14.

Prelude

As suggested in the sports injury research framework, TRIPP, one of the first stages is a detailed understanding of the incidence rates, severity, and aetiology of injuries in a given sport. However, it is important to understand the sport itself first, the nature of the game, the physical and physiological demands on players, injury epidemiology, and current state of implementing any preventive measures in general. Therefore, the purpose of this narrative review was to examine the current literature relating to the game of futsal, its performance demands, injuries, and injury prevention, and identify potential gaps for future research directions. After a comprehensive literature search, a total number of 37 studies published between January 1990 (a year after the first FIFA Futsal World Cup) and May 2019 were included in the review. Twelve studies were focused on the nature of the game and performance demands of playing futsal demonstrating a higher intensity of futsal compared to football with more repeated sprints involved. Ten studies dealt with the injury epidemiology in futsal, of which five were designed as prospective studies. The results showed a high injury rate in futsal that was comparable to or slightly higher than in football. Given futsal is a variation of football, fifteen studies focused on the use of the 11+, an injury-prevention measure developed mainly for football but also showing the effectiveness in other sports, were included in the review. Of all these studies, ten examined the effects of the 11+ in other sports, and only five studies were conducted in futsal. However, only one study was focused on the effects of the 11+ on the risk of injuries in futsal. The results showed that structured, neuromuscular warm-ups can reduce the risk of injuries and enhance the performance of players.

The outcomes of this literature review highlight the gaps in the current research relating to the game of futsal. Despite some similarities with football, both games have significant differences that need to be considered when creating new training methods or developing injury prevention programmes. The intensity and nature of futsal may

contribute to injury rates and the need for injury prevention strategies. There is also limited data on the injury epidemiology and prevention in futsal, especially in the case of amateur players. Therefore, the literature review suggests future research directions are towards a more detailed picture of incidence rates in futsal and investigating the effectiveness of injury prevention measures implemented in futsal, especially in the community-based, amateur environment.

Introduction

Futsal is a fast-paced, dynamic sport derived from association football and played widely across the world[1]. Compared to 11-a-side football, the game is played on hard surfaces in a reduced space, usually indoors, but it can also be played outdoors[2]. The nature of the game puts an emphasis on an individual's technique, creativity, footwork, agility, coordination, quick reflexes and fast decision-making[3-5]. High levels of physical and psychological preparation are also crucial[7]. From a biomechanical point of view, futsal is characterised by sudden changes of direction, quick accelerations and decelerations, and greater ground reaction forces compared to football[8]. Due to these demands placed on players, a comparable injury profile to football is seen[40, 84]. With the growing popularity of futsal,[28] the issue of safety and injury prevention is becoming more important[9,10]. In 2016, it was estimated that over 60 million people play futsal globally, which corresponded to around 20% of people playing football worldwide[28]. This number increased from 11% reported in 2006 by FIFA[29]. Injury-prevention programmes have been shown to significantly reduce the risk of injuries and to enhance the performance of athletes in several other sports (football, basketball, rugby)[64-69]. One of these programmes, the 11+, was designed specifically to prevent injuries in football. It has since been validated, and shown to be effective, in both men's and women's football[70, 76, 83, 85].

Although there is one systematic review providing the summary of evidence-based research related to the sport of futsal, the main focus was on the development, coaching, physiological, psychological, technical and tactical elements of the sport[86]. The aim of this narrative review was to summarise the current knowledge and evidence relating to futsal in terms of the nature of the game, performance demands on players, and mainly on the injury epidemiology, and injury-prevention strategies. The purpose of the knowledge gained from this review was to determine if further research on the injury prevention in futsal was required and if current injury-prevention programmes, such as the 11+, were appropriate for the demands, injury rates and patterns in futsal.

Methods

This review considered peer-reviewed journal publications from January 1990 (a year after the first FIFA Futsal World Cup) until May 2019. The search strategy was systematic in the design but did not follow a full systematic review methodology. The main author used several search strings and keyword searches that led to the relevant literature linked to futsal. The following keywords were chosen and used in various combinations with Boolean operators (AND and OR); futsal, performance, physiology, football, injury, epidemiology, the 11+, injury prevention. The review only included publications written in the English language, full-text or abstracts, and relevant to the review (futsal and established keywords).

The methodological quality of each paper focused on injury prevention and performance in futsal was assessed using the PEDro rating scale, a validated, 11-item scale to rate the quality of randomized controlled trials. The papers were assessed by two authors using the PEDro scale independently. Any discrepancies in the scores were discussed and a final score agreed by both authors.

Findings

The nature of the game and performance demands on players

Due to the speed, non-stop flow of the game and plenty of goalmouth action, futsal has become attractive for both spectators and players[28]. The nature of the game puts an emphasis on an individual's technique, improvisation, creativity, footwork, agility and coordination[4, 5]. Reduced playing space forces players to make decisions that require speed and quick reflexes[28]. High levels of players' physical and psychological preparation are also crucial[7]. It has been reported that the fastest way to learn the fundamentals of football is in the futsal environment[7, 87]. For all these reasons, futsal has been used more and more by traditional football players as a supplementary activity to improve their skills[4, 7, 71]. A number of world-famous players including Pele are reported to have developed their talents playing futsal[88, 89].

A number of studies have suggested that the nature of the game taxes both the anaerobic and aerobic metabolic pathways[90-92]. The physiological characteristics have been analysed using laboratory testing methods and also by The Futsal Intermittent Endurance Test (FIET), a new field-testing method[90, 92]. The FIET has been developed to imitate the movement demands of futsal and it is considered a valid field test to assess specific futsal aerobic endurance[90, 92]. A summary of key physiological characteristics of futsal players is shown in Table 2[93]. Compared to football players, the results suggest that futsal players have higher values of the following variables; maximal heart rate

(HR_{max}), the heart rate at the ventilatory threshold (HR_{VT}), the percentage of maximal heart rate *(% HR_{max})*, the maximum rate of oxygen consumption (VO_{2max}), oxygen consumption at the ventilatory threshold (VO_{2VT}), and the percentage of maximal oxygen consumption (*% VO_{2max}*)[93].

Table 2 - Comparison of chosen physiological parameters between futsal and football players.

Physiological parameter	Futsal players	Football players
HR_{max} (BPM)	198 ± 8	189 ± 10.7
HR_{VT} (BPM)	177.2 ± 10.1	167.1 ± 10.8
% HR_{max} (%)	96.7 ± 2.3	88.4 ± 2.4
VO_{2max} ($ml \cdot kg^{-1} \cdot min^{-1}$)	62.5 ± 4.3	52.1 ± 4.6
VO_{2VT} ($ml \cdot kg^{-1} \cdot min^{-1}$)	58.7 ± 5.6	43.1 ± 4.6
% VO_{2max} (%)	93.9 ± 5.3	76 ± 8.4

Besides the physiological demands of the game, previous studies have also focused on the physical demands and the profile of game activities based on the video analysis of movements (Table 3)[90, 91]. These studies have shown that futsal players cover 4-6km on average per 1 game, with 26% of this distance spent at high intensity and approximately 8.9% of the total distance run at sprinting speed[91, 94, 95]. Futsal players also perform 9 exercise activities per 1 minute of play on average and a high-intensity effort every 23s of play[90, 96]. The work-to-rest ratio was reported to be 1:1, i.e. for every minute of "work" there is approximately 1 minute of "rest"[97].

Table 3 - Futsal game activities classified by cut-off speed and values of physiological parameters based on laboratory treadmill testing.

Game activity	Cut-off speed based on treadmill testing *(km/h)*	Cut-off speed based on treadmill testing *(m/s)*
Standing	0 – 0.4	0 – 0.1
Walking	0.5 – 6	0.1 – 1.7
Low-intensity running	6.1 – 12	1.7 – 3.3
Medium-intensity running	12.1 – 15.4	3.3 – 4.3
High-intensity running	> 15.5	> 4.3
Sprinting	> 18.3	> 5.1

A number of studies compared futsal and football in terms of physiological and physical demands, and these studies have found that both games require suitable aerobic power to maintain the high pace of play, especially due to the need for energy recovery between repeated sprints[97-99]. However, the intensity of game is much higher in futsal, which

results in a consistent need for higher levels of anaerobic capacity, as most of the crucial moments of play last no longer than 5 seconds[97, 99]. Futsal is, therefore, considered an intermittent high-intensity game that requires substantial aerobic and anaerobic capacities, along with substantial muscular power of the lower extremities to compete at a high level[90, 91, 97, 100, 101]. Despite some similarities with football, both games have significant differences that need to be considered when creating new training methods or developing injury prevention programmes[97]. The intensity and nature of futsal may also contribute to injury rates and the need for injury prevention strategies.

Injury epidemiology in futsal

With the growing population of futsal players there are several factors that contribute to increased injury risk, in particular the professionalisation of the sport, higher physical and physiological demands on players, the nature of the game, and the playing environment[5, 30, 31]. There have been several studies focusing on the injury occurrence in futsal (Table 4)[5, 30, 31, 40-45]. Referred to as a modality of football, the rate of futsal injuries has been found to be comparable to the rate in football[30, 40, 45, 84]. Considering the total number of player hours (training and match hours together), the incidence rate in football has been reported to range from 2.0 to 5.9 injuries per 1000 player hours and the incidence rate in futsal has been showed to range from 2.2 to 5.3 injuries per 1000 player hours[30, 40, 45, 84]. Several studies only reported the number of futsal injuries per 1000 player match hours, not including training hours[41-43]. In that case, the incidence rate has been reported to range from 91.5 to 208.6 injuries per 1000 player match hours.

Table 4 - Summary of studies investigating injury rates in futsal.

Study	***Design***	***Injury definition***	***Population***	***Follow-up***	***No. of injuries (per 1000 player hours)***
Uluöz (2016)	Retrospective cohort study	Any tissue damage caused by futsal regardless of subsequent absence from games or training sessions (Junge & Dvorak, 2000)	66 Turkish female futsal players of university teams	1 competition season	93 injuries (-)
Serrano (2013)	Retrospective cohort study	Any physical complaint sustained by a player that results from a futsal match or futsal training session, irrespective of the need for medical attention or time loss from futsal activities (Fuller et al., 2006)	411 Portuguese futsal players (284 males) of diverse competitive levels	Retrospective recall of 3 main injuries found during the sports career in futsal	512 injuries (-)
Gayardo (2012)	Retrospective cohort study	Injury with compromising which had presented at least one of the following consequences: decrease in the quantity or level of sports activity for at least 1 day, or which had needed medical evaluation or treatment	147 Brazilian female futsal players participating in the National League of Futsal	1 season (2010–2011)	104 injuries (-)
Angoorani (2014)	Prospective cohort study	Any physical complaint sustained by a player that results from a futsal match or futsal training session, irrespective of the need for medical attention or time loss from futsal activities (Fuller et al., 2006)	55 Iranian national futsal players (23 males, 17 females, 15 U-23 males)	March 2011 to September 2012	54 injuries (2.22)
Van Hespen (2011)	Prospective cohort study	Any physical complaint associated with futsal (received during training session or a match) that limits athletic participation for at least the day after the day of the onset (Faude, Junge, Kindermann, & Dvorak, 2005)	77 Dutch elite male futsal players	1 season of premier league male futsal (2009-2010)	58 injuries (3.1)
Hamid (2014)	Prospective cohort study	Any physical complaint sustained by a player that results from a futsal match, irrespective of the need for medical attention or time loss from futsal activities (Fuller et al., 2006)	468 Malaysian amateur futsal players (238 males)	1 season of the 2010 FELDA/FAM National Amateur Futsal League (141 matches)	86 injuries (91.5)
Junge (2010)	Prospective cohort study	Any physical complaint sustained by a player that results from a futsal match which received medical attention from the team physician, regardless of the consequences with respect to absence from match or training session (Fuller et al., 2006)	Futsal players of 3 consecutive Futsal World Cups	3 consecutive Futsal World Cups (136 matches in total)	165 injuries (195.6)
Ribeiro (2006)	Prospective cohort study	any physical complaint arising during the match regardless of the consequences with respect to subsequent absence from matches or training session (Junge, Dvorak, Graf-Baumann, & Peterson, 2004)	180 Brazilian futsal players (17-20 years old)	15th Brazilian Sub20 Team Selection Championship (23 matches)	32 injuries (208.6)

The studies focusing on injury epidemiology in futsal have also focused on injury characteristics, such as the injured body part, type of injury, cause of injury, and severity of injury (Table 5)[5, 30, 31, 41-43]. The lower extremities have been shown to be the most frequently injured body part (87% of all injuries), followed by the upper extremities (up to 24% of all injuries), and head and trunk (up to 22% of all injuries)[5, 30, 31, 41-43].

Of all the injuries to the lower extremities, the ankle, knee and thigh (groin) were the sites most commonly injured[5, 30, 31, 41-43]. Ankle injuries reached up to 51% of all injuries, followed by thigh/groin injuries (up to 28%) and knee injuries (up to 23%)[5, 30, 31, 41-43]. The studies showed that ligament injuries (sprains and ruptures, up to 52% of all injuries), skin injuries (contusions, up to 44% of all injuries) and muscle injuries (strains and ruptures, up to 18% of all injuries) were the most common types of injuries in futsal[5, 30, 41-43]. Concerning types of injury, some studies have shown that the rate of concussion reaches a significant value in futsal (4% of all injuries on average)[30, 41, 42]. This is more than four times the rate of concussion in football (1% of all injuries on average)[54, 55]. A harder ball, harder surface, and reduced space may be possible reasons for this difference.

Table 5 - Summary of studies investigating injury characteristics in futsal.

Study	***Injured body part (3 most common)***	***Anatomical site (3 most common)***	***Type of injury (3 most common and concussion)***	***Cause of injury***	***Severity of injury***
Uluöz (2016)	Lower extremity (57.0 %) Upper Extremity (23.7 %) Head and trunk (19.3 %)	Ankle (26.9 %) Knee (21.5 %) Low back (16.1 %)	-	Contact (58.1 %) Non-Contact (29.0 %)	1-3 days (10.8 %) 4-7 days (34.4 %) 8-28 days (25.8 %) >28 days (29.0 %)
Serrano (2013)	-	Ankle (50.6 %) Thigh (18.3 %) Knee (13.3 %)	Sprain (48.8 %) Muscular rupture (14.8 %) Fracture (8.4 %)	Non-Contact* (55.8 %) Contact* (44.2 %)	0-3 days (5.5 %) 4-7 days (10.5 %) 8-28 days (52.7 %) >28 days (31.3 %)
Gayardo (2012)	Lower extremity (86.5 %) Upper extremity (9.6 %) Head and trunk (3.8 %)	Ankle (28.9 %) Thigh (24.0 %) Knee (23.1 %)	-	Non-Contact (51.9 %) Contact (46.2 %)	0-6 days (4.8 %) 7-28 days (52.9 %) >28 days (33.7 %)
Angoorani (2014)	Lower extremity (85.2 %) Head and trunk (9.3 %) Upper extremity (5.6 %)	Ankle (40.7 %) Knee (22.2 %) Groin (13.0 %)	Sprain (51.8 %) Strain (13.0 %) Ligament rupture (7.4 %) Concussion (3.7 %)	Non-Contact* (70.4 %) Contact* (24.1 %)	1-3 days (33.3 %) 4-7 days (38.9 %) 8-28 days (14.8 %) >28 days (13.0 %)
Hamid (2014)	Lower extremity (65.1 %) Head and trunk (22.1 %) Upper extremity (12.8 %)	Knee (23.0 %) Ankle (21.0 %) Chest and back (14.0 %)	Contusion (36.0 %) Sprain (32.6 %) Strain(16.3 %) Concussion (3.5 %)	Contact (63.0 %) Non-Contact (37.0 %)	0 days (71.0 %) 1-7 days (8.0 %) 8-28 days (15.0 %) >28 days (6.0 %)
Junge (2010)	Lower extremity (69.7 %) Head and trunk (20.0 %) Upper extremity (10.3 %)	Knee (15.8 %) Thigh (13.9 %) Ankle (12.1 %)	Contusion (44.2 %) Sprain (19.4 %) Strain (17.6 %) Concussion (4.2 %)	Contact (60.6 %) Non-Contact (34.5 %)	0 days (43.0 %) 1-3 days (26.1 %) 4-7 days (4.2 %) 8-28 days (7.9 %) >28 days (1.2 %)
Ribeiro (2006)	Lower extremity (84.4 %) Head and trunk (12.5 %) Upper extremity (3.1 %)	Ankle (43.8 %) Thigh (28.1 %) Knee (12.5 %)	Contusion (31.3 %) Sprain (28.1 %) Strain (9.4 %)	Contact (65.6 %) Non-Contact (34.4 %)	0 days (65.6 %) 1-7 days (18.8 %) 8-28 days (12.5 %) >28 days (3.1 %)

* in a study by Serrano et al. (2013) and Angoorani et al. (2014), contact injuries refer to injuries caused by a contact with an opponent and non-contact injuries represent all other injuries.

With respect to the cause of injury, there are two main mechanisms; contact and non-contact[5, 30, 31, 41-43]. An injury may occur during a contact (with another player, the ball, the equipment, etc.) or a non-contact situation (a fall/trip/slip, kicking the ball, a sudden change of speed or direction, planting and/or cutting, landing). Most injuries in futsal have been shown to be caused by contact situations (up to 66% of all injuries), which is comparable to football (up to 73% of all injuries)[41-44, 54, 55]. The most common contact injury was with another player (up to 46% of all contact injuries)[31, 44]. However, it was also demonstrated that non-contact injuries might reach a significant value in futsal (up to 52% of all injuries)[31]. This might be an indication of inadequate preparation of players before an exposure (a training session or a match).

Regarding the severity of injury, studies have shown that the results are influenced by the study design[5, 30, 31, 41-43]. In retrospective studies, moderate (8-28 days lost) and severe injuries (>28 days lost) reached higher frequency than minor (0-3 days) or mild injuries (4-7 days lost)[5, 31, 44]. A recall bias might be a possible reason for underestimating light/minimal and mild injuries, because more severe injuries are easier to remember[41]. In one study, the players were asked to refer to three main injuries in their futsal career[5]. This fact could also result in players remembering only the most severe injuries which had the highest impact in their career. Prospective studies have shown that most injuries in futsal are mild[5, 30, 41-43]. In football, higher rates of moderate and severe injuries have been reported[54].

An injury can be further distinguished, whether it occurs during one specific, identifiable event (acute/trauma injury), or if it is caused by repeated micro-trauma without a single, identifiable event (overuse injury)[48]. The reviewed studies show that most injuries were of an acute/traumatic nature with frequency up to 79% of all injuries[40, 44]. Overuse injuries were demonstrated to only contribute up to 26% of all injuries. However, these injuries are very difficult to determine due to two objective reasons; firstly, due to the gradual onset of symptoms resulting in an overuse injury,[40, 44] and secondly, because of the definition of injury, which is mostly time loss, and players might often play on with an overuse injury[103]. Significant differences were reported between the rates of overuse injuries based on the method of data collection[103].

Injuries can also be classified whether they occurred during a match or training session[48]. Several studies have shown that the frequency of training injuries (up to 63% of all injuries) in futsal is higher than in a match (up to 40% of all injuries)[5, 30, 31]. However, the number of training hours is usually much higher than match hours[30]. Therefore, although the frequency of training injuries is higher, the incidence rate of these injuries (1.6 injuries

per 1000 player hours) is much lower than the incidence rate of match injuries (6.3 injuries per 1000 player hours)[30]. Similar results have been found in football when comparing the incidence rate of injuries in a match and training session[54]. Situations of higher competitiveness, commonly associated with the game, might result in a higher risk of injury, which could be a reason for the differences in the incidence rates between a match and training session.

Injury prevention and performance in futsal

Injury-prevention programmes have been shown to significantly reduce the risks of injuries and to enhance the performance of athletes in a range of sports[64, 65, 67-69]. The 11+ is one such programme that has been found effective and successful at preventing football-related injuries (up to 53% injury reduction)[68, 70, 77, 104]. Despite its validated reduction of injury rates among football players, the 11+ was also shown to lose its efficacy or effectiveness (depending on the study design) if not performed consistently and regularly[70, 71, 76, 77, 83]. Several studies have suggested that the 11+, developed by sport-related medical professionals and researchers, reduced the injury occurrence significantly only if the uptake by players was high and the programme was performed more than once a week[70, 71, 76, 77, 83, 104].

Although there are several studies focusing on the injury characteristics and injury occurrence in futsal,[5, 30, 31, 41-45] the implementation and evaluation of any preventive measures in futsal has been poorly investigated. As football and futsal are very similar in the game demands, this review has identified 5 studies that met the inclusion criteria for this review. These studies examined the effectiveness of the 11+ to prevent injuries or improve performance in the futsal environment[105-109]. The characteristics of these studies are summarised in Table 6.

Table 6 - Summary of studies investigating injury-prevention measures in futsal.

Study	***Design***	***Population***	***Follow-up***	***Outcome variables***
Lopes (2019)	RCT*	Amateur male futsal players IG[a]: 37 players (age: 27.0±5.1 years) CG[a]: 34 players (age: 26.0±5.1 years)	IG[a]: 10 weeks of the 11+ programme CG[a]: 10 weeks of regular futsal warm-ups	Agility test (T-test) Sprint test (30m sprint) Flexibility test (sit-and-reach test) Vertical jump test (squat jump)
Reis (2013)	RCT*	Adolescent male futsal players (age: 17.3±0.7 years) IG[a]: 18 players CG[a]: 18 players	IG[a]: 12 weeks of the 11+ programme CG[a]: 12 weeks of standard jogging and ball exercises	Isokinetic quadriceps and hamstring strength test (peak torque) Vertical jump test (squat jump) Countermovement jump test Sprint test (5m and 30m sprint) Agility test (T-test) Technical skill test (slalom-dribbling test) Balance test (single-legged flamingo balance test)
Soares (2019)	Prospective cohort study	Youth male futsal players (n = 14, age: 12.6±0.7 years)	18 weeks of the 11+ programme	Isokinetic strength test of knee flexor and extensor muscles (peak torque)
Zein (2014)	RCT*	Youth futsal players playing in high school teams (age: 16.2±0.9 years) IG[a]: 9 players CG[a]: 11 players	IG[a]: 4 weeks of the 11+ programme CG[a]: 4 weeks of routine futsal training	Core strength test (plank test) Vertical jump test (squat jump) Agility test (Illinois agility test)
Lopes (2018)	RCT*	Amateur male futsal players IG[a]: 31 players (age: 27.0±5.1 years) CG[a]: 34 players (age: 26.0±5.1 years)	IG[a]: 2 periods of 10 weeks of the 11+ programme separated by a 10-week period in-between CG[a]: 20 weeks of a combination of running, ball, and dynamic stretching exercises	Injury incidence (number of injuries per 1000 player hours) Warm-up compliance (number of sessions per week) Injury characteristics

* RCT – randomised controlled trial
[a] IG – intervention group; CG – control group

The methodological quality of each paper, except one study (not an RCT study design),[108] was assessed using the PEDro rating scale (Table 7), a validated tool to rate the quality of RCTs evaluating some specific intervention[110]. The mean quality score of the reviewed studies was 6.5 ±0.5 (out of 10). All studies satisfied the items of the PEDro scale related to random allocation of subjects, measures of at least one key outcome obtained from more than 85% of the subjects initially allocated to groups, the treatment or control condition received by all subjects as allocated, the results of between-group comparisons being present for at least one key outcome, and both point measures and measures of variability for at least one key outcome. In addition, all the rated studies assured that groups were similar at baseline regarding important prognostic factors. In two studies the allocation of subjects was not concealed, which could result in a selection bias[107, 109]. All studies failed to meet criteria for subject blinding, therapist blinding, and assessor blinding.

Table 7 - PEDro scores.

Study	**Scores for PEDro criteria**											**PEDro overall quality score (/10)**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
Lopes (2019)	1	1	1	1	0	0	0	1	1	1	1	7
Reis (2013)	1	1	0	1	0	0	0	1	1	1	1	6
Zein (2014)	1	1	0	1	0	0	0	1	1	1	1	6
Lopes (2018)	1	1	1	1	0	0	0	1	1	1	1	7
Mean score ±SD												6.5 ±0.5

Four of the studies focused on the influence of the 11+ on players' performance measures,[105, 107-109] and one study focused on the effectiveness of the 11+ to prevent the number of injuries in futsal[106]. In the case of the effect of the 11+ on players' performance, studies have found different results in several outcome measures. The study by Lopes et al. (2019) found no short or long-term performance enhancement in sprint (30-m sprint), flexibility (sit-and-reach test), agility (T-Test), and jump (squat jump) in the intervention group after 10 weeks of the 11+ performance (mean number of sessions per week was 1.9 ±0.1)[105]. In contrast to this study, the study by Reis et al. (2013) found a

significant improvement (p<0.05) in squat jump (14%) and countermovement jump (10%), 5-m and 30-m sprint (9% and 3% respectively), agility (5%), slalom (5%), and balance (smaller number of falls by 30% in the non-dominant leg) performances after twelve weeks of executing the 11+ (mean number of sessions per week was 1.8 ±0.1)[107]. There were no changes in the control group. Significant improvement (p < 0.05) in agility (4%) was also found in the study by Zein et al. (2014) compared to the control group[109]. This study also showed an enhancement in core strength (40%) in the intervention group after 4 weeks of performing the 11+ (two sessions per week). There was no significant improvement found in squat jump. The age of players might be one of the reasons for the differences in the results of studies. In the study by Lopes et al. (2019) the participants were adult male players up to 10 years older than the participants of other studies (Reis et al., 2013; Zein et al., 2014). There may be greater potential for improved movement patterns in younger players, because their basic patterns have not been completely established, and they can be modified and developed more easily[70]. The duration of the intervention and warm-up routines in the control group might be other influencing factors that caused the differences in results. Unfortunately, studies did not specify the warm-up routines in the control group in detail.

Two studies also analysed the influence of the 11+ on the isokinetic strength of knee flexor (hamstrings, H) and extensor muscles (quadriceps, Q) in the futsal environment[107, 108]. Both studies showed a significant improvement in the isokinetic performance of flexors and extensors of the knee and a significant improvement in muscular asymmetries between the dominant and non-dominant limbs of players. In a study by Reis et al. (2013), quadriceps concentric (15-27%) and hamstrings concentric (9-13%) and eccentric (13%) peak torque increased significantly (p<0.05) compared to the control group[107]. This study also found an improvement of antagonist/agonist balance around the knee (functional H:Q ratio increased by 2-9%). Similar results were shown in the other study[108]. After 18 weeks of the 11+, there was a significant improvement in the isokinetic performance of the knee's extensor and flexor muscles and decreased muscular asymmetries between the limbs of young futsal athletes. However, this study only analysed pre- to post-intervention changes without any control group.

Only one study focused on the effectiveness of the 11+ to reduce the number of injuries in the futsal environment[106]. After 20 weeks (five months) of the 11+, with average exposure of 1.78 ±0.28 sessions per week, significant differences were found in the total number of injuries (44% injury reduction, p=0.014), acute injuries (48% injury reduction, p=0.007), lower limb injuries (54% injury reduction, p=0.032), and training injuries (62% injury reduction, p=0.028) compared to the control group[106]. While the sample size used

in this paper is very small, and thus caution is needed when interpreting the results, the findings suggest that futsal injuries can be reduced using a structured, neuromuscular warm-up programme.

Conclusion

Futsal, a five-a-side version of association football, has globally experienced significant growth. Despite some obvious similarities with football, the games have significant differences in physical and physiological demands. Due to the growing population of futsal players and the comparable injury profile to football, injury prevention has become a priority. Although the injury rates and injury characteristics have been shown to be similar to football, this review found significant differences in the rates of concussion and the severity of injuries. The frequency of concussion in futsal (4% of all injuries on average) has been shown to be more than four times higher than in football 1% of all injuries on average). Most injuries in futsal have been found to be mild (0-7 days), which is significantly different from football with most of the injuries being reported as moderate (8-28 days) or severe (>28 days). This review has highlighted a lack of evidence relating to the implementation and validation of injury preventive measures in futsal. There is some evidence the 11+ can improve physical performance in futsal players and one study has shown a benefit in terms of injury reduction. Further research is needed investigating the effectiveness of injury prevention measures implemented in futsal and in particular the possible use of the 11+ in the futsal environment.

CHAPTER 3: Incidence and characteristics of injuries during an amateur futsal competition.

This chapter comprises the following paper prepared for submission to the *Journal of Science and Medicine in Sport.*

Reference

Tomsovsky L, Reid D, Whatman C, Fulcher M. Incidence and characteristics of injuries during an amateur futsal competition. *Journal of Science and Medicine in Sport* 2020. Prepared for submission.

Prelude

Given the need for more research on the epidemiology of injuries in futsal identified in Chapter 2, this chapter follows the first two stages of the TRIPP framework, with the goal to establish the incidence rate, severity, aetiology, and mechanisms of injury in the New Zealand community-based environment in particular. The purpose of this chapter was to describe the incidence rates and characteristics of injuries sustained during a year-long, amateur futsal season. Data was collected from 420 teams: 198 junior (U13), 134 high school (U17), and 88 adult teams, over the course of one season using a specifically designed paper-based injury report card. A total of 131 injuries were sustained during 1723 matches, which is equivalent to an incidence rate (*IR*) of 11.4 injuries per 1000 player hours or 7.6 injuries per 1000 player matches. Most injuries were sustained by junior players (*IR*=14.0 injuries per 1000 player hours), followed by adult (*IR*=10.4 per 1000 player hours), and high school players (*IR*=8.2 per 1000 player hours). The observed incidence rate of overall injuries was higher in female players compared to male players (13.0 vs 10.9 injuries per 1000 player hours), however this difference was not statistically significant. The majority of injuries affected the lower extremity (56%), followed by head and neck (24%), and the upper extremity (17%). The most common body parts injured were the ankle (25%), head (22%), and knee (17%). Most injuries occurred during contact situations (88%). Over half of the injuries (52%) stopped players finishing the match while 13% of injuries required medical attention. The results reveal a high rate of injury in amateur futsal players, especially injuries to the lower extremity and head injuries. Most injuries were sustained during contact situations, evenly distributed between contact with the ball and another player.

Introduction

Futsal, a 5-a-side version of association football, is a fast-paced sport played on a smaller hard pitch and usually indoors[1]. Its popularity has been growing globally, and in

2016, more than 60 million players were estimated to play futsal[28, 29]. Futsal is one of the fastest growing sports in New Zealand with more than 20,000 registered players; a 314% increase over five years[111]. From a physiological and physical perspective, futsal is defined as an intermittent high-intensity game that requires substantial anaerobic and aerobic capacities and involves sudden changes of direction, quick accelerations and decelerations, more repeated sprints and greater high-intensity phases than football[8, 90, 91]. The game relies on players' individual technique, creativity, agility, coordination skills, and fast decision-making[5, 28].

Due to the growing population of futsal players, professionalisation of the sport, high physical and physiological demands on players, the nature of the game, and the playing environment injuries are a growing concern[5, 30, 31]. The rate of futsal injuries has been compared to the rate of injury in football. The rate of futsal injuries has been found to be slightly higher than the rate in football when the data was collected during the whole season (match and training injuries together)[30, 40, 53, 54]. With respect to tournaments, the rate of futsal injuries has been found to be up to three times higher than the rate in football[41, 42, 55]. A harder futsal ball, the smaller and harder surface of the futsal pitch, and the faster speed of the futsal game can result in a higher risk of collisions and injuries, which may account for the differences in the incidence rates between futsal and football. Although there have been several studies focused on injury epidemiology in futsal, most of them have been in elite or sub-elite players[5, 30, 31, 41, 42]. To our knowledge, there has only been two studies involving amateur futsal players[56, 57]. Their rate of injuries has been found to be comparable to the rate in amateur football when the data was collected during the whole season and more than two times greater in the case of tournaments[56, 57]. However, one of these studies was mainly focused on the effectiveness of an injury-prevention programme (the 11+) to prevent the risk of injuries in male players,[56] and the other study only involved youth players (under 21 years) during one tournament[57].

Therefore, the aim of the current study was to describe the incidence rates and characteristics of injuries in amateur futsal players of both genders and different age groups during a year-long futsal competition. The study was conducted as part of the development and implementation of an injury-prevention warm-up for futsal.

Methods

A prospective cohort study was conducted during the 2019 futsal competition in one of the largest futsal-playing centres in New Zealand, the Edgar Centre in Dunedin. The competition lasted 16 weeks for junior (U13), 15 weeks for high school (U17), and 19 weeks for the adult league. There were 198 junior teams (144 male and 54 female teams)

competing in a total of 792 matches, 134 high school teams (88 male and 46 female teams) competing in a total of 514 matches, and 88 adult male teams competing in a total of 417 matches. The study was approved by the Auckland University of Technology Ethics Committee (AUTEC #18/379).

Injuries were reported by players and recorded by the referees after every match using a specifically designed paper-based match report card (Fig. 3). The match report card included a section for reporting any injuries sustained during the match. Referees were trained in the use of the match report card. The match report cards were submitted in an electronic form to the research centre on a weekly basis.

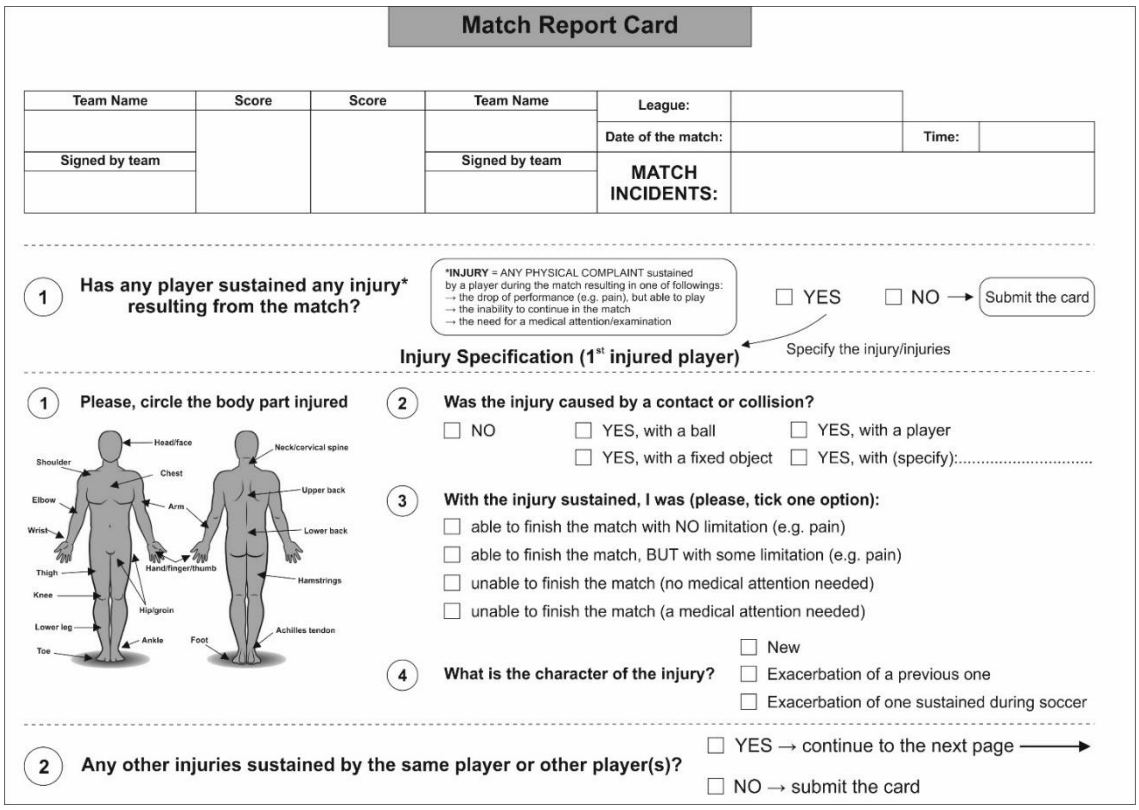

Figure 3 - A specifically designed, paper-based match report card.

An injury was defined as “any physical complaint sustained by a futsal player during the match, irrespective of the need for medical attention or time loss from futsal activities”, which was based on the respective consensus statement used in other studies conducted in football and futsal[48]. Detailed aspects of the injury were assessed using four additional questions to identify the body site of injury, cause of injury, severity of injury, and character of injury. Contact injuries were defined as injuries caused by contact with the ball, another player, or a fixed object. The severity of injury was assessed by the ability of a player to finish the match (able to finish the match, unable to finish the match or unable to finish the match with medical attention needed).

Data on match exposure was collected on a team basis. The injury rates are reported as the number of injuries per 1000 player hours and per 1000 player matches. Player hours were calculated as the number of team matches multiplied by five players, and by two thirds of an hour (40 minutes), because a futsal game consists of two equal periods of 20 minutes. Any extra time allocated for a match and the reduction in the number of players on a court were not considered, because these are rare exceptions at an amateur level. The incidence rate per 1000 player hours was then calculated as the number of injuries multiplied by 1000 and divided by the total number of player hours. Player matches were calculated by multiplying the number of team matches by five players. The incidence rate per 1000 player matches was then calculated as the number of injuries multiplied by 1000 and divided by the total number of player matches.

Differences in the proportion of male versus female teams and the proportion of teams in each age group were assessed via a Chi Square test. Incidence rates are presented as means with standard errors. A multivariate Poisson regression analysis (with player hours included as an offset variable) was used to estimate the incidence rate ratios to compare the risk of injury between genders and between the three age groups. Rate ratios were tested using the Wald Test and they are presented with 95% confidence intervals. All tests were two-tailed and the threshold for statistical significance was set at $p<0.05$. All statistical analyses were conducted using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA).

Results

The study included a total of 420 teams: 320 male (76%) and 100 female teams (24%). Of these 198 were junior (47%), 134 were high school (32%), and 88 were adult (21%) teams. Baseline characteristics and match exposure are summarised in Table 8. There was a significant difference in the proportion of teams by age group (χ^2=44.632 (2), p<0.001), with more junior than high school and adult teams. There was also significantly more male than female teams (χ^2=119.336 (1), p<0.001). The total exposure time of all teams was 11487 hours, which corresponded to a total of 17230 player matches.

Table 8 - Baseline characteristics and exposure of teams.

	Junior Teams (47%)			**High School Teams (32%)**			**Adult Teams (21%)**			**Total**
	Male	Female	Total	Male	Female	Total	Male	Female	Total	
Number of teams (%)	144 (73)	54 (27)	198	88 (66)	46 (34)	134	88 (100)	0 (0)	88	420
Number of matches	576	216	792	338	176	514	417	0	417	1723
Player Hours	3840	1440	5280 (26.7±0)*	2253	1173	3426 (25.6±1.6)*	2780	0	2780 (31.6±1.7)*	11487 (27.4±2.5)*
Player matches	5760	2160	7920 (40.0±0)*	3380	1760	5140 (38.3±2.4)*	4170	0	4170 (47.3±2.5)*	17230 (41.0±3.8)*

*A total number of player hours and player matches for each age group (mean ± SD).

A total of 131 injuries were reported during the competition, which is equivalent to an incidence rate (*IR*) of 11.4 injuries per 1000 player hours or 7.6 injuries per 1000 player matches (Table 9). Most injuries were sustained by junior players (*IR*=14.0 injuries per 1000 player hours, *n*=74, 57%), followed by adult (*IR*=10.4 per 1000 player hours, *n*=29, 22%,), and high school players (*IR*=8.2 per 1000 player hours, *n*=28, 21%,). The most frequent body site injured was the lower extremity (*n*=74, 57%), followed by head/neck (*n*=31, 24%), and upper extremity (*n*=22, 17%). Ankle was the most frequent body part injured (*n*=33, 25%), followed by head (*n*=29, 22%), and knee (*n*=22, 17%). The majority of injuries occurred in a contact situation (*n*=115, 88%) and they were mainly caused by contact with the ball (*n*=56, 49%) or by contact with another player (*n*=53, 46%). Regarding the severity of injuries, players were able to finish the match in 63 cases (48%). 68 injuries (52%) did not allow players to finish the match, of which 17 cases (13%) needed medical attention.

Table 9 - Baseline characteristics and exposure of teams.

	Junior Teams			**High School Teams**			**Adult Teams**	**Total**
	Male	Female	Total	Male	Female	Total	Male	
Number of injuries	53	21	74	15	13	28	29	131
Per 1000 player hours (95% CI)	13.8 (10.5 to 17.1)	14.6 (9.2 to 20.0)	14.0 (11.2 to 16.8)	6.7 (3.4 to 10.6)	11.1 (6.0 to 17.1)	8.2 (5.6 to 11.6)	10.4 (7.0 to 14.1)	11.4 (9.8 to 13.3)
Per 1000 player matches (95% CI)	9.2 (7.0 to 11.4)	9.7 (6.1 to 13.3)	9.3 (7.5 to 11.2)	4.4 (2.3 to 7.1)	7.4 (4.0 to 11.4)	5.4 (3.7 to 7.7)	7.0 (4.7 to 9.4)	7.6 (6.5 to 8.9)
Body Section*								
Head/neck	9 (2.3)	4 (2.8)	13 (2.5)	4 (1.8)	3 (2.6)	7 (2.0)	11 (4.0)	31 (2.7)
Upper Extremity	12 (3.1)	3 (2.1)	15 (2.8)	2 (0.9)	2 (1.7)	4 (1.2)	3 (1.1)	22 (1.9)
Lower Extremity	30 (7.8)	12 (8.3)	42 (8.0)	9 (4.0)	8 (6.8)	17 (5.0)	15 (5.4)	74 (6.4)
Body Part*								
Head	8 (2.1)	4 (2.8)	12 (2.3)	3 (1.3)	3 (2.6)	6 (1.8)	11 (4.0)	29 (2.5)
Knee	8 (2.1)	2 (1.4)	10 (1.9)	3 (1.3)	2 (1.7)	5 (1.5)	7 (2.5)	22 (1.9)
Ankle	15 (3.9)	6 (4.2)	21 (4.0)	5 (2.2)	2 (1.7)	7 (2.0)	5 (1.8)	33 (2.9)
Cause of injury*								
Non-contact	7 (1.8)	2 (1.4)	9 (1.7)	0 (0)	1 (0.9)	1 (0.3)	6 (2.2)	16 (1.4)
Contact	46 (12.0)	19 (13.2)	65 (12.3)	15 (6.7)	12 (10.2)	27 (7.9)	23 (8.3)	115 (10.0)
Contact with*								
Ball	25 (6.5)	12 (8.3)	37 (7.0)	6 (2.7)	5 (4.3)	11 (3.2)	8 (2.9)	56 (4.9)
Player	20 (5.2)	5 (3.5)	25 (4.7)	9 (4.0)	6 (5.1)	15 (4.4)	13 (4.7)	53 (4.6)
Fixed object	1 (0.3)	2 (1.4)	3 (0.6)	0 (0)	1 (0.9)	1 (0.3)	2 (0.7)	6 (0.5)
Severity of injury*								
Able to finish match	28 (7.3)	11 (7.6)	39 (7.4)	6 (2.7)	5 (4.3)	11 (3.2)	13 (4.7)	63 (5.5)
Unable to finish match	19 (4.9)	7 (4.9)	26 (4.9)	8 (3.6)	6 (5.1)	14 (4.1)	11 (4.0)	51 (4.4)
Medical attention	6 (1.6)	3 (2.1)	9 (1.7)	1 (0.4)	2 (1.7)	3 (0.9)	5 (1.8)	17 (1.5)

*Values are numbers (incidence rates per 1000 player hours) of injuries.

Regarding the age groups and gender, there were significantly fewer injuries overall in high school teams compared to junior teams (incidence rate ratio (*IRR*)=0.59, 95% CI 0.37 to 0.89, *p*=0.013). Specifically, there were significantly fewer contact injuries

(*IRR*=0.64, 95% CI 0.40 to 0.90, *p*=0.044), contact injuries caused by contact with the ball (*IRR*=0.46, 95% CI 0.23 to 0.90, *p*=0.024), and injuries allowing players to finish the match (*IRR*=0.43, 95% CI 0.20 to 0.82, *p*=0.012). There were no significant differences found between adult and junior teams. When comparing adult teams to high school teams, the results indicated a trend towards more non-contact injuries in adult compared to high school teams (*IRR*=7.33, 95% CI 0.89 to 61.43, *p*=0.064). The incidence rate of 13.0 injuries per 1000 player hours in female players was higher than in male players (*IR*=10.9 injuries per 1000 player hours) however this difference was not statistically significant (*IRR*=1.19, 95% CI 0.74 to 1.65, *p*=0.620).

Discussion

This prospective study represents one of only few studies investigating the incidence rates and characteristics of injuries in futsal sustained by amateur players. The objective of the study was to describe futsal-related injuries and differences between genders and among three different age groups during an amateur futsal competition.

A total of 131 injuries were sustained during 1723 matches, which is equivalent to an incidence rate of 11.4 injuries per 1000 player hours or 7.6 injuries per 1000 player matches. These results are similar to those reported in Portuguese amateur adult futsal players where the incidence rate of 11.0 injuries per 1000 player hours was observed[56]. These findings are, however, in contrast with studies following elite or professional futsal players over a season where the incidence rate is reportedly much lower (*IR*=2.2 injuries per 1000 player hours in Iranian players[30] and *IR*=3.1 injuries per 1000 player hours in Dutch male players[40]). Similar differences in injury rates between amateur and elite players have also been found in tournament-focused study designs[41-43, 57]. The higher incidence rate has been shown in amateur Malaysian futsal players (*IR*=292.4 injuries per 1000 player hours)[57] compared to results from three consecutive male futsal World Cups (*IR*=195.6 injuries per 1000 player hours),[41] Malaysian national adult male and female futsal tournament (*IR*=91.5 injuries per 1000 player hours),[42] and Brazilian 15th U20 male Selection Championship (*IR*=208.6 injuries per 1000 player hours)[43]. It has been suggested the higher injury rates in amateur compared to elite players might be attributed to a lower level of physical fitness in amateur players[32, 57].

Additionally, it has been shown that performing a structured, neuromuscular warm-up routine can improve neuromuscular control, balance, agility, strength, and thus improve the level of physical fitness of futsal players, and it can also reduce the number of injuries[56, 106, 107]. However, amateur teams might not warm up properly, consistently, and regularly due to the lack of time, space, coaching, and any specific, structured routine[80,

[112]. The differences might also be due to a smaller number of players in amateur teams that can result in the faster onset of fatigue during the match and thus a higher risk of injury[42, 113].

The lower extremity was the most common body section injured (57%), followed by head/neck (24%) and upper extremity (17%). These results are consistent with other studies where injuries to the lower extremity accounted 65-85% of all injuries, injuries to the head/neck area ranged from 2% to 22%, and injuries to the upper extremity accounted for 6-21%[30, 41-43, 56, 57]. The present study found ankle injuries were most frequent among futsal players (25%), followed by head injuries (22%) and knee injuries (17%). Except head injuries, the findings are similar to those reported in other studies with ankle injuries accounting for up to 44%, knee injuries accounting for up to 31% and thigh injuries reaching up to 28% of all injuries[30, 41-43, 56, 57]. Head injuries accounted for 3-13% in other studies focused on futsal injuries[30, 41-43, 57]. Unfortunately, there was no additional assessment of head injuries in the present study due to the lack of medical professionals to provide more detailed information about these injuries. As a result, it is not known if these injuries may have been potential concussions, however, there were ten head injuries (*IR*=0.87 per 1000 player hours) where players did not finish the match. There were two concussions in Iranian national futsal players, equivalent to an incidence rate of 0.08 injuries per 1000 player hours[30]. Similar trends have been seen in football, where the incidence rate of 0.32 concussions per 1000 player hours has been found in New Zealand amateur players, compared to the incidence rate of 0.06 concussions per 1000 player hours in European professional players[54, 58]. In the case of tournament-focused study designs, studies have shown a higher incidence rate of concussions in futsal players (up to 8.3 per 1000 player hours)[41] compared to football (*IR*=1.2 concussions per 1000 player hours)[55]. Generally, the results of all studies have suggested higher incidence rates of concussions in futsal compared to football in different study designs and different playing level[30, 41, 54, 55, 58]. The smaller court size, harder playing surface, harder ball, and more contact situations are likely contributors to the increased risk of concussions in futsal.

Most injuries observed in the current study were sustained in a contact situation (88%), especially in contact with the ball (49%) and with another player (46%). These results are consistent with other studies, regardless of playing level, that have, however, suggested lower proportion of contact injuries (60-70%)[41-43, 56, 57]. In contrast to the present study, the proportion of contact injuries caused by another player was higher in other studies (87-93%)[42, 56]. The reason for a higher proportion of ball injuries in the current study may be due to differences in data collection and also the inclusion of

younger players[42, 56]. One study, including injuries from training sessions and matches of elite players, has demonstrated that the majority of injuries were sustained in non-contact situations (70%)[30]. The elite playing level might have accounted for this difference, because a similar study involving amateur players has shown the same trend towards a higher proportion of contact injuries as the previous studies[56]. However, more studies of similar designs would be needed to verify this.

Regarding the severity of injuries, the present study demonstrated a large percentage of players did not finish the match (52%) and of these, 13% required medical attention. However, this data cannot be compared to other studies due to the lack of medical professionals assessing the injuries and due to the lack of any follow-up communication with injured players to find out the number of days elapsed before a player's return to full participation. The results of other studies have shown a trend towards less severe injuries in futsal (90% of injuries recovered within 7 days),[30, 41-43, 56, 57] which is in contrast with football where higher rates of moderate and severe injuries have been reported[54].

Regarding the effects of age groups and gender on the incidence rates and characteristics, there was significantly fewer injuries overall in high school teams (41% fewer) and 36% fewer contact injuries, especially injuries sustained in contact with the ball (54% fewer), compared to junior teams. However, significantly fewer high school players were able to finish the match (57% fewer) compared to junior ones suggesting a higher proportion of more severe injuries in high school teams. There was no significant difference between adult and junior teams. Adult teams showed a trend towards more non-contact injuries compared to high school teams (a 7.3 times higher incidence rate than in high school players), but this difference was not statistically significant. To our knowledge, this is the first study comparing injury rates among three different age groups. In the case of effects of gender on the incidence rates, there was no significant finding between male and female teams.

To our knowledge, this is the first study to investigate and compare the injury rate and characteristics among amateur futsal players of both genders and among players of three different age groups. The large sample of amateur players and the prospective study design are other strengths of the current study. Collecting injury data right after a match also reduced the possibility of recall bias.

There are several limitations that should be considered when interpreting the results of the present study. Firstly, there were no medical professionals on site to record and assess the injuries. To our knowledge there is no validated tool that can be used to

record injuries rates in this recreational environment. As a result, injuries were recorded by referees together with players using a modified match report card that was created specifically for this project. Thus, the lack of more detailed information about injuries, underreporting/overreporting and errors made during the data collection are all potential problems. Although the injury report card was not validated using any descriptive epidemiology study that would have followed a cohort of amateur futsal players, there was a minimum of incomplete injury cards returned to the research team. Therefore, relying on the injury reporting by referees together with players after a match appears to be valid and sustainable in the community-based futsal environment. However, this hypothesis needs to be further investigated. Secondly, there was no follow-up with injured players to assess the severity of injury. Therefore, the severity of injuries was assessed based on player's ability to finish the match or to seek immediate medical attention. Finally, data on match exposure was collected on a team basis, not individually, which could have influenced the results. In addition, only amateur teams from one futsal centre were involved in the study and therefore, the results cannot be generalised to other futsal centres or other playing levels.

Future studies should focus on the further investigation of the incidence rates and characteristics in other futsal centres, at all levels of play, and using medical professionals to assess injuries in detail.

Conclusion

The results of the current study demonstrate high rates of injury in amateur futsal with injuries to the lower extremity being the most common, the ankle being the most frequent single body part injured, and that most injuries were the result of contact situations. The results also demonstrate a high number of head injuries. Although high school players had fewer overall injuries compared to junior players, these injuries appear to have been more severe. Given the growth of the game more information about incidence rates and characteristics in futsal players, especially in an amateur or recreational setting, is needed to develop futsal-specific injury-preventive measures.

SECTION 2: THE DEVELOPMENT, IMPLEMENTATION, AND EVALUATION OF A NEUROMUSCULAR WARM-UP PROGRAMME IN FUTSAL.

CHAPTER 4: Futsal FastStart; the development of a futsal-specific warm-up.

This chapter comprises the following paper published in the *New Zealand Journal of Sports Medicine.*

Reference

Tomsovsky L, Reid D, Whatman C, Fulcher M. Futsal FastStart; the development of a futsal-specific warm-up. *New Zealand Journal of Sports Medicine* 2020;**47**(1):15-19.

Prelude

This chapter aligns with stage 3 of the TRIPP framework that is focused on the development of specific injury-prevention measures strongly guided by the findings of Chapter 3. However, this chapter also includes a part of stage 5 of the TRIPP model which was to describe the intervention context to inform implementation strategies using a focus group approach with key stakeholders (coaches, players, sport medicine professionals). The purpose of this chapter was to develop a novel, futsal-specific warm-up programme for amateur futsal players considering the challenges of the community-based futsal environment. Two focus groups were conducted: one with six futsal players and coaches, and the other with four sport medicine professionals. All participants agreed that a warm-up was important to prevent injuries and the issues of time and space available to warm up were highlighted. Warming up as a team and incorporating a ball was suggested to potentially improve the players' buy in to warm up. The 11+, an injury-prevention warm-up used in football, was considered an adequate cornerstone from which to develop a novel, futsal-specific warm-up to target the reduction futsal injuries. The input from key stakeholders enabled the development of a novel, futsal-specific warm-up for amateur players ("Futsal FastStart").

Including futsal players and coaches in the design has been hypothesised to enhance delivery and adherence to the warm-up. However, whether this warm-up has any impact on injury prevention has yet to be determined.

Introduction

Futsal is a fast-paced, dynamic sport derived from association football, played on hard surfaces in reduced space mostly indoors, and widely played across the world[1]. Due to the comparable injury profile to football and the growing population of futsal players (in 2016, it was estimated that over 60 million people play futsal globally), the issue of safety becomes more important[28, 40, 84]. The increased participation and relatively high rate of injury could result in greater morbidity and financial costs for both players and

administrators. Although there are several studies focusing on the injury characteristics and injury occurrence in futsal,[5, 30, 31, 40-42, 44] the implementation and evaluation of any preventive measures in futsal has been poorly investigated.

Injury-prevention programmes have been shown to significantly prevent the risk of injuries and to enhance the performance of athletes[64-68]. The 11+, a warm-up routine developed by sport medicine professionals and researchers, is one such programme that was found effective in preventing football-related injuries[70, 76, 83, 85]. Despite having been well-validated and shown to reduce injury rates among players, the effectiveness of the 11+ was shown to be strongly dependent on the uptake of the warm-up by players[70, 71, 76, 83, 85]. Unfortunately, the uptake of the 11+ by players has been shown to be poor outside of the research setting, mainly due to poor, evidence-based, injury-prevention knowledge dissemination among players and coaches, and due to delivery strategies[78]. The issue of warm-up uptake (compliance or adherence depending on the study design) is, therefore, one of the key factors in successful injury prevention.

Despite its efficacy and effectiveness, the use of the 11+ as a common warm-up in the community-based futsal environment may not be realistic. Firstly, the 11+ was developed by sport medicine professionals and sport researchers, rather than by players and coaches. As coaches are considered the most feasible method of reaching community-based athletes,[80] including them in the development of such programmes could lead to improved adherence[79, 81, 82]. Secondly, the 11+ was developed for football. It has been shown that if a warm-up did not include enough sport-related activities, the uptake was more likely to be lower[76]. Futsal-specific activities, therefore, must be considered when designing an injury-prevention intervention. Finally, the 11+ was developed to be performed on a football pitch. However, a warm-up needs to be implementable in the sport-related environment[79]. In the case of futsal, the reduced space, less time to perform a warm-up, as well as a harder surface, need to be considered.

Thus, the aim of this study was to guide the development of a warm-up for recreational futsal players via two focus groups with coaches, players, as well as sport medicine professionals.

Methods

This study utilised two focus groups to investigate the current warm-up habits in the New Zealand (NZ) futsal environment and common barriers to warm up in futsal, with a key aim to develop a novel warm-up for recreational futsal players. The study was approved by the Auckland University of Technology Ethics Committee (# 18/215).

Participant recruitment

The recruitment of participants was facilitated by New Zealand Football and by Axis Sports Medicine (a FIFA Medical Centre of Excellence). Sport medicine professionals focused on the injury prevention and members of Auckland Football Federation (all futsal coaches and current or former players) were invited via email. Two focus groups were conducted, the first consisting of futsal players and coaches representing all levels of the futsal competitive environment (*n=6*), and the second consisting of sport medicine professionals (two sport and exercise physiotherapists and two sport and exercise physicians). All participants were approached via email and those willing to participate were sent more detailed information about the study and a consent form. Participants signed a consent form on the day of the focus group allowing for all discussions to be audio taped.

Focus group protocol

Both focus groups followed the same protocol (Table 10) with two sections. The first part was focused on a general perception of warm-up in futsal, and then specifically at a recreational level. The second part dealt with the use of 11+ in futsal and the issue of uptake of a warm-up.

Table 10 - The focus group protocol.

Initial set of questions
Do you think a warm-up is a significant/important tool to reduce/prevent injuries?
What thoughts and observations do you have about warm-ups in the futsal environment? What are the challenges to warm up at a recreational level?
Second set of questions
What thoughts do you have about the 11+? Is it feasible in the futsal environment? How would you change the 11+ to satisfy the demands of futsal?
In your opinion, what could improve the uptake of a warm-up in the recreational futsal environment?

Procedure

Both focus groups were conducted by the same moderator, one of co-authors (MF), and lasted no longer than one hour. The primary researcher (LT) attended both focus groups and took comprehensive notes. The focus group with futsal players and coaches was conducted in a meeting room at a futsal centre. The focus group with sport medicine professionals was run in a meeting room at one of Axis Sports Medicine's clinics.

The discussion in each focus group commenced with a short introduction and a brief explanation of the session by the moderator. Each participant was given some time to

ask any questions regarding the session and to introduce themselves. The first question of the focus group protocol then followed. The first question was designed to be an opening, easy-to-answer question to encourage all the participants to talk and feel comfortable[114]. The participants were always given enough time to discuss each question thoroughly until no more opinions were mentioned. Once there were no other questions to ask, and all opinions were expressed, the moderator thanked the participants and closed the session.

Data analysis

Data analysis was conducted by the primary researcher. Focus group discussions were voice recorded and transcribed verbatim by the researcher to reduce the possible loss of useful pieces of information. Thematic analysis was then used to deductively and inductively identify patterns or themes within the qualitative data[115, 116]. In designing this research, there were three overarching areas of interest, which formed the initial deductive themes. These were the perceived importance of a warm-up and the challenges to warm up in futsal; the 11+ in the futsal environment; and the delivery strategies for a warm-up. During the initial coding phase, these deductive themes served to guide the search for data of interest. The primary researcher then systematically worked through the data set, using inductive analysis. A 6-phase framework for doing a thematic analysis was used[117]. All data was read and re-read to become familiar with the data and early impressions were documented using notes. Each part of the data that was relevant to any of the questions was then coded into shorter, more meaningful sections. Open coding, i.e., developing and modifying the codes while working through the coding process, was preferred to pre-set codes[116]. The codes were examined to identify the preliminary themes[115]. A preliminary theme represented several codes that fitted together and provided some specific, significant information[116]. These themes were mostly descriptive. Preliminary themes were then associated with all the data that supported it[115, 116]. The final themes were defined based on the review of preliminary themes. A novel warm-up for recreational futsal ("Futsal FastStart") was then developed using all the findings from focus groups.

Results

Thematic analysis, using verbatim transcripts of discussions from both focus groups and comprehensive notes resulted in three key themes. The first theme, *The use of a warm-up in the recreational futsal environment*, was identified based on participants' perception of a warm-up importance and the barriers to warm up at a recreational level. The second theme, *The structure of a futsal-specific warm-up*, resulted from the discussion focused on the demands of the futsal game, use of the 11+ and exercises that could be included

in a futsal-specific warm-up, and the challenges highlighted in the previous part. The last theme, *The issue of adherence*, was identified based on participants' ideas on how to improve players' and coaches' buy in to perform a warm-up. Each theme is supported with illustrative quotes to support their interpretation.

Theme 1: The use of a warm-up in the recreational futsal environment

In both focus groups, a warm-up was considered to be very important to prevent and/or reduce injuries by all participants. Evidence-based warm-up routines in particular were considered key to reducing the number of injuries occurring in a sport. However, the participants mentioned the influence of the level of performance. Based on the coaching and playing experience, the higher the level of competition was, the more emphasis was placed on a proper warm-up before a game or training session. In the case of the recreational level, participants agreed that a warm-up was not considered important by players and various pre-game routines could be seen.

Sport medicine professional:" … This type of a warm-up [pointing at the 11+] is very important. I am talking about an evidence-based, neuromuscular warm-up…"
Futsal player and coach:" … The most people that perform futsal at a high level rank a warm-up as important, but if you are not at such competitive level, you might not see a warm-up as that important…Therefore, you can see a variety of teams with different warm-ups. A mix of kicking ball at a goal, a few strides there and back, not much more than that…"

Participants in both focus groups agreed that space and the lack of any authority (a manager, a coach) were common barriers to warm up at recreational level. The lack of knowledge about potential risk of injuries and the perception of a futsal game as a social event more than competition were considered to be further barriers to performing a warm-up properly by futsal players at a recreational level. Turning up five minutes before a game was said to be the result of this mind-set of players.

Futsal player:" … The space is an issue. Because of games running on courts, you might not have the whole court available, unless your game is scheduled to be the first that day… Most of the teams at this level don't have a designated coach or a manager to coordinate a warm-up either…"

Sport medicine professional:" … If you asked me to play futsal at this level, I would turn up 5 minutes before a game and be ready to get on to the court… I also wonder if people

approach a game of futsal with a low expectation of injury risk….So, definitely, educating them by saying there is the risk of injury you may not be aware of might be helpful…"

Theme 2: The structure of a futsal-specific warm-up

Both focus groups agreed that a futsal-specific warm-up should include some initial movement depending on space available. Initial jogging/running (if space allows) or jumping/skipping were mentioned to increase heart rate and "switch the muscles on". Dynamic stretches were the next elements to be included. Specifically, hip external/internal rotations and high knees/heel flicks were highlighted to activate the full range of motion of joints and to warm up the groin area. To improve functional performance and to satisfy the demands of a game, balance and changing-direction movements were stressed in both focus groups due to a high number of ankle injuries in futsal. Running forward/backward and single-leg movements were considered important by all participants. It was also mentioned that the pace of a warm-up should be gradually increased.

Sport medicine professional:" … Give them a jog or run to bring the heart rate up. In reduced space, you can incorporate some jumping/skipping, on-spot movements… After that, there should be some dynamic movements, and some that are then replicated on the court… If you tell me, there are many ankle injuries, then single-leg balancing movements are very important…"

Futsal coach:" … I would start with a few lengths of some running… Then some high knees and heel flicks, opening and closing gates… The balance is very important for futsal, so going side-to-side, I guess, exploding off one foot, all quite relevant to futsal as there are lots of checking, changing directions, and all in high intensities… All team squad also needs to be warm at kick-off, because within three or four minutes the whole team is off and subs need to be ready to sprint…"

All participants were asked about the 11+ and its use in the futsal environment. Regarding part 1 of the 11+ (running exercises), participants highlighted running straight ahead, quick forwards and backwards, and rotations of hips ("hip in/out"). Exercises for core and hamstrings strength (part 2 of the 11+) were mentioned to be often skipped due to time constraints and because they could be painful when performed on a hard surface. Participants also pointed out that jumping and landing was not common in futsal. However, the balance (part 2) and plant and cut movements (part 3) of the 11+ performed in a dynamic way were highlighted by all participants.

Futsal coach:" … Running forwards/backwards, changing direction…That is game-related… Hamstring and core exercises are usually the ones we skip. They also hurt because of hard surface, so it seems a bit inappropriate for futsal… Jumping and landing is definitely less common in futsal than in football…"

Sport medicine professional:" … You can use some lunging/squatting pattern to switch on the core… Jumping movements? Definitely less important for futsal…Plant and cut, very important…"

Theme 3: The issue of adherence

To encourage adherence to a warm-up, participants agreed that the programme needed to be shorter than the 11+, performed as a team, and incorporate a ball into a warm-up to engage players and to make it more fun. Five minutes was suggested as a realistic time for recreational futsal players to warm up. It was also suggested that giving players some structured routine to follow and to perform in a short period of time, could improve adherence to a warm-up.

Sport medicine professional:" … I would probably keep it very short on this level. I think five minutes could be good…And I think people are more likely to do it as a team… Honestly, players might not really know what they could do in a short amount of time and that [a routine to follow] might help them. And that might be enough…"

Futsal player:" … If we can incorporate a ball with some shots on a goal 30 seconds before kick-off, something like that might be useful…"

Overall, sport medicine professionals came up with an idea to make a warm-up compulsory and part of the game. According to them, this could improve not only the uptake of a warm-up by players, but also the issue of space available. A referee could be in charge of a warm-up to make sure players are properly prepared for a game and a ball could be incorporated more easily. One participant described it as follows:

Sport medicine professional:" … You might do it as a part of a game so that if your game is scheduled for 7:30 pm, then at 7:30 pm you start a warm-up. A referee could lead that and you would make it rules of a game… And it would also reduce the challenge of space, because you could use a court…"

In summary the findings from the focus groups indicate several key items thought to be important and meet the requirements for a futsal-specific warm-up for recreational

players. A novel warm-up should be short (within five minutes), sharp (the pace gradually increased), performed as a team, and incorporate a ball if enough space is available. A futsal-specific warm-up should start with some initial running, followed by dynamic stretches, such as hip in/out, or high knees/heel flicks. Change of direction movements, such as running forward/backward and side to side, and balancing movements (propping and holding, planting and cutting) should be included to simulate game-related tasks. Based on these results, a novel, futsal-specific, warm-up for recreational futsal was developed by the research team (Futsal FastStart, Fig. 4).

Figure 4 - Futsal FastStart warm-up programme developed based on the findings from focus groups.

Discussion

The results of the current study indicate that all participants agreed a warm-up is important to reduce injuries. Evidence-based, neuromuscular warm-ups were mentioned to be key tools to prevent injuries. This opinion is in accordance with the results of other studies focusing on the evaluation of such programmes in real-world conditions[64-68, 70, 83]. The level of competition was identified as an important factor in the perception of warm-up importance and ultimately adherence. The lack of knowledge of the injury risks associated with playing futsal and the ability to prevent injury was found to be a possible reason why players did not find a warm-up necessary at a recreational level. This is consistent with the results of other studies in a variety of sports[80, 117-119]. Therefore,

educating players about injury risks playing futsal might be a way to increase players' perception of warm-up importance in a community-based futsal environment.

The effectiveness of any structured, neuromuscular warm-up programme designed to prevent the risk of injuries is strongly dependent on coaches' and players' uptake[71, 76, 80]. Previous research has shown that the higher the uptake, the greater the injury reduction[71, 76, 80]. Other studies have found that the coach, their education and positive attitude towards a warm-up, is a key factor to promote prevention and motivate players to perform a warm-up routine[76, 80, 120, 121]. The use of the coach was also the most feasible method to deliver injury prevention measures in the community-based environment[80]. The lack of a coach or a manager was mentioned to be very common in the New Zealand futsal recreational environment. Participants also suggested that another reason for not performing a warm-up was the lack of any structured routine for use in futsal. It has been shown that the uptake of injury-prevention programmes in sport is strongly dependent on the types of exercises included in a warm-up[76]. If there was a perception of lack of sport-specific exercises, the uptake of a warm-up dropped significantly (by more than 80%)[76]. Due to all these challenges, a different implementation strategy and a warm-up consisting of futsal-specific movements could improve players' uptake of a warm-up[76, 82].

Due to some similarities between football and futsal, the 11+ was suggested to be a useful source of exercises for a novel, futsal-specific warm-up. However, factors such as the reduced space, less time to perform a warm-up and a harder playing surface, needed to be considered. A novel, futsal-specific warm-up ("Futsal FastStart") was, therefore, designed to be performed within five minutes, as a team, and using any space available. The warm-up is structured into seven steps starting with the initial running/jogging to increase heart rate. The second step consists of high knees/heel flick exercises, common and popular movements among players, followed by hip external/internal rotations (hip in/out), based on the 11+,[122] to activate the full range of hip joint motion and warm up the groin area. The third and fourth steps (quick forwards and backwards running, lateral jumps) represent change of direction tasks which are common in the futsal game[91, 97]. These movements, adopted from the 11+, also teach proper landing mechanics with a correct leg alignment (knee over toe position) and improve balance and coordination. Participants also considered these exercises very important due to a high number of ankle injuries in futsal and due to the demands of game[5, 31, 40, 41, 44]. The fifth step involves squats with calf raises to activate core muscles and strengthen the lower extremity muscles. Participants reported that the 11+ exercises enhancing core (the static bench, sideways bench) and hamstrings strength (the Nordic hamstring exercise) were often skipped due to time constraints and the pain when done on a hard surface. It has also

been shown that hamstring injuries are less common in futsal compared to football. The results of some studies showed that hamstring injuries constituted around 6% of all futsal injuries,[41] compared to about 12% of all injuries in football[54]. The sixth step consists of a planting and cutting movement adopted from the 11+, which was highlighted as a game-related task. The main goal is to prepare players for sudden changes of direction and increase the intensity. The last step should be performed on the court involving some sprints with a sudden change of direction, and some passing and shooting drills to replicate the following futsal activity.

The importance of undertaking a focus group approach when designing a programme was deemed important in this study so that a programme that engaged players and coaches from the start that they gained ownership of should improve future uptake of the warm-up.

Limitations and future directions

To our knowledge, this is the first study to draw upon the perspectives of players, coaches and sport medicine professionals to inform the development of a warm-up. There are limitations that should be considered when interpreting the results. Firstly, the number of participants was small. Secondly, the focus groups were conducted only once without any follow-up to discuss or review the programme that was developed. Future studies could, therefore, include a broader spectrum of participants to provide more generalisable findings and they could involve follow-up sessions to provide even deeper insight into the issue of a warm-up.

Conclusion

When designing a structured warm-up routine in recreational futsal, participants made three key suggestions. Firstly, the warm-up should be short, three to five minutes, and sharp to reproduce the intensity of game. Secondly, the warm-up should consist of futsal-specific movements and should ideally performed as a team rather than individually. And thirdly, a warm-up should incorporate a ball to engage players and to make it more fun. Based on these findings, a novel, futsal-specific warm-up for futsal players at a recreational level has been developed (“Futsal FastStart”). Future research should be focused on the effectiveness of the programme to prevent the risk of injuries using a longitudinal study in the futsal community-based environment.

CHAPTER 5: The effect of a neuromuscular warm-up on injury rates in New Zealand recreational futsal players.

This chapter comprises the following paper prepared for submission to *Physical Therapy in Sport*.

Prelude

This chapter involves a formal evaluation of the effectiveness of injury-prevention measures within the implementation context as recommended in stage 6 of the TRIPP framework. A quasi-experimental study design was used to investigate the effectiveness of a futsal-specific, neuromuscular warm-up programme ("Futsal FastStart") with the aim of reducing the risk of injuries in New Zealand amateur futsal players. Injury data was collected at two futsal centres from 878 amateur futsal teams (458 teams in the intervention group, 420 teams in the control group) of both genders and three age groups (U13, U17, adults) over the course of one season. There were 131 injuries in the control group and 78 injuries in the intervention group (incidence rate ratio (*IRR*)=0.72, 95% CI 0.59 to 1.06, *p*=0.117). The implementation of the warm-up programme did not result in a lower number of injuries overall nor injuries to the lower extremity. However, there were significantly fewer contact injuries (*IRR*=0.68, 95% CI 0.51 to 0.98, *p*=0.035) that are common in amateur futsal players, especially injuries caused by contact with the ball (*IRR*=0.48, 95% CI 0.27 to 0.78, *p*=0.040). In addition, subgroup analysis, based on the stratification of teams in the intervention group into tertiles based on adherence to the warm-up, showed significantly fewer injuries overall (*IRR*=0.52, 95% CI 0.29 to 0.97, *p*=0.038) and lower extremity injuries (*IRR*=0.32, 95% CI 0.14 to 0.81, *p*=0.015) among teams with high adherence to the warm-up compared to teams with low adherence. Significantly fewer injuries overall (*IRR*=0.50, 95% CI 0.26 to 0.97, *p*=0.041) were also found in the high adherence group compared to the intermediate adherence group.

These findings suggest that a shorter futsal-specific warm-up can reduce the number of contact injuries in amateur futsal players. There is also preliminary evidence the warm-up could reduce all injuries if adherence is high.

Introduction

Futsal is a fast-paced sport derived from football and played widely across the world[1]. In 2016, over 60 million people were estimated to play futsal globally[28, 29]. Since New Zealand Football introduced futsal in 2010, the number of registered players has increased from 700 to more than 21,000 by the end of 2015[111]. With the growing popularity of futsal, the issue of safety and injury prevention is becoming more important[9,

[10]. The rate of futsal injuries has been found to be comparable to the rate in football in the case of elite players, and greater in the case of recreational players[30, 40, 41, 45, 56, 84]. The increased participation and high rate of injury could result in greater morbidity and financial costs for both players and administrators. Although there have been several studies focused on injury epidemiology in futsal,[5, 30, 31, 40-42, 44, 45] the implementation and evaluation of preventive measures has been poorly investigated.

Neuromuscular warm-up programmes have been shown to prevent the risk of injuries and to enhance the performance of athletes[64-69]. One of these programmes, the 11+, was designed to prevent the risk of injuries in football. It has since been shown to be effective in both men's and women's football, and at different levels of competition[64, 68, 70, 71, 76, 77, 83, 85]. It has also been shown to be effective for preventing the risk of injuries in amateur futsal players[56]. Despite the many studies that have reported the effectiveness of the 11+ it should be noted this is strongly dependent on the uptake (compliance or adherence depending on the study design) of the warm-up[70, 71, 76, 77, 83]. To improve both the protective effect and the uptake by players, it has been suggested a successful warm-up needs to meet three criteria[76, 79-82]. It needs to be implementable in the sport-specific environment, it needs to include sport-related activities, and it should involve coaches during its development as they play a key role in the delivery of the programme[80].

The primary aim of this study was to examine the effectiveness of a novel developed futsal specific warm-up (Futsal FastStart) for reducing the risk of injuries in New Zealand recreational futsal players. The secondary aim was to investigate the effect of adherence to the Futsal FastStart on the risk of injuries in the intervention group (subgroup analysis). The warm-up programme was developed in collaboration with futsal coaches and players, considered the challenges of the community-based futsal environment, consisted of futsal-specific exercises and was based on the 11+[112].

Methods

Study design

A quasi-experimental study design was used in the present study. This design was chosen for the following reasons: Firstly, there has been a lack of studies focused on the effectiveness of preventive measures to prevent the risk of injuries in the "real-world" context compared to studies that have examined the efficacy of these measures under "ideal" conditions. Secondly, the warm-up was designed for amateur futsal teams in the community-based environment. These teams often lack coaches, sport medicine professionals, or any other representatives that could supervise the delivery of the warm-

up. The teams were, therefore allocated to one or other arm of the study based on the geographic location of futsal centres rather than being truly randomly assigned to either intervention or control groups. One centre was deemed and agreed to be the control group and the other centre agreed to be the intervention group. This quasi-randomisation was done to ensure the two study groups were not able to contaminate the data collection as the two centres were 900 kilometres apart. Thirdly, the sample size estimation highlighted the need for a high number of participating teams that required more than one futsal centre to be involved.

The study was conducted during the 2019 futsal competition (a total of 20 weeks) and it was approved by the Auckland University of Technology Ethics Committee (AUTEC), reference number 18/379.

Sample size estimation

The sample size estimation was undertaken with several considerations. Based on the results of previous studies,[41-43, 65] it was estimated that 20% of players would get injured playing futsal during a season. As the proposed warm-up was much shorter than the 11+ and performed maximally once a week, without any training sessions, it was hypothesised that a relative injury risk reduction of 20% could be reached[57]. Similar to other studies,[42, 71, 72] we used the outputs from the futsal injury database, collected by NZ Football during the previous season, to estimate the intra-cluster correlation coefficient (ICC), i.e., a team-cluster effect. The ICC enabled calculation of the inflation factor for cluster effects due to the allocation of players by their teams and to estimate the sample size needed. Given the inflation factor of 1.37 (intra-cluster correlation coefficient of 0.04) and considering a cluster size of ten players per team, 2030 players (406 teams) in each group would provide an acceptable statistical power of 80% at the 5% significance level to detect 20% difference between both groups.

Participants

Participants were recruited from two of the largest futsal-playing centres in New Zealand, the Edgar Centre in Dunedin and the ASB Sports Centre in Wellington. An open invitation was sent to all teams participating in the 2019 futsal competition either in Dunedin or Wellington via official emails from respective football federations. All recreational teams that participated in either the junior (U13), high school (U17) or adult futsal competition were invited to take part in this study with no exclusion criteria. A total of 878 teams (458 teams in Wellington and 420 teams in Dunedin) agreed to participate in the study with no teams declining the invitation. All teams were sent an email explaining the study, the expectations during the study period, and a consent/assent form. Teams were included

in the study after returning the consent/assent forms signed by a team representative or a parent of player.

Teams were not randomized to the intervention or control group, but the allocation was based on the geographic separation of both centres to reduce player contamination with the intervention. Teams based in Dunedin (420 teams) served as a control group and teams in Wellington (458 teams) as an intervention group. Teams in the intervention group were given information/instruction on how to implement and perform the warm-up programme before their matches. Teams in the control group were asked to warm up via their usual routine with no formal instructions.

The intervention warm-up programme

The intervention group used the Futsal FastStart warm-up programme[112]. The programme was developed following focus groups involving members of the NZ futsal community (players and coaches) together with sport medicine professionals and was based on the 11+[112]. The structure consisted of initial jogging/running and dynamic stretches, followed by exercises focused on stability, balance and change of direction (Fig. 5). The programme was designed to be done within three to five minutes and performed at least once a week.

Figure 5 - Futsal FastStart warm-up programme developed based on the findings from focus groups.

The warm-up programme was introduced to the teams in the intervention group via the research team. Teams received an instructional video of the warm-up and a poster explaining each exercise in detail. The coaches and players were encouraged to concentrate on the quality of their movements to improve neuromuscular control. All movement principles were in keeping with those promoted in the 11+.

During the playing season, three activation zones were set up at the intervention venue for teams to perform the warm-up. Activation zones were equipped with posters showing each exercise and step-by-step instructions. For every competition day there were three to five warm-up facilitators who delivered the warm-up to teams either in the activation zones, or on the courts before games. Researchers followed up with both futsal centres by email and telephone every week to promote adherence. A member of the research team visited the intervention centre in person every two weeks; this allowed coaches, players, and warm-up facilitators to ask questions and give feedback on the warm-up programme and injury registration. Regular visits from the research team also helped to maintain motivation and adherence.

Exposure and injury registration

Injuries were reported by referees after every match using a specifically designed paper-based injury report card (Fig. 6). The report card was designed to be simple to understand and completed by a lay person within a couple of minutes. Referees were trained in the use of the report card. The cards were then gathered by court managers and submitted in an electronic form to the research centre on a weekly basis.

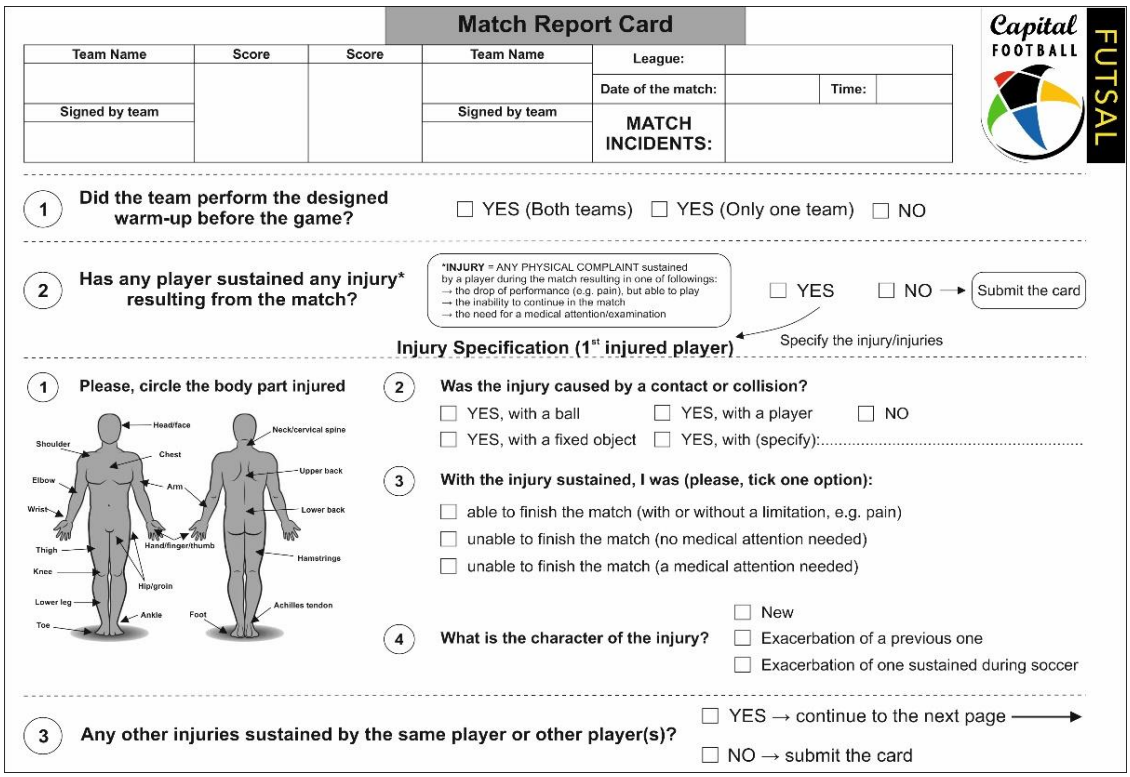

Figure 6 - A specifically designed, paper-based injury report card.

An injury was defined as “any physical complaint sustained by a player during the match, irrespective of the need for medical attention or time loss from futsal activities” based on the consensus statement proposed by Fuller et al (2006)[48]. The nature, cause and severity of injuries were also recorded. Contact injuries were further divided into those caused by contact with the ball, another player, or a fixed object. The severity of injury was determined by the ability of a player to finish the match.

Data on match exposure was collected on a team basis. The incidence rates were expressed per 1000 player hours. Player hours were calculated by multiplying the number of team matches by five players then multiplying this by 2/3s (as a futsal game consists of two equal periods of 20 minutes). Extra time and the reduced number of players on a court are rare exceptions at a recreational level, and, therefore, they were not considered to be significant. The incidence rates per 1000 player hours were then calculated as the number of injuries multiplied by 1000 and divided by a total number of player hours.

Outcome measures

The primary outcome variable was the incidence rate of all injuries sustained during the study period. The secondary outcomes were the incidence rates of injuries to the lower extremity, injuries to three most common body parts injured (ankle, head, knee),

contact/non-contact injuries, and severity of injuries. To improve the internal validity[123], a rate of head injuries was used as a non-equivalent outcome (also referred to as a negative control outcome) that was not expected to change in response to the intervention.

Statistical methods

Descriptive analyses were utilised using a Chi Square test to compare categorical variables (age group and gender) between teams in both study groups. Incidence rates were estimated, and they are presented as means with standard errors. An intention-to-treat multivariate Poisson regression analysis (with player hours included as an offset variable) was used to estimate the incidence rate ratios for primary and secondary outcomes to compare the risk of injuries between the control and intervention group. Covariates (age group and gender of teams) were included in the analysis as potential risk factors.

To examine a possible dose-response relationship between the adherence of teams to the Futsal FastStart warm-up and risk of injuries, a subgroup analysis, adjusted for age group and gender of teams, was conducted to compare the incidence rates between teams in the intervention group. Teams were stratified into three groups of adherence tertiles (low, intermediate and high) based on the number of warm-up sessions completed throughout the competition as suggested in previous studies[70, 71, 76].

Incidence rate ratios were tested using the Wald Test. The Poisson model was also used to calculate confidence intervals for the incidence rate ratios assuming constant risk of injury per group. Incidence rate ratios are presented with 95% confidence intervals. All tests were two-tailed and the results with P values ≤0.05 were considered as significant. All statistical analyses were conducted using IBM SPSS Statistics for Windows, version 26 (IBM Corp., Armonk, NY, USA).

Results

The final sample consisted of 878 teams; 458 teams in the intervention group, and 420 teams in the control group (Table 11) with no dropouts. Of all teams, 360 were junior (41%), 396 were high school (45%), and 122 were adult teams (14%). Regarding the gender of teams, 613 were male (70%) and 265 were female teams (30%). Baseline characteristics by group are summarised in Table 11. There was a significant difference in the proportion of high school (χ^2=41.166 (1), p < 0.001), adult (χ^2=25.290 (1), p < 0.001), and female teams (χ^2=16.254 (1), p < 0.001) between groups, but no difference in the proportion of male (χ^2=1.646 (1), p=0.199) or junior teams (χ^2=3.924 (1), p=0.050).

Table 11 - Baseline characteristics of participating teams. Values are numbers (%) of teams.

	Control Group (*n*=420, 48%)			**Intervention Group (*n*=458, 52%)**		
Gender	Male	Female	Total	Male	Female	Total
Junior	144 (73)	54 (27)	198 (47)	98 (60)	64 (40)	162 (35)
High School	88 (66)	46 (34)	134 (32)	161 (61)	101 (39)	262 (58)
Adult	88 (100)	0 (0)	88 (21)	34 (100)	0 (0)	34 (7)

Exposure of teams

Teams in the intervention group played a total of 1409 matches (6.2 matches per team, SD: 0.6, 95% CI 6.1 to 6.2) corresponding to a total of 9393 player hours. Teams in the control group played a total of 1723 matches (8.2 matches per team, SD: 0.8, 95% CI 8.1 to 8.3) corresponding to a total of 11487 player hours. The exposure of teams is summarised in Table 12.

Table 12 - Exposure data (in player hours) for the control and interventions groups.

Number of teams	**Control Group**	**Intervention Group**	**Total**
	420	458	878
Number of matches (total)	1723	1409	3132
Player hours (*h*)	11487	9393	20880
Player matches	17230	14090	31320

Injury characteristics

A total of 209 injuries were sustained during the season; 78 injuries in the intervention group and 131 injuries in the control group. Most injuries were new (*n*=198, 95%) with ten injuries (5%) representing an exacerbation of a previous injury. Table 13 shows the summary of the most common injury characteristics for both groups.

Table 13 - Most common body sections and body parts injured, character of injury, cause of injury, and severity of injury for both groups and sub-groups.

	Control Group (131 injuries, 63%)	**Intervention Group (78 injuries, 37%)**	**Total (209 injuries)**
Body Section*:			
Head/Neck	31 (24)	18 (23)	49 (23)
Trunk	4 (3)	4 (5)	8 (4)
Upper Extremities	22 (17)	12 (15)	34 (16)
Lower Extremities	74 (56)	44 (56)	118 (57)
Body Part*:			
Ankle	33 (25)	17 (22)	50 (24)
Head	29 (22)	18 (23)	47 (23)
Knee	22 (17)	11 (14)	33 (16)
Cause of injury*:			
Non-contact	16 (12)	14 (18)	30 (14)
Contact	115 (88)	64 (82)	179 (86)
Contact with*:			
Ball	57 (50)	23 (36)	80 (45)
Player	53 (46)	36 (56)	89 (50)
Fixed Object	5 (4)	5 (8)	10 (5)
Severity of injury*:			
Able to finish match	63 (48)	43 (55)	106 (51)
Unable to finish match	51 (39)	28 (36)	79 (38)
Medical attention	17 (13)	7 (9)	24 (11)

*Values are numbers (%) of injuries.

Effect of the warm-up programme

The intention-to-treat analysis revealed no significant difference in the incidence rate of overall injuries, nor in the incidence rate of lower extremity injuries between the intervention group and the control group (Table 14). The incidence rate ratio (*IRR*) between the intervention and control group was 0.72 (95% CI 0.59 to 1.06, p=0.117) for all injuries and 0.73 (95% CI 0.55 to 1.21, p=0.315) for injuries to the lower extremity. Similarly, there was no significant difference in the risk of ankle, head, or knee injuries, nor in the severity of any injury. There were significantly fewer contact injuries (*IRR*=0.68, 95% CI 0.51 to 0.98, p=0.035), especially injuries caused by a contact with the ball (*IRR*=0.48, 95% CI 0.27 to 0.78, p=0.040). The incidence rate of head injuries, a negative control outcome, was not significantly different between groups (*IRR*=0.76, 95% CI 0.41 to 1.49, p=0.456).

Table 14 - Number of injuries, incidence rates and rate ratios comparing the control and intervention groups.

Intention-to-treat analysis						
	Control Group		**Intervention Group**		**Control vs Intervention**	
	Injuries[a]	Incidence*	Injuries	Incidence	Rate Ratio (95% CI)	P value
All injuries	131 (63)	11.4 (0.9)	78 (37)	8.3 (0.9)	0.72 (0.59 to 1.06)	0.117
Lower Extremities	74 (56)	6.4 (0.7)	44 (56)	4.7 (0.6)	0.73 (0.55 to 1.21)	0.315
Body Part:						
Ankle	33 (25)	2.9 (0.5)	17 (22)	1.8 (0.4)	0.62 (0.41 to 1.41)	0.385
Head	29 (22)	2.5 (0.4)	18 (23)	1.9 (0.4)	0.76 (0.41 to 1.49)	0.456
Knee	22 (17)	1.9 (0.4)	11 (14)	1.2 (0.3)	0.63 (0.35 to 1.57)	0.430
Cause of injury:						
Non-contact	16 (12)	1.4 (0.3)	14 (18)	1.5 (0.4)	1.07 (0.75 to 3.60)	0.218
Contact	115 (88)	10.0 (0.8)	64 (82)	6.8 (0.8)	0.68 (0.51 to 0.98)	0.035**
Contact with:						
Ball	57 (50)	5.0 (0.6)	23 (36)	2.4 (0.5)	0.48 (0.27 to 0.78)	0.040**
Player	53 (46)	4.6 (0.6)	36 (56)	3.8 (0.6)	0.83 (0.59 to 1.49)	0.730
Severity of injury:						
Able to finish match	63 (48)	5.5 (0.6)	43 (55)	4.6 (0.7)	0.84 (0.62 to 1.42)	0.757
Unable to finish match	51 (39)	4.4 (0.6)	28 (36)	3.0 (0.5)	0.68 (0.44 to 1.16)	0.168
Medical attention	17 (13)	1.5 (0.3)	7 (9)	0.7 (0.3)	0.47 (0.21 to 1.37)	0.196

[a]Values are numbers (%) of injuries.
*Incidence rate ratios are presented as mean values with standard errors.
**Significant results ≤0.05.

Adherence to the warm-up programme

The warm-up programme was performed by teams in the intervention group at 1690 sessions (mean 3.8 sessions per season, SD: 2.3, range 0-9) out of 2818 possible sessions (cumulative utilisation of 60%), corresponding to a mean of 0.6 (SD: 0.3) warm-up sessions per week (utilisation frequency). Teams were stratified into tertiles of adherence based on the number of warm-up sessions completed during the season: low adherence tertile (utilisation frequency=0.2, SD: 0.1; range=0-1 sessions per week), intermediate adherence tertile (utilisation frequency=0.6, SD: 0.1; range=2-3 sessions per week), and high adherence tertile (utilisation frequency=0.9, SD: 0.2; range=4-9 sessions per week).

Subgroup analysis revealed a significantly lower number of all injuries (*IRR*=0.52, 95% CI 0.29 to 0.97, *p*=0.038) and injuries to the lower extremity (*IRR*=0.32, 95% CI 0.14 to 0.81, *p*=0.015) in the high adherence group compared to the low adherence group (Table 15). Significantly fewer injuries overall (*IRR*=0.50, 95% CI 0.26 to 0.97, *p*=0.041) were also found in the high adherence group compared to the intermediate adherence group.

There were no significant differences between the intermediate adherence and low adherence groups.

Table 15 - Number of injuries (%), incidence rates (presented as means with standard errors) and rate ratios comparing subgroups based on adherence to the warm-up. Significant values ≤0.05 (*).

	Low adherence (n=204 teams, 45%)		**Intermediate adherence (n=111 teams, 24%)**		**High adherence (n=143 teams, 31%)**		**Low *v* Intermediate adherence**		**Low *v* High adherence**		**Intermediate *v* High adherence**	
	Injuries	Incidence	Injuries	Incidence	Injuries	Incidence	Rate Ratio (95% CI)	P value	Rate Ratio (95% CI)	P value	Rate Ratio (95% CI)	P value
All injuries	40 (51)	9.7 (1.5)	23 (30)	10.0 (2.0)	15 (19)	5.0 (1.2)	1.03 (0.65 to 1.83)	0.734	0.52 (0.29 to 0.97)	0.038*	0.50 (0.26 to 0.97)	0.041*
Lower Extremities	26 (65)	6.3 (1.1)	12 (52)	5.2 (1.4)	6 (40)	2.0 (0.8)	0.83 (0.38 to 1.58)	0.484	0.32 (0.14 to 0.81)	0.015*	0.38 (0.16 to 1.18)	0.102
Body Part:												
Ankle	10 (25)	2.4 (0.7)	5 (22)	2.2 (0.9)	2 (13)	0.7 (0.5)	0.92 (0.30 to 2.61)	0.826	0.29 (0.06 to 1.27)	0.099	0.32 (0.06 to 1.67)	0.176
Head	7 (18)	1.7 (0.6)	5 (22)	2.2 (1.0)	6 (40)	2.0 (0.8)	1.29 (0.55 to 6.52)	0.316	1.18 (0.47 to 5.13)	0.475	0.91 (0.26 to 2.88)	0.822
Knee	8 (20)	1.9 (0.7)	2 (9)	0.9 (0.6)	1 (7)	0.3 (0.2)	0.47 (0.10 to 2.18)	0.330	0.16 (0.02 to 1.43)	0.104	0.33 (0.04 to 4.80	0.493
Cause of injury:												
Non-contact	8 (20)	1.9 (0.7)	5 (22)	2.2 (0.9)	1 (7)	0.3 (0.3)	1.16 (0.38 to 3.61)	0.783	0.16 (0.02 to 1.55)	0.121	0.14 (0.02 to 1.35)	0.092
Contact	32 (80)	7.8 (1.2)	18 (78)	7.8 (1.7)	14 (93)	4.7 (1.2)	1.00 (0.61 to 2.02)	0.733	0.60 (0.35 to 1.27)	0.219	0.60 (0.32 to 1.31)	0.224
Contact with:												
Ball	13 (41)	3.1 (0.8)	5 (28)	2.2 (1.0)	5 (36)	1.7 (0.7)	0.71 (0.32 to 2.71)	0.889	0.55 (0.20 to 1.77)	0.356	0.77 (0.20 to 2.36)	0.544
Player	17 (53)	4.1 (0.9)	12 (67)	5.2 (1.5)	7 (50)	2.4 (0.9)	1.27 (0.57 to 2.60)	0.614	0.59 (0.24 to 1.43)	0.240	0.46 (0.20 to 1.36)	0.185
Severity of injury:												
Able to finish match	18 (45)	4.4 (1.0)	14 (61)	6.1 (1.5)	11 (73)	3.7 (1.1)	1.39 (0.75 to 3.25)	0.233	0.84 (0.44 to 2.08)	0.911	0.61 (0.29 to 1.46)	0.295
Unable to finish match	16 (40)	3.9 (0.9)	9 (39)	3.9 (1.3)	3 (20)	1.0 (0.6)	1.00 (0.49 to 2.57)	0.787	0.26 (0.08 to 1.01)	0.052	0.26 (0.07 to 1.02)	0.051
Medical attention	6 (15)	1.5 (0.6)	0 (0)	0.0 (0.0)	1 (7)	0.3 (0.3)	0.00 (0)	-	0.20 (0.02 to 1.74)	0.146	-	-

Discussion

The objective of this study was to investigate the effectiveness of a futsal-specific, warm-up programme designed to reduce injuries in recreational futsal players. In addition, the effects of different levels of adherence of players to the warm-up on the injury rate were examined.

The effect of the warm-up on injury rates

Although the warm-up did not result in a significant difference in the rate of all injuries, nor injuries to the lower extremity between the intervention and control group, the observed rate ratios (0.72 and 0.73) suggest a trend towards a lower number of these injuries in the intervention group. There were, however, significantly fewer (by 32%) contact injuries, especially injuries caused by contact with a ball (by 52%). These results are consistent with previous studies reporting a lower risk of contact injuries using the 11+[70, 72]. Due to the nature of the game, reduced space, a harder surface, and a lot of contact situations, the results seem to suggest a protective effect of the warm-up on players resulting in less contact injuries specifically.

Although there are several studies focusing on injury epidemiology in futsal,[5, 30, 31, 40-43] the implementation and evaluation of any preventive measures has been poorly investigated. To our knowledge, only one previous study has focused on the effectiveness of a warm-up programme (the 11+) to prevent the risk of injuries in amateur futsal players[56]. Significant differences were found in the total number of injuries (44% fewer injuries, p=0.014), acute injuries (48% fewer injuries, p=0.007), and injuries to the lower extremity (54% fewer injuries, p=0.032) compared to the control group[56]. The sample size used in this study was however very small (n=65 adult male players), and thus caution is needed regarding the generalisability of these results. However, the findings are consistent with the current study suggesting that some common futsal injuries can be prevented using a specific, neuromuscular warm-up programme.

Adherence to the warm-up and injury rates

The Futsal FastStart, as with other sport-related warm-up programmes, is a multifaceted programme that addresses many factors that could influence the risk of injury[64, 70]. It is, therefore, difficult to determine exactly which part of the programme might have been responsible for the observed effects on injury rates. However, the uptake of a warm-up (compliance or adherence depending on the study design) has been shown to be one of the key factors in successful injury prevention[70, 71, 76, 77, 83]. Previous studies focused on the 11+ in football have suggested the warm-up needs to be performed at least twice a week to demonstrate the preventive effect[70, 71, 77, 83]. However, Soligard et al. (2010)

reported significantly fewer football injuries with an average utilisation frequency of 1.5 sessions of the 11+ per week and a trend towards fewer injuries in the case of an average utilisation frequency of 0.7 sessions of the 11+ per week[76]. In the current study, the cumulative utilisation of the warm-up programme among all teams was 60% and teams completed the warm-up with an average utilisation frequency of 0.6 ±0.3 sessions per week.

Subgroup analysis showed the high adherence group had significantly fewer injuries overall compared to the teams with lowest and intermediate adherence (48% and 50% fewer respectively). Teams with high adherence to the warm-up also had a lower rate of lower extremity injuries (68% lower) compared to teams with the lowest adherence. These findings are consistent with other studies demonstrating a more protective effect of a warm-up with increasing adherence[70, 71, 76]. The results provide preliminary evidence that a short, sport-specific warm-up can effectively reduce injuries with sufficient adherence.

Methodological considerations

To our knowledge, this is the first study to examine the effectiveness of a futsal-specific injury prevention intervention in the "real-world" context. The study was conducted among teams of both genders and among teams of three different age groups with an adequate sample size to assess the effectiveness of the programme to reduce injuries. Another strength of the current study was a subgroup analysis investigating the influence of adherence on injury rates.

However, the present study acknowledges several methodological limitations. Firstly, given the quasi-experimental design of the study, there was no true random allocation of teams to study groups. The randomisation was pragmatic, based on the geographic separation of futsal centres, to reduce the player contamination with the intervention. This resulted in a non-equivalent distribution of teams in terms of their gender and age group.

To minimise this constraint of internal validity, all statistical analyses were adjusted for gender and age groups as possible confounding variables that could bias the intervention effect. The internal validity can also be improved by including a non-equivalent outcome (a negative control outcome) that is not expected to change in response to the intervention[123]. For this purpose, the rate of head injuries was chosen, because the warm-up was not designed to prevent these injuries. Secondly, the participants, data

collectors (referees and court managers), and investigators were not blinded, which could have biased the participants' behaviour in the study.

There are also several limitations that should be considered when interpreting the results of the current study. Firstly, teams did not train, and they only played one game a week, which resulted in a low exposure to the warm-up in the intervention group (once a week maximally). Secondly, most teams had no coach or team representative to supervise players during the warm-up. Apart from the junior teams, players were responsible for following the warm-up instructions using the resources provided or they had the warm-up delivered by one of the educated warm-up facilitators. Thirdly, referees and players were responsible for the injury data collection without any medical professionals to assess injuries. This limits precision regarding individual diagnoses and severity of injuries. Fourthly, due to logistical and financial reasons, usual warm-up routines of teams in the control group were not recorded. As they could have included some of the components of the Futsal FastStart warm-up, it may have resulted in an unintentional prevention of injuries to some degree. Finally, only amateur teams from one futsal centre were involved in the intervention group and therefore, the results cannot be generalised to other futsal centres or other playing levels.

Conclusion

The use of a newly developed, futsal-specific warm-up programme was not found effective to reduce overall injuries in community futsal players. However, there were fewer contact injuries that are common in amateur futsal players. In addition, there is preliminary evidence the warm-up could reduce overall injuries and injuries to the lower extremity if adherence is high.

Future studies should focus on further investigation of the effects of the Futsal FastStart warm-up across different age groups, genders and playing levels.

CHAPTER 6: Discussion and Conclusion

Discussion

The overall purpose of this thesis was to develop and implement a novel, futsal-specific, neuromuscular warm-up ("Futsal FastStart") in the New Zealand community-based futsal environment. The process of development and implementation was informed by the Translating Research into Injury Prevention Practice (TRIPP) framework[81].

Firstly, it was necessary to summarise the available scientific evidence relating to the nature of the game, performance demands on players, injury epidemiology, and current injury-prevention strategies in futsal (Chapter 2). The rate of futsal injuries has been found to be slightly higher than the rate in football when the data was collected over an entire season,[30, 40, 53, 54] or up to three times higher than the rate in football in the case of tournaments[41, 42, 55]. A harder futsal ball, the smaller and harder surface of the futsal pitch, and the faster speed of the futsal game can result in a higher risk of collisions and injuries, which may account for the differences in the incidence rates between futsal and football. A key limitation of the reviewed literature was that most studies have focused on elite or sub-elite players and to date, there has only been two studies involving amateur futsal players[56, 57]. In these studies, the rate of injuries has been found to be comparable to the rate in amateur football when the data was collected over the whole season and more than two times greater in the case of tournaments[56, 57].

In the case of the injury-prevention strategies in futsal, the current review identified five studies, of which four were focused on the effects of the 11+ warm-up on the performance measures of players, with only one study focused on the effects of the 11+ to prevent the risk of injuries[105-109]. Therefore, the results of the literature review highlighted a gap in knowledge regarding the lack of injury data from amateur futsal players and another gap regarding the implementation and evaluation of any preventive measures, especially in the community-based futsal environment.

Given the limited evidence on injuries in amateur futsal players a better understanding of incidence rate, severity, aetiology, and mechanisms of injury in this environment was needed. According to stage 1 and 2 of the TRIPP framework this is essential before developing or evaluating any preventive measures. For this purpose, a quasi-experimental study was conducted to describe the incidence rates and characteristics of injuries in New Zealand amateur futsal players of both genders and different age groups during a year-long futsal competition (Chapter 3). The competition lasted 16 weeks for junior (U13), 15 weeks for high school (U17), and 19 weeks for the adult league. Data

was collected from 420 teams: 198 junior, 134 high school, and 88 adult teams. The results found the incidence rate to be 11.4 injuries per 1000 player hours or 7.6 injuries per 1000 player matches. These injury rates were similar to those reported in Portuguese amateur adult futsal players (*IR*=11.0 injuries per 1000 player hours)[56] but higher than elite or professional futsal players (*IR*=2.2 injuries per 1000 player hours in Iranian male players[30] and *IR*=3.1 injuries per 1000 player hours in Dutch male players[40]). It has been suggested the higher injury rates in amateur compared to elite players might be attributed to a lower level of physical fitness in amateur players[32, 57]. The differences might also be due to a smaller number of players in amateur teams that can result in the faster onset of fatigue during the match and thus a higher risk of injury[42, 113].

Regarding the injury characteristics, the majority of injuries affected the lower extremity (56%), followed by head and neck (24%), and upper extremity (17%). These results were consistent with other studies where injuries to the lower extremity accounted for 65-85% of all injuries, injuries to the head/neck area ranged from 2% to 22%, and injuries to the upper extremity accounted for 6-21%[30, 41-43, 56, 57]. The most common body parts injured were the ankle (25%), head (22%), and knee (17%). With the exception of head injuries, the findings were similar to those reported in other studies with ankle injuries accounting for up to 44%, knee injuries accounting for up to 31% and thigh injuries reaching up to 28% of all injuries[30, 41-43, 56, 57]. Head injuries accounted for 3-13% in other studies focused on futsal injuries[30, 41-43, 57]. Unfortunately, there was no additional assessment of head injuries in the current study due to the lack of medical professionals to provide more detailed information about these injuries. Generally, the results of all studies have suggested higher incidence rates of concussions in futsal compared to football in different study designs and different playing level[30, 41, 54, 55, 58]. The smaller court size, harder playing surface, harder ball, and more contact situations are likely contributors to the increased risk of concussions in futsal. Due to growing awareness of head injuries in sport[124] and possible consequences associated with sport-related concussion, a high incidence rate of head injuries found in this study needs further investigation and more detailed assessment by sport medicine professionals.

Most injuries occurred during contact situations (88%), especially in contact with the ball (49%) and with another player (46%). Regardless of playing level, these results were consistent with other studies that found contact injuries to be the most common cause of injury in futsal[, 41-43, 56]. However, the proportion of contact injuries has been found lower (60-70%) compared to the present study[41-43, 56]. The present study also showed that contact injuries were evenly distributed between those caused by contact with the ball (ball injuries, 49%) and those caused by collision with another player (player injuries,

46%). The proportion of ball injuries is higher than reported previously and the proportion of player injuries lower than previously reported (87-93%)[42, 56]. These differences may be due to different methods of data collection and also the inclusion of younger players in the current study compared to previous studies[42, 56].

Over half of the injuries (52%) stopped players finishing the match while 13% of injuries required medical attention. This data cannot be compared to other studies due to the lack of medical professionals assessing the injuries and the lack of any follow-up communication with injured players to find out the number of days elapsed before a player's return to full participation.

With respect to the effects of age group and gender on the incidence rates and injury characteristics, there was significantly fewer injuries overall in high school teams (41% fewer) and 36% fewer contact injuries compared to junior teams. However, significantly fewer high school players were able to finish the match (57%) compared to junior players suggesting a higher proportion of more severe injuries in high school teams. There was no significant difference in incidence rates between adult and junior teams. To our knowledge, this is the first study comparing injury rates among three different age groups. With respect to gender, the observed incidence rate (*IR*) of 13.0 injuries per 1000 player hours in female players was higher than in male players (*IR*=10.9 injuries per 1000 player hours). However, this difference was not found statistically significant (*IRR*=1.19, 95% CI 0.74 to 1.65, *p*=0.62). Overall, the results of this chapter provided novel insights into the nature of injuries in amateur futsal, suggesting a high rate of injury, especially lower extremity and head injuries. These findings assisted the development of futsal-specific, injury-prevention measures.

Neuromuscular warm-up programmes have been consistently shown to be effective in the prevention of injuries across a broad range of research settings, designs, and sports[56, 64-75]. One of these programmes, the 11+, was designed to prevent the risk of injuries in football. It has since been shown to be effective in both men's and women's football, and at different levels of competition[64, 68, 70, 71, 76, 77, 83, 85]. There is also preliminary data that indicates the programme can prevent the risk of injury in amateur futsal players[56]. Importantly the results of previous studies have found the uptake of the warm-up programme among participants (either compliance or adherence depending on the study design) to be one of the key factors in successful injury prevention[70, 71, 76, 77]. In the case of the 11+, it has been demonstrated that the more sessions of the programme were completed by players, the lower the risk of injuries was achieved[70, 71, 76]. Unfortunately, the uptake of the 11+ by players has been shown to be poor outside of

the research setting, mainly due to poor, evidence-based, injury-prevention knowledge dissemination among players and coaches, and the associated delivery strategies[78].

In an attempt to overcome some of the identified barriers to adherence, a novel, futsal-specific warm-up programme ("Futsal FastStart") was designed based on the 11+ with modifications informed by the opinions of members of the New Zealand futsal community (players and coaches) and sport medicine professionals via focus groups (Chapter 4). Stage 3 and 5 of the TRIPP framework highlight the need to get input from key stakeholders, consider their attitudes and opinions, and discuss the implementation strategy for the warm-up in the community-based environment. As a result of the focus group feedback the warm-up programme consisted of futsal-specific exercises adapted from the 11+ and also considered the challenges of the community-based futsal environment (the reduced space, less time to perform a warm-up, as well as a harder surface). The warm-up was able to be performed within five minutes, as a team, and using any space available. It was structured into seven steps starting with the initial running/jogging and dynamic stretches, followed by exercises focused on stability, balance, neuromuscular control, and change of direction. These exercises were considered important for several reasons. Firstly, they have been demonstrated to represent common tasks in the futsal game[91, 97]. Secondly, they have been consistently shown not only to prevent injuries, but also to improve the awareness and control during running, planting, cutting, landing, and other change of direction movements[70, 72-75]. Thirdly, these exercises were considered important due to a high number of ankle injuries in futsal and due to the demands of game[5, 31, 40, 41, 44]. And lastly, although neuromuscular warm-up programmes include multiple components (e.g., strength, balance, and agility exercises) and therefore, it is difficult to investigate the contribution of each one of them to performance enhancement and injury prevention, they have been shown to reduce the risk of injuries when designed specifically for the sport-related environment[62, 125-127].

The effectiveness of the Futsal FastStart warm-up to reduce the risk of injuries in New Zealand amateur futsal players was then evaluated as outlined in stage 6 of the TRIPP framework. The programme was performed by the intervention group before every game, once a week maximally, and compared to the control group that followed their usual warm-up routines with no formal instructions. Although the warm-up did not result in a significantly lower incidence rate of all injuries in the intervention group, the observed incidence rate ratio (*IRR*=0.72) suggests a trend towards a lower risk of injuries. This result is similar to a study conducted at forty Dutch primary schools, which investigated the effects of a five-minute neuromuscular warm-up on the rates of physical activity

injuries[128]. This study did not result in a significant reduction of all injuries, but there was a trend towards a lower rate of injuries[128].

However, there were significantly (32%) fewer contact injuries in the present study, especially injuries caused by contact with a ball (52% fewer), in the intervention group compared to the control group. These results are consistent with previous studies reporting a lower risk of contact injuries using the 11+[70, 72] and neuromuscular warm-up programmes used in other sports and settings as well[62, 125]. Due to the nature of the game, reduced space, a harder surface, and a high number of contact situations, the results indicate a protective effect of the warm-up on players to prevent contact injuries specifically.

To examine a possible dose-response relationship between the adherence of teams to the Futsal FastStart warm-up and risk of injuries, a subgroup analysis, adjusted for age group and gender of teams, was conducted to compare the incidence rates between teams in the intervention group. Teams were stratified into three groups of adherence tertiles (low, intermediate, and high) based on the number of warm-up sessions completed throughout the competition as suggested in previous studies. Subgroup analysis revealed a significantly lower number of all injuries (*IRR*=0.52, 95% CI 0.29 to 0.97, *p*=0.038) and injuries to the lower extremity (*IRR*=0.32, 95% CI 0.14 to 0.81, *p*=0.015) in the high adherence group compared to the low adherence group. Significantly fewer injuries overall (*IRR*=0.50, 95% CI 0.26 to 0.97, *p*=0.041) were also found in the high adherence group compared to the intermediate adherence group. There were no significant differences between the intermediate adherence and low adherence groups. These findings are consistent with previous studies providing preliminary evidence of a protective effect of a warm-up when adherence is high[56, 65, 67-71, 76, 104].

The cumulative utilisation (number of sessions completed of total possible) of the Futsal FastStart warm-up programme among all teams in the intervention group was 60% and teams completed the warm-up with an average utilisation frequency (number of sessions completed per week) of 0.6 ±0.3 sessions per week. Previous studies focused on the 11+ in football have suggested the warm-up needs to be performed at least twice a week to be effective[70, 71, 77, 83]. However, one study reported significantly fewer football injuries with an average utilisation frequency of 1.5 sessions of the 11+ per week and a trend towards fewer injuries in the case of an average utilisation frequency of 0.7 sessions of the 11+ per week[76]. The results of the current study have shown a similar uptake of the Futsal FastStart by players compared to studies focused on the 11+ in football, where

the cumulative utilisation ranged from 60% to 77%[68, 70, 104]. However, the studies conducted in football involved coaches, physiotherapists or other sports medicine professionals that guaranteed the delivery of the 11+. In the current study, most teams did not have a coach, nor any sports medicine professional to deliver the Futsal FastStart. Apart from the junior teams, players were responsible for following the warm-up instructions using the resources provided or they had the warm-up delivered by one of the educated warm-up facilitators. These findings highlight the good level of adherence achieved with the Futsal FastStart and what is possible in a community setting. The inclusion of coaches in the development of the programme likely helped as coaches are considered key stakeholders when looking to reach community-based athletes[80]. It has also been shown that if a warm-up was not designed specifically to fit in the sport-related environment and it did not include enough sport-related activities, the uptake was more likely to be lower[76, 79]. This is likely another reason why adherence in the current study was good. The warm-up programme consisted of futsal-specific exercises adapted from the 11+ and it also considered the challenges of the community-based futsal environment. The results suggest a short, sport-specific warm-up can be effective for reducing injuries if there is sufficient adherence.

Practical implications

Based on the outcomes of this thesis, there are several practical implications that will be beneficial for practitioners, players, coaches, and researchers when developing, implementing, or evaluating an injury-prevention warm-up programme:

- The development of preventive measures and implementation strategies in the sport-related environment should always include input from key stakeholders (players, coaches, sport medicine professionals, governing bodies).
- When developing injury-prevention strategies for futsal, the focus should be on lower extremity and head injuries as these are the most frequent body parts injured.
- The education of key stakeholders, workshops for coaches, promotion of the preventive measures ahead of the start of sports competitions, as well as adequate resources for players (activation zones, digital content, facilitators) are essential to improve the coaches' and players' buy in to maximise adherence.
- A good and frequent communication between the research team and the centres is key for a high number of teams being recruited and minimising dropouts.
- The adherence with a warm-up can be increased by including key stakeholders in the development and implementation of the warm-up, using sport-related exercises, and addressing the challenges of a given sport environment.

- With appropriate training, injury reporting in community sport can be captured by referees. This may reduce the pressure on organisations to have medical personnel present at all games to capture injury rates. Linking the injury recording with the recording of match statistics helps to facilitate this process.
- A short, sport-specific warm-up performed at least once a week can reduce the risk of injuries in a community sports environment.
- Other sports in NZ with large community based amateur competitions (e.g. netball and basketball) should look to implement a similar short pre-game sport specific warm-up.

Limitations

There are several limitations that should be considered when interpreting the outcomes of this thesis that are outlined below:

- Only two focus groups with a small number of participants were conducted to address the development and implementation strategies of the Futsal FastStart warm-up (Chapter 4). The focus groups were also conducted only once, without any follow-up to discuss or review the programme.
- There was no final follow-up, questionnaire, or survey to analyse coaches', players' and other key stakeholders' opinions and attitudes towards the Futsal FastStart, its design, structure, or implementation.
- There were no medical professionals on site to record and assess the injuries during both the epidemiological research as well as intervention research (Chapter 3, Chapter 5). Injuries were recorded by referees together with players using a modified match report card. Thus, the lack of more detailed information about injuries, underreporting and mistakes during the data collection could not be excluded.
- There was no follow-up with injured players to confirm the severity of injury (Chapter 3, Chapter 5). Therefore, the severity of injuries was assessed based on player's ability to finish the match or to seek immediate medical attention. Unfortunately, this limits comparison of the results of this thesis with other similar studies, where the severity is assessed by the number of days lost due to injury. Additionally, the lack of medical professionals did not enable more detailed information about the high number of head injuries and potential concussions that are a growing concern in futsal.
- Data on match exposure was collected on a team basis and individual player exposure estimated from this (Chapter 3, Chapter 5). This may have resulted in reduced precision regarding the adherence of individual players with the warm-up programme, injury rates, and match exposure.

- Only amateur teams from one futsal centre were involved in the epidemiological study (Chapter 3), as well as in the intervention group in the intervention study (Chapter 5), and therefore, the results may not be generalisable to all futsal centres or all playing levels.
- The teams in the intervention study (Chapter 5) were not randomly allocated to the intervention group. The randomisation was pragmatic, based on the geographic separation of both centres, to reduce the player contamination with the intervention. Therefore, there were significant differences in teams' distribution and demographics between both groups that could have influenced the results.
- Teams in the intervention group (Chapter 5) did not train and played only one game a week, which corresponded to a low exposure to the warm-up (once a week maximally).
- Most teams in the intervention group (Chapter 5) had no coach or team representative to supervise players during the warm-up. Apart from the junior teams, players were responsible for following the warm-up instructions using the resources provided or they had the warm-up delivered by one of educated warm-up facilitators.

Future research directions

The limitations listed above can help identify future directions for injury research in New Zealand. The recommendations for future research are listed below:

- In terms of the development and implementation strategies, future studies could include a broader spectrum of key stakeholders in any given sport to provide more generalisable findings. Additionally, there is the need for follow-up sessions to provide even deeper insight into the issue of developing and implementing any injury-prevention measures as suggested in the TRIPP framework.
- Based on the TRIPP framework, the assessment of injury prevention in the real-world conditions should concurrently involve TRIPP Stage 1, injury surveillance, and also TRIPP Stage 5, implementation strategies. This could provide a more detailed understanding of the coaches', players', and governing bodies' attitudes towards the interventions that are about to be implemented in a given sports environment. Therefore, there should be a follow-up with the key stakeholders to define potential modifications of interventions to improve the implementation and adherence to the preventive measures.
- Due to the lack of injury data in futsal, especially in the community-based environment, future studies should focus on further investigation of the incidence rates, severity, aetiology, and mechanisms in other futsal centres at all levels of

play. The epidemiological studies should also involve sport medicine professionals to assess injuries in detail, especially the severity, type, nature of head injuries, overuse and recurrent injuries.

- Future studies should also focus on the investigation of possible risk factors (age, gender, the level of adherence to a warm-up, playing level) that might influence the effectiveness of the Futsal FastStart warm-up programme.

Conclusion

This thesis provides a novel insight into incidence rates and characteristics in New Zealand amateur futsal players and a unique method for development and implementation of a novel, futsal-specific, warm-up programme (the Futsal FastStart) in the community-based environment. Although the Futsal FastStart warm-up programme has not been found effective for preventing injuries overall, there were significantly fewer contact injuries that are common in amateur futsal players. In addition, there is preliminary evidence Futsal FastStart (a short sport-specific warm-up) could be effective in reducing injuries in community futsal players if adherence is high.

The findings should assist with promoting and implementing the programme to coaches, players, and other futsal governing bodies as part of pre-match preparation for all futsal players. Future research should address the thesis limitations and build on the ideas presented in this thesis for a better understanding of the effects of the Futsal FastStart warm-up on futsal players.

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APPENDIX A: Ethical Approval 18/215 for Chapter 4

AUTEC Secretariat

Auckland University of Technology
D-88, WU406 Level 4 WU Building City Campus
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

24 May 2018

Duncan Reid
Faculty of Health and Environmental Sciences

Dear Duncan

Ethics Application: 18/215 **Injury prevention in Futsal: An observational longitudinal prospective study to assess the influence of the modified FIFA 11+ injury prevention program**

I wish to advise you that a subcommittee of the Auckland University of Technology Ethics Committee (AUTEC) has **approved** your ethics application.

This approval is for three years, expiring 24 May 2021.

Non-Standard Conditions of Approval

1. In the Information Sheet disclose project funding, and consider limiting the confidentiality that can be offered due to the fact that there is only a small pool of potential participants who are known to each other, and that the focus groups are to held at the premises of the association;
2. Consideration of koha, given time commitment of participants and level of funding this is available.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: lubostomsovsky@gmail.com; chris.whatman@aut.ac.nz

APPENDIX B: Consent form and Information Sheets for Ethical Approval 18/215 for Chapter 4

Consent Form

Project title: ***Injury Prevention in Futsal: the development of a new injury-prevention warm-up program specific for futsal via a method of focus groups.***

Project Supervisor: ***Professor Duncan Reid***

Researcher: ***Luboš Tomšovský***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 01/05/2018.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that identity of my fellow participants and our discussions in the focus group is confidential to the group and I agree to keep this information confidential.
- ○ I understand that notes will be taken during the focus group and that it will also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then, while it may not be possible to destroy all records of the focus group discussion of which I was part, I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

***Approved by the Auckland University of Technology Ethics Committee on* 24 May 2018.** ***AUTEC Reference number* 18/215.**

Note: The Participant should retain a copy of this form.

Participant Information Sheet

Futsal players

Date Information Sheet Produced:

01/05/2018

Project Title

Injury Prevention in Futsal: the development of a new injury-prevention warm-up program specific for futsal.

An Invitation

Dear potential participant,

My name is Luboš Tomšovský and I'm a PhD student at Auckland University of Technology. You are being invited to take part in one of the first stages of my PhD research study that is focused on the development of a new injury-prevention warm-up program for futsal. The warm-up structure will be based on the empirically verified and validated program used in soccer, known as "The FIFA 11+", and it may be modified via a method of focus groups to be futsal-specific. A focus group is an opinion-seeking discussion consisting of 10-15 people that are asked to share their opinions, ideas, perceptions, suggestions and/or recommendations about a particular topic or area of interest (injury-prevention warm-up program specific for futsal in our case). I believe that by involving you, a futsal player, a successful warm-up program, to reduce injuries in futsal and/or minimize their risks, can be developed. By involving you I also believe that the new program can improve coaches' and players' buy in to perform the warm-up properly, consistently and regularly. The compliance of such programs is always crucial and a challenge, which significantly influences the results of similarly-focused studies about the injury prevention. Your participation could help minimize this potential adverse effect and it could help implement the warm-up program to futsal players more easily.

What is the purpose of this research?

The purpose of this part of the research is to see if modifying the warm-up program used in soccer ("The FIFA 11+") is helpful to futsal. The involvement of the futsal community and also sport medical professionals is believed to develop a successful warm-up routine for futsal players to reduce the number of injuries, to minimize their potential risks and to improve the players' warm-up compliance.

How was I identified and why am I being invited to participate in this research?

You are being invited as a player of one of NZ futsal teams.

How do I agree to participate in this research?

You can confirm your participation by replying to this invitation via email to me, the primary researcher, at:

lubostomsovsky@gmail.com

You will be provided with a consent form. If at any point you have any questions, please do not hesitate to ask me via the email above. Once you have understood the study you can complete the consent form.

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

Once the focus group is formed, you and other participants willing to be involved in the research will receive suggestions of dates of the focus group meeting. The official date of the meeting will be then determined based on the discussion of your and other participants' availability and announced to you via email. The meetings will be at QBE Stadium in Albany, Auckland, the headquarters of NZ Football. At the beginning of the focus group, the consent form will be completed. Your task, as a participant, will be then to assist us with the development of a new injury-prevention warm-up program specific for futsal and to give us a feedback on our suggestions via your

opinions, perceptions, and/or recommendations. The length of the focus group meeting will depend on the discussion; however, the length of the meeting should not exceed 2 hours.

What are the discomforts and risks?

There should not be any kind of discomfort or embarrassment for you during the focus group. The atmosphere will be kept positive. No risk is anticipated.

What are the benefits?

Potential benefits for you:

- You, as a player of one of NZ futsal teams, will have the opportunity to express your own opinions, suggestions and recommendations regarding the development of a new injury-prevention warm-up program.

- You will gain deeper knowledge and the insight into the issue of injuries, their characteristics and possible ways to prevent them in their specific sport.

- The warm-up program will be specific for your needs, demands and requirements.

- The designed program will be available for you at the end of the study to use as your warm-up routine.

The wider community:

- The outcomes of the research will lead to the development of a new injury-prevention warm-up program specific for futsal. At the end of the study, this program will be available for the whole futsal community to use.

- A newly-designed warm-up program could later work as a basis of similar warm-up programs for other sports and it could be therefore later spread not only in the futsal community, but also in other similar change of direction sports and communities.

How will my privacy be protected?

Once you are willing to participate in the focus groups, after reading the consent form thoroughly and understanding your role in the research, you will give an official consent at the beginning of the focus group meeting. During the meeting, there will be no need to provide any more personal information except your name because of the discussion structure of the focus group.

The consent form, containing your name, will be stored separately from the other data in a locked cabinet in an office of my primary supervisor.

No personal information provided by you will be knowingly revealed to any third parties.

What are the costs of participating in this research?

There are no other costs for you except your time. The length of the focus group meeting will depend on the discussion; however, the length should not exceed 2 hours. The meeting will take place just once and no additional focus group participation is planned. All other potential communication will happen via email, provided at the beginning of the focus group meeting.

What opportunity do I have to consider this invitation?

You have 2 weeks to consider and respond (accept or refuse) to the invitation via email to me:

lubostomsovsky@gmail.com

Will I receive feedback on the results of this research?

In case you are interested in the outcomes of this part of my research, you will be allowed to indicate it when filling in the consent form at the beginning of the focus group meeting. The summary of the outcomes will be then provided to you at the end of the study via email.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Luboš Tomšovský, lubostomsovsky@gmail.com.

Project Supervisor Contact Details:

Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Approved by the Auckland University of Technology Ethics Committee on 24 May 2018, AUTEC Reference number 18/215.

Participant Information Sheet

Futsal development officers/sport medical professionals

Date Information Sheet Produced:

01/05/2018

Project Title

Injury Prevention in Futsal: the development of a new injury-prevention warm-up program specific for futsal.

An Invitation

Dear potential participant,

My name is Luboš Tomšovský and I'm a PhD student at Auckland University of Technology. You are being invited to take part in one of the first stages of my PhD research study that is focused on the development of a new injury-prevention warm-up program for futsal. The warm-up structure will be based on the empirically verified and validated program used in soccer, known as "The FIFA 11+", and it may be modified via a method of focus groups to be futsal-specific. A focus group is an opinion-seeking discussion consisting of 10-15 people that are asked to share their opinions, ideas, perceptions, suggestions and/or recommendations about a particular topic or area of interest (injury-prevention warm-up program specific for futsal in our case). I believe that by involving you, a futsal development officer or a sport medical professional, a successful warm-up program, to reduce injuries in futsal and/or minimize their risks, can be developed. By involving you I also believe that the new program can improve coaches' and players' buy in to perform the warm-up properly, consistently and regularly. The compliance of such programs is always crucial and a challenge, which significantly influences the results of similarly-focused studies about the injury prevention. Your participation could help minimize this potential adverse effect and it could help implement the warm-up program to futsal players more easily.

What is the purpose of this research?

The purpose of this part of the research is to see if modifying the warm-up program used in soccer ("The FIFA 11+") is helpful to futsal. The involvement of the futsal community and also sport medical professionals is believed to develop a successful warm-up routine for futsal players to reduce the number of injuries, to minimize their potential risks and to improve the players' warm-up compliance.

How was I identified and why am I being invited to participate in this research?

You are being invited as a member of a NZ futsal federation or a professional/researcher focused on sports medicine, injuries in sports and/or injury prevention.

How do I agree to participate in this research?

You can confirm your participation by replying to this invitation via email to me, the primary researcher, at:

lubostomsovsky@gmail.com

You will be provided with a consent form. If at any point you have any questions, please do not hesitate to ask me via the email above. Once you have understood the study you can complete the consent form.

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

Once the focus group is formed, you and other participants willing to be involved in the research will receive suggestions of dates of the focus group meeting. The official date of the meeting will be then determined based on the discussion of your and other participants' availability and announced to you via email. The meetings will be at QBE Stadium in Albany, Auckland, the headquarters of NZ Football. At the beginning of the focus group, the consent form will be completed. Your task, as a participant, will be then to assist us with the development of a

new injury-prevention warm-up program specific for futsal and to give us a feedback on our suggestions via your opinions, perceptions, and/or recommendations. The length of the focus group meeting will depend on the discussion; however, the length of the meeting should not exceed 2 hours.

What are the discomforts and risks?

There should not be any kind of discomfort or embarrassment for you during the focus group. The atmosphere will be kept positive. No risk is anticipated.

What are the benefits?

Potential benefits for you:

- The outcomes of the research will be beneficial to you, as a futsal development officer, for two main reasons. Firstly, your active involvement in the development of a new injury-prevention warm-up program will provide deeper knowledge and insight into the issue regarding injuries in futsal and possible ways to prevent them. Secondly, the newly-designed warm-up program will be available for you at the end of the whole study, together with summary from other focus groups, to implement it to all teams in your federations.

- You, as a sport medical professional, will benefit from the outcomes of the research as well. The results of focus groups will provide you with opinions, suggestions, recommendations and feedback when developing new injury-prevention warm-up program. That should help you better understand the needs and demands of players of a specific sport that could be later useful in developing other similar injury-prevention programs specific for other sports.

The wider community:

- The outcomes of the research will lead to the development of a new injury-prevention warm-up program specific for futsal. At the end of the study, this program will be available for the whole futsal community to use.

- A newly-designed warm-up program could later work as a basis of similar warm-up programs for other sports and it could be therefore later spread not only in the futsal community, but also in other similar change of direction sports and communities.

How will my privacy be protected?

Once you are willing to participate in the focus groups, after reading the consent form thoroughly and understanding your role in the research, you will give an official consent at the beginning of the focus group meeting. During the meeting, there will be no need to provide any more personal information except your name because of the discussion structure of the focus group.

The consent form, containing your name, will be stored separately from the other data in a locked cabinet in an office of my primary supervisor.

No personal information provided by you will be knowingly revealed to any third parties.

What are the costs of participating in this research?

There are no other costs for you except your time. The length of the focus group meeting will depend on the discussion; however, the length should not exceed 2 hours. The meeting will take place just once and no additional focus group participation is planned. All other potential communication will happen via email, provided at the beginning of the focus group meeting.

What opportunity do I have to consider this invitation?

You have 2 weeks to consider and respond (accept or refuse) to the invitation via email to me:

lubostomsovsky@gmail.com

Will I receive feedback on the results of this research?

In case you are interested in the outcomes of this part of my research, you will be allowed to indicate it when filling in the consent form at the beginning of the focus group meeting. The summary of the outcomes will be then provided to you at the end of the study via email.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Luboš Tomšovský, lubostomsovsky@gmail.com.

Project Supervisor Contact Details:

Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Approved by the Auckland University of Technology Ethics Committee on 24 May 2018, AUTEC Reference number 18/215.

Participant Information Sheet

Futsal coaches

Date Information Sheet Produced:

01/05/2018

Project Title

Injury Prevention in Futsal: the development of a new injury-prevention warm-up program specific for futsal.

An Invitation

Dear potential participant,

My name is Luboš Tomšovský and I'm a PhD student at Auckland University of Technology. You are being invited to take part in one of the first stages of my PhD research study that is focused on the development of a new injury-prevention warm-up program for futsal. The warm-up structure will be based on the empirically verified and validated program used in soccer, known as "The FIFA 11+", and it may be modified via a method of focus groups to be futsal-specific. A focus group is an opinion-seeking discussion consisting of 10-15 people that are asked to share their opinions, ideas, perceptions, suggestions and/or recommendations about a particular topic or area of interest (injury-prevention warm-up program specific for futsal in our case). I believe that by involving you, a futsal coach, a successful warm-up program, to reduce injuries in futsal and/or minimize their risks, can be developed. By involving you I also believe that the new program can improve coaches' and players' buy in to perform the warm-up properly, consistently and regularly. The compliance of such programs is always crucial and a challenge, which significantly influences the results of similarly-focused studies about the injury prevention. Your participation could help minimize this potential adverse effect and it could help implement the warm-up program to futsal players more easily.

What is the purpose of this research?

The purpose of this part of the research is to see if modifying the warm-up program used in soccer ("The FIFA 11+") is helpful to futsal. The involvement of the futsal community and also sport medical professionals is believed to develop a successful warm-up routine for futsal players to reduce the number of injuries, to minimize their potential risks and to improve the players' warm-up compliance.

How was I identified and why am I being invited to participate in this research?

You are being invited as an active coach of one of NZ futsal teams.

How do I agree to participate in this research?

You can confirm your participation by replying to this invitation via email to me, the primary researcher, at:

lubostomsovsky@gmail.com

You will be provided with a consent form. If at any point you have any questions, please do not hesitate to ask me via the email above. Once you have understood the study you can complete the consent form.

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

Once the focus group is formed, you and other participants willing to be involved in the research will receive suggestions of dates of the focus group meeting. The official date of the meeting will be then determined based on the discussion of your and other participants' availability and announced to you via email. The meetings will be at QBE Stadium in Albany, Auckland, the headquarters of NZ Football. At the beginning of the focus group, the consent form will be completed. Your task, as a participant, will be then to assist us with the development of a new injury-prevention warm-up program specific for futsal and to give us a feedback on our suggestions via your

opinions, perceptions, and/or recommendations. The length of the focus group meeting will depend on the discussion; however, the length of the meeting should not exceed 2 hours.

What are the discomforts and risks?

There should not be any kind of discomfort or embarrassment for you during the focus group. The atmosphere will be kept positive. No risk is anticipated.

What are the benefits?

Potential benefits for you:

- You will get an opportunity to participate in the development of a new injury-prevention warm-up program specific for needs and demands of futsal players.

- The outcomes of the research should benefit you with knowledge and the insight into the issue of injuries, their characteristics and possible ways to prevent them.

- The newly designed warm-up program will be available for you at the end of the study with the summary from other focus groups. You will be then allowed to use the warm-up program in your own team.

The wider community:

- The outcomes of the research will lead to the development of a new injury-prevention warm-up program specific for futsal. At the end of the study, this program will be available for the whole futsal community to use.

- A newly-designed warm-up program could later work as a basis of similar warm-up programs for other sports and it could be therefore later spread not only in the futsal community, but also in other similar change of direction sports and communities.

How will my privacy be protected?

Once you are willing to participate in the focus groups, after reading the consent form thoroughly and understanding your role in the research, you will give an official consent at the beginning of the focus group meeting. During the meeting, there will be no need to provide any more personal information except your name because of the discussion structure of the focus group.

The consent form, containing your name, will be stored separately from the other data in a locked cabinet in an office of my primary supervisor.

No personal information provided by you will be knowingly revealed to any third parties.

What are the costs of participating in this research?

There are no other costs for you except your time. The length of the focus group meeting will depend on the discussion; however, the length should not exceed 2 hours. The meeting will take place just once and no additional focus group participation is planned. All other potential communication will happen via email, provided at the beginning of the focus group meeting. However we will provide some reimbursement for travel costs via petrol vouchers.

What opportunity do I have to consider this invitation?

You have 2 weeks to consider and respond (accept or refuse) to the invitation via email to me:

lubostomsovsky@gmail.com

Will I receive feedback on the results of this research?

In case you are interested in the outcomes of this part of my research, you will be allowed to indicate it when filling in the consent form at the beginning of the focus group meeting. The summary of the outcomes will be then provided to you at the end of the study via email.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Luboš Tomšovský, lubostomsovsky@gmail.com.

Project Supervisor Contact Details:

Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Approved by the Auckland University of Technology Ethics Committee on 24 May 2018, AUTEC Reference number 18/215.

APPENDIX C: Ethical Approval 18/379 for Chapter 3 and Chapter 5

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

30 October 2018

Duncan Reid
Faculty of Health and Environmental Sciences

Dear Duncan

Re Ethics Application: **18/379 Injury prevention in futsal: A prospective study to assess the influence of the modified FIFA 11+ injury prevention programme**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 30 October 2021.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/research/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/research/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/research/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries, please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor
Executive Manager
Auckland University of Technology Ethics Committee

Cc: lubostomsovsky@gmail.com; chris.whatman@aut.ac.nz

APPENDIX D: Consent forms and Information Sheets for Ethical Approval 18/379 for Chapter 3 and Chapter 5

AUT
TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Consent Form

Project title: ***Injury Prevention in Futsal: a prospective study to assess the influence of a newly developed, futsal-specific, warm-up routine on match-related injuries.***

Project Supervisor: ***Professor Duncan Reid***

Researcher: ***Luboš Tomšovský***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 31/08/2018.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data or tissue that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Participant's signature: .....

Participant's name: .....

Participant's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 30 October 2018. AUTEC Reference number 18/379.

Note: The Participant should retain a copy of this form.

Parent/Guardian Consent Form

Project title: ***Injury Prevention in Futsal: a prospective study to assess the influence of a newly developed, futsal-specific, warm-up routine on match-related injuries.***

Project Supervisor: ***Professor Duncan Reid***

Researcher: ***Luboš Tomšovský***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 31/08/2018.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw my child/children and/or myself from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw my child/children and/or myself from the study then I will be offered the choice between having any data that is identifiable as belonging to my child/children and/or myself removed or allowing it to continue to be used. However, once the findings have been produced, removal of our data may not be possible.
- ○ I agree to my child/children taking part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

Child/children's name/s : .....

.....

Parent/Guardian's signature: .....

Parent/Guardian's name: .....

Parent/Guardian's Contact Details (if appropriate):

.....

.....

.....

.....

Date:

Approved by the Auckland University of Technology Ethics Committee on 30 October 2018. AUTEC Reference number 18/379.

Note: The Participant should retain a copy of this form.

Participant Information Sheet

Futsal players

Date Information Sheet Produced:

31/08/2018

Project Title

Injury Prevention in Futsal: a prospective study to assess the influence of a newly developed, futsal-specific, warm-up routine on match-related injuries.

An Invitation

Dear potential participant,

My name is Luboš Tomšovský and I'm a PhD student at Auckland University of Technology. You are being invited to be part of my PhD research study that is focused on improving performance and reducing injury risk in futsal. The number of match-related injuries is now almost three times higher compared to football and it is, therefore, a significant issue. In cooperation with members of the NZ futsal community and sport medical professionals, we have developed a new, futsal-specific, warm-up routine that is based on the validated programme used in football, known as the FIFA 11+. This programme has been shown effective in preventing injuries in football. As football and futsal are very similar in demands of the sport, we believe that the newly developed, warm-up routine, based on the FIFA 11+, could reduce the high number of match-related injuries in futsal too. You, a futsal player, will be asked to perform the structured warm-up programme ideally before every game. The routine will not take longer than 3-5 minutes. After every game you will be asked to help referees fill in the injury report card, in case of an injury sustained in the game, and answer honestly if your team performed the warm-up or not. If you and your team are willing to participate, you will be included in a prize draw to win futsal gear provided by NZ Football. The NZ Football association provides funding of my project. I am not employed by the NZ Football.

What is the purpose of this research?

The purpose of the research is to see if modifying the warm-up programme used in soccer (The FIFA 11+) is helpful to futsal. The aim is to compare the effect of the newly developed warm-up programme on the number of match injuries amongst a group of recreational futsal players compared to another group of recreational futsal players currently using their regular or minimal warm-up routines.

How was I identified and why am I being invited to participate in this research?

You are being invited as a player of one of NZ recreational futsal teams.

How do I agree to participate in this research?

You can confirm your participation by replying to this invitation either via email to me, the primary researcher, at:

lubostomsovsky@gmail.com

or in person at the venue of futsal competitions (ASB Stadium) prior or after games.

You will be provided with a consent form. If at any point you have any questions, please do not hesitate to ask me via the email above. Once you have understood the study you can complete the consent form.

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

At the start of the study, you will receive information and a demonstration of the warm-up structure via adequate resources (videos, posters). You will be then followed up for one season (Term 1 – Term 4, 2019) and you will be encouraged to perform the structured warm-up routine before every game. The venue of matches will be equipped with warm-up resources (flags, videos, posters) and research assistants, who will help to deliver the

warm up to you. After every game you will be asked to help referees fill in the injury report card, in case of any injury sustained in the game, and provide information, if your team performed the warm up or not.

What are the discomforts and risks?

There should not be any kind of discomfort or embarrassment for you during the study. No risk is anticipated.

What are the benefits?

Potential benefits for you:

- You, as a futsal player, will receive a structured, futsal-specific warm-up programme to follow before every game

- By using the newly developed warm-up programme before every game, the risk of match-related injuries will be potentially reduced, your preparedness for a game improved, and your performance possibly enhanced

The wider community:

- The programme will be available for the whole futsal community to use, especially if the programme results in the match-injury reduction

- The newly designed warm-up programme could later work as a basis of similar warm-up programmes for other sports and it could be therefore later spread not only in the futsal community but also in other similar change of direction sports and communities.

How will my privacy be protected?

After reading the consent form thoroughly and understanding your role in the research, you will give an official consent before the start of the competitive season in 2019. During the study, there will be no need to provide any more personal information.

The consent form, containing your name, will be stored separately from the other data in a locked cabinet in an office of my primary supervisor. No personal information will be knowingly revealed to any third parties.

What are the costs of participating in this research?

There are no other costs for you except your time. The warm-up routine before every game should not exceed 3-5 minutes. After the game you will be asked to help referees fill in the injury report card together with warm-up performance (yes/no as a team). This should not exceed 1-2 minutes.

What opportunity do I have to consider this invitation?

You have 2 weeks to consider and respond (accept or refuse) to the invitation via email to me at:

lubostomsovsky@gmail.com

or in person at the venue of futsal competitions (ASB Stadium) prior or after games.

Will I receive feedback on the results of this research?

In case you are interested in the outcomes of my research, the results and summary will be made available via the NZ Football website and also via websites of both football federations included (Capital Football in Wellington and Football South in Dunedin).

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Luboš Tomšovský, lubostomsovsky@gmail.com.

Project Supervisor Contact Details:

Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Approved by the Auckland University of Technology Ethics Committee on 30 October 2018, AUTEC Reference number 18/379.

Participant Information Sheet

Parents of futsal players

Date Information Sheet Produced:

31/08/2018

Project Title

Injury Prevention in Futsal: a prospective study to assess the influence of a newly developed, futsal-specific, warm-up routine on match-related injuries.

An Invitation

Dear parents,

My name is Luboš Tomšovský and I'm a PhD student at Auckland University of Technology. Your child is being invited to be part of my PhD research study that is focused on the injury prevention in futsal. Together with members of the NZ futsal community and sport medical professionals, we have developed a new, warm-up programme that has been hypothesized to reduce the high number of injuries in futsal. Your child, and its team, will be asked to perform the structured warm-up programme before every game. The routine will not take longer than 3-5 minutes. After every game they will be asked to help referees fill in the injury report card, in case of any injury occurred in the game, and answer honestly if their team performed the warm-up or not. If your child and its team are willing to participate, they will be included in a prize draw to win futsal gear provided by NZ Football. The NZ Football association provides funding of my project. I am not employed by the NZ Football.

What is the purpose of this research?

The purpose of the research is to see if the new warm-up programme is helpful to reduce the number of injuries in futsal. The aim is to compare the effect of the newly developed warm-up programme on the number of match injuries amongst a group of recreational futsal players compared to another group of recreational futsal players currently using their regular or minimal warm-up routines.

How was I identified and why am I being invited to participate in this research?

Your child is being invited as a player of one of NZ recreational futsal teams.

How do I agree to participate in this research?

You can confirm the participation of your child by replying to this invitation either via email to me, the primary researcher, at:

lubostomsovsky@gmail.com

or in person at the venue of futsal competitions (ASB Stadium) prior or after games.

You will be provided with a consent form and an assent form for your child. If at any point you have any questions, please do not hesitate to ask me via the email above. Once you have understood the study, the consent form and the assent form can be completed.

The participation of your child in this research is voluntary (it is your choice) and whether or not you choose to let your child participate will neither advantage nor disadvantage your child. You and your child are able to withdraw from the study at any time. If you or your child choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you and/or your child removed or allowing it to continue to be used. However, once the findings have been produced, removal of your data may not be possible.

What will happen in this research?

At the start of the study, you and your child will receive information and a demonstration of the warm-up structure via adequate resources (videos, posters). Your child will be then followed up for one season (Term 1 – Term 4, 2019) and they will be encouraged to perform the structured warm-up routine before every game. The venue of matches will be equipped with warm-up resources (flags, videos, posters) and research assistants, who will help to deliver the warm up to your child. After every game your child will be asked to help referees fill in the

injury report card, in case of any injury sustained in the game, and provide information, if they performed the warm up or not.

What are the discomforts and risks?

There should not be any kind of discomfort or embarrassment for you and your child during the study. No risk is anticipated.

What are the benefits?

Potential benefits for your child:

- Your child, as a futsal player, will receive a structured, futsal-specific warm-up programme to follow before every game

- By using the newly developed warm-up programme before every game, the risk of match-related injuries will be potentially reduced, your child's preparedness for a game improved, and their performance possibly enhanced

The wider community:

- The programme will be available for the whole futsal community to use, especially if the programme results in the match-injury reduction

- The newly designed warm-up programme could later work as a basis of similar warm-up programmes for other sports

How will the privacy be protected?

After reading the consent form thoroughly and understanding your child's role in the research, you will give an official consent before the start of the competitive season in 2019. Your child will be asked to give an official assent to participate. During the study, there will be no need to provide any more personal information.

The consent form, containing your child's name, will be stored separately from the other data in a locked cabinet in an office of my primary supervisor. No personal information will be knowingly revealed to any third parties.

What are the costs of participating in this research?

There are no other costs for your child except your time. The warm-up routine before every game should not exceed 3-5 minutes. After the game your child will be asked to help referees fill in the injury report card together with warm-up performance (yes/no as a team). This should not exceed 1-2 minutes.

What opportunity do I have to consider this invitation?

You have 2 weeks to consider and respond (accept or refuse) to the invitation via email to me at:

lubostomsovsky@gmail.com

or in person at the venue of futsal competitions (ASB Stadium) prior or after games.

Will I receive feedback on the results of this research?

In case you are interested in the outcomes of my research, the results and summary will be made available via the NZ Football website and also via websites of the football federation (Capital Football in Wellington).

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Luboš Tomšovský, lubostomsovsky@gmail.com.

Project Supervisor Contact Details:

Professor Duncan Reid, Duncan.reid@aut.ac.nz, 09 921 9999 ext 7806.

Approved by the Auckland University of Technology Ethics Committee on 30 October 2018, AUTEC Reference number 18/379.