Comparison of Finnish and international youth football in intensity and tempo

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The aim of this thesis was to compare intensity and tempo in youth football matches with Finnish and international teams. Matches with two Finnish teams were compared with matches where at least one of the teams were international. A comparison was also made team-wise. Event and movement data from matches from 12-, 13-, and 14-year-old boys' and girls' tournaments held between 2022 and 2024 was analysed. After processing, 54 to 87 matches per age group were included in the final data set — 430 matches overall. Duration of these matches were two halves of either 15 or 20 minutes. Tempo was analysed as various sets of events per minute as well as within ball possession sequences. Pass velocities were examined as well. Intensity was analysed by comparing average and top speeds of players as well as using a formula to calculate intensity from movement variables: total distance, distance at a speed of over 15 km/h, and number of accelerations and decelerations. It was found that events are performed more frequently in international matches than in Finnish ones when analysed over the course of the whole match. International teams perform ball events more frequently in relation to overall ball possession time as well as when analysing ball possession sequences individually. Finnish players pass with more velocity in females' matches. Elite international players reach higher top speeds than elite Finnish players, although on average Finnish players reach a similar level. Average speed of Finnish players was found to be higher than the average speed of international players. Intensity was found to be slightly higher within Finnish players when studying the values calculated with the formula.

Keywords: football, soccer, intensity, tempo, data analysis, Finnish, youth

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Tämän tutkielman tarkoituksena oli vertailla intensiteettiä ja tempoa nuorten jalkapallo-otteluissa kansallisten ja kansainvälisten otteluiden välillä. Vertailu toteutettiin myös joukkuekohtaisesti suomalaisten ja kansainvälisten joukkueiden välillä. Otteludata kerättiin WiseSportin toimesta Eerikkilässä vuosina 2022–2024 järjestetyistä turnauksista, joissa parhaat suomalaiset juniorijoukkueet pelaavat turnaukseen kutsuttuja kansainvälisiä joukkueita vastaan. Tutkimukseen sisällytettiin 12–14-vuotiaiden sekä poikien että tyttöjen turnaukset. Datan prosessoinnin jälkeen 54–87 ottelua ikäryhmää kohti sisällytettiin aineistoon — 430 ottelua kaiken kaikkiaan. Otteluiden kesto kaikissa ikäryhmissä oli kaksi 15 tai 20 minuutin puoliaikaa. Intensiteettiä tarkasteltiin lähinnä pelaajien liikkeen tilastojen avulla, ja tempoa tapahtumadatan avulla. Pelaajien keski- ja huippunopeuksia käytettiin mittaamaan joukkueiden intensiteettiä. Intensiteettiarvo laskettiin myös erillisellä laskukaavalla, joka koostui kokonaismatkasta, kiihdytysten määrästä sekä yli 15 km/h nopeudella juostusta matkasta. Tempoa tarkasteltiin tapahtumien, eli esimerkiksi syöttöjen, laukauksien, kuljetusten, jne. toistumistiheytenä. Tarkasteltiin myös erikseen pallonhallintajaksojen tempoa, sekä syöttöjen ja kuljetusten tiheyttä. Tempoa tarkasteltiin myös syöttönopeuksilla, sekä syöttökartoilla. Kansainvälisissä otteluissa todettiin olevan hieman kovempi tempo sekä kansainvälisten joukkueiden todettiin pitävän yllä kovempaa tempoa syöttöjen ja kuljetusten osalta, sekä pallonhallintajaksoittain. Suomalaisten pelaajien keskinopeuksien todettiin olevan hieman korkeampia, mutta huippunopeuksissa kansainväliset pelaajat ylittivät suomalaiset pelaajat. Intensiteettiarvoa tarkasteltaessa suomalaiset pelaajat ylsivät hieman parempiin tuloksiin.

Asiasanat: jalkapallo, intensiteetti, tempo, data-analyysi, suomalainen, juniori

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1 Introduction

I started playing football when I was 6 years old and after that, there was no turning back. I fell in love with the sport and have been an enthusiastic player and spectator ever since. As far as I can remember, I have been especially interested in the tactical side of the game. As the data gathering and analysis methods have developed and gained popularity in the world of football, my interest in tactics through data and statistics has grown at the same rate and elevated my interest in data analytics in the process.

When I introduced my interest in writing my thesis about data analytics in Finnish football to the Football Association of Finland (FAoF), I was proposed with an idea to research intensity and tempo in Finnish youth football. During discussions with experts and analysts under the FAoF, they stated that matches between two Finnish youth teams seem slower in tempo and lower in intensity than matches where an international team is present.

In this thesis the intensity and tempo of Finnish youth football matches and teams are comparatively analysed with international matches and teams. Football, in this thesis refers to association football where two teams of 11 players use their body, arms excluded, to get the ball into the opposition's goal. The problem statement provided by the Football Association of Finland is that intensity and tempo are much higher internationally than in Finland [1]. A survey of the U15 boys' Finnish national team after their first international matches against Portugal in

November 2021 highlighted this issue. The collective outcome of the survey was that the players were surprised of the intensity and tempo in those matches. This thesis provides a thorough analysis of differences in intensity and tempo between Finnish and international matches and teams.

Tempo and intensity are attributes that are viewed positively in relation to success. In the most recent strategy published by the FAoF [2], the second strategic objective is to enable more players to make international breakthroughs in the top 10 leagues. The most important aspects of developing elite players is to improve their technical and physical capabilities. Tempo and intensity are important factors in developing technical and physical ability. More elite players would create financial profit for clubs through transfer fees as well as in growth in interest of spectators. Elite players would increase the success of national teams and act as role models to the new generation, which in turn would increase interest in football as a hobby and increase the number of players.

The data used in the analysis of this thesis was gathered by WiseSport [3], a Finnish sports analytics company, which provides data to junior and professional teams in both football and ice hockey. The data was gathered from Huuhkaja- and Helmarileagues [4] from 2022 to 2024. These tournaments held by Eerikkilä [5] contain the best Finnish youth teams aged from 12 to 14, as well as some invited international youth teams. The Finnish teams are chosen by a qualification process to ensure that the best Finnish teams and players get to experience the final tournament where they get to face international teams.

The purpose of this research was to answer these research questions:

RQ1: How can intensity and tempo be measured in data?

RQ2: Is match tempo higher in youth matches where one or both teams are international than in youth matches between two Finnish teams? Is there a difference between intensity or possessional tempo between Finnish and international teams?

RQ3: How do intensity and tempo change over the course of the match?

The rest of the thesis is organized as follows: Chapter 2 starts by providing background of football in general, with the rules and terminology that are needed to understand the thesis. Specific rules of the youth tournaments that are analysed are provided. A general overview of how data is used as a tool in professional football is provided. Intensity and tempo are defined and their current state of academic research is described. The motivation of why it is important to study intensity and tempo is stated both internationally and on a national level. In Chapter 3, a more thorough description of the data as well as the methods used to analyse the data are provided. Chapter 4 is the main chapter of this thesis where the results of the thesis are presented. In Chapter 5, possible causes and rationale for the results are discussed. Limitations encountered during the process are explained and thoughts on possible improvements on the research are considered. Ideas and recommendations on future work both academically and non-academically are presented. Finally, the research processes and results are concluded in Chapter 6.

2 Background

This chapter describes the rules of football generally. A definition for both tempo and intensity regarding football is illustrated. A literature review on the use of data analytics in professional football as well as the current academic research on the topic is provided. Next, the motivation of the need to research intensity and tempo in Finnish football is justified by describing the relation to match performance. Lastly, the current state intensity and tempo analysis in football, specifically in Finland, is researched.

2.1 Football generally

Football, in this thesis, refers to association football where two teams of 11 players playing on a rectangular field aim to score goals by getting the ball in the opposition team's goal using their body excluding their hands and arms. The winning team is determined by the number of goals scored. The official rules of football are governed by the International Football Association Board (IFAB) [6] at all levels within the Member Associations of FIFA, including the Football Association of Finland. The rules can vary based on the competition. At the senior level, a football match consists of two 45-minute halves with a 15-minute break in between. Additional time is allocated based on delays in the game that often range from zero to five minutes per half. [6]

The football pitch is constructed by two touchlines and two goal lines as seen in

Figure 2.1. The goals sit on the goal lines. For national matches the touchline must be between 90 and 120 meters long, while the goal line must be between 45 and 90 meters. For international matches the ranges are stricter and most professionally used pitches are built to follow these regulations where the touchline is between 100 and 110 meters and the goal line is between 64 and 75 meters. [6]

The area around both goals is known as the penalty area. The penalty area is constructed with two 16.5-meter-long parallel lines of the touchlines starting on the goal line, 16.5 meters from the post, and a line connecting these lines. The penalty area is an important area in football analysis since most goals are scored from inside this area [7]. Inside the penalty area is another box, which is known as the 5-yard box. Goal kicks must be taken from inside this area.

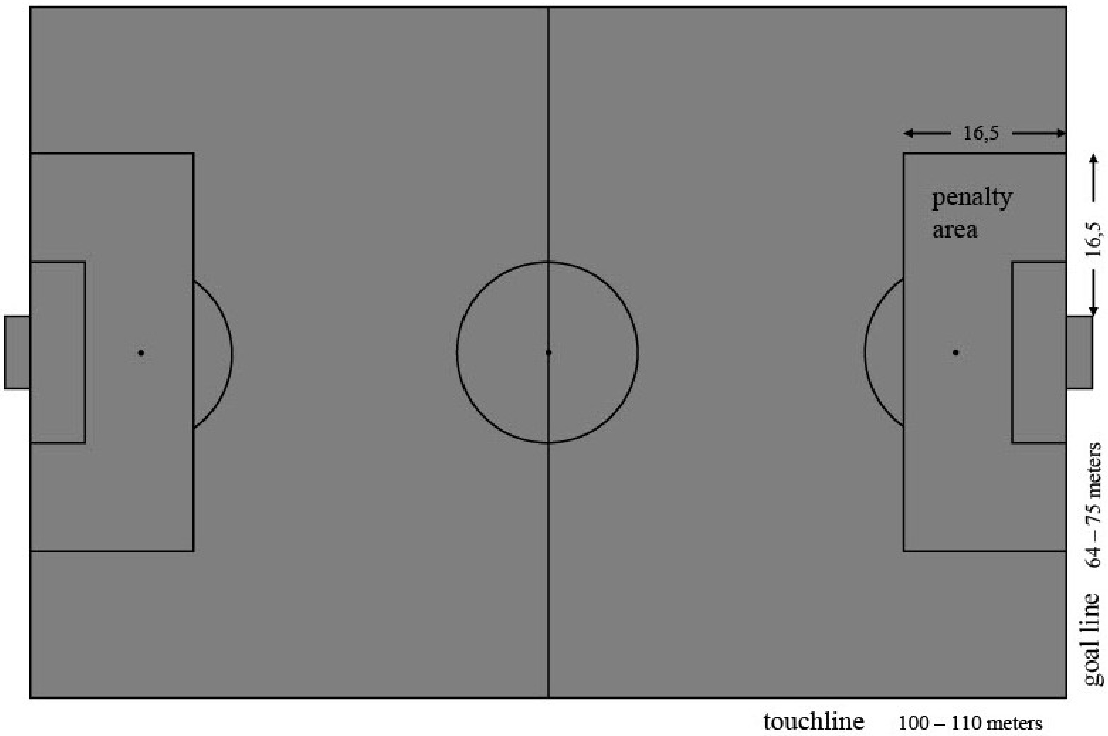

Figure 2.1: The dimensions and terminology of the football pitch. Image: Konsta Nyman

2.1.1 Tournament specifics

In youth football, the dimensions as well as the match duration vary based on the competition and the age of the players. The age groups in question in this thesis in Huuhkaja- and Helmarileagues also play in varying pitch dimensions. The match duration is two halves of 20 minutes or 15 minutes in all age groups. In these tournaments points are awarded per half, but this was ignored in this thesis since the purpose was to research intensity and tempo overall and not specifically its relation to success. The dimensions and team sizes by which each tournament was played varied. The general guidelines for the rules are that younger players play with 8 players in each team with a smaller pitch with dimensions 63 meters by 45 meters. Older players play with 11 players on each team with a standard pitch dimension of 100 meters by 65 meters [4]. The tournament specific rules are presented in Table 2.1.

Table 2.1: Tournament specific rules in Huuhkaja- and Helmarileagues with the used pitch dimensions as noted in the data.

			Match duration	Format	Pitch dimensions
2022	Boys	Age group 12	2x15min	11 v. 11	$100m \times 63m$
		Age group 13	2x20min	11 v. 11	$100m \times 63m$
		Age group 14	2x15min	11 v. 11	$100m \times 63m$
	Girls	Age group 12	2x20min	8 v. 8	$63m \times 40m$
		Age group 13	2x20min	11 v. 11	$100m \times 63m$
		Age group 14	2x20min	11 v. 11	$100m \times 63m$
2023	Boys	Age group 12	2x20min	11 v. 11	$100m \times 63m$
		Age group 13	2x20min	11 v. 11	$100m \times 63m$
		Age group 14	2x20min	11 v. 11	$100m \times 63m$
	Girls	Age group 12	2x20min	8 v. 8	$63m \times 40m$
		Age group 13	2x20min	11 v. 11	$100m \times 63m$
		Age group 14	2x20min	11 v. 11	$100m \times 63m$
2024	Boys	Age group 12	2x20min	11 v. 11	$100m \times 63m$
		Age group 13	2x20min	11 v. 11	$100m \times 63m$
		Age group 14	2x15min	11 v. 11	$100m \times 63m$
	Girls	Age group 12	2x20min	8 v. 8	$63m \times 40m$
		Age group 13	2x20min	11 v. 11	$100m \times 63m$
		Age group 14	2x15min	11 v. 11	$100m \times 63m$

2.2 Data analysis in football

The use of data analytics has increased rapidly in the world of football in recent years. Particularly, various aspects of the game are studied in regard to success. The findings are used to alter tactics and strategies of teams as well as preparations for the matches. The tactical analysis of data has only surfaced in recent years, as the attention to the importance of tactics has grown in research and the data gathering methods have developed. [8], [9]

The rise of the use of data analytics in football to improve performance is largely due to the development of more sophisticated data gathering methods [9] whereas previously performance prediction analysis in football has focused on simple statistics and foreknowledge of the match [10]. The use of data gathering systems that utilize wearable technology was permitted by FIFA in 2015, which accelerated the increase of research of more sophisticated methods. Local (LPS) or Global Positioning Systems (GPS) are used to gather tracking data — all time position of all players and the ball. This enabled the generation of new methods to analyse football performance and tactics through data. In addition, events can be automatically detected from the tracking data with far more context than before, which can be used to calculate more sophisticated and informative metrics. Context of an event often include the positions and directions of movement of other players. Examples of these more sophisticated metrics include the xG (expected goals) [11] and PPDA (passes per defensive action) [12] metrics, which have gained interest within the football community in the last years. Research on even more complex metrics that describe the inter-team entropy or space control for example is on-going [9].

The validation of positioning systems in sports has been extensively researched with reports of *good* or *valid* accuracy [13]–[15]. There are mainly three types of tracking systems: LPS, GPS and video tracking. The data that was used in this thesis was gathered using an LPS with the help of computer vision from video.

LPSs use various radio technologies to track the position of the players and the ball using beacons and tags. GPSs are based on satellite connections to tags. LPSs have been proven to be more accurate than GPSs and video tracking in sport specific tasks. The most common LPS technology researched in literature regarding football is ultra-wideband (UWB) technology, but the LPS that gathered the data for this thesis uses Bluetooth technology.

Automatic event detection from tracking data is also an important area of interest. It enables a more consistent and available method to gather information about events from a match. Event detection is performed by a rule-based algorithm, directly from tracking data [16]. The specific method used by WiseSport is not disclosed publicly, but research on other event detection algorithms is publicly available. A method by Bischofberger et al. [16] detects passes and shots by measuring the acceleration of the ball, and the distance of the closest player to the ball for them to realistically be able to contact the ball to perform a pass or a shot. This is a very broad description of passes and shots and can describe for example deflections or unintentional touches. Deflections and unintentional touches happen mostly immediately after a deliberate shot or a pass and therefore can be removed algorithmically by detecting a pass or shot that occurred shortly before the touch. Shots are differentiated from passes by an algorithm that uses various rules of the speed and direction of the ball, receiving players (opponents goalkeeper or player), distance and angle to opponents' goal from the starting position. These are only examples of event detection, but similar methods are used to detect various other events such as throw ins, corner kicks, tackles and ball contests.

One significant focus of data analysis in football has been on set pieces such as corner kicks and free kicks. Corner kicks especially, are a great opportunity for in depth data analysis and applications for AI, as they are taken from a fixed position, from a paused game so that players can position themselves according to predefined formations, happen frequently with little success up to date [17]. The use of AI in corner kicks has not shown significant success as of yet [18]. This does not mean that set pieces aren't analysed constantly. Set pieces from teams such as Arsenal FC and Inter Milan have gained significant attention of the football community during the 2024/25 season due to their effectiveness. The methods of developing new tactics have not been disclosed publicly, except by an increase in specialist personnel. The FAoF also hired a set piece coach to the men's national team in March of 2025 [19].

However, it is academically researched that general data analysis methods are widely used in today's football industry. Lolli et al. conducted survey research in 2022 of how data analysis is used in the football industry by professional clubs and federations [20]. The study included 29 of the 32 federations that partook in the World Cup Qatar 2022™ as well as 32 of the member clubs of the Aspire in the World Fellows which include top football clubs of the world in addition to 5 other federations that didn't take part in the World Cup Qatar 2022™. Nearly a third of the organizations in the World Cup Qatar 2022™ and over half of the respondents in the Aspire in the World Fellows reported that '*data management is standardized with well-defined procedures where different data sources are integrated within a shared platform and elaborated by dedicated IT architects and data analysts*'. Data sources are described as different forms of data: tracking data, video and event data. The application of data insights is found to be deficient. Information systems are less frequently used, and results are communicated poorly to aid decision making in match strategy, as well as medical or recruiting processes. Reporting of results of data analysis is lacking both in federations and in clubs, although some federations and clubs reporting clear communication of insights.

Lolli et al. also researched coaches' opinions on the previously mentioned sophisticated metrics provided by international data analytics providers [20]. The majority of the metrics included in the study were reported as '*very useful*' or '*extremely use-*

ful'.

A bachelor's thesis written by Weckström [21] studies the use of performance data by Finnish football clubs in Veikkausliiga — the top division of Finnish male football. The research is performed similarly to the research by Lolli et al. A survey of data utilization was filled out by 3 of the 12 clubs in Veikkausliiga. All three of the participating clubs mentioned that data is used to analyse training as well as competitive matches, and one respondent mentioned the use of WyScout — one of the international data analytics providers. All three clubs describe that the previously mentioned metrics are used to analyse matches. Tracking data is used to follow the physical load on players in all three participant clubs. Although the use of data analytics was reported by all three clubs, the overall state of data utilization appears to be superficial in Finnish organizations. All three clubs highlight the lack of time, personnel and expertise as the greatest challenge. Untrained people with other responsibilities use too much time to find and apply informative insights from the data. Only one club of the three reported that a dedicated data analytic is employed, who is responsible for recruitment only. The same club mentioned that their head coach has experience in data analytics. The other two clubs had only coaches and sports analytics as a part of their team. The development of data analytic processes was also concrete in only one of the three clubs. It is also important to note that a participation bias might skew the results. A response rate of 25% does not accurately describe the results of all Finnish top division clubs. More data-oriented clubs are probably more willing to take a survey on data utilization.

The use of data in organizations and clubs require systematic processes of handling big data [9]. The sports analytics platforms have tackled this issue with performance and tactical analysis with automatic event detection and sophisticated metrics calculated in real-time from raw data. They offer intuitive user interfaces and APIs which allow customisable use cases specific for the need. They allow the use of various data types, and for example efficient use of videos by automatically clipping important moments using event data.

Other limitations of data utilization are privacy and the fear of losing a competitive edge. Even performance data can have significant impacts on the image of a player which could influence their career in harmful ways. Organizations are unwilling to share data publicly in the fear of losing their competitive edge. These factors slow the progression of data analysis methods in private organizations.

Nevertheless, with advances in big data technologies, more and more sophisticated metrics and ways to analyse the collective behaviour of teams are developed and researched to enable a deeper analysis of tactics. A football match after all, is a dynamic state of positions of the ball and players, which even sophisticated metrics from event data give only a narrow insight to. In a dynamic state, players need to make decisions based on their experience and strategic commandments stated by the coach. These decisions define the tactical behaviour of an individual and a team. A study by Low et al. [22] reviewed the existing research on collective behaviour of football teams using tracking data. The previously mentioned metrics are all bound to the event data. Metrics could be directly derived from tracking data. These metrics can describe the tactical collective behaviour of a team more thoroughly. Examples of these metrics are team surface area, length and width of formation, average distance to centroid and synchronization of movement. These metrics are already in use in today's analysis to some extent.

2.3 Intensity and tempo in football

In modern football, intensity and tempo are used widely as buzzwords commercially. They are used to describe the visually distinct energy and speed of play that is present in the match. A clear definition is needed to be able to perform the analysis and comparison of this thesis. In literature, tempo is often stated as pass tempo, which is the speed of passes [23] or the number of touches per ball involvement [24], and intensity is analysed by examining the frequency of high-intensity activities such as total distance ran, total high-speed distance ran [25], [26]. The definitions for tempo and intensity in football vary [27]. Thorough definitions used in this thesis are provided in Chapter 3.

A highly regarded sports magazine, The Athletic, provided a review in 2022 of what is meant by intensity in the football community. Former players and reputable coaches were interviewed on the topic, and their answers were concluded in an article [28]. Simply concluded, many experts describe intensity as the speed and energy of performing actions. Many also highlight the collective approach — that the team's intensity is not only the speed and energy of individuals, but an organizational structure and co-operation of the team. One former player described that intensity is equivalent to tempo — that it is the rate of ball movement, as well as the horizontal movement of the ball.

Many of the former players and coaches brought up the psychological aspect of intensity — that it means to be focused and ready for the match.

In academic research, intensity is often described as a collection of running performance variables [25], [26], [29], [30]. Running performance is commonly described as some combination of these variables: total distance covered, distance covered in five or six speed zones ((standing), walking, jogging, running, high-speed running, sprinting), total number of accelerations, number of high-intensity accelerations, total number of decelerations, and number of high-intensity decelerations. There is no standardized method used in literature to define the speed zone ranges [31]. An example of the speed zone definitions states as follows: walking from 0 to 7.2 km/h, jogging from 7.2 to 14.3 km/h, running from 14.3 to 19.7 km/h, high-speed running from 19.7 to 25.1 km/h, and sprinting $>$ 25.1 km/h [30]. Note: in this thesis, the speed zones are defined differently — described in 3.1 — due to the nature of the data. This is justified because the research is conducted on youth matches, not adult matches as is often the case in literature.

2.3.1 Relation to match performance

Tempo and intensity are viewed by experts as a positive factor in a team's performance — the higher the intensity and tempo of a team, the better they perform. This is evident in all conversation around intensity and tempo. In the article of The Athletic, the lack of intensity is described as a problem by the coaches after lost games, and high intensity is praised by coaches after won games [28]. However, it is also mentioned that it is not always best to keep up the intensity throughout the match. The team in possession can control the intensity and keeping possession while tuning the intensity down can be very effective.

The correlation between high-intensity activity frequency and performance has been well researched. It has been concluded that high-intensity activities are a significant factor in the team's performance. Di Salvo et al. [25] state that total high-intensity distance correlated negatively with a team's performance in a study conducted on the English Premier League from 2003 to 2006. However, in the same study, it was concluded that without possession, the top teams ran less in high-intensity velocities. This highlights that at least in the early 2000s, the top teams had more of the possession and could control a lower intensity while controlling the ball and attack with high intensity.

Rhodes et al. [29] research individual match outcomes with high-intensity accelerations and decelerations in the 2019/2020 season of the English League Two — the fourth-highest competition in England. A significant positive correlation was found between the frequency of high-intensity activities and match outcome. In other studies, physical performance attributes — of which the intensity activities are part — have been found to correlate with match outcome [30]. Modric et al. also compared a player performance metric to intensity activities in the 2018/2019 season of the top Croatian competition. The performance metric is a position-specific single value calculated by an algorithm from game performance statistics, such as shots, passes, tackles, etc. It was found that the connection between high-intensity activities is position-specific to the performance metric. For example, for the forwards, high-speed sprinting distance is strongly positively correlated with the performance metric, whereas for defenders, there is a slight negative correlation between these variables. For defenders, positive correlations are found with high-intensity accelerations and the slower running distance. This might be because of the nature of the possessions. Defenders are usually making defensive runs, which indicate the success of the opposing team's attack, thus lowering the score of the defender, and vice versa for the forwards.

Similarly, Chmura et al. [32] found that forwards and wide midfielders ran statistically more in won matches than in drawn or lost matches, and defenders in turn ran more in lost matches in the German Bundesliga from 2014 to 2017. Distances in high-intensity velocities follow the same pattern. In the low-intensity speed zones thresholded by 11 km/h in this study, longer distances were covered in won matches compared to drawn or lost matches. Mid-intensity zones were covered more in lost matches by defenders and central midfielders than in drawn or won matches, with no difference in forwards and wide midfielders. This highlights the importance of total distance in regard to match outcome, as well as the effectiveness of shifting intensity from low to high in contrast to a constant average intensity level.

A decline in intensity from the first half to the second half is reported in all studies where timeline analysis was included [25], [26].

2.3.2 Youth football demands in comparison to professional football

Since our analysis is performed on youth football and a vast majority of research in literature is conducted professional football, it is important to examine the physiological differences between them. Reynolds et al. [33] researched the physiological demand differences between U18, U23 and the first team players in an English football club. The most significant differences were found in metrics that could describe intensity such as sprint distance, high-intensity burst distance, high speed running distance and impact forces. No differences were found in total distance covered for example.

2.4 Intensity and tempo in Finnish football

The FAoF has conducted research [1], [34]–[36] in recent years regarding Finnish football. The research focused on the analysis of what is done well in Finnish football, and what the areas are where improvement is needed. This research was conducted with the purpose of improving the development of youth players, with a goal to produce more and better elite players. This was done by comparing aspects of the Finnish national team and the Finnish football leagues to international ones, and detecting the demands that Finnish teams and players need to meet to succeed at the international level.

In these analyses, one key aspect that was studied is intensity and tempo. As mentioned in the introduction, the FAoF described an issue of a lack of intensity and tempo found through visual inspection, statistical analysis, and psychological surveys of the players. Tempo is mostly defined as pass tempo — the amount of passes per ball possession minute. Intensity is examined by video analysis and statistics of high-intensity movement.

It is clear that Finnish male players lack physical attributes which cause the lack of ability to keep up with elite players in intensity [1]. Pass tempo is found to be close to the top teams in Europe but pass tempo alone does not describe the speed and tempo of play. With the female national team, Finland ranks highly in pass tempo [34]. Intensity is not studied directly in the women's analysis.

Although at the international level, differences in intensity and tempo are not very clear when comparing the Finnish national teams to other national teams, a clear difference can be found with the national leagues. The Finnish men's top division — Veikkausliiga — is compared with other European top divisions and, similarly, the women's top division — Kansallinen liiga — is compared to Europe's other women's top divisions. Here, a tempo measurement of actions per ball possession minute is used, which is a more comprehensive definition of overall tempo. In this metric, both leagues rank at the very bottom of the studied leagues. Both leagues have a great average duration of ball possessions, but actions happen infrequently. All actions are analysed also separately, and in most, Finland's leagues are ranked very low. Attacking is also far less frequent than in Europe's other leagues. Teams in both Finnish leagues aim to keep possession of the ball and therefore control the game. This highlights a passive philosophy. Teams are more likely to want to keep possession and control the tempo of the game and therefore progress cautiously. The team not in possession is cautious in pressing and would rather prevent the progression of the attacking team than to win the ball. [1], [34]

A question is raised that, with this obsession of control, players do not get to experience critical situations, such as goal-scoring opportunities and box-defending situations, as often as in other European leagues [1]. This is especially a problem in youth player development. It is therefore encouraged to play with a faster tempo and attack more, to get more experience of critical situations. The under-19 (U19) and under-17 (U17) national youth teams of both boys and girls were also analysed

[35], [36]. The same issues are persistent in youth team analysis. In the boys' teams, actions such as dribbles, shots, and goals are far less frequent in comparison to other European national teams. The number of attacks per ball possession minute is also very low. Pass tempo is average. In the girls' teams, the tempo statistics are much better. This is partly due to a large skill difference that is still apparent in women's football, which lifts the statistic when playing against lower-tier nations.

We can get an insight into intensity through the success rate of duels. Duels are intensive 1v1 situations, where often the stronger and more intensive duellist wins. In U17 boys, the success rate of duels in the opponent's half is similar to the average of Europe's level, but in U19, it has dropped to the bottom. In the defensive half, the success rate of duels is weak in both U17 and U19 teams. In both the girls' teams, the success rate of duels is average.

An article written about the 2024 Huuhkaja- and Helmarileagues provides an insight into the problem statement provided by the FAoF [37]. The results show that Finnish teams don't perform as well as international teams. In the 2024 Huuhkajaleague (boys), international teams have scored over twice the number of goals, won over twice the number of matches, and shot over twice the number of shots than Finnish teams in matches between an international and a Finnish team. In Helmarileague (girls), this difference is not as substantial but still apparent. During these competitions, physical performance tests are also conducted. The tests include a running speed test of 5, 10, 20, and 30 meters, a jumping test, and a direction change with and without the ball. Finnish players fall behind international players in these tests as well. These tests provide the foundation of the maximal intensity that players are able to achieve.

3 Materials and methods

3.1 Data

The data used in this thesis is event and movement statistic data gathered by WiseSport from youth football tournaments held by Eerikkilä. Tournaments of 12- to 14-year-old boys and girls were held during 2022–2024. The tournaments were played in an indoor arena, which enabled the use of the data gathering system.

3.1.1 WiseSport's system

WiseSport is a Finnish sports data platform which uses computer vision and a local positioning system (LPS) developed by Quuppa to gather spatiotemporal data from football matches. It automatically detects events, creates statistics and other analytics for the use of the clubs, spectators and betting providers.

Quuppa's real-time location system uses Bluetooth technology with angle and distance estimation of the tags to multiple beacons to gather spatiotemporal data [38]. The positioning frequency of the system is very high compared to other similar methods researched in literature — 100 Hz for the ball and 33 Hz for players compared to about 15 to 20 Hz. The coordinates and time stamps are synchronized so the data is not affected by any potential latency. Positive and negative accelerations are noted as a numerical value of how many accelerations have the players performed. Both positive and negative accelerations are defined as a constant period of over a second where the acceleration of the player is at least 0.5 m/s^2. Pitch dimensions and beacon locations are manually measured for each pitch which ensures the accuracy of the data.

3.1.2 Data sets and processing

Two separate data sets were fetched from WiseSport's system — an event data set, and a movement statistic data set. The event data set holds all events such as passes, shots, duels etc. of all matches of the tournaments in question. In this data set, an instance is a single event. The variables in this data set include various information from the event: match and tournament IDs, the event type, time from the start of the match, timestamps, the players taking part in the event, x- and y-coordinates of starting and ending location of the event and result of the event. All variables were not available for every event type. For example, the result was not available for ball contest events and for shots, only the starting coordinates were available. The movement statistic data set includes the movement statistics of all players of all matches such as total distance covered, time on field, top speed and time in various speed zones.

Match information such as team names, age group and year of the tournament was merged into both data sets from another set according to match ID. Since the idea of the thesis was to compare international teams with Finnish teams, international teams were identified from the sets semi-manually by first listing all unique teams, identifying international teams and using RegEx syntax to find all spellings of international teams. A correct identification was ensured.

In the event data set matches where there were gaps of over five minutes in events were removed from the set, as well as matches with less than 300 events. The only age group where the matches were played on the smaller pitch was the F12 age group. The coordinates of events of these tournaments were scaled to the same pitch dimensions as for the other tournaments. The matches were supposed to be normalized so that in each match for both halves, the home team always attacks to the right. This was not the case in all matches. The matches where problems were found were identified and normalized. The remaining matches as represented in Table 3.1 were used in the analysis.

Table 3.1: Number of matches analysed by age group.

Age group	**Number of matches**
F12	54
F13	68
F14	74
M12	82
M13	65
M14	87

It was also found that some events were noted even though the game was paused — for example, passing the ball to the centre spot after a goal for a kick off. Therefore, all events noted to occur 10 seconds before kick offs were removed. This is a robust fix to an issue, but it reduces the proportion of incorrectly noted events.

Players' statistics for a match were removed from the movement data set if the player had played for less than five minutes.

3.2 Data analysis methods

First, a time-series analysis was performed on matches. The matches were grouped to two categories — ones where both teams were Finnish, and ones where one or both teams were international. The overall match tempo was analysed temporally. Overall match tempo, in this thesis was calculated as actions per minute. Actions that were included in the analysis are: passes, shots, dribbles, throw ins, free kicks, goal kicks and corner kicks. For clarity and representativeness of the data, the matches were cut from the end at 35 minutes as only a few matches were longer in reality. The match was separated into time bins of 5 minutes in which the number of events was calculated. This duration was chosen as a medium to get enough data points into one time bin, but enough time bins over the course of the match.

To get a more precise insight into the difference between Finnish and international teams, tempo was analysed also on a team basis. Possession intervals were identified from the event data, and tempo was calculated per possession. Possession was defined as a sequence of at least five consecutive events of the same team. Possessional analysis of tempo enabled the separation on team and not match basis. Temporal analysis was done by calculating the median and quantile values for values falling into the time bin in question. Possessions were placed into time bins based in their starting time. There were possession sequences, which contained large time gaps. This could be due to a fault in the system or simple a pause in the game where the last event before the pause, and first event after the pause are performed by the same team. For example, if a team gets a free kick, the last possessional event before the free kick is a dribble, and the first event after the pause is a shot or a pass taken from the free kick. These pauses were replaced by the average gap between passes of the team in the same match. This is justified by the definition of tempo as it should account for time when the game is paused.

A further separation was executed on ball events after a discussion with an expert from the FAoF. Ball events were defined as passes and dribbles only. To get more comprehensive and insightful results, a ball possession duration was fetched from WiseSport's system and ball event tempo was calculated by dividing the amount of ball events by the ball possession duration of a team. The ball possession duration of a team was recorded only as a single value per match, which meant that a temporal analysis of ball event tempo was not possible.

Furthermore, tempo was analysed as the speed of passes. This is not a widely used method to analyse tempo but was included in this analysis. Average pass speed could describe the intent and tempo of play as well as intensity. It was also analysed temporally. In all temporal analyses, the 1st and 3rd quantiles were also included. As pass speed wasn't originally included in the data, it was generated by calculating the distance between the start and end coordinates and dividing this distance by the duration of the pass calculated from the starting and ending timestamps. The scaling of the pitch dimensions and coordinates of matches of age group F12 was done after the calculation of pass speed to ensure a realistic value of pass speed.

All tempo distributions were compared by calculating a single value for a match and plotting the distribution of these values. Statistical tests were performed on these distributions to test whether there was a statistically significant difference between the distributions.

The Kolmogorov-Smirnov (K-S) test — explained in subchapter 3.2.1 — was used to test the statistical significance of differences between the two categories of matches of all tempo distributions. In addition, A mixed ANOVA — explained in subchapter 3.2.2 — was used to test the statistical significance between match tempo differences. This test also calculates the temporal difference significance during the progression of the match. A significance threshold value of 0.05 was used in all statistical tests. First, the density distributions of overall match tempo, ball event tempo, possessional tempo and pass speed were calculated.

The spatial aspect of tempo was analysed by studying pass heatmaps. Passes were chosen as the event type to analyse spatial tempo because a vast majority of events were passes and inspecting a visual map is more informative when only one event type is displayed. The distribution of pass starting locations was plotted onto an image of the football pitch. Some processing had to be performed on the data to get insightful results. Originally, most passes were taken from the centre spot, or on the edge of the 5-yard box. It is obvious that a vast majority of these are kick offs and goal kicks. Passes that start exactly at the centre spot were removed.

Teams often take short goal kicks, which means that small passes are made in or near the 5-yard box after goal kicks. Passes that started and ended near the 5-yard box were also removed. All passes made by the goal keepers were removed. This reduced the packing of passes to determined set piece locations and highlighted the true concentration of passes in open play. The distribution of pass locations was further analysed only on the x-axis of the pitch, which indicated how high or low up the pitch the teams played on average. A K-S test was used to test the difference in pass location distributions.

Intensity was analysed using movement statistics of players. Differences between the distributions of average and top speeds were tested with the K-S test. A formula derived from an article by Urrutia et al. [39] was used to calculate an intensity value from movement statistics. The formula is devised of the average of total distance per minute, high-intensity distance per minute and the number of positive and negative accelerations per minute. The values are scaled by using reference values. In the original article, the reference value could be of an individual or a group. Since, the player identifiers were inconsistent in the data throughout different matches, generic group maximums of age groups were used as reference values. The used formula is presented next where TD_{min} is total distance per minute, HID_{min} is high intensity distance per minute and $AcDe_{min}$ is the number of positive and negative accelerations per minute. The max suffixes indicate the maximum reference values. High-intensity distance was defined as distance covered in speeds of over 15 km/h.

$$Intensity = \frac{\frac{TD_{min}}{TD_{min\_max}} \times 100 + \frac{HID_{min}}{HID_{min\_max}} \times 100 + \frac{AcDe_{min}}{AcDe_{min\_max}} \times 100}{3}$$

The original formula also includes the number of sprints per minute, but this was left out as it was not available in the data. The intensity value distributions were also tested with the K-S test.

3.2.1 Kolmogorov-Smirnov test

The Kolmogorov-Smirnov test [40] also known as the K-S test is a non-parametric statistical goodness of fit test. A non-parametric test doesn't rely on any assumptions such as the normality distribution of the underlying distribution. The K-S test can be used to test whether a sample follows a specific distribution such as the normal distribution or the gamma distribution. This is known as the one-sample K-S test. In this thesis, the two-sample K-S test was used where two independent samples are tested to see if they follow the same distribution. The null hypothesis of the test is that the two samples are from the same distribution.

The K-S test utilizes a cumulative distribution function (CDF) to compare the distribution of two independent samples. The two-sample K-S test uses two empirical distribution functions (EDF) derived from the two samples. The value of an EDF at a sample point x is the fraction of sample points that are less than or equal to x. The EDF is noted mathematically as

$$F(x) = \frac{1}{n} \sum_{i=1}^{n} \mathbf{1}(-\infty, x](X_i)$$

where n is the size of the sample, X_i is the ith instance of the sample and $1(-\infty, x](X_i)$ is an indicator function which equals to 1 if the ith instance is less than or equal to x and 0 otherwise. We can see that the value of $F(x)$ is equal to the fraction of instances smaller than or equal to x.

Two EDFs are formed of the two samples and are then compared. The test statistic D defined as the maximum difference between the two EDFs. If the two samples create similar EDFs, the test statistic D is minimal.

The p-value is calculated using the test statistic D and the sample sizes. The p-value indicates the probability of observing as large or larger test statistic D if the samples were derived from the same distribution. A small probability indicates that the samples are probably derived from different distributions. A p-value smaller than the chosen threshold value indicates a small enough probability that the samples were randomly drawn from the same distribution, that the null hypothesis can be rejected. A threshold value of 0.05 was set in this thesis.

3.2.2 A Mixed ANOVA model

The mixed ANOVA model [41] is a statistical test that is used to test differences between groups that have been split according to two factors. One of the factors is called a within-subject factor and the other a between-subject factor. Usually, the between-subject factor is a characteristic of the group such as gender, or simply a division between a test group and a control group. In this analysis, internationality level is the between-subject factor. The within-subject factor usually represents some different conditions within the group, or different time points of measurements. Time is the within-subject factor in this analysis. The mixed ANOVA model tests differences between the mean values of the groups and the null hypothesis is that there is no significant difference between the means of the groups divided according to the within-subject or between-subject factors.

The mixed ANOVA model tests three different aspects of the factors: the difference within the between-subject factor divided groups, the difference within the within-subject factor divided groups and their interaction [42]. The null hypothesis of the interaction test is that one factor does not influence the effect of the other factor. In this analysis these three tested factors were: the difference between tempo in international and Finnish matches, the difference of tempo across the course of the match and the interaction of these two factors — that whether internationality level influences the progression of tempo across the match or not.

The mixed ANOVA model works by calculating the effects of the factors on the dependent variable. In this analysis, the within-subject factor is time. Tempo is notated eight times per match so the test would include eight within-subject factor measurements. A simplified example of two within-subject factor measurements is presented next. The effects are extracted from the following equations

$$\frac{Y_1 + Y_2}{2} = b_0 + b_1 X + e$$

$$Y_1 - Y_2 = b_0 + b_1 X + e$$

where Y_1 and Y_2 are vectors of the within-subject grouped values, X is a vector of the between-subject factor indicator coded to a numeric value around $0 — -1$ and 1 for example. Variable e is an error factor. The coefficient b_1 in the first equation is the main effect of the between-subject factor, internationality in this analysis. A higher value indicates a difference in the dependent value mean between the groups. In the second equation, coefficient b_0 gives the effect of the within-subject factor, which is time in this analysis and coefficient b_1 is the interaction effect.

In the analysis of this thesis, the dependent variable is measured eight times which would result in eight Y vectors. A more generic equation is needed [43]:

$$Y_{ijk} = \mu + \rho_{ij} + \alpha_j + \beta_k + (\alpha\beta)_{jk} + \epsilon_{ijk}$$

To simplify terminology, the groups of this analysis are used to describe this equation. Y_{ijk} denotes the value of the ith subject in the jth internationality group in the kth time bin. Variable μ is the mean of all values, ρ_{ij} is a random effect factor, α_j is the between-subject factor effect, β_k is the within-subject factor effect, $\alpha\beta_{jk}$ is the interaction effect and ϵ_{ijk} is an error factor.

A limitation of the mixed ANOVA model is that is requires the data to follow a few assumptions. The dependent variable should be continuous and normally distributed in each group of both the within-subject and between-subject divisions. The Shapiro-Wilk test of normality [44] was used to test this and it was found that the vast majority of groups were normally distributed. Similarly, the variance should be equal in each group. This was tested with the Levene's test [45] and it was declared that this assumption holds. The covariances between all combinations of the within-subject factored groups should be equal. This is also known as sphericity. Mauchly's test of sphericity [46] was used to confirm this. Age group M13 was found to violate this assumption, so an adjustment was made with Greenhouse-Geisser correction [47]. Observations must be independent. This was assumed, although there might be dependencies between the matches. For example, later matches when a team has already played during the day might be slower in tempo due to fatigue. Lastly, no significant outliers should appear in the data. This was addressed visually.

4 Results

Results are presented in this chapter. The age groups are coded with M and F representing male and female age groups, respectively. This is followed by a number which signifies the age. International teams and matches are always presented in red, and Finnish teams and matches in blue. When analysed on match basis, a match is labelled as international if at least one of the two teams is international.

4.1 Tempo

4.1.1 Match tempo

Match-wise temporal analysis of overall match tempo is presented in Figure 4.1. Visually, a higher tempo is kept in international matches during the whole course of the match, than in matches where both teams are Finnish. Similarly, with all age groups combined in Figure 4.3 international matches average a higher tempo than Finnish ones.

All age groups and both internationality groups show a general decline of match tempo as the match progresses. The quantiles, represented by the shaded areas show the deviation of the distributions. The deviations are similar in most age groups, but in the later age groups some differences can be made out. In F14, international matches deviate more than Finnish ones, and the opposite in M14.

Overall match tempo distributions are shown in Figure 4.2. Due to quite a small

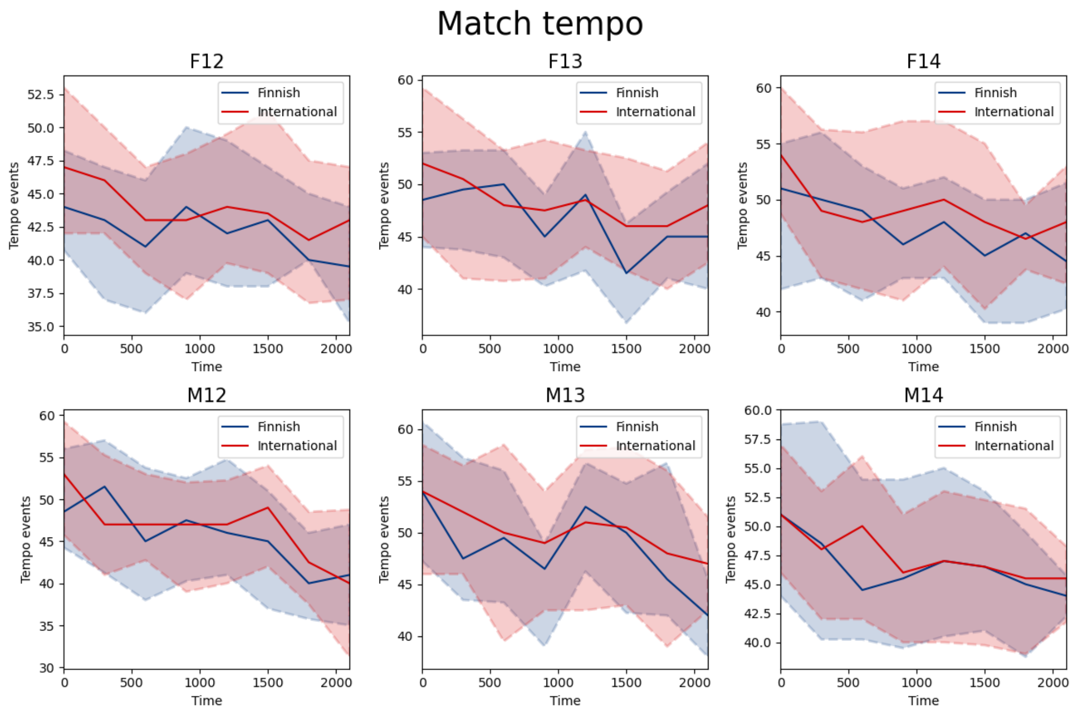

Figure 4.1: Temporal comparison of match tempo between Finnish and international matches across different age groups. Plot: Konsta Nyman

population, visually distinct differences are difficult to detect. Slight indication of higher tempo in international matches is visible, similarly to the temporal analysis.

The mixed ANOVA test and the K-S test show that the difference in most age groups is not statistically significant. With the mixed ANOVA test the significance level does not fall below the threshold value in any age groups as shown in Table 4.1. The K-S test raises the F13 age group as the only statistically significant result as shown in Table 4.2. The mixed ANOVA test shows the temporal difference across the match. In Table 4.1 the *time bin* variable represents the progress of tempo during the match. This result is statistically significant in all age groups. Tempo slows down as the match progresses. The mixed ANOVA method tests the statistical significance of the interaction of the variables. A significant p-value is reported in age group M14. This indicates that internationality level affects the progression of match tempo statistically significantly in this age group. This can be explained

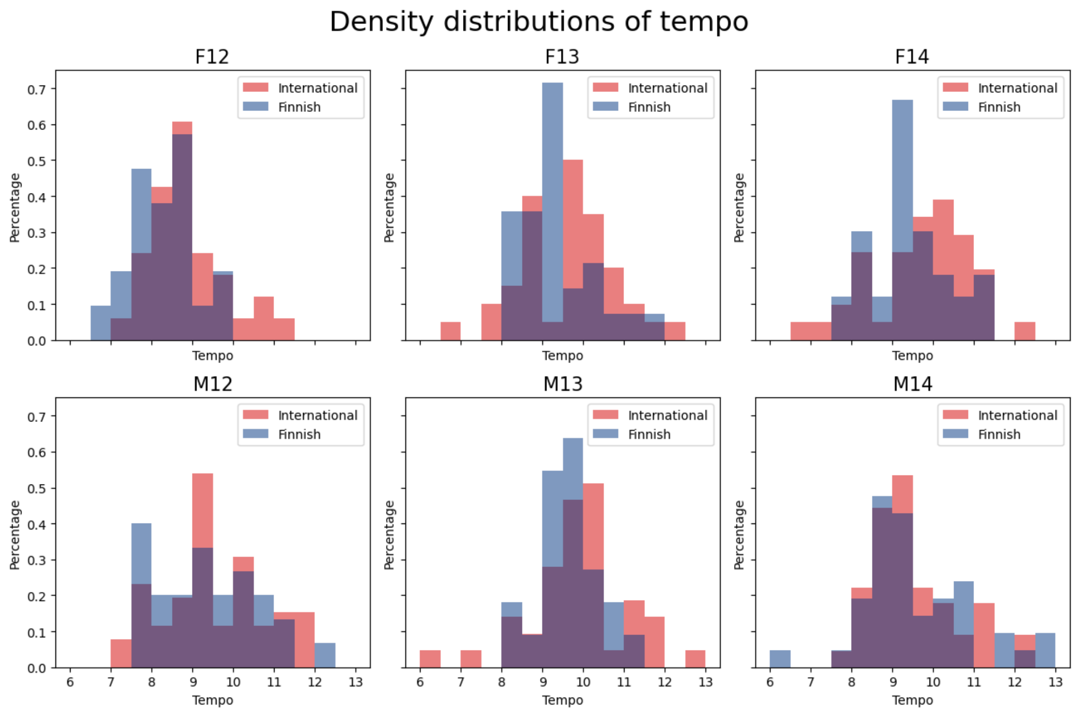

Figure 4.2: Density distributions of overall match tempo. Plot: Konsta Nyman

in the deviating spike at the 600 second mark in Figure 4.1. Tempo increases in international matches at the halfway mark of the first half as in Finnish matches a decline in tempo occurs.

Table 4.1: Mixed ANOVA p-values of tempos across time bins for each age group. The asterisk (*) indicates a Greenhouse–Geisser corrected p-value.

	F12	**F13**	**F14**	**M12**	**M13**	**M14**
Internationality level	0.079	0.284	0.061	0.339	0.383	0.837
Time Bin	0.020	0.002	0.000	0.001	0.001*	0.006
Interaction	0.955	0.515	0.952	0.737	0.725	0.046

Table 4.2: Kolmogorov–Smirnov test p-values and mean values of match tempo of Finnish and international matches by age group.

	F12	**F13**	**F14**	**M12**	**M13**	**M14**
P-value	0.293	0.034	0.076	0.945	0.327	0.910
Finnish Mean	8.35	9.36	9.41	9.36	9.64	9.58
International Mean	8.89	9.62	9.71	9.46	9.88	9.54

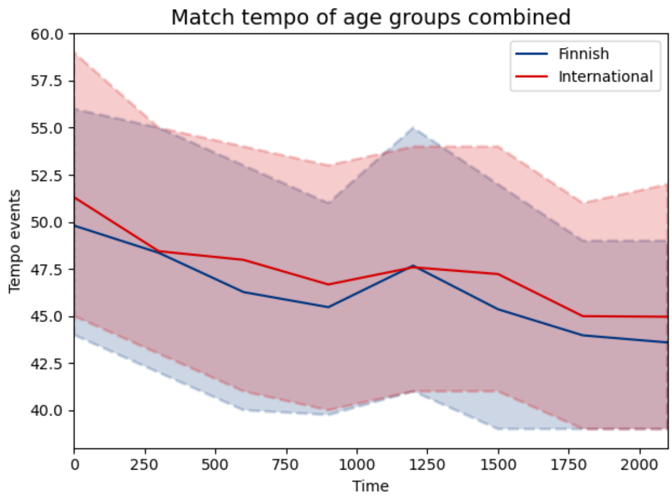

Figure 4.3: Temporal comparison of match tempo between Finnish and international matches of all age groups combined. Plot: Konsta Nyman

Tempo was further analysed by including only events more closely related to ball possession: passes and dribbles. Ball possession duration of the match was used to calculate the frequency of events on a team-basis. The density distributions of these ball event tempos are displayed in Figure 4.4. Again, the small sample of matches results in visually indistinguishable differences between the two categories. Age groups M12 and M13 show a slight difference in the distributions. The K-S test, however, reveals statistically significant differences in almost all age groups. The test results are displayed in Table 4.3. Clear differences can be seen in age groups M12 and M13 especially with p-values of 0.001. In the female groups, the differences are not as clear although statistically significant. Age group M14 doesn't result in a statistically significant difference.

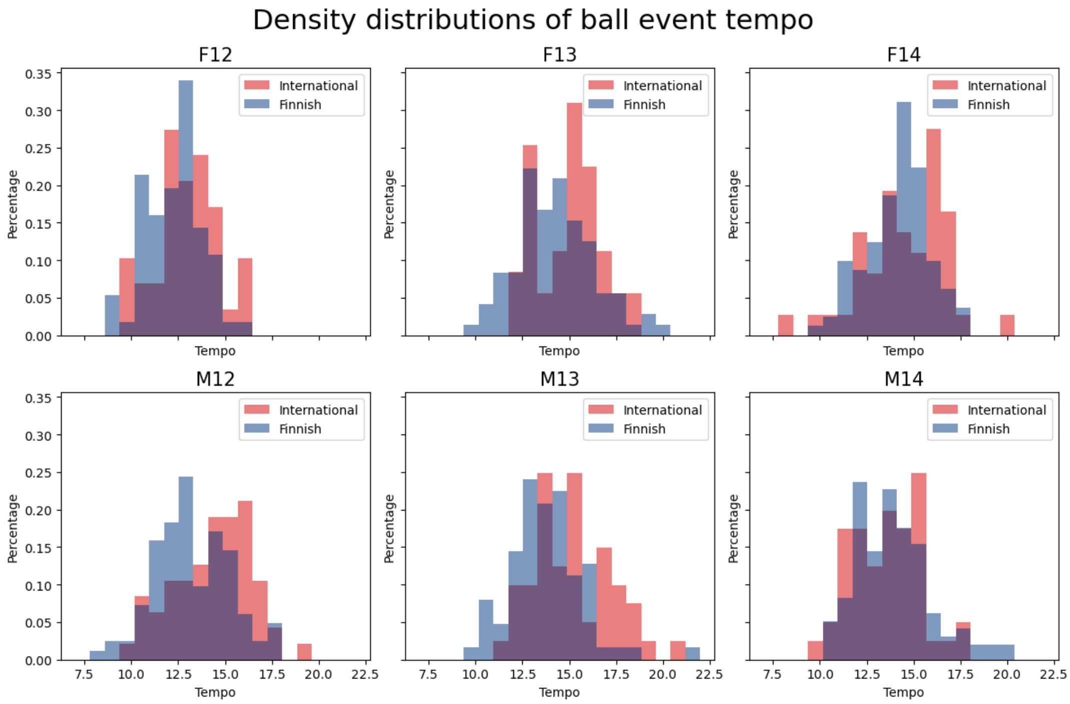

Figure 4.4: Density distributions of only passes and dribbles. Plot: Konsta Nyman

Table 4.3: Kolmogorov–Smirnov test p-values and mean values of ball event tempo of Finnish and international teams by age group.

	F12	F13	F14	M12	M13	M14
P-value	0.028	0.009	0.037	0.001	0.001	0.727
Finnish Mean	12.29	14.26	14.17	13.24	13.83	13.91
International Mean	12.95	14.98	14.55	14.37	15.18	13.56

4.1.2 Possessional tempo

Ball possessional tempo is presented in Figure 4.5. With this method, a clear distinction between international and Finnish teams was found. With the K-S test results displayed in Table 4.4 p-values fall below the threshold value of 0.05 in age groups F12, F14 and M14 and differences in these age groups are visible also in the distribution graphs displayed in Figure 4.6. All p-values are considerably low compared to match-wise analysis and mean values of possessional tempo are higher with international teams in all age groups.

Possessional tempo does not follow the same rate of decline as match tempo although there is a slight decline still apparent. This means that when the ball is in play, close to a similar tempo can be kept, but the rate of possessions and active play is less frequent towards the end of the match.

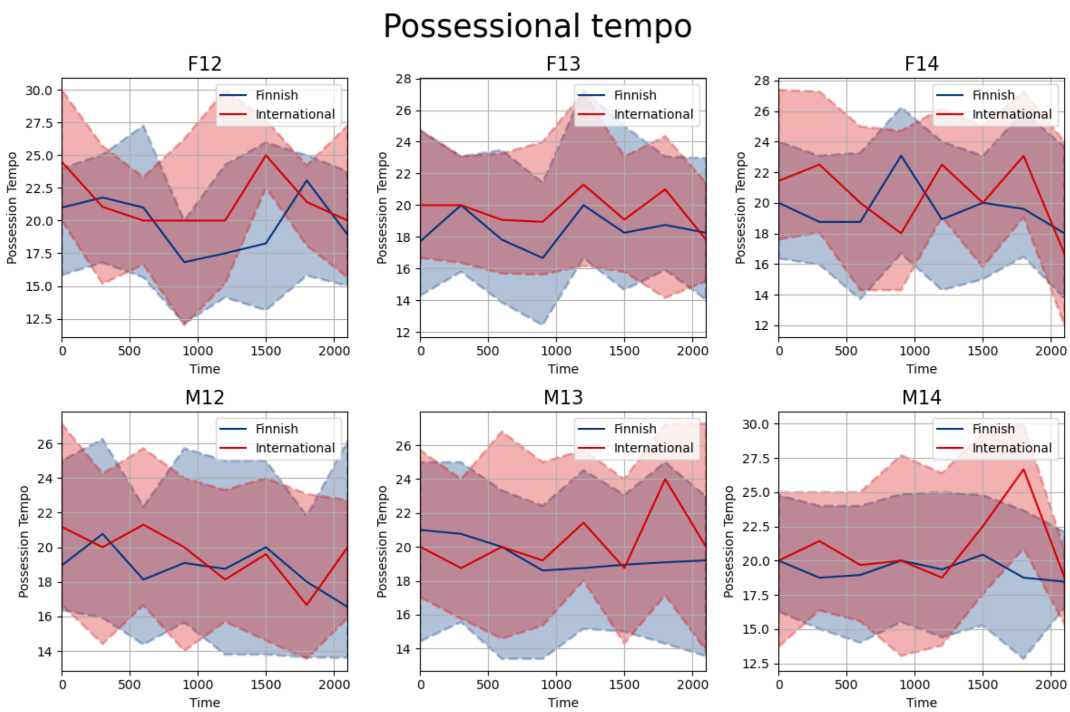

Figure 4.5: Temporal comparison of average possession tempo between Finnish and international teams across different age groups. Plot: Konsta Nyman

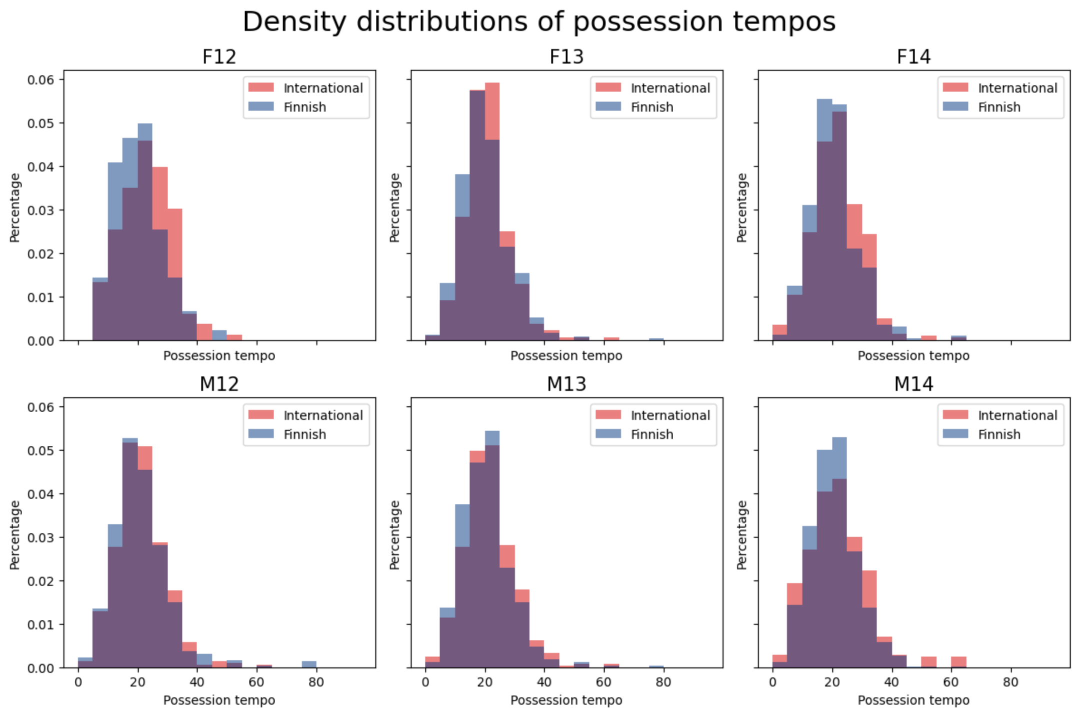

Figure 4.6: Density distributions of possession tempo. Plot: Konsta Nyman

Table 4.4: Kolmogorov–Smirnov test p-values and means of possession tempos for Finnish and international teams by age group.

	F12	**F13**	**F14**	**M12**	**M13**	**M14**
P-value	0.008	0.059	0.021	0.330	0.110	0.022
Finnish Mean	19.93	19.63	20.31	20.51	20.02	20.19
International Mean	22.27	20.41	21.24	20.66	21.06	21.30

4.1.3 Passes

Average pass velocities are presented temporally in Figure 4.7 and their distributions in Figure 4.8. Between international and Finnish teams, there is a clear difference visually in age groups F12 and F14, where in both Finnish teams pass with more velocity. A decline throughout the course of the match is not present. Similar observations can be made from the distributions. Finnish teams tend to pass with more velocity on average.

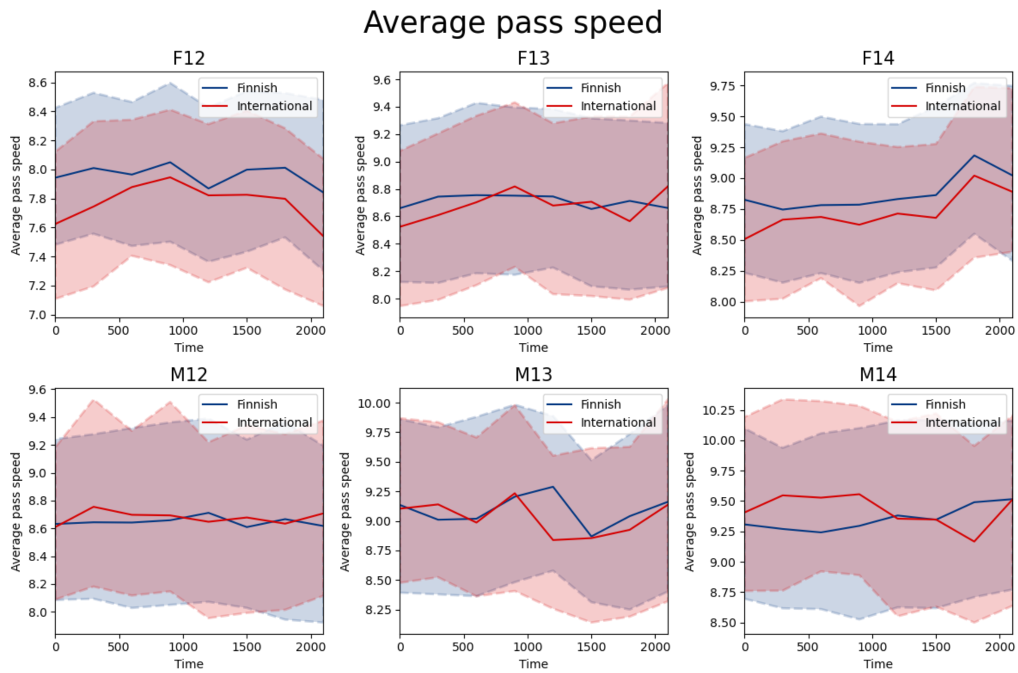

Figure 4.7: Temporal comparison of average pass velocity between Finnish and international teams across different age groups. Plot: Konsta Nyman

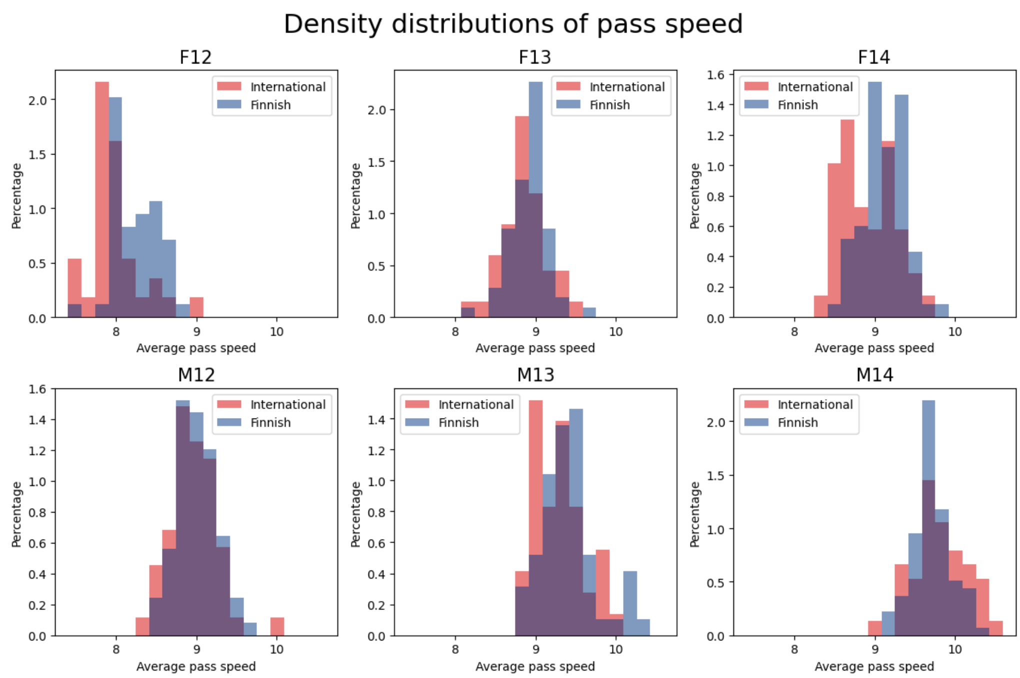

Figure 4.8: Average pass speed distributions. Plot: Konsta Nyman

The K-S test results of pass velocity distributions displayed in Table 4.5 highlight the statistical significance of the differences in age groups F12 and F14. Other age groups reach low *p*-values as well, except age group M12.

Table 4.5: Kolmogorov–Smirnov test *p*-values and means of pass velocity distributions for Finnish and international teams by age group.

	F12	**F13**	**F14**	**M12**	**M13**	**M14**
P-value	<0.001	0.176	0.001	0.723	0.106	0.056
Finnish Mean	8.24	8.93	9.12	9.00	9.42	9.71
International Mean	7.98	8.87	8.91	8.96	9.29	9.82

The passing heatmaps in Figure 4.9 show a spatial representation where play was concentrated. It is important to note here, that matches in age group F12 were played on the smaller pitch dimensions and are here scaled to the same dimensions as other age groups. The results are not comparable across age groups.

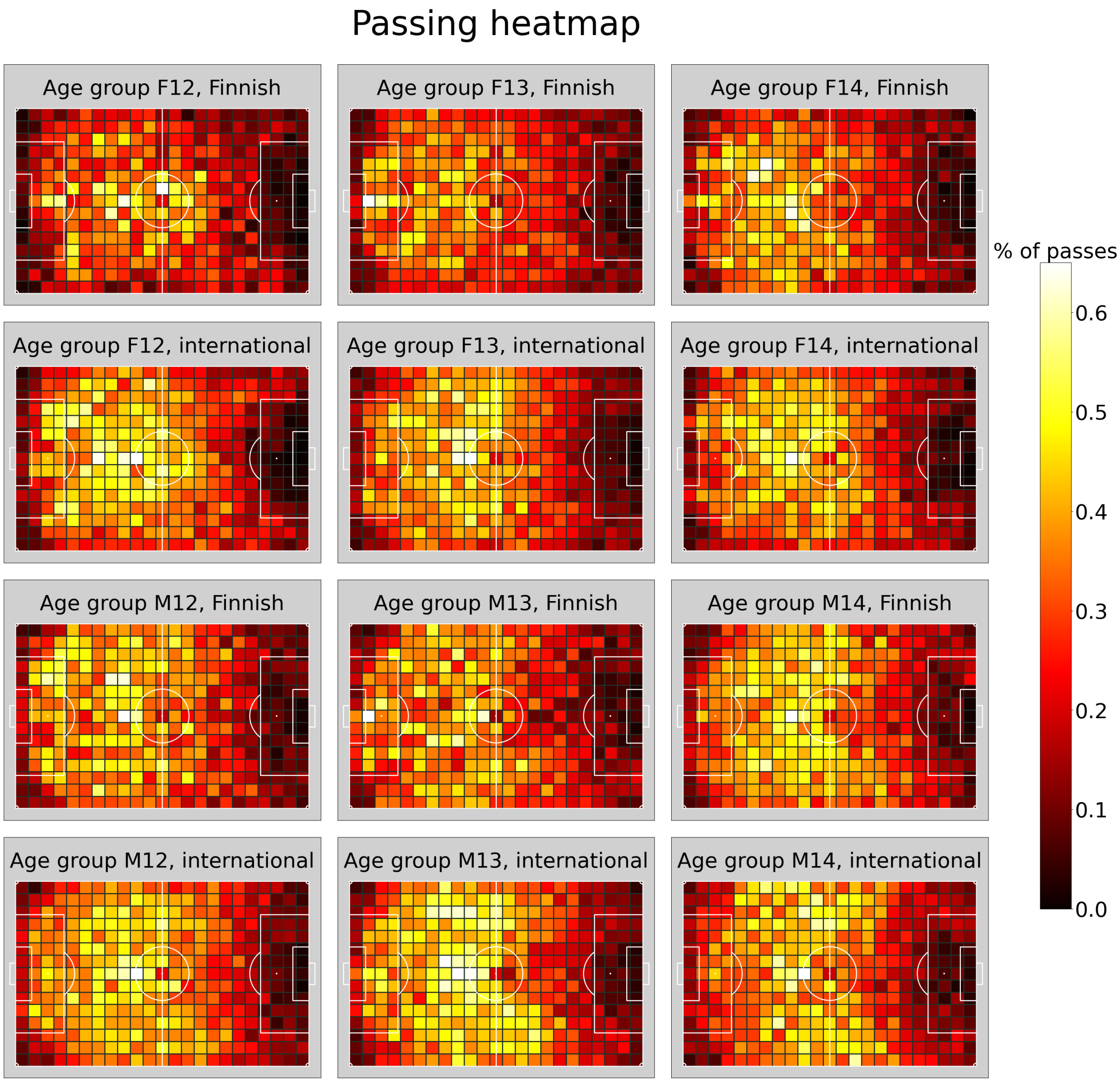

Figure 4.9: Passing heatmaps of all age groups divided by internationality. The colours indicate the frequency of passes given from the position. White areas indicate high passing activity, while dark areas show little to no passing. Plot: Konsta Nyman

It is apparent that international teams pass the ball further up the pitch on average in all age groups. This is further analysed in a one-dimensional distribution displayed in Figure 4.10. The K-S test results displayed in Table 4.6 show statistically significant results in all age groups, although in the opposite direction in age group F12.

In all age groups except M14, it seems that international teams tend to keep the ball close to the centre lane while Finnish teams' possessions are more spatially sparse.

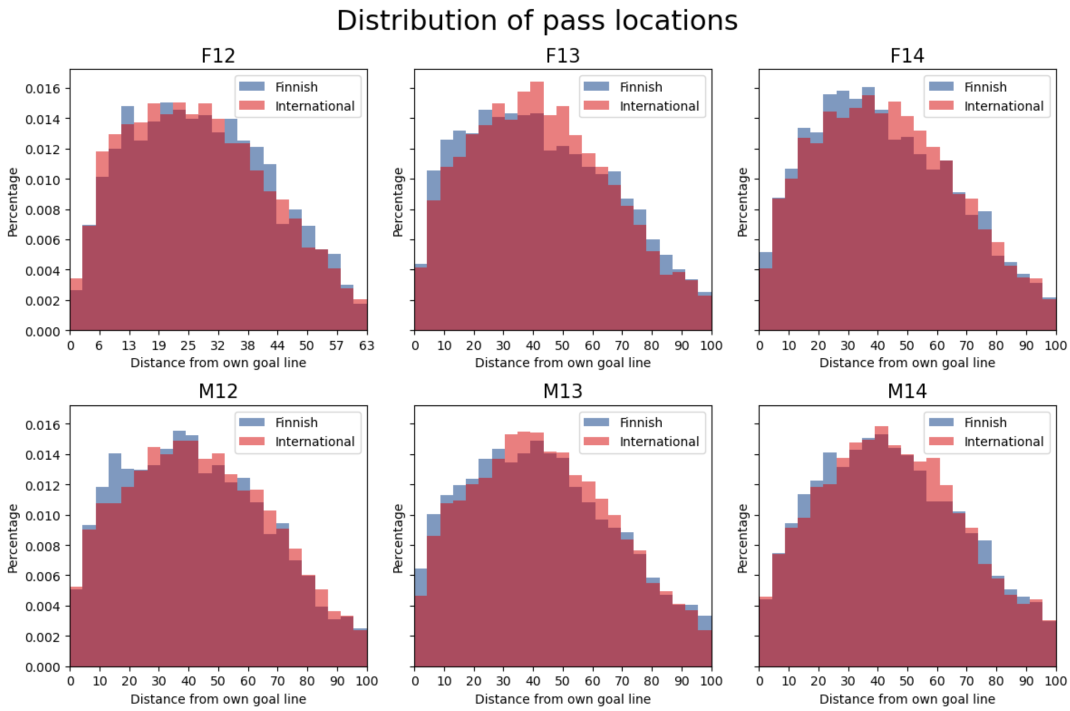

Figure 4.10: One dimensional distribution of the starting locations of passes. Plot: Konsta Nyman

Table 4.6: Kolmogorov–Smirnov test p-values of pass distributions difference between internationality level and mean x-coordinates of passes by age group.

	F12	**F13**	**F14**	**M12**	**M13**	**M14**
P-value	0.014	$<$0.001	$<$0.001	0.001	$<$0.001	0.046
Finnish Mean	44.56	42.75	42.09	42.56	43.11	44.67
International Mean	43.30	43.07	43.13	43.78	43.85	45.02

4.2 Intensity

Intensity was first analysed by plotting and testing average and top speed distributions. Finnish players' average speeds are higher than international players' speeds in most age groups as is shown in Figure 4.11. In the case of top speed, the results are opposite as shown in Figure 4.12. International players reach higher top speeds on average and most importantly, the fastest international players are faster than the fastest Finnish players. The difference is especially clear in boys' age groups.

The K-S test verified these observations. In age groups F13, M12 and M14 Finnish players have a higher average speed statistically significantly as presented in Table 4.7. Top speed distributions between international and Finnish players differed statistically significantly in all male age groups as well as the F13 age group as presented in Table 4.8. In age group M14, international players reach a higher top speed, but international players are also at the tail end of the distribution and Finnish players are more tightly packed with a top speed of around 7.4 m/s.

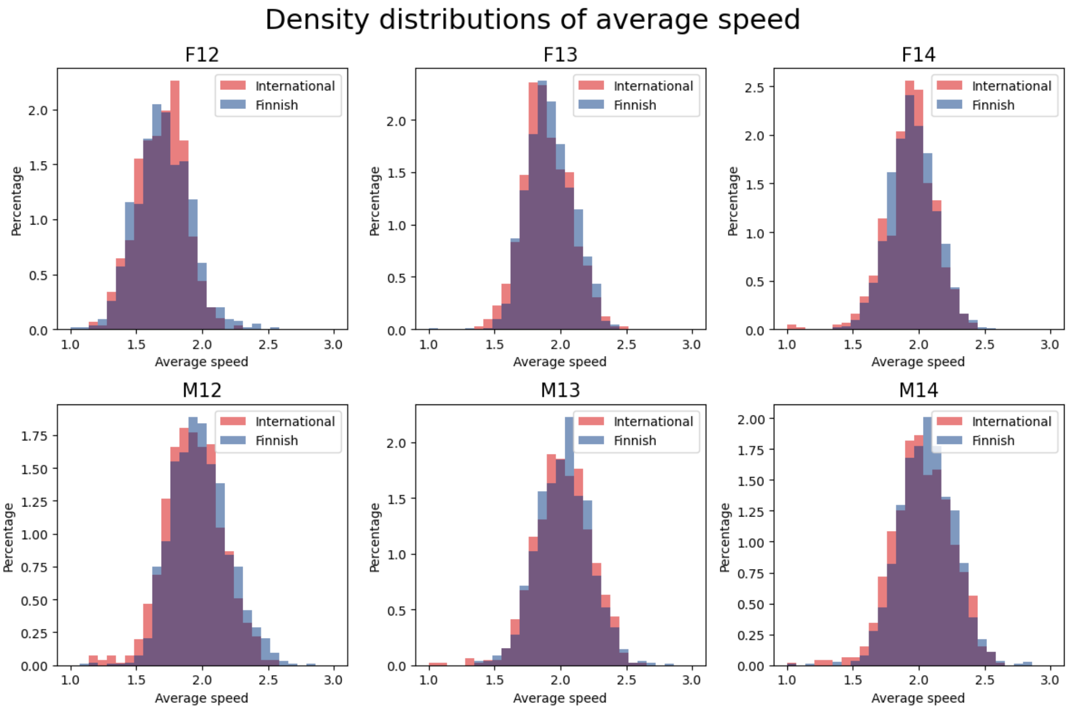

Figure 4.11: Density distribution of average speed of players. Plot: Konsta Nyman

The distributions of the intensity values calculated with the intensity equation are presented in Figure 4.13. In age groups of 12 and 13 no differences can be made out visually. In age group F14 the diversity of players is larger amongst Finnish

Table 4.7: Kolmogorov–Smirnov test p-values of difference in average speed for each age group.

	F12	**F13**	**F14**	**M12**	**M13**	**M14**
P-value	0.203	0.003	0.467	$<$0.001	0.580	0.005
Finnish Mean	1.69	1.91	1.95	1.98	2.02	2.06
International Mean	1.69	1.88	1.94	1.93	2.01	2.03

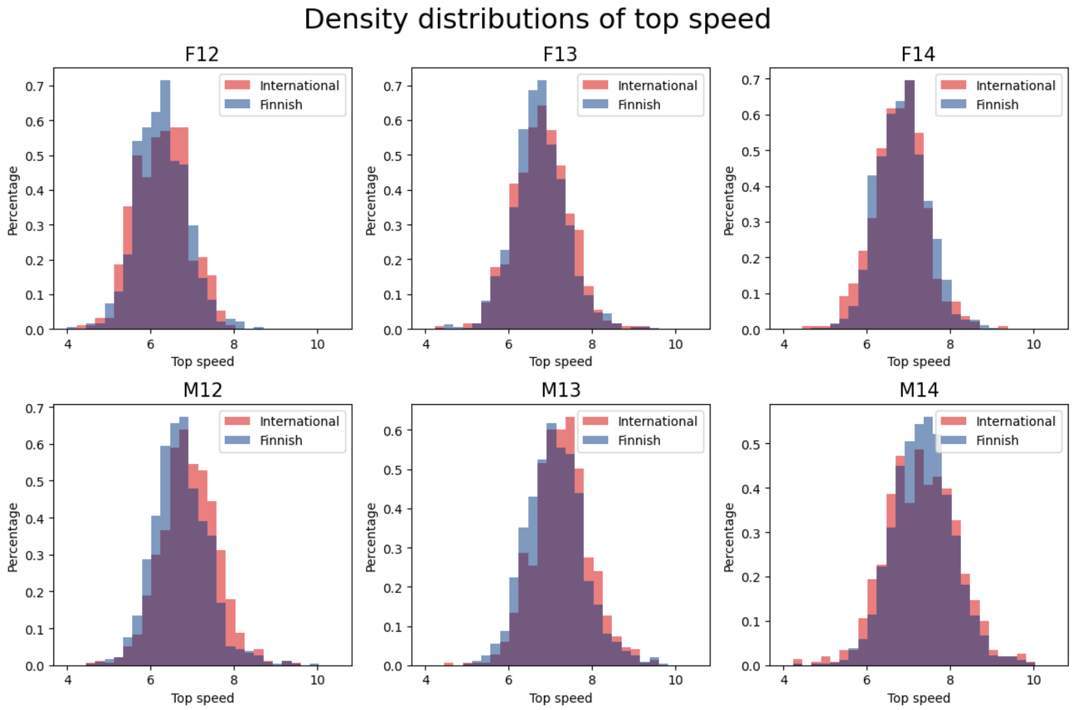

Figure 4.12: Density distributions of top speed of players. Plot: Konsta Nyman

players — there are players who achieved a higher intensity value than international players, but also players who didn't reach as high as international players. International players reach more similar values and therefore the distribution has a higher peak and kurtosis. In age group M14, Finnish players reach a higher intensity value on average. These observations are verified with the statistical significant K-S test results, displayed in Table 4.9.

Table 4.8: Kolmogorov–Smirnov test p-values of difference in top speed for each age group.

	F12	F13	F14	M12	M13	M14
P-value	0.294	0.034	0.330	$<$0.001	$<$0.001	0.042
Finnish Mean	6.25	6.74	6.85	6.73	7.12	7.35
International Mean	6.28	6.79	6.79	6.90	7.25	7.33

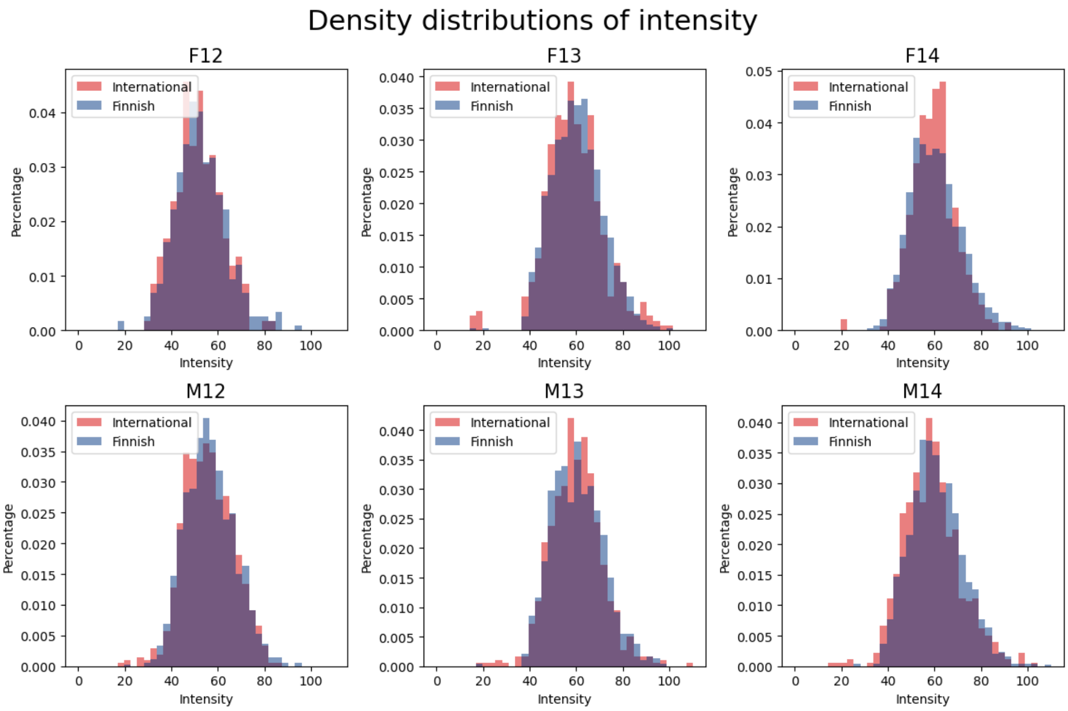

Figure 4.13: Density distributions of intensity calculated as an average of total distance per minute, distance in high-intensity speed zones per minute, and the amount of positive and negative accelerations per minute. Plot: Konsta Nyman

Table 4.9: Kolmogorov–Smirnov test p-values of difference in intensity distributions for each age group.

	F12	F13	F14	M12	M13	M14
P-value	0.649	0.086	0.048	0.355	0.249	0.001
Finnish Mean	52.67	60.42	60.34	56.57	60.65	60.78
International Mean	51.58	59.48	59.60	55.96	59.99	58.95

5 Discussion

The first research question focused on identifying how intensity and tempo could be measured using match data. Although not statistically validated, the methods chosen in this thesis to describe tempo and intensity can be viewed as valid descriptions of them. The findings closely followed the observationally formed hypothesis set by football experts of the FAoF. The literature review revealed that similar methods have been previously used and validated in research. Tempo can be measured using the frequency of actions with respect to possession time. The validity of intensity measures was not as strong as the measures of tempo. Top speed is a valid measure of intensity, but average speed and the equation used in the analysis were not.

Another aim of this thesis was to confirm if tempo and intensity were higher in matches where one or both of the teams were international than in matches where both teams were Finnish as well as in directly comparing international teams with Finnish teams by analysing possessional tempo, as stated in RQ2. These claims are confirmed by the results, especially in team-wise comparison of possession and ball actions per ball possession minute. Match tempo was found to be slower in Finnish matches in all age groups. However, although in male groups pass speed difference was found to be minimal, in female groups Finnish players pass with more velocity on average. This means that in these age groups Finnish players stay longer on the ball. There could be many reasons for this. This could be a built-in philosophy learned from a young age. Finnish players are taught to keep careful control of the ball and are therefore more likely to take their time when finding passes. International players might play riskier one-touch passes more often, which requires a collective idea of a strategy — that options are always provided so that passes can be given quickly. Another viewpoint could be that international players do not have the courage to keep the ball, that they would rather try to pass than to keep the ball to themselves even under pressure. This could have been analysed with pass success rates but was left out of scope for this thesis. One reason could also be simply the technical ability of players. More skilled players get control of the ball faster and can therefore move it along faster.

It was also found that Finnish players have a higher average speed, but a slower top speed in many age groups, especially in males. High average speed and a low top speed denotes a low variation of intensity. Variation in intensity is often described as a good tactical aspect in the football community, as lowering intensity can save energy while conditioning the opponent to a false sense of safety and then surprising them by suddenly, but collectively, raising intensity. These results indicate that international teams can time their use of energy for important moments better, by fluctuating their intensity and by result, creating more danger. This could also be simply a result of the match narratives. It is apparent in the data from ball possession percentages and shot amounts that Finnish teams have to defend more against international teams. Deeply defending teams often need to run more at a moderate speed to move their defensive shape along the movement of the ball.

The third and last research question addressed an idea that tempo and intensity would possibly change throughout the match. Due to limitations in the data, the progression of intensity could not be examined but a clear decline of tempo was found in all age groups. The number of match tempo events decreased about 15 % steadily from the first five minutes of the match to the last five minutes of the match on average.

5.1 Outcomes

The key outcomes of this thesis were that Finnish teams don't tend to keep as high tempo as international teams on the ball and Finnish players' top speeds are lower than the top speeds of international players. It was speculated that physical and technical aspects as well as internalized fundamentals could be reasons for these findings. When it comes to intensity, the physiological extreme capacity needs to be high to reach the top speeds, strength in duels etc. needed at the elite level and a strong fitness to be able to carry intensity throughout the season. Technical ability is needed to keep up a high tempo and be able to perform in high intensity matches with the ball. The physiological capability and technical ability of players are absolute fundamentals to be able succeed and win football matches consistently. Some results can be achieved with lower capabilities with a defensive tactic for example, but these results should not be praised when looking for success in long term. Successful tactics that coaches use are developing more and more into a direction which requires high physical performance from players. Implementation of these tactics and as a result, succeeding require the physical and technical ability of players to meet a certain level [9].

The psychological aspect of football — the preparation, hunger to win, self-confidence and willingness to fight for the team — cannot be understated when considering intensity. Preparation before a game and motivation during a game to push hard is vital aspect of intensity. The intensity of elite teams shouldn't come as a surprise to youth players in their first experiences with international matches. A consensus that can be made from the answers of the U-15 team after their first international matches against Portugal is that the Portuguese players pressed faster. Controlling the ball and passing it had to executed much faster that the players had been used to. This is key. Players should be *used to* playing in high tempo with more intensive pressing, since this is the norm at the elite international level. Finnish players shouldn't believe that their technical level is at the required level, which they will do before they have been exposed to an elite level of intensity and tempo. This should be done from a very young age. Another reason why international matches have more intensity and tempo could be motivation — players of both teams are more motivated in games where the other team is from another nation, when they feel like they are not only representing their team and club, but the whole country.

Although physiological and psychological aspects are needed to be elite to carry out tactics that the coach wants to implement with high intensity, this issue goes both ways. Tactical aspects of the game directly result to changes on the physiological demands of players. Especially in adult football, if a team aims to keep a high tempo in the match by pressing higher and therefore forcing quicker actions of opposite players and themselves attacking quickly, they will naturally use more energy. This can result in injuries and a drop in performance for individuals. The physical condition of players is absolutely vital for any team. To choose tactics that the players are able to execute sustainably is important especially in club football, not as much in national federations.

For now, though, I think the focus of youth player development should be on the physiological and technical ability of individuals. These aspects are a prerequisite to be able to execute tactics with a level of intensity and tempo that is required to compete with the elite level of the world. Finnish players that have these attributes are exceptions, not the norm. The details of physical and technical development should be shaped by an expert, but in my opinion, allowing the game to be a bit less controlled — especially in youth football — might be a viable solution to create faster matches with more opportunities for experiencing high-intensity situations and actions.

It seems that the topflight of Finnish male football is already heading in this direction, as the beginning of the current season has seen an average of 3,27 goals per game as of the 28th of April as for many previous seasons the only 2,66 goals have been scored per match [48]. This issue is important in the youth leagues as well as the top league as the elite youth players make their debut in Veikkausliiga very early.

5.2 Limitations

The data — or the lack of it, or rather the simplicity of it — induced most of the limitations encountered in this thesis. There were simple issues such as incomplete or faulty matches, which needed to be left out. Outcomes of duels were not recorded, which would have been a good indicator if intensity, since duels and ball contests are often won by the more intensive duellist.

Another limitation was that the formula used to calculate intensity, was originally used in physical load estimation in the source article. Although high-speed distances and accelerations could be viewed as intensity metrics, total distance should not, even if viewed in respect to time. It is equal to average speed, which is not a good indicator of intensity.

A great gap in this research was that the defensive team could not be analysed for tempo or intensity as events where only recorded in regard to the ball. The inclusion of all sprints wouldn't be difficult but would give much more insight into the intensity of teams. The metrics used to analyse intensity in this thesis were recorded throughout the whole match which gave only a single value per match per player. The often-used metric — PPDA — could not be used to analyse the intensity of pressing, since defensive actions were absent in the data. A "hack" could have been made by defining unsuccessful passes, or ball contests made after a passing sequence as defensive actions, but these would have been both unreliable and inaccurate definitions of pressing. A pressure on ball metric would be needed instead.

Intensity was difficult to analyse all in all. It would have been beneficial if duels were recorded with more information, for example the speed which players approach the duel, or even the result of the contest. As mentioned, information about sprints would have also been beneficial. To record every period in which a player runs above a specific threshold speed, with some information such as the duration, distance and variance in speed would give more thorough and accurate insights into intensity. Raw tracking data, or team-wise metrics would have been needed to analyse collective intensity, which was described as an important aspect by many experts in [28].

5.3 Future work

Another viewpoint to analyse tempo and intensity in the future could be to describe tempo as power, and intensity as energy. If information about specific events such as duels and sprints was available, the energy of these actions could be measured. This would be a great measure of intensity, since intensity is often defined as actions performed with some energy. Tempo would describe energy usage per time or actions per time, which would also be a good definition of tempo. With this method, faster and stronger actions would raise the tempo also. These methods would require much richer data, where a continuous value of speed would be the best. It could be sufficient if events included some information about speed which would turn into energy — the speed at which players approach a duel for example.

Although the exact methods big organizations and clubs use in data analysis are not disclosed publicly, due to the apparent resources and personnel invested in data analysis it is probable that they use complex big data storage and processing systems for all purposes of data: recruitment, medical, tactical etc. And even though the utilization of data is developing rapidly and more and more conversation revolves around it, I believe, that the utilization of data at least in terms of tactics is still in the beginning stages. As the football industry adopts even more to the use of data, who knows what will evolve.

As mentioned, Finnish top division clubs use sophisticated statistics to analyse matches of their own as well as of their oppositions. This becomes apparent also from broadcasts of Veikkausliiga matches where teams are often analysed based on these metrics. However, the lack of expertise of data analysts is clear in Finnish organizations which slows the process of making discoveries and adopting solutions to improve the tactics as well as using more complex methods to find deeper revelations. The trend of the international elite level could be followed, and resources could be allocated so that specific analysts could be hired to help coaches and organizations to make better tactical, medical and recruitment decisions.

I think that only the tip of the iceberg is explored of the utilization of data analytics in tactical analysis of football as the metrics that are used now are still quite simple. Tracking data offers endless possibilities. Spatial control is a vital aspect of success in a football match, which is also researched actively. Methods to analyse spatial control using tracking data are developed continuously with an increasing interest using Voronoi diagrams for example. Models of spatial control could be used to evaluate the ability of individual players to position correctly, if not even help open new ideas of strategy to coaches. Collective behaviour is also an important aspect of football analysis of the future.

Studying Finnish football players against international players gives great insights into the level that is needed to succeed at the elite level. I think that a closer look into the success of Finnish teams against the elite level could be done by comparing a Finnish team playing against another Finnish team with the same Finnish team playing against international teams. This would highlight key differences in demands of physiological and technical aspects. Analysing ball event tempo, pass success rate, and intensity could give insights into the nature of matches, and how well Finnish teams cope with the presumed higher pressing intensity and speed of international players. To be able to play from the back on the ground or finding solutions to surpass the press even under high pressure is a fundamental aspect of succeeding in a football match. The attitude towards Finnish teams or the Finnish national team playing against elite teams shouldn't be about surviving. It should be about matching or even outperforming the elite players and teams.

6 Conclusion

The purpose of this thesis was to analyse youth football match data in terms of intensity and tempo. A comparison was made between Finnish and international matches and teams to research a hypothesis made through observation by experts in the Football Association of Finland: intensity and tempo is higher in matches where one or both teams were international. Event and movement data from three different age groups from both male and female youth football tournaments held in 2022–2024 was used to analyse intensity and tempo. Tempo was analysed using event frequency and pass speeds as well as a spatial analysis of the concentration of passes, and intensity by running speeds, distances and accelerations.

It was found that in most age groups tempo was not statistically significantly faster in international matches when compared to Finnish matches, although slightly faster on average. A clearer distinction was found when analysing ball events separately. Ball events (passes and dribbles) were more frequent within international teams per ball possession minute statistically significantly in almost all age groups. When analysing ball possessions as separate periods, international teams were found to perform events more frequently on average. Pass velocity of Finnish teams was found to be faster in female age groups. International teams were found to play slightly further up the pitch according to average pass starting locations.

The average speed of Finnish players was found to be higher than the average speed of international players in most age groups. However, top speeds were found to be higher within international players on average statistically significantly, especially in male age groups. Most importantly, the fastest international players were significantly faster than the fastest Finnish players. An intensity value was calculated with total distance, high-speed distance and the number accelerations which resulted in similar results in Finnish and international players. Finnish players even topped international players in some age groups.

Physiological and technical tests reveal that young Finnish players are behind in most abilities of international players. The main take-away from this thesis is that Finnish players are slower and not as technically refined as international players. One reason for this could be that from a young age Finnish teams like to keep control of the game too excessively and young players get too little experience on high-intensity situations and playing under strong pressure. This obsession of control should be eased especially in youth games. This would especially improve the technical ability of players as well as the psychological understanding of demands. The physical capability of players should be developed more all in all, especially outside match situations.

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