



PHYSICAL ANALYSIS

OF THE FIFA WOMEN'S
WORLD CUP FRANCE 2019™

FIFA®



WOMEN'S WORLD CUP
FRANCE 2019

FOREWORD

Dazzling technical skill, packed stadiums and a surge in interest all over the world: the FIFA Women's World Cup France 2019™ was both a sporting and a commercial success. The tournament marked a turning point in the development of women's football, as it convinced even the more sceptical fans of the power, beauty and impact of the game.

The development of women's football is a priority for FIFA and, following the tournament, we announced the doubling of our investment in this area to USD 1 billion over four years. The action in France showed that we are on the right track, providing undeniable evidence of the progress that has already been made on and off the pitch.

Financial support is one thing, but information is key to professionalise the sport even further. Only by making the most of data can we work effectively and sustainably on the development of the women's game and take it forward – whether through a tailor-made talent development approach or through targeted coach education. The insights gained can also be harnessed to optimise players' preparations and thus their performance.

The third edition of the physical analysis is an important building block to improve and reach our goal. It not only provides an analysis of the matches and teams at France 2019, but also includes trends observed at the tournament and practical recommendations on how best to react and train in order to be successful.

I hope that it will be a valuable resource for everyone who shares our ambition to drive women's football on to the next level.

Arsène Wenger

FIFA Chief of Global Football Development





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AUTHOR INTERVIEWS

About the authors

Paul Bradley and Dawn Scott are leaders in high-performance research and in implementing findings in the field. They both work at the highest levels of football, translating the latest research data into best practice.



Dr Paul Bradley

Author

Paul Bradley is a BASES-accredited sports scientist with chartered status from the Science Council (CSci). He has published over 60 peer-reviewed articles on the science of football and is currently an Associate Editor for the journal *Science and Medicine in Football* and an Advisory Board member for the *Journal of Sports Sciences*. In addition, he works as a Reader in Sports Performance at Liverpool John Moores University (LJMU), leads the Vizrt/LJMU football portfolio and is a consultant for FC Barcelona.

How important is scientific research in the development of sport?

Research is absolutely critical to the future development of most sports, including football. Although football is not necessarily a science, the application of scientific principles to football is how research impacts the game. The adoption of scientific research within the football domain has undoubtedly revolutionised the game in the form of advances in monitoring, match analytics, training, nutrition, psychology and technology, amongst others. This progress will continue to gain even more momentum if research and development are an integral part of sport.

What implications does scientific research have for the women's game?

The FIFA Women's World Cup in France clearly highlighted the growing popularity of the women's game and, for this

to continue, then investment is vital. To ensure that this time and financial investment is applied wisely and in the most appropriate manner, it's imperative that stakeholders have the relevant information to make informed decisions. Thus, science is the perfect vehicle for this, given the objectivity and rigour that go into conducting research. This is especially true for women's football, as there is currently a limited number of research publications on all aspects of the women's game, ranging from the science/medicine perspective through to the psychological/social aspects. More investment is needed to ensure the women's game doesn't just reach the required standard but actually sets the standard! High-quality research will be an important driver of this in the future.

What are some key areas of the women's game that need further research and why?

The very short answer would be all aspects, given the scarcity of information on women's football. However, a really good start would be to comprehensively evaluate the modern demands of the women's game, as most research questions will be informed by this. For instance, a really granular overview of the physical demands of elite women's football will allow each nation to benchmark themselves against each other. This will help the coach to design conditioning drills to enable players to be fully prepared in relation to performance, but more so in relation to mitigating the risk of injury. This latter point is particularly important, given that injuries are by far the greatest problem we encounter in football in terms of their impact on players. This is especially relevant for the women's game, given the potentially greater occurrence of serious, long-term injuries (e.g. knee ligament injuries) compared to male players. Another important avenue for future research is a continued endeavour to understand the true impact of the menstrual cycle on female players' performance, injury risk and general well-being. But a "bigger-picture" perspective is needed, as we should ensure all of the aforementioned research is not reductionist

in nature (e.g. conducted in isolation). A more joined-up/integrative approach to research is needed that links all aspects to a global research framework on women's football (e.g. the demands linked to performance, injury and the menstrual cycle, as everything is connected!).

How can MAs/clubs encourage universities to get involved in research on women's football?

Collaborative research relationships between various MAs/clubs and universities are vital for the future development of the women's game. A key barrier is the perceived benefit of research in this area. So, it's imperative that there be dialogue between parties about key research questions that actually have a real-world impact. The most impactful questions usually come from the industry via stakeholders, coaches and even players themselves. These questions can then be explored scientifically by academics to provide appropriate solutions and ultimately drive change. Conducting more impactful research would allow MAs/clubs to see the benefits of research and development and this would feed into a positive loop of appreciation for this type of activity. Another issue that halts research progress in the women's game is the lack of funding for projects in this area at both the university and industry level. The creation of specialised grants or even symposia/conferences is key to bring academics and MA/club representatives to the table for further dialogue.

While working on the Physical Analysis of the FIFA Women's World Cup France 2019, what surprised you about some of the outcomes?

The first surprising outcome was the sheer magnitude of the change in demands from the Women's World Cup 2015 in Canada compared to the 2019 tournament in France – especially given there was very little change in the demands between the 2011 and 2015 competitions. Although there was a belief amongst the media, coaches and players that the game had recently evolved, this position lacked evidence.

Collaborative research relationships between various MAs/clubs and universities are vital for the future development of the women's game



We observed that intense running had increased across various playing positions by approximately 16-32% from Canada 2015 to France 2019

Intuitively, the avid observer of women's football could clearly perceive this change in demands subjectively. However, in science, a more objective, tangible overview is needed, not only to confirm this observation but more importantly to indicate its magnitude of change. So, when we observed that intense running had increased across various playing positions by approximately 16-32% from Canada 2015 to France 2019, it was a clear confirmation of the game's evolution. To put this into perspective, some of my previous research found a similar increase in the demands observed in the English Premier League across a seven-year period. By contrast, this trend for the women's game was over just a four-year period, which could indicate a more rapid evolution.

The second unique outcome of the research was the realisation that "context is king" when interpreting the physical demands of women's football. For instance, the same player in two separate matches would have vastly different demands based on the context of the game (e.g. the opposition standard, score, tactics and system employed). The most striking example was from a full-back across two games. In the first game, the team was much more attack-minded, thus the full-back had a dual role that required her to be defensive out of possession (closing down, doing recovery running, covering, etc.) but very attacking in possession

(overlapping and running with the ball in wide areas). The second game, meanwhile, was against a team that were more astute tactically and in attack. This resulted in the full-back spending more time carrying out defensive duties like closing down and covering space/opposition players in wide defensive areas. This deeper position resulted in a more compact shape out of possession for the team. The dual role of the full-back in the first game required a higher work rate and this is probably the reason for her covering not only a greater total distance but also >100% more sprinting distance (Zone 5). Therefore, using contextualised physical data (e.g. indicating the tactical purpose of the physical efforts) to provide more insight can be valuable for practitioners. More research in future should consider linking the physical and tactical data together to provide more insight and to get greater coach and player buy-in.



Dawn Scott

Author

Dawn Scott has worked extensively in the high-performance area of women's football both in England and in the USA, at the pinnacle of the youth and senior game alike. Dawn was part of the USA teams that won two FIFA Women's World Cups (2015 and 2019) and the gold medal at the 2012 Olympics. She is now working with the English national team as the Senior Women's Physical Performance Manager, a role that she took up at the end of 2019.



You have participated in four FIFA Women's World Cups. Were there any differences in the physical performances of teams? If so, what were the biggest differences?

I have now been fortunate enough to support teams across the past four World Cups: England (2007) and the USA (2011, 2015 and 2019). A big difference across the tournaments was an apparent increase in the overall fitness of all of the competing nations, largely due to increased resources in the female game. In comparing the 2015 and 2019 tournament data, it is evident that there was more distance completed at the higher speeds in 2019 and that the range of high-speed distance completed by teams (i.e. the difference between how much such distance the top and bottom teams covered) was reduced. Again, this means that some of the lower-ranked teams completed significantly more higher-intensity activity in 2019 compared to 2015, which could be reflective of higher fitness levels. Obviously, you cannot discount the effect of the type of surface, environmental conditions, travel/jet lag and the number of days between games on the recovery and subsequent physical capability of teams.

The work that you did around a player's menstrual cycle was one of the key difference-makers for the USA and is an important factor for female athletes. How did you get the players to buy in and how did you approach the discussion with the male coaching staff?

In preparing the players for the World Cup, we focused on the aggregation of gains and covered many areas of every player's performance, and the work and education around the menstrual cycle were one facet of that performance

model. I feel that if an area can impact player performance and you educate players, as well as the coaches and relevant staff, on the benefits, then player buy-in is the easy part of the process. We had been tracking the menstrual cycle of players for the previous two years and then started to conduct some correlation analysis with wellness markers, and for some players, there seemed to be a higher incidence of certain symptoms (sore muscles, poor sleep and general fatigue) close to the onset of their period (day 1 of the menstrual cycle). Julian Haigh (an NWSL Sport Scientist) and I travelled to all of the NWSL teams during pre-season and delivered an educational session on the menstrual cycle, highlighting symptoms that players might be experiencing and, even more so, stressing that they could be reduced through simple changes/additions to their diet and lifestyle. At each club, we asked the male staff (coaches and support staff) to sit in on those meetings to start breaking down that taboo and embarrassment of talking about it with male staff. By the end of each of those sessions, the players were more engaged and willing to talk about it.

// An integrated and cohesive medical and physical-performance team is essential for preparing players //

How important is athlete monitoring and what are the implications for training if coaches have access to this information? What changes?

I feel that this is a crucial part of the planning process for training and ultimately player preparation. The first step is for the coaches and the performance staff to plan the training periodisation model, largely depending on the individual needs of players, the match schedule and the phase of the season. From this model, individual training sessions will be planned, with a technical, tactical and physical focus as appropriate. In preparation for that training, it is important to know the physical status of all the players in terms of whether they are available for that training session, and generally how they are feeling and/or have responded to the previous day's training (the training dose response). It is standard practice now for players to complete a wellness check-in every day; this generally consists of subjective questions related to sleep, fatigue, muscle soreness and readiness to train, and can also include more objective measures such as hydration and range

of motion/tightness around specific joints. Once players have completed this, their final participation in training can be determined, and at times, training may need to be modified for individual players and/or the whole group if many players display increased markers of fatigue/soreness. Additionally, in training, players now wear tracking systems, such as heart-rate and GPS units. This enables performance staff to track internal (heart rate) and external load measures (GPS – distance, speed and acceleration) in training and match play, as well as collecting each player's rating of perceived exertion (RPE; internal load) for the session. This information can then be used to meet with the technical coaches and medical staff, to then plan and finalise the next training session/match availability. This integration of athlete monitoring data enables the individual player to be supported and the physical preparation to be adjusted to the individual needs of the player.

What are the key areas in physical performance that teams need to focus on and what/how many staff do you feel that teams need?

I feel that an integrated and cohesive medical and physical-performance team is essential for preparing players, as ultimately, the aim is to maximise player availability for the coaches by optimising physical performance, whilst minimising injury risk. From a physical perspective, I feel that the key areas are to monitor the wellness of the players, plan and track training and match loads, and then oversee the recovery strategies of the players, also encompassing nutrition and hydration practices. I feel that one full-time high-performance coach can oversee that support for a team effectively, but a second coach can assist in that process and increase the capability for individualising that support.

When you were working within the team environment, how many staff members worked with you and what were their roles? How did you work with your head coach, Jill Ellis?

In total, the US women's national team had 43 staff members for the World Cup in France, comprised as follows: four members of coaching staff, seven scouts (one with the team and six remote), three performance analysts, three administrators, two equipment managers, one chef, seven media officers/content editors, two doctors, four athletic trainers, three massage therapists, five security officers and two high-performance coaches. Myself and the other high-performance coach worked together to support the players, in conjunction with the medical staff, in relation to nutrition and recovery strategies, strength sessions, warm-ups and physical training on the pitch. We monitored the training load

on the pitch, working with individual players using return-to-play (RTP) protocols, and communicating and meeting with the coaches daily to review the training/match completed and to plan the next session. We would also meet daily with the medical staff to discuss individual players and anything specific each player would need. Myself and Jill Ellis would speak multiple times each day in camp; even mealtimes can be important for discussing the finer details of training or planning.

How much communication and planning are done with your head coach and other coaching staff?

This is crucial to ensure the physical preparation is aligned with the technical and tactical strategy of the coaching staff. Jill and her assistants wanted the team to play a high-pressing game, and that meant the players needed to have a high endurance capacity and the capability for repeated sprint activity during matches. Outside of camp, we would all speak regularly every week, which would involve debriefing one camp and then planning for the next one. In camp, we would all speak several times each day.

How closely do you work with the medical team when you are planning sessions, periodisation and recovery, etc.?

As highlighted previously, this is crucial for the effective management of players. There should be integration of high-performance and medical support for all elements of a player's preparation; the person taking the lead on that would just depend on the needs of the individual player.



The players need to take ownership of what they need to do to be prepared to perform //

What do MAs/clubs need to ensure they do to help their players to compete and/or stay ahead of the pack?

I feel that a big part of this is the education of the players, especially in terms of the physical demands of their position on the pitch, first and foremost, and what it takes to be physically prepared to perform in that position. Ultimately, the players need to take ownership of what they need to do to be prepared to perform. That includes training on and off the pitch, as well as the other 22 hours outside of training,

encompassing recovery strategies and lifestyle. As soon as one training session/match ends, players are now preparing for the next training session/match and everything they do in that time period will impact how available they are to perform. It is important that MAs and clubs work together to provide integrated support for international players, as ultimately, everyone wants the same outcome in terms of optimising the performance of the player.

How can smaller MAs bridge the gap in the physical performance of their teams?

If MAs don't have the staff and resources, then there are resources available to help inform them in certain areas, such as the FIFA 11+ injury-prevention programme, the FIFA Technical Report and the physical analysis.



CHAPTER 1 INTRODUCTION

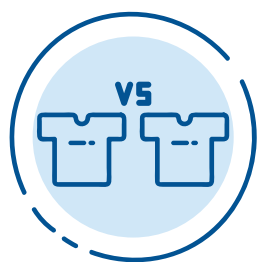
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This Women's World Cup in France has been phenomenal, emotional, passionate, fantastic. The best Women's World Cup ever. Something extraordinary happened here.

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FIFA President Gianni Infantino's verdict during the closing press conference at the FIFA Women's World Cup 2019™ was emphatically upbeat. Indeed, women's football continues to flourish. The FIFA Women's World Cup™ is the largest women's sporting tournament in the world, showcasing some of the best athletes on the planet. France 2019 saw unprecedented interest in the tournament, with viewership, attendances and digital engagement reaching record heights across the globe. With 52 matches in 30 days, FIFA (2019) reported broadcast audiences of over 1 billion, over 1.1 billion views on the tournament's official digital channels and over 1.1 million attendees – all records for the competition. The final between the USA and the Netherlands was the most-watched FIFA Women's World Cup match ever, with an average live audience of 82.18 million (up by 56% on the 2015 final audience: 52.56 million). Over the whole tournament, matches were played in nine Host Cities across France and broadcast in 205 territories around the world, and the average live-match audience was 17.27 million viewers – more than double the 8.39 million average of Canada 2015.

A total of 146 goals were scored at the 2019 tournament, the exact number of goals scored in 2015, equalling the highest yet, with an average of 2.8 goals per game, which is higher than the rate in 2011, but a lower scoring rate compared to previous tournaments. Attendances at the games have been consistent across the previous three tournaments, with many sold-out games, which shows continued support for and interest in women's football. FIFA and individual nations also reported many media and digital records during the 2019 tournament, again reflecting the ever-increasing popularity of the women's game. Furthermore, according to The FA in England (2019), there has been a 42% increase in the number of regional centres for five- to 11-year-olds to play football nationwide, and the number of female clubs went up by 32% in the six months immediately following the competition. Following the World Cup, there were record attendances at English Women's Super League (WSL) games, with more than 100,000 people attending the opening

**RECORD GLOBAL
BROADCAST
AUDIENCE****1.12 billion****France 2019****LIVE AUDIENCE
FOR THE FINAL****Canada 2015****52.56 million****82.18 million****France 2019**

three rounds of the WSL, topping the approximately 92,000 who attended across all 110 games in the 2018/19 season, and many games were hosted at Premier League stadiums. England also entertained Germany in front of a crowd of almost 80,000 fans at Wembley Stadium, which was close to the 80,203 who watched the USA's defeat of Japan at Wembley in the final of the 2012 Women's Olympic Football Tournament. Similarly, in the National Women's Soccer League (NWSL) in the US, attendance numbers skyrocketed after the World Cup. League-wide attendances increased 70% from games before the World Cup to games after the tournament, whilst attendances following the World Cup showed a 53% increase from average numbers in 2018.

Despite this continued growth in women's football, there is still a lack of scientific literature on female athletes generally (Mujika and Taipale, 2019; Nimphius, 2019), and whilst a wealth of data exists regarding the physical demands of men's football, this is still sparse regarding the women's game. Much of the research on women's football to date

(Datson et al., 2014; Scott et al., 2020a) has focused on the physical characteristics of female players, encompassing demographic variables (age, body height and weight), as well as their physical fitness profiles. However, such research has largely featured a small number of players and/or a variety of assessment methods, making comparisons difficult. Much less research has focused on training quantification and the match physical demands on female football players. An understanding of the demands of match play is vital to develop a systematic training model, and programmes that reflect and are specific to the physical loads players will complete during games. In conjunction with the technical, tactical and psychological preparation of players, specialised physical preparation can make the difference in success at the elite level. Competing in multiple games over a short period of time further increases the physical demands on players to maintain performance and be successful. Physical planning and preparation can be key in ensuring players are optimally prepared to deal with successive games with limited recovery time. The more information available in relation to the physical match demands, especially during tournament play, the more specific it is possible to be with the physical preparation of players to cope with such loads, thereby optimising performance and mitigating the risk of injury.

Davis and Brewer (1993) were the first to report any data on female players, with unpublished data on female national-team players (N=7) using a very basic video-based method. This study provided information on general activity, with very limited detail reported pertaining to high-speed activity. Further research using a similar method (Krustrup et al., 2008; Mohr et al., 2008; Andersson et al., 2010), but with larger sample sizes (n=13-58), reported that female players generally covered 10km during match play, with top international female players engaging in an average of 1.7km of high-speed running (HSR) during matches, which differed from elite male players, who covered approximately 2-3km in HSR during a match (Mohr et al., 2003). This finding is consistent with the higher endurance levels (senior males completed 97% more distance during the Yo-Yo Intermittent Recovery Test Level 1 compared to senior female players) found in senior male compared to female players at a professional football club (Mujika et al., 2009) and hence indicative of a reduced capability to recover and subsequently complete the same amount of HSR as male players. Additionally, previous research reported the amount of HSR performed by female football players as being related to the competition level and ranging between 0.7 and 2.0km during a match (Krustrup et al., 2005; Mohr et al., 2008). It has also been demonstrated that the same female player covered a greater amount of HSR

when playing an international match than when competing in a domestic league match (Andersson et al., 2010), which again is important for preparing players for any additional physical load they could face during international football.

With the advancement of technology and the evolution of women's football in general, and in an attempt to address some of the limitations of the earlier research, more recent studies have used more sophisticated data analysis and capture methods (GPS technology and semi-automated camera systems), which have been commonplace in male football for some time now (Bradley et al., 2014; Hewitt et al., 2014; Vescovi, 2012; Vescovi and Favero, 2014; Bradley and Vescovi, 2015; Datson et al., 2016; Meylan et al., 2016; Datson et al., 2019; Trewin et al., 2018a, 2018b; Scott et al., 2020a, 2020b). Few studies to date have used GPS technology to determine the match demands on female players, however, in part because the use of wearables to obtain such data during games was only approved by FIFA in 2015. In unpublished data collected during the 2018 NWSL season, using 10Hz GPS technology, the analysis of 2,552 individual game files across 181 games showed the average total distance (ToDi) covered by players to be 9.8km, with an average of 531m covered in HSR (>19km/h). On average, players completed 40 high-speed (>19km/h) and 11 sprint efforts (>22.5km/h). Scott et al. (2020b) also reported that, across two seasons in the NWSL, players clocked up 10,068±615m, covering 2,401±454m, 398±143m and 122±69m in the generic total HSR (>12.5km/h), very-high-speed running (VHSR; >19km/h) and sprint-distance (SPR; >22.5km/h) load categories. In the largest study to date on women's football, Scott et al. (2020a) conducted an analysis of 220 players during 3,268 individual match observations, comparing domestic and international players during match play within the NWSL using 10Hz GPS. Although not significant, domestic players covered slightly more total distance (10,092±420m compared to 10,046±456m for international players), whereas international players completed slightly – but not significantly – more HSR (2,412±288m v. 2,406±262m), VHSR (507±123m v. 452±108m) and SPR (160±66m v. 118±54m) compared to domestic players. Whilst physical qualities and output in matches may impact upon performance outcomes, they were not generally indicative of player levels (international or domestic) in elite women's football in the NWSL. Such analysis shows that the average physical game demands of domestic and international players competing in the same league, as well as domestic compared to international football, are very similar in terms of ToDi and HSR, which challenges the earlier work by Mohr et al. (2008). This could be due to the development of the women's game, an increase in the funding

and level of professionalism and players now completing full-time training with their clubs (Emmonds et al., 2018), as well as the advancement of technology and methods used. The comparison of data captured from different methodologies (data using video editing v. GPS technology methods) should always be made with caution, since the between-system agreement is problematic (Anderson et al., 2016), and simply comparing data between different systems would be erroneous given the lack of interchangeability between technologies (Buchheit and Simpson, 2016).

Datson et al. (2016) used a semi-automatic camera system to conduct an analysis of the physical demands of different playing positions during competitive female international match play. A total of 148 individual match observations were undertaken on 107 outfield players, with a median of two matches per player and only full matches being included. The data demonstrated that central midfielders (CMs) completed the highest total distance and high-speed running (10,985±706m and 2,882±500m), whilst central defenders (CDs) posted the lowest figures (9,489±562m and 1,901±268m). The researchers also found that there was a reduction in work rate from the first to the second half. Using the same data set, Datson et al. (2019) did a more in-depth analysis of high-speed activity, which has been determined to be an integral component of football performance (Bradley et al., 2009; Di Salvo et al., 2009). The authors provided a detailed analysis of position-specific repeated sprint activity (RSA) and repeated high-speed activity (RHSA), the latter also including HSR, which helps to provide a more practically valid representation of the repeated high-speed demands of match play. The key findings showed that 2-3 effort RHSA (>19.8km/h) bouts of ~6m occurred most frequently during international female match play, with maximum requirements of 4-effort RSA of ~5m observed. The study also found that the mean recovery duration between HSR efforts was ~40 seconds; however, over 40% of all recovery durations recorded were under ten seconds, both of which can have implications for training prescription, to ensure players are prepared for the physical demands they will face during match play. Additionally, when comparing positions, Datson et al. (2019) found that central defenders completed fewer short-duration (<10-second) recoveries (34% compared to 40-43%) and more long-duration (>60-second) recoveries (33% compared to 19-23%) compared to players in other positions. These findings should be taken into account when considering the type of training prescription for individual players.

Recently, Trewin et al. (2018a) examined the match-to-match



variation in elite women's football using 10Hz GPS. Elite female football players ($n=45$) from the same national team were observed during 55 international fixtures across a five-year period (2012-2016), which made for a total of 172 match files. Their results showed that total distance per minute exhibited the smallest variation when both the full match and peak-five-minute running periods were examined (coefficient of variance (CV) is the spread of data as a percentage: $CV=6.8-7.2\%$). Sprint efforts were the most variable during a full match ($CV=53\%$), whilst high-speed running per minute exhibited the greatest variation in the post-peak five-minute period ($CV=143\%$). Peak running periods were observed as more variable than full-match analyses, with the post-peak period proving highly variable. Such findings highlight the variability of physical match demands, with the higher-speed activity being the most variable, which again is important for ensuring players are prepared for the most intense periods of match play from both a performance-capability and an injury-prevention perspective.

One inconsistent area in women's football research to date concerns the speed zones used. Bradley et al. (2013) examined the gender differences in match-performance characteristics of elite football players during UEFA Champions League matches using a multi-camera system. The authors used the same speed zones for both genders and generally found

large gender differences, specifically for the higher speed zones, and they concluded that research was warranted to establish gender-specific speed thresholds for elite football players. Datson et al. (2016, 2019) used velocity thresholds that have commonly been used in the analysis of male players (Bradley et al., 2013; Di Salvo et al., 2013), with 19.8km/h as the zone for HSR and 25.1km/h for the SPR zone; the authors felt that the speed zones previously proposed for female players (Bradley and Vescovi, 2015) were not representative of the physical characteristics of elite female players. Again, this highlights the differing opinions on the speed zones that should be used for female players. A few studies (Dwyer and Gabbett, 2012; Vescovi, 2012; Bradley and Vescovi, 2015) more recently have tried to standardise such zones and be more reflective of the physical capabilities of female players. Park et al. (2018) aimed to develop generic zones for the analysis of external load data collected in international women's football matches. The authors examined methods to identify four zones in each completed half of match play (277 observations). The analysis determined that 12.5, 19.0 and 22.5km/h were most appropriate as entry criteria into HSR, VHRSR and SPR locomotor categories respectively, for the purpose of external load assessments in elite women's football; these thresholds were adopted in the most recent studies by Scott et al. (2020a, 2020b). The more data that can be collected on female players, the better the insight that

can be gained in terms of the physical demands that players will face during games, which can help with the planning of specific conditioning programmes to ensure players are better prepared for those physical demands. Furthermore, with larger sample sizes and more information regarding positional and tactical impact and age-specific demands for female players, the preparation can become even more refined and specialised.



In comparison to 2015, the 2019 tournament presented different physical challenges to the competing teams, which should be factored in when comparing between the tournaments. These encompassed:

1. **Surface.** During the 2015 tournament, all the games were played on football turf for the first time in a FIFA tournament. On the other hand, all the games in 2019 were played on grass.
2. **Environmental conditions.** During the 2015 tournament, the average temperature (mean \pm SD) for games was 22.1 \pm 2.7°C (range: 16-27°C), relative humidity was 50.3 \pm 12.6% (30-79%) and wind velocity was 12.8 \pm 6.6km/h (1-25)km/h, so the conditions varied between games and locations. Additionally, nine games were played indoors. During the 2019 tournament, all the games were played outdoors and the average temperature and relative humidity were 22.9 \pm 4.9°C (range: 15-32°C) and 58.3 \pm 11.8% (range: 35-82%) respectively. Hence, the environmental conditions, at the extreme, were more challenging in 2019 and could have had a bigger impact on the physical output of players during some of those games, in accordance with the arguments put forward by Trewin et al., (2018b).
3. **Jet lag and travel fatigue.** In 2015, the six match venues in Canada were spread across five time zones, meaning that long distances were sometimes travelled between games. All the games during the 2019 tournament were contested in the same time zone. For the 2015 final alone, the USA travelled from Montreal to Vancouver, a journey of around 3,000 miles and a three-hour time-zone shift.

Whilst the current analysis of physical match performances does not aim to be scientific in nature, it will take into account the challenges outlined above with regard to the interpretation and application of the data, and make reference to some of the scientific data now available on women's football. The analysis will be descriptive in nature but will aim to increase the understanding of the physical demands of elite football match play and thus help to continue developing the game across the world. Therefore, the key aims of this analysis are as follows:

1. to increase the knowledge base and information available on the physical demands placed on elite female football players, and the associated physical match demands during tournament play;
2. to provide a comprehensive analysis of the physical workloads completed by individual teams, with consideration of the effects of successive games, stage in the game, tournament phase, confederation



- membership and final tournament ranking;
- 3. to give an overview of the positional demands of elite female match play;
- 4. to provide guidelines on the general and position-specific physical preparation and training of female players based on the findings of this report; and
- 5. to provide recommendations for further research to continue to assist in the development of women's football worldwide, including an attempt to standardise the speed zones used in the analysis of elite female football players.

The FIFA President is continuing to raise the stakes, and at the FIFA Football Conference in September 2019, promised to invest USD 1 billion in the women's game over the following four years. This came on the back of confirming that the tournament will expand to a 32-team format for the 2023

event, in a bid to exploit the game's new boom. As FIFA redoubles its commitment to the development of the women's game, the more information that can be gathered about the physical demands during match play, the more it will be possible to help in the physical preparation of players, enabling the development of more effective training programmes. Improving the physical status of players worldwide can only serve to further increase the level and intensity of match play in the women's game, and keep the best players on the pitch to improve the standard and entertainment as a spectator sport. In addition, this publication will give less developed countries in women's football and their coaches, technical directors, physical trainers and support staff a good overview of where the top women's teams in the world stand in terms of their physical fitness and the demands of the game.

CHAPTER 2 METHODOLOGY

Players' characteristics

In total, 552 players from 24 countries were officially registered to participate in the FIFA Women's World Cup France 2019 (France 2019) from 7 June to 7 July. Prior to the commencement of the tournament, the players' age, height and body mass (mean±SD) were 26.1±4.1yr (range: 16-41yr), 167.5±6.4cm (range: 148-187cm) and 61.1±6.4kg (range: 46-88kg) respectively. Nevertheless, only 436 of these players recorded any official playing time according to the data provider. The average age, height and body mass (mean±SD) of this distinct group of players, and the corresponding spreads, were 26.3±4.0yr (range: 17-41yr), 167.3±6.5cm (range: 148-187cm) and 60.7±6.3kg (range: 46-80kg) respectively.

NB: the physical characteristics above were submitted by each of the registered national teams according to articles 25 and 26 of the competition regulations. Thus, the above data was not measured independently for the purposes of this report and could be subject to accuracy variations based on the procedures used by each national team.

Venue information and environmental conditions for matches

Data was collected from all 52 matches at France 2019 and is presented in the results and analyses sections. Matches were distributed across nine Host Cities/venues across France, the specific details of which are found in the figure below. During

the tournament, the average temperature and humidity were 22.9±4.9°C (range: 15-32°C) and 58.3±11.8% (range: 35-82%) respectively, but environmental conditions varied somewhat by venue, as summarised below.

Match analysis system

Games during the FIFA Women's World Cup Canada 2015™ (Canada 2015) and France 2019 were analysed using the same multi-camera computerised tracking system (STATS LLC, Chicago, IL, USA). All player movements were captured by three high-definition cameras operating at 20Hz. Cameras were positioned near the halfway line at a minimum height of 10m above pitch level. The reliability and validity of this system have been quantified to verify the capture process and subsequent accuracy of the data (Bradley et al., 2009; Linke et al., 2018). After system calibration and various stringent quality control processes, the data captured was analysed using match analysis software. This produced a data set on each team and player's activity pattern during a match using specified speed zones.

Speed zones

Players' activities were coded into the following:

- Zone 1 (0-7km/h)
- Zone 2 (7-13km/h)
- Zone 3 (13-19km/h)
- Zone 4 (19-23km/h)
- Zone 5 (>23km/h)





Venue information and environmental conditions for France 2019 matches. Note: the figures displayed above reflect the capacities for the tournament, which do not always coincide with the usual maximum capacities.

These zones were employed after extensively reviewing the women's match analysis literature (Bradley et al., 2014; Bradley and Vescovi, 2015; Datson et al., 2014; Nakamura et al., 2017; Park et al., 2018) and on the basis of speed thresholds used by applied sports scientists working with some of the top-ranked women's teams. As there was no general consensus across studies, it was decided that no attempt would be made to link speed zones to movement categories (e.g. jogging, running and sprinting). The selection of the aforementioned zones is in line with recent scientific work that used advanced statistical techniques (k-means, Gaussian-mixture-model and spectral-clustering methods) on elite women's match analysis data and determined that the most appropriate upper speed demarcations would be approximately 13-19, 19-23 and >23km/h (Park et al., 2018). Additional justification for these zones is provided by maximal aerobic speed indices derived from international women's players matching the upper thresholds (Scott and Lovell, 2017).

Match data was broken down into various categories for analysis based on:

- level of analysis (match, team and individual level)
- match period (full match, first and second half, 15-minute intervals, added time)
- tournament phase (group and knockout stages, final)
- confederation membership:
 - o the AFC (five teams: Australia (AUS), China PR (CHN), Japan (JPN), Korea Republic (KOR) and Thailand (THA))
 - o CAF (three teams: Cameroon (CMR), Nigeria (NGA) and South Africa (RSA))
 - o Concacaf (three teams: Canada (CAN), Jamaica (JAM) and the United States of America (USA))
 - o CONMEBOL (three teams: Argentina (ARG), Brazil (BRA) and Chile (CHI))
 - o the OFC (one team: New Zealand (NZL))
 - o UEFA (nine teams: England (ENG), France (FRA), Germany (GER), Italy (ITA), the Netherlands (NED), Norway (NOR), Scotland (SCO), Spain (ESP) and Sweden (SWE))
- final tournament ranking
- playing position (goalkeepers and outfield players including central defenders, full-backs, central midfielders, wide midfielders and forwards)
- comparison of main results for France 2019 v. Canada 2015
- match outcome: win, loss or draw
- round of game
- number of days between games
- tactical formation

NB: the match data from Canada 2015 had to be reanalysed using the new speed zones and data analysis procedures used in the current report in order to compare it with the France 2019 results more accurately. Differences in the methodological and data analysis procedures between the current report and the previously published report on the 2015 tournament (FIFA, 2015) may account for some discrepancies in the final results and the reader must interpret the between-tournament results with this in mind. The comparison is further impacted by incomplete data sets. For instance, due to technical difficulties, data from some of the 2015 matches (Canada v. China PR, Sweden v. Nigeria, USA v. Australia, Nigeria v. USA, Mexico v. France, Korea Republic v. Spain, Germany v. France and Germany v. England) was missing, with all other games included in the data analyses. All France 2019 matches were included.

All data was reported as averages unless otherwise stated,



with some standard deviations and ranges included to provide more insight to the reader regarding the data spread. When appropriate, data was analysed using statistical software (SPSS, Chicago, IL, USA), but it is worth noting that the results of these analyses are not displayed and were only used by the researchers to interpret data trends. In such cases, data normality was verified using histograms and z-scores. To quantify statistical differences between measures, various t-tests and analysis-of-variance measures were used. Effect sizes were also calculated to determine the meaningfulness of the differences. Relationships between selected variables were evaluated using Pearson's product-moment correlation test. Statistical significance was set at $P < 0.05$.

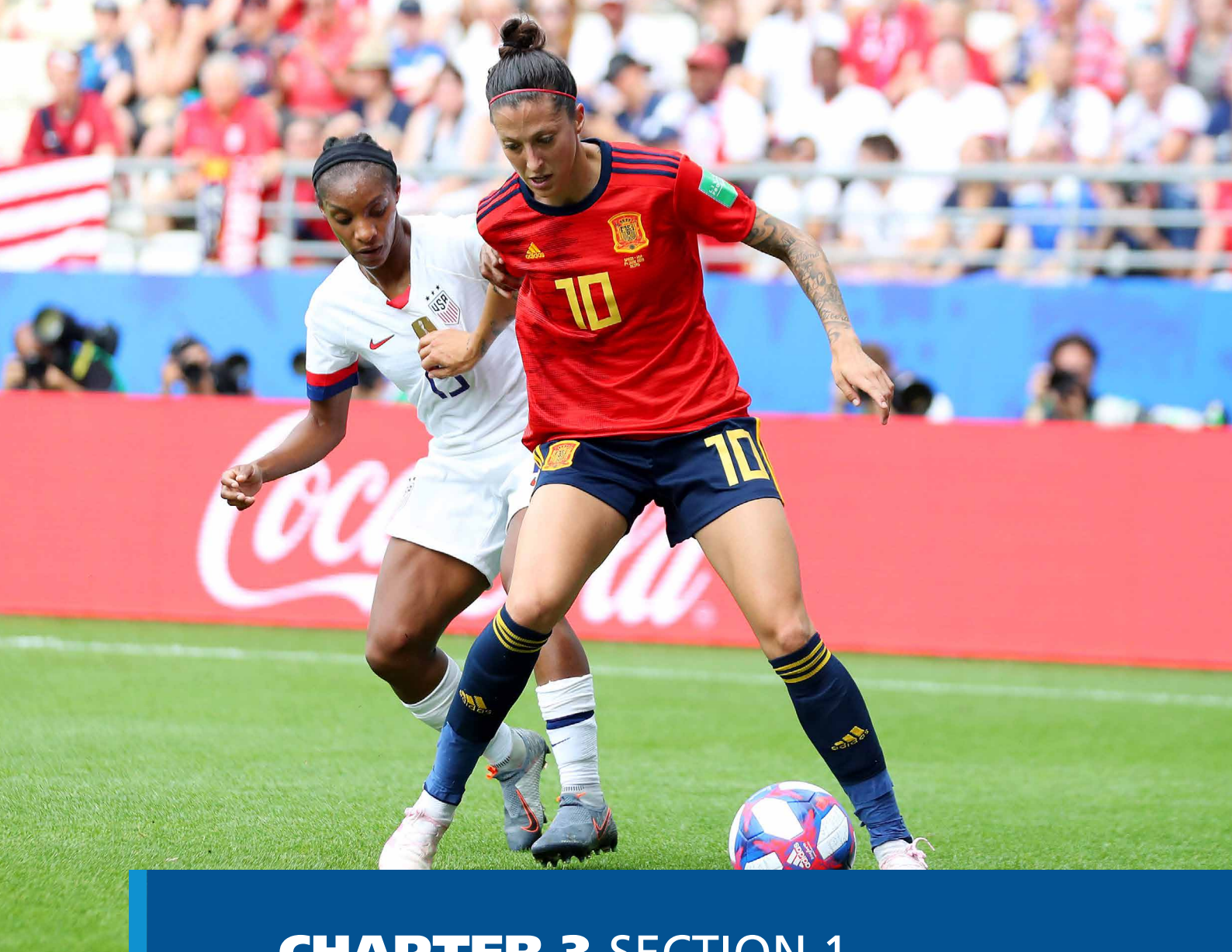
Team analyses involved the summation of all match-physical-performance values of outfield players who participated in



games, including substitutes (no goalkeeper data included). Thus, data trends were the sum of all individual outfield player values presented as team totals. All analyses were performed on match data collected over the duration of a normal match or regular time plus added time (e.g. 90-94 minutes), but no extra-time data was included.

Positional analyses involved the examination of the match physical performances of individual players in various tactical roles in the team. Only players who completed the

entire match were evaluated. Match data collected over the duration of a normal match or regular time plus added time (e.g. 90-94 minutes) was computed, but no extra-time data was included. Player roles were specific to each match and were verified after watching the game.



CHAPTER 3 SECTION 1

Team analysis | Playing time

3.1.1 Match duration

The average duration of all matches during France 2019 was 97:43min (range: 93:13-107:54min) including added time, but without taking extra time into account, whereas the actual playing time on average was 54:41min (range: 42:03-66:25min), 56% of the overall match duration. As can be seen from Table 1, out of the last four editions of the FIFA Women's World Cup, the actual playing time was highest in 2011, both as an absolute figure and relative to the match duration, 56:21min and 59% respectively.

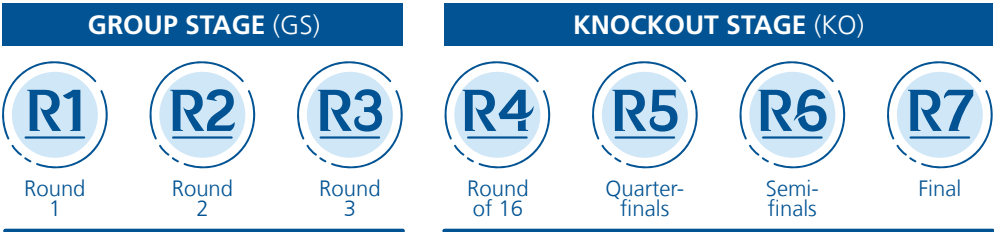
France 2019 was the first women's football tournament that used VARs.



Table 1. Comparison of actual playing time and match duration at recent FIFA Women’s World Cups

FIFA Women’s World Cup	Actual playing time (min:ss)	Match duration (min:ss)	Actual playing time (%)
2007	53:40	94:23	57
2011	56:21	95:07	59
2015	53:21	95:02	56
2019	54:41	97:43	56

As can be seen, the match duration in 2019 was more than two minutes longer than at the tournaments in 2011 and 2015, which could be in part due to the introduction of the video assistant referee (VAR) system at the latest tournament, with the delay in making decisions being factored in and resulting in increased stoppage time being added at the end of matches. Moreover, during the 2019 tournament (Table 2), the match duration for the knockout stage was three minutes longer than the average for the group stage, and two minutes longer than the average for all games. However, the actual playing time was lower, 54:05 compared to 54:56 and 54:41min for the group stage and all matches respectively.



Finally, the average duration of the first half of matches was 47:35min, with the ball in play for 27:38min (58% of the half’s duration), whilst the second half lasted around three minutes longer on average, with an average duration of 50:23min; however, the actual playing time was slightly lower at 27:17min (54%).

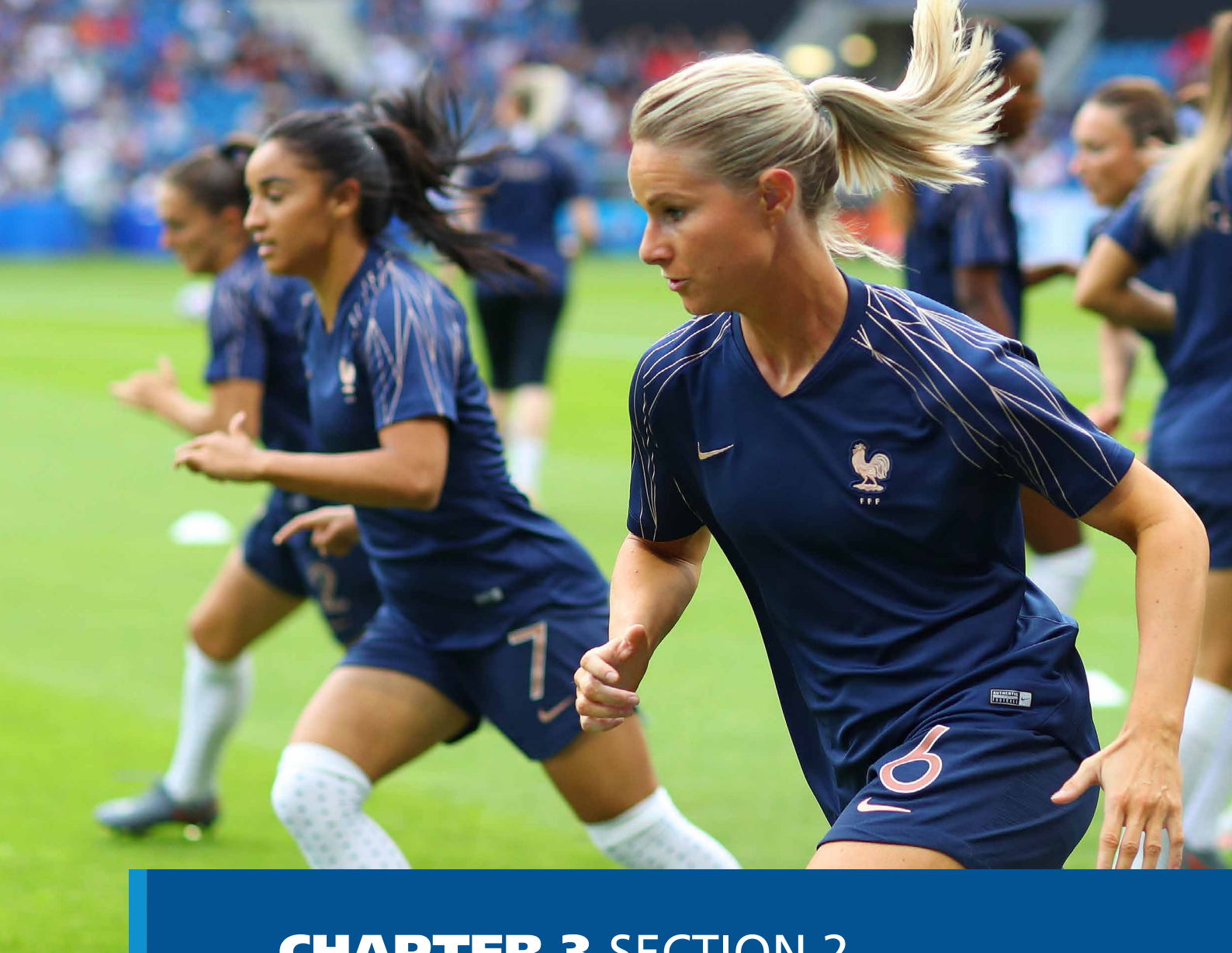
Table 2. Comparison of actual playing time and match duration at France 2019 by tournament stage

France 2019: stage of tournament	Actual playing time (min:ss)	Match duration (min:ss)	Actual playing time (%)
All games	54:41	97:43	56
Group stage	54:56	96:49	57
Knockout stage	54:05	99:44	54



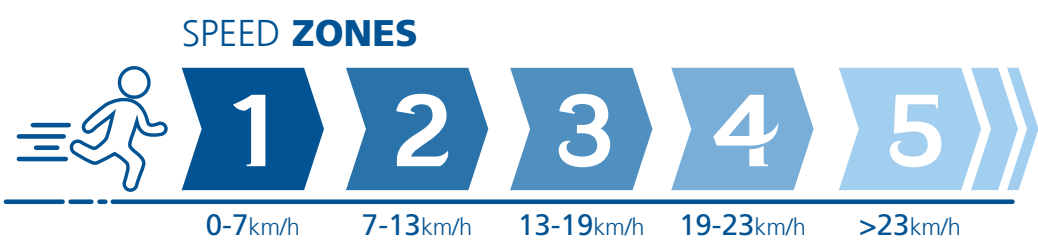
3.1.2 Summary

- Matches during France 2019 lasted more than two minutes longer than at any of the previous three tournaments, with the average duration being 99:44 min (9:44min of added time) during the knockout stage.
- The actual playing time, relative to the match duration, was similar to at the 2015 and 2007 tournaments, but slightly lower than at the 2011 tournament.
- The longest match duration in 2019 was 107:54min, which can have implications for the physical preparation of players in ensuring they are able to maintain performance beyond 90 minutes only.
- Some of the factors that could explain the variation in actual playing time between and within tournaments include the introduction of the VAR system in 2019, the playing surface (football turf was used in 2015), the timing and logistics of the ball being returned after going out of play, as well as the tactical strategies employed by individual teams.



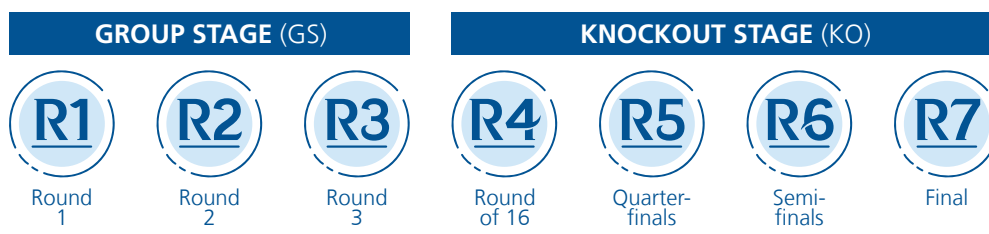
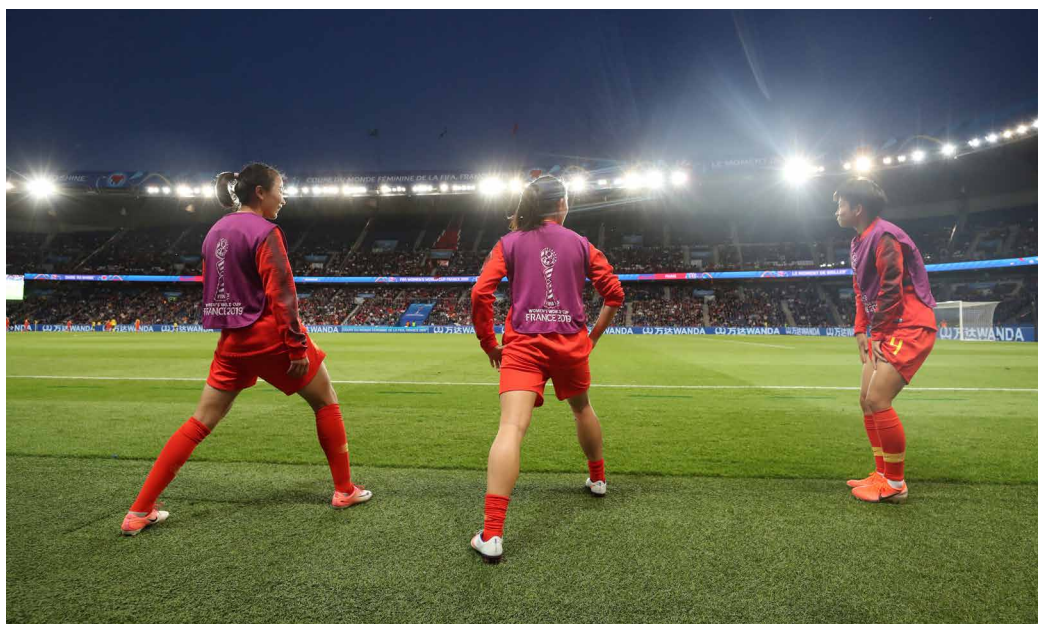
CHAPTER 3 SECTION 2

Team analysis | Distances and speed zones during matches



3.2.1 Analysis of total distances covered and speed zones during matches

An analysis of the distances covered by all of the teams across the last two tournaments (Figure 1) shows an average total distance (ToDi) of 105,007m per match during Canada 2015 and 104,364m during the most recent edition in 2019. *Please note that the speed zones for the 2011 data are slightly different to the 2015 and 2019 tournaments, hence only the total distance for that tournament can be compared to the more recent tournaments.



Relative to the average total distance covered (Figure 1), the distances clocked up in each of the speed zones were very similar in 2015 and 2019. However, in absolute terms, during the 2019 tournament, teams averaged slightly less distance (38,563m v. 41,255m, -7%) in Zone 2, but more distance in Zone 3 (21,681m v. 20,625m, 5%), and much greater distances in Zone 4 (4,957m v. 4,310m, 15%) and Zone 5 (1,808m v. 1,399m, 29%). This suggests that whilst the total distance was comparable between the two tournaments, on average teams covered a much greater amount of ground at higher speeds in 2019, running an additional 15% and 29% in zones 4 and 5 respectively.

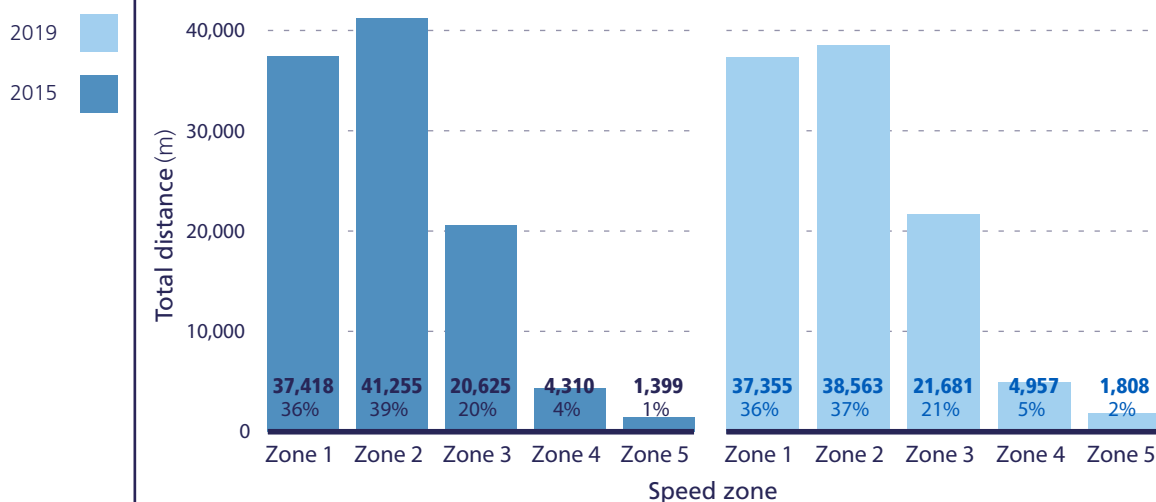


Figure 1. Analysis of the average distances covered at Canada 2015 and France 2019

Generally, teams covered more ground in the higher speed zones during the 2019 tournament compared to 2015

Table 3 shows a summary of the average distances covered and the percentage breakdown relative to the total distance at Canada 2015 and France 2019, for all speed zones and depending on the stage of the tournament: all games, the group stage and the knockout stage. As can be seen, the per-match average for the full tournament was slightly lower (<1%) in 2019 compared to 2015. For the group stage only, teams on average covered 3% more total distance in 2019. However, for the knockout stage, teams averaged 7% less total distance in 2019.

Table 3. Analysis of the average distances covered per match and tournament stage at Canada 2015 and France 2019

	Stage of tournament	Total distance (m)	Zone 1 (m)	Zone 1 (%)	Zone 2 (m)	Zone 2 (%)	Zone 3 (m)	Zone 3 (%)	Zone 4 (m)	Zone 4 (%)	Zone 5 (m)	Zone 5 (%)
2015	All games	105,007	37,418	36	41,255	39	20,625	20	4,310	4	1,399	1
	Group stage	101,174	36,195	36	39,357	39	20,098	20	4,191	4	1,334	1
	Knockout stage	112,194	39,712	35	44,815	40	21,614	19	4,533	4	1,521	1
2019	All games	104,364	37,355	36	38,563	37	21,681	21	4,957	5	1,808	2
	Group stage	104,192	36,880	35	38,785	37	21,823	21	4,957	5	1,747	2
	Knockout stage	104,759	38,444	37	38,054	36	21,357	20	4,958	5	1,948	2

Generally, teams covered more ground in the higher speed zones during the 2019 tournament compared to 2015 (Table 4). Whilst distances at speeds <13km/h tended to decrease in 2019, distances covered above 13km/h and more noticeably >23km/h were far greater in 2019, suggesting a faster, higher-tempo game in 2019 compared to 2015.

Table 4. Analysis of the percentage change for each speed zone from Canada 2015 to France 2019

Stage of tournament	Total distance (%)	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Zone 4 (%)	Zone 5 (%)
All games	-1	-0.2	-7	5	15	29
Group stage	3	2	-1	9	18	31
Knockout stage	-7	-3	-15	-1	9	28



Figures 2 and 3 show the average total distance per team covered at speeds of 0-13km/h and >13km/h, plotted against the average team metreage for all of their matches throughout the 2015 and 2019 tournaments respectively. The figures are ranked by distance at >13km/h, with the lowest values from left to right. At both the 2015 and 2019 tournaments, six of the seven teams that covered the lowest amount of ground at >13km/h were eliminated from the tournament in the group stage. In 2015 (Figure 2), Sweden, Germany and the USA (all 37%) – a trio including two of the four semi-finalists – covered the greatest amount of distance at >13km/h, whilst the other two semi-finalists, Japan and England, both covered 35% of their total distance at >13km/h. In 2019 (Figure 3), Germany, China PR and Australia (all 41%) – none of whom reached the semi-finals – covered the most distance at >13km/h, which was higher than the distance at those speeds in 2015. The four semi-finalists in 2019 – the USA, the Netherlands, Sweden and England – respectively covered 38%, 35%, 35% and 38% of their distance at those higher speeds. In 2015, Côte d'Ivoire and Spain (both 28%) covered the least distance at >13km/h and neither team progressed beyond the group stage. Similarly, during the 2019 tournament, Jamaica and Scotland (both 34%) covered the lowest distance at >13km/h and were knocked out in the group stage. Interestingly, 2019 runners-up the Netherlands covered the fifth-lowest distance at >13km/h from an absolute perspective (26,907m, 35%).

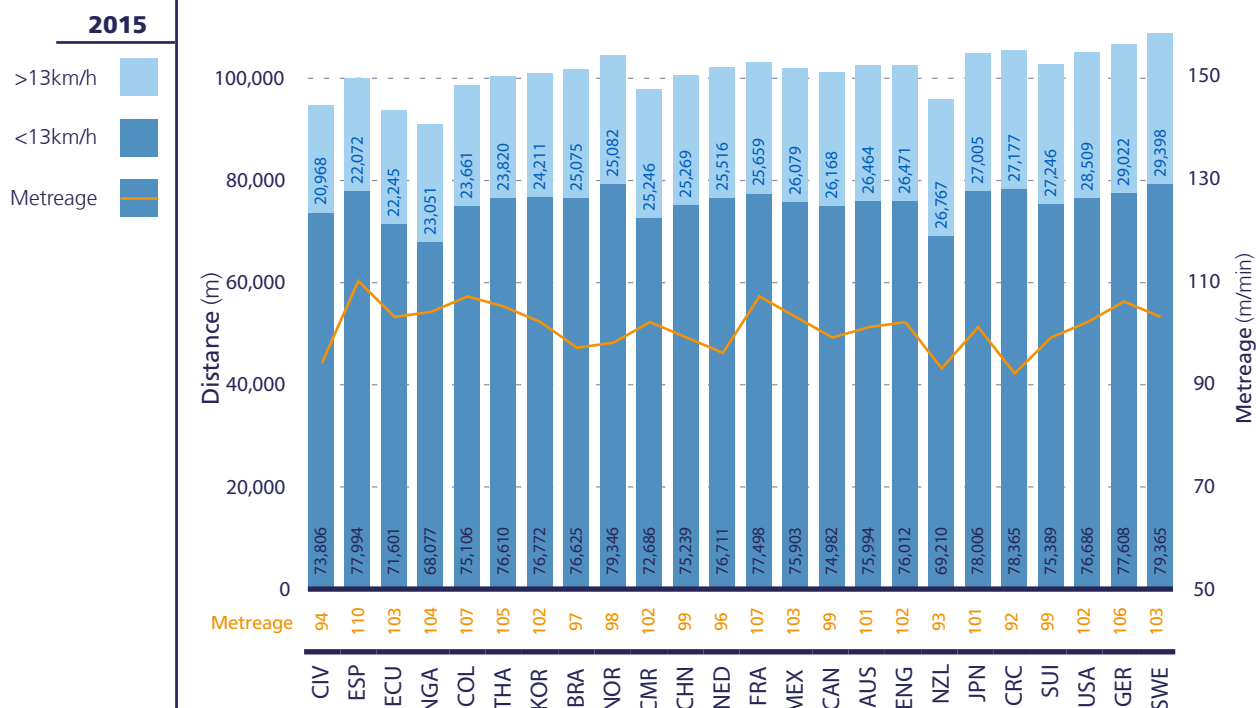


Figure 2. Analysis of the total distance covered (at 0-13km/h and >13km/h) and metreage at Canada 2015



In 2015, there was a moderate correlation between the distance covered at 0-13km/h ($r=0.39$) and the final placing of the team, whilst there was a much stronger correlation ($r=0.57$) with the distance that teams covered at >13km/h, and the relationship with the metrage for total distance was small ($r=0.15$). This suggests that teams that covered more distance at >13km/h had a greater chance of success. For 2019, the correlations between distance covered at 0-13km/h ($r=0.32$) and >13km/h ($r=0.37$), and metrage for total distance ($r=0.24$), were moderate to small, suggesting less of a relationship with the outcome of games/team success. During the 2015 tournament, there was a much greater range of total distance (91,128-108,763m; 17,635m) covered by each team compared to the 2019 tournament (96,595-108,926m; 12,331m), suggesting an increase in the ability to complete higher physical loads during the 2019 competition. Similarly, the range of distance covered at >13km/h was higher during the 2015 tournament (20,968-29,398m; 8,430m) compared to 2019 (25,658-31,526m; 5,868m), again suggesting that teams at the 2019 tournament, overall, had a greater capacity to complete activity at higher speeds, and those distances covered were more equitable between teams.

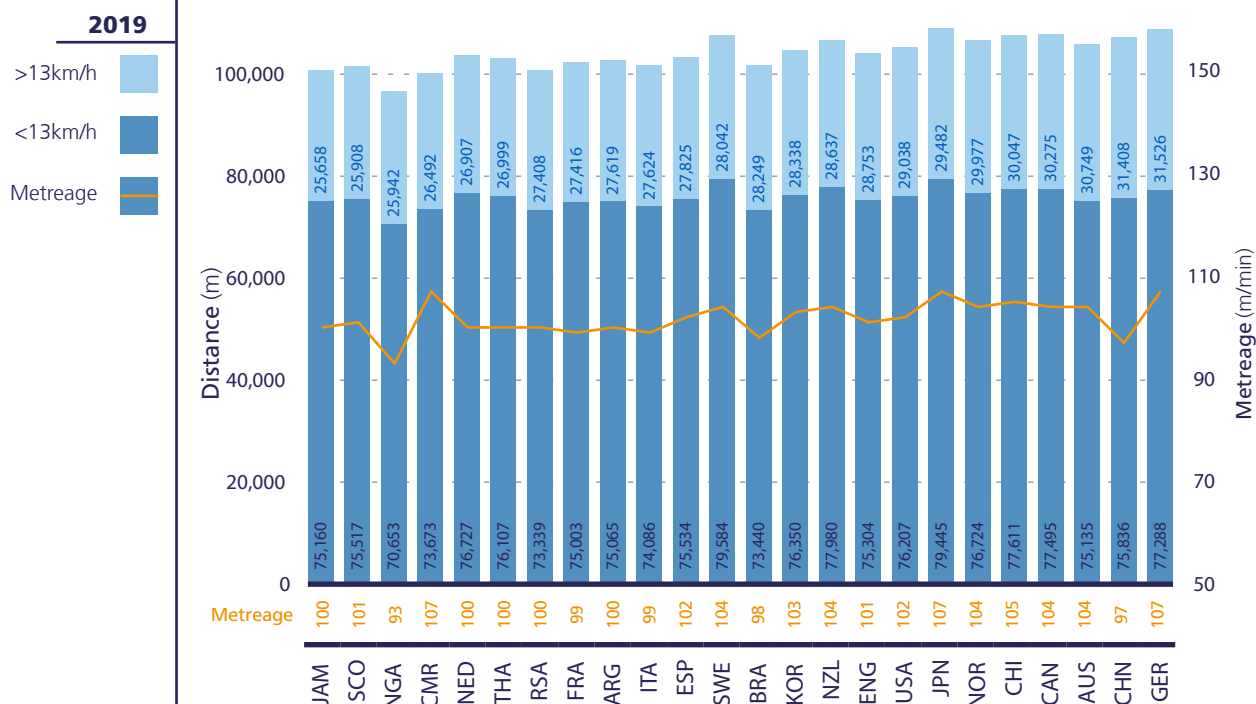


Figure 3. Analysis of the total distance covered (at 0-13km/h and >13km/h) and metrage at France 2019

2015

1st half —

2nd half —

Figures 4 and 5 show the metrage for total distance for the first and second half of matches for each team, throughout the 2015 and 2019 tournaments respectively. In 2015, the only teams to increase their metrage in the second half were New Zealand (14%) and Canada (3%), albeit New Zealand also had the lowest first-half metrage (89m/min), whilst all other teams had a decrease in their total-distance metrage from the first to the second half. The greatest decreases were registered by Thailand (-9%) and Nigeria (-13%), two of the lowest-ranked teams at the tournament. As an average, for the full tournament, metrage for total distance generally decreased from 104m/min in the first half to 100m/min in the second half, a 4% decrease in overall work rate.

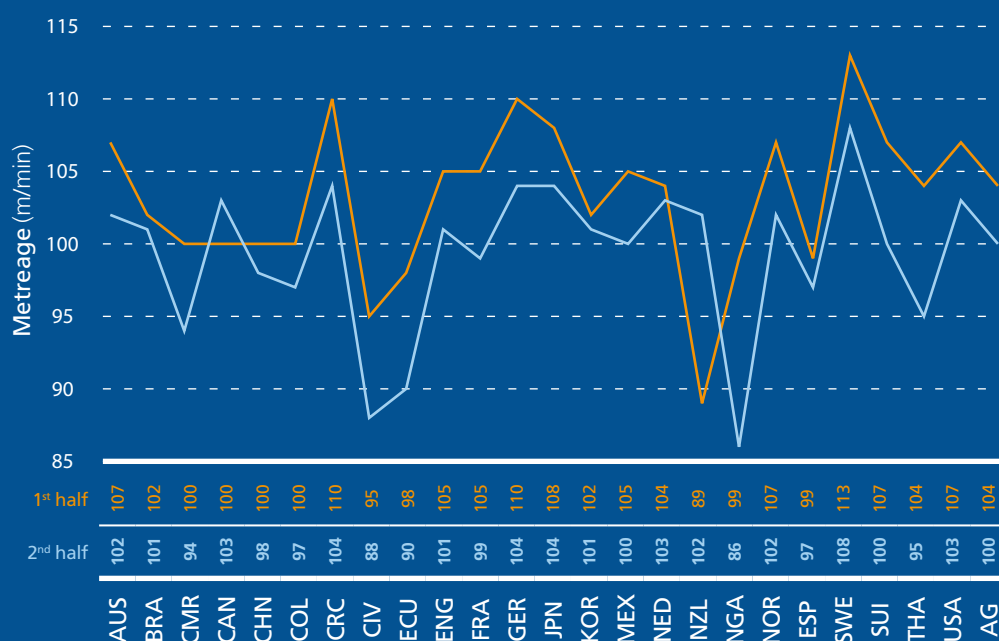


Figure 4. Analysis of the average metrage for total distance during the first and second half of matches at Canada 2015

2019

1st half —

2nd half —

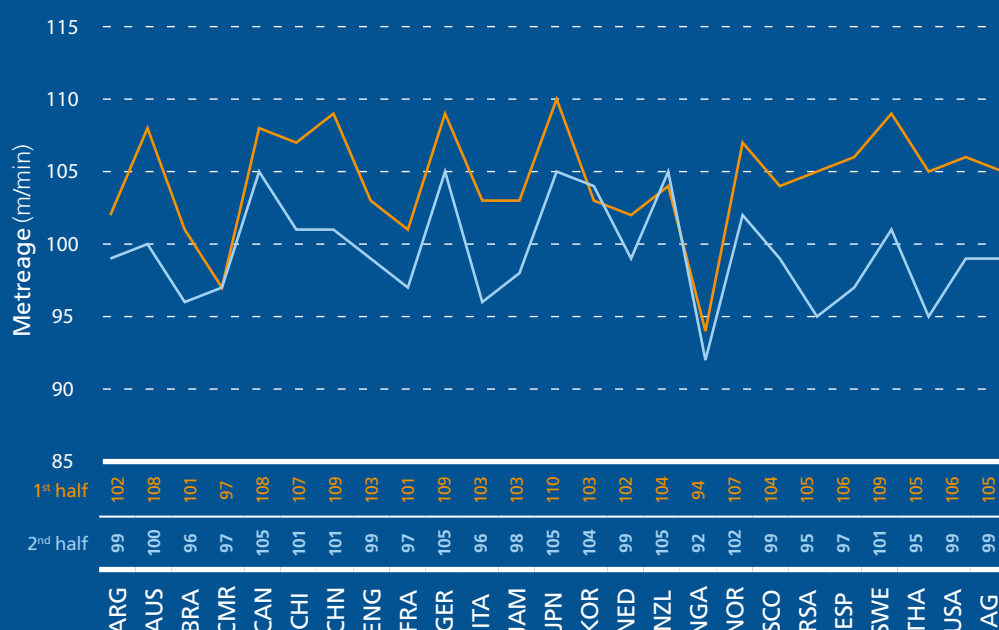


Figure 5. Analysis of the average metrage for total distance during the first and second half of matches at France 2019



Similarly, at the 2019 tournament, only two teams increased their metrage for the total distance they completed from the first to the second half, with New Zealand again being one of those with an increased work rate, although only slightly from 104m/min to 105m/min (a 1% increase). Cameroon were the only other team to very slightly increase their metrage from the first to the second half, although they also had the second-lowest overall metrage (97m/min for each half). All other teams decreased the metrage of their total distance from the first to the second half, with the greatest decreases (all -9%) coming from Thailand – who had posted the same drop in 2015 – and South Africa, both of whom were eliminated in the group stage, and Spain, who were eliminated in the round of 16. Many factors may have contributed to this, including the nature of the match, the need to defend/score a goal, tactical strategy, fatigue, individual player fitness levels, and substitution patterns and impact, as well as technical factors.

Figure 6 shows the total distance covered in each half by each team at France 2019, as well as the percentage difference between each half. Whilst the metrage for total distance for most teams decreased from the first to the second half, the absolute total distance covered was the same or

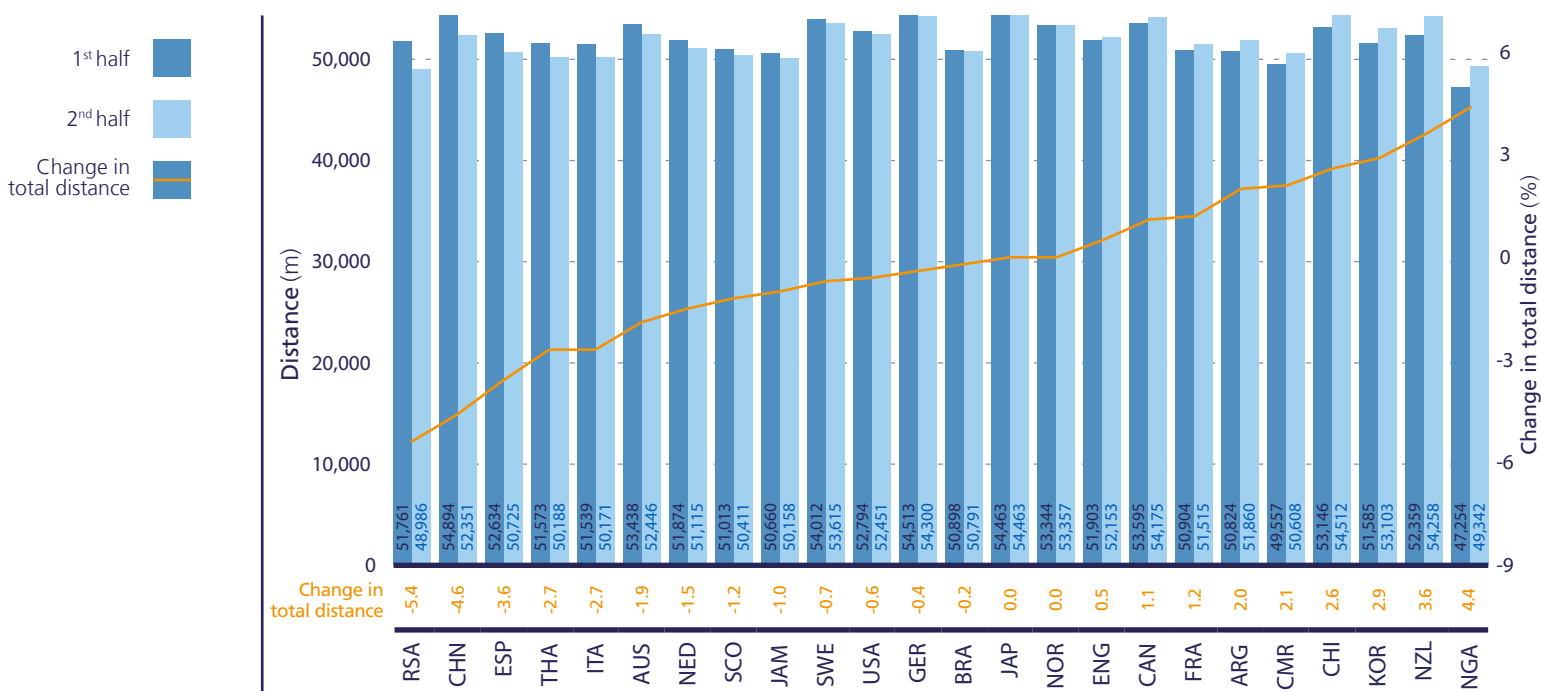


Figure 6. Analysis of the total distances covered during the first and second half of matches at France 2019

increased for over half of the teams. More added time is generally included at the end of games, and at the 2019 tournament, the second half of games was, on average, almost three minutes longer than the first half; this may have influenced the reduced metreage for total distance observed, especially in cases where there were stoppages in play for substitutions, VAR reviews and tactical ploys. Nigeria (4%) and New Zealand (4%) both had the biggest increase in total distance from the first to the second half, although Nigeria also covered the lowest absolute total distance of the 24 competing teams. The four teams reaching the semi-finals of the tournament (the USA, the Netherlands, Sweden and England) completed a similar amount of total distance in the first and second half of games. During the 2015 tournament, the difference in total distance from the first to the second half ranged from -6% (Côte d'Ivoire) to 8% (New Zealand, China PR) – a much larger range compared to the 2019 tournament. As for the four semi-finalists in 2015, the USA and England covered a similar amount of ground from the first to the second half of matches, whilst Germany (-3%) completed less distance on average during the second half of matches and Japan (3%) covered more distance in the second half.

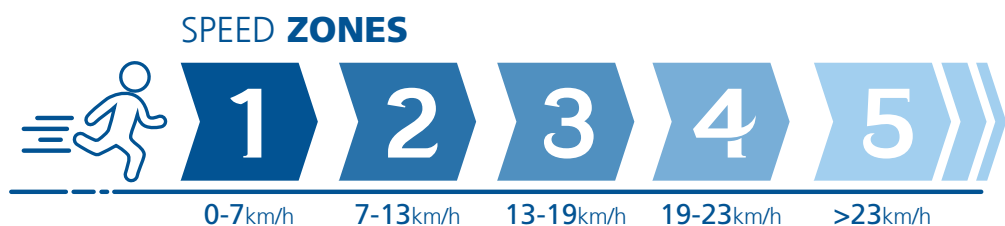
3.2.2 Summary

- Where the last three tournaments are concerned, total distance decreased from 2011 to 2015 but then increased again in 2019.
- One of the biggest differences from 2015 to 2019 was that the range of total distance covered by teams was much reduced in 2019 (30% lower), suggesting that teams are more able to cover a similar amount of distance during matches. Similarly, the range of distance covered at >13km/h also dropped by 30% in 2019, again suggesting that all teams are now capable of completing a greater amount of higher-intensity running activity during matches. This could be a result of the tactical systems employed by teams and the physical output required to be successful; it could also suggest that players' individual fitness levels have improved, resulting in a greater capacity to complete higher-intensity actions.
- Although the average total distance at the 2015 and 2019 tournaments was comparable, during the 2019 tournament, on average, teams completed slightly less lower-speed running (<13km/h) per match and 5%, 15% and 29% more distance in zones 3, 4 and 5 respectively. This again suggests that distance was covered at a greater intensity during matches, which could be the result of players' improved fitness levels as well as the tactical strategies of individual teams.
- By expressing the total distance per minute, the work rate (metreage) of teams can be determined. Based on this, Thailand, South Africa and Spain (-9%) all had the biggest drop in work rate from the first to the second half, the first two teams being eliminated in the group stage. Thailand also had the biggest decrease in 2015, suggesting that their players tired the most from the first to the second half of matches.
- Some of the factors that could contribute to these observations include the playing surface (football turf in 2015), the nature of the match (e.g. first v. third group game and needing a result, group stage v. knockout round), the ranking/level of the opposition, the need to defend/score a goal, tactical formation and strategy and how that changes throughout the match, fatigue, match in tournament, individual player fitness levels, substitution patterns and impact, VAR decisions and delays, as well as technical factors, amongst others.
- What is apparent from these results alone is that the amount of higher-intensity activity completed by teams has increased from 2015, and the physical preparation of players therefore needs to reflect that and prepare players optimally.



CHAPTER 3 SECTION 3

Team analysis | Activity in high-speed zones



3.3.1 Analysis of Zone 3, Zone 4 and Zone 5 activity

Figures 7 and 8 show the average total distance per team covered at >13km/h (broken down into zones 3, 4 and 5), plotted against the team's average possession for all matches throughout the 2015 and 2019 tournaments respectively. The figures are ranked by distance at >19km/h, with the lowest values from left to right. Such speeds are generally when players are more involved in the match, on and off the ball, and can have more impact on the match outcome. For the 2015 tournament, there was a

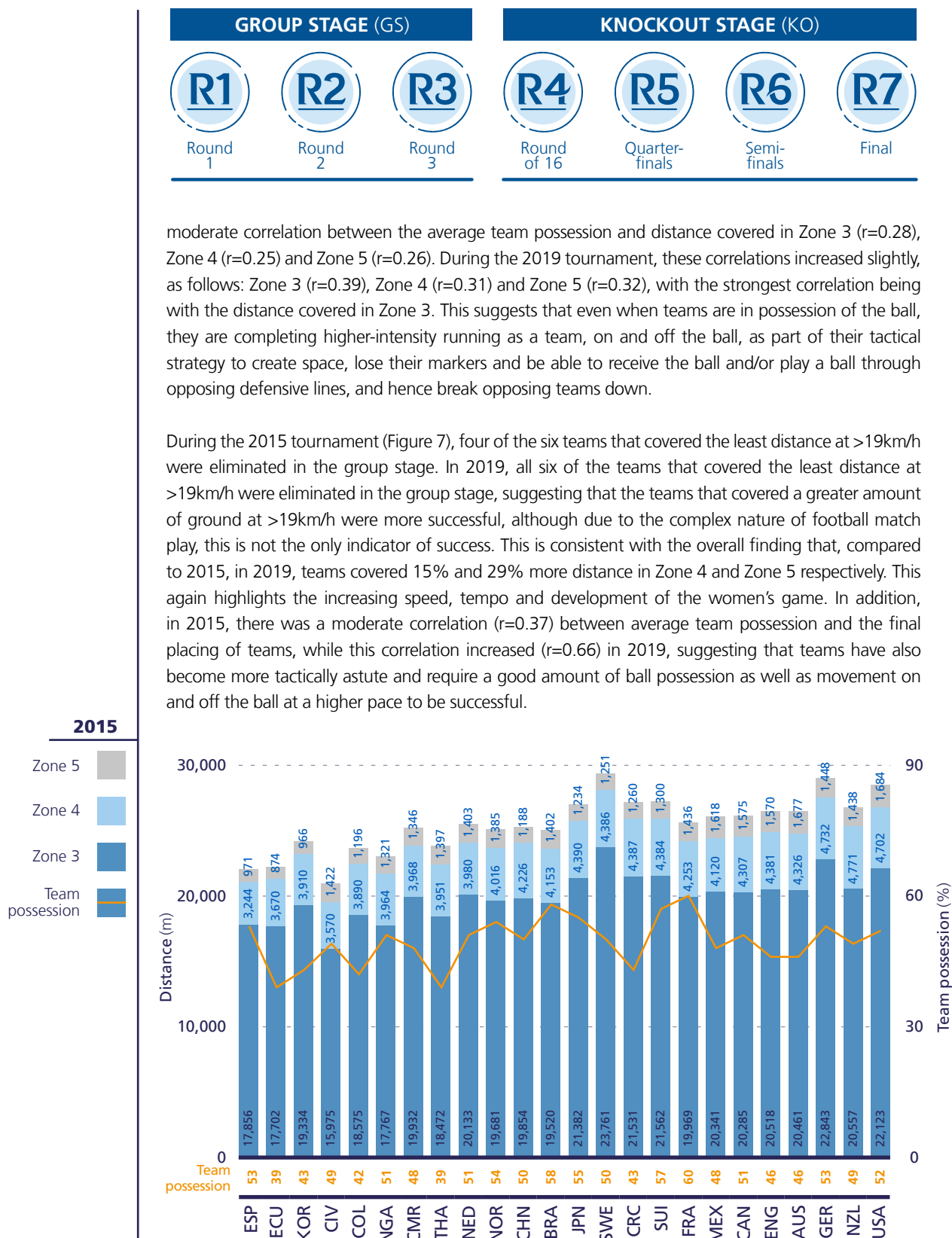


Figure 7. Analysis of the distances covered at $>13\text{km/h}$ and average team ball possession at Canada 2015

Figure 9 shows a comparison of the average total distance covered at >19km/h (broken down into Zone 4 and Zone 5), plotted against the average number of team efforts in Zone 5 for the 2015 and 2019 tournaments, showing a breakdown for the group stage, knockout stage and all games. As can easily be seen, all of the distances and efforts completed at these higher speeds were much higher during the 2019 tournament. For the all-game average in 2019, distances covered in zones 4 and 5 increased by 15% and 29% respectively, and the number of Zone 5 efforts increased by 24%, compared to the 2015 tournament. The differences between the distances and efforts completed during the group stage and knockout rounds only can also be compared (Figure 9). For the 2015 tournament, the distances covered in zones 4 and 5 during the knockout stage increased by 2% and 8% respectively, and the number of Zone 5 efforts increased by 9%, compared to the group stage. In 2019, there was a negligible difference in distance completed in Zone 4 between the group and knockout stages; however, the

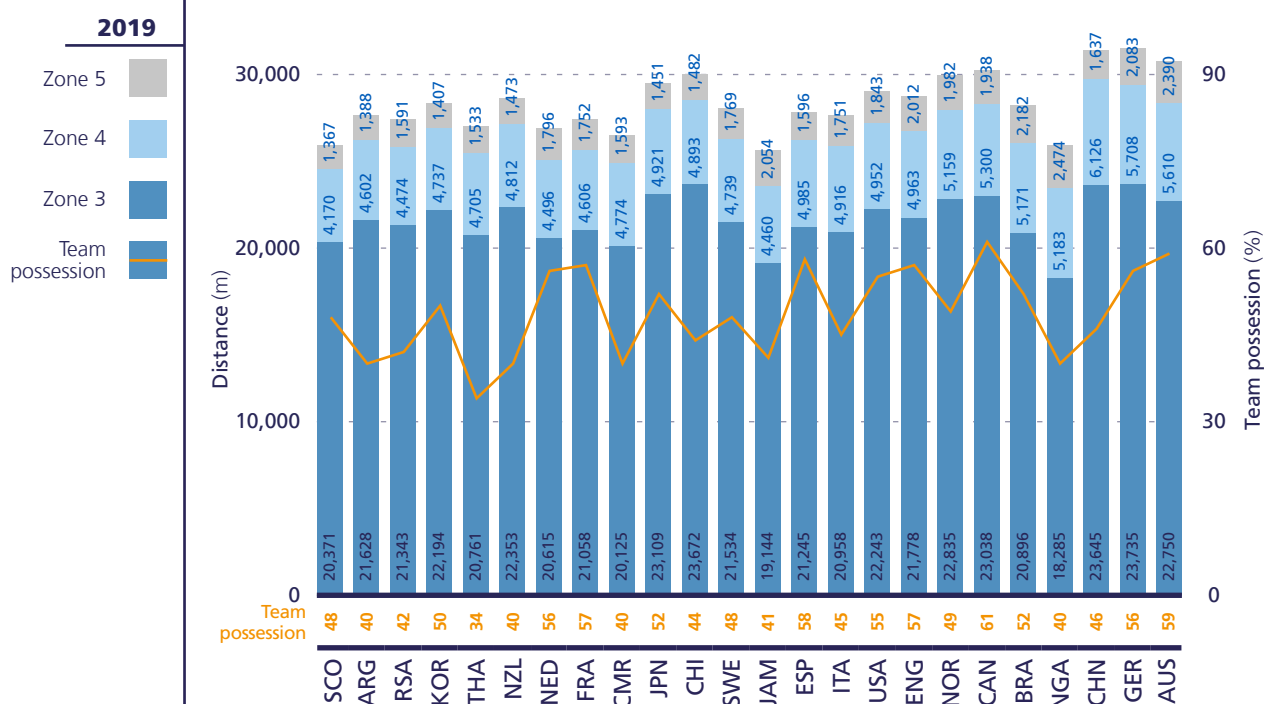


Figure 8. Analysis of the distances covered at >13km/h and average team ball possession at France 2019

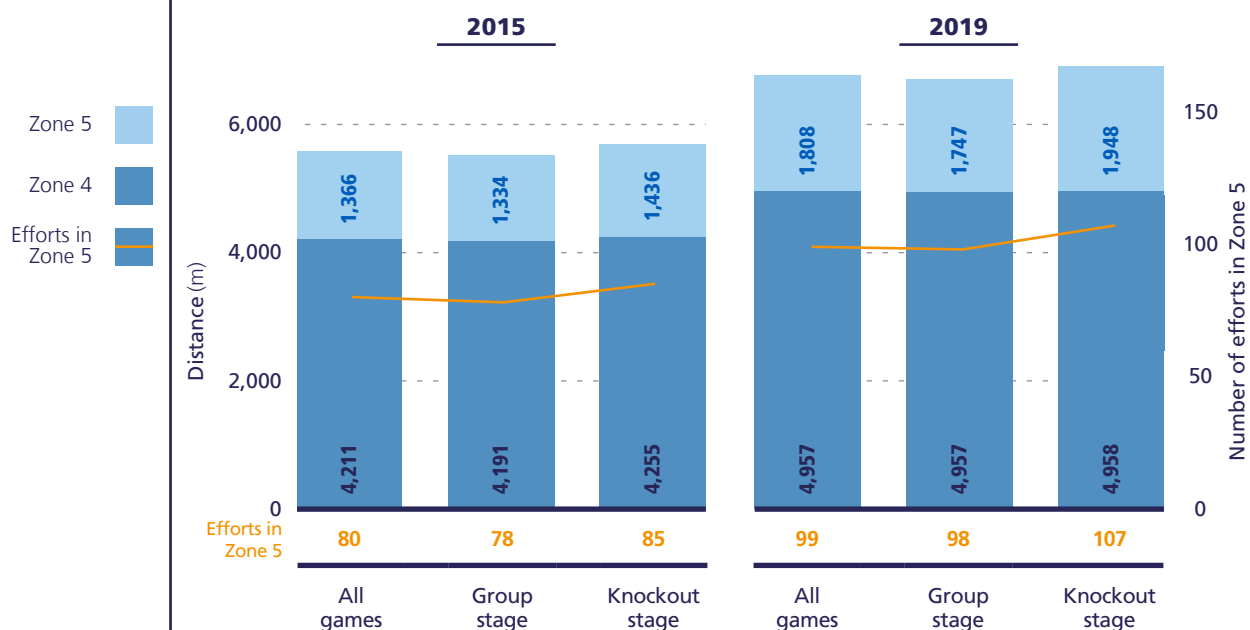


Figure 9. Analysis of the distances covered at >19km/h and efforts in Zone 5 at France 2019 and Canada 2015

distance completed in Zone 5 during the knockout stage increased by 12%, and the number of Zone 5 efforts increased by 8%, compared to the group stage. In comparison, for both tournaments, there was only a very small increase in total distance from the group to the knockout stage, 2% and 1% for 2015 and 2019 respectively. This again suggests that, whilst there is very little difference in the total distance completed in the group stage compared to the knockout rounds, the amount of distance and number of efforts completed at the higher-intensity speeds are greater again, suggesting a further increase in the pace of the games involving the higher-ranked teams, and an increased physical load placed on players for their team to be successful.

Figures 10 and 11 show the average total distance, for each team, covered at >19km/h (broken down into Zone 4 and Zone 5), plotted against the average number of team efforts in Zone 5 for all of their matches throughout the 2015 and 2019 tournaments respectively. The figures are ranked by distance at >19km/h, with the lowest values from left to right. On average, throughout the 2015 tournament, the winners the USA completed the most distance in Zone 5, followed by New Zealand, who were eliminated in the group stage; hence, whilst completing more running at higher intensities has been shown to lead to more success in teams, simply completing more higher-speed activity is not a guarantee of success alone. The USA also completed an average of 100 efforts in Zone 5 for each match, compared to 75 on average for the eight teams eliminated in the group stage. At the 2015 tournament, there was a moderate correlation between the final ranking of the team and the distance covered in Zone 5 ($r=0.40$), as well as the number of Zone 5 efforts ($r=0.42$). There was a much stronger correlation ($r=0.54$) between the distance covered by teams in Zone 5 and the final placing of teams at the 2019 tournament. This is consistent with the strong correlation ($r=0.57$) outlined above between the final placing of teams and the distance covered at >13km/h.

As was shown previously (Figure 9), all distances covered at >19km/h and efforts completed in Zone 5 were higher during the 2019 tournament, and this is evident in Figure 11. Six of the eight teams that were eliminated in the group stage in France covered the least distance at >19km/h; however, unlike in 2015, where three of the four semi-finalists were in the top five for the most distance at >19km/h, the teams that reached the semi-finals in 2019 ranked eighth, ninth, 13th and 18th (out of 24) for the most distance covered at >19km/h. This suggests that despite the average increase in the distance covered at higher speeds from 2015 to 2019, and from the group stage to the knockout rounds, the tactical strategy and understanding of teams and individual players alike are also important to be successful.

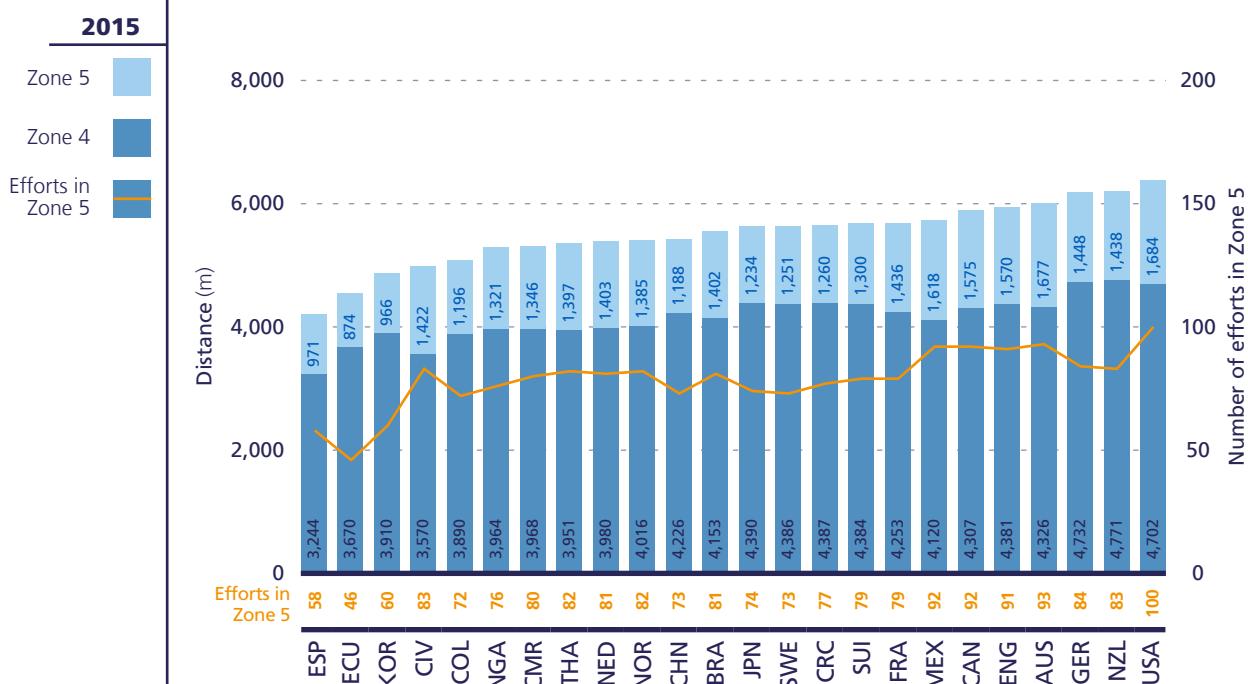


Figure 10. Analysis of the distances covered at >19km/h and efforts in Zone 5 at Canada 2015

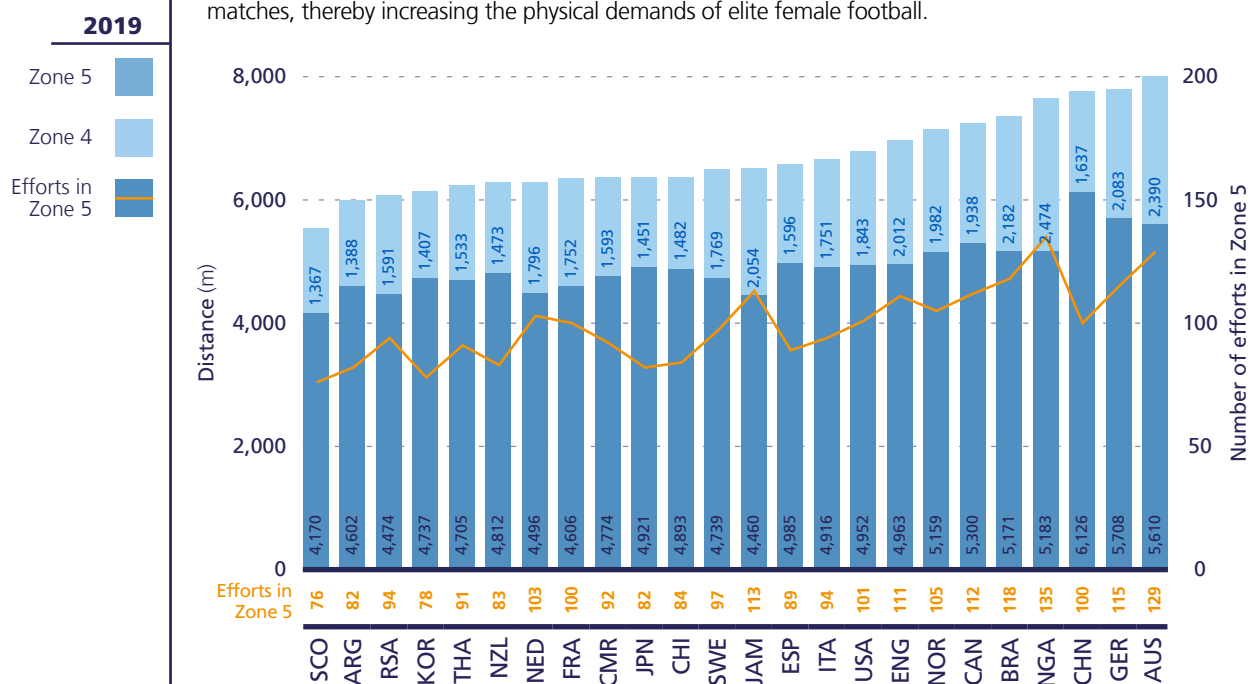


Figure 11. Analysis of the distances covered at >19km/h and efforts in Zone 5 at France 2019

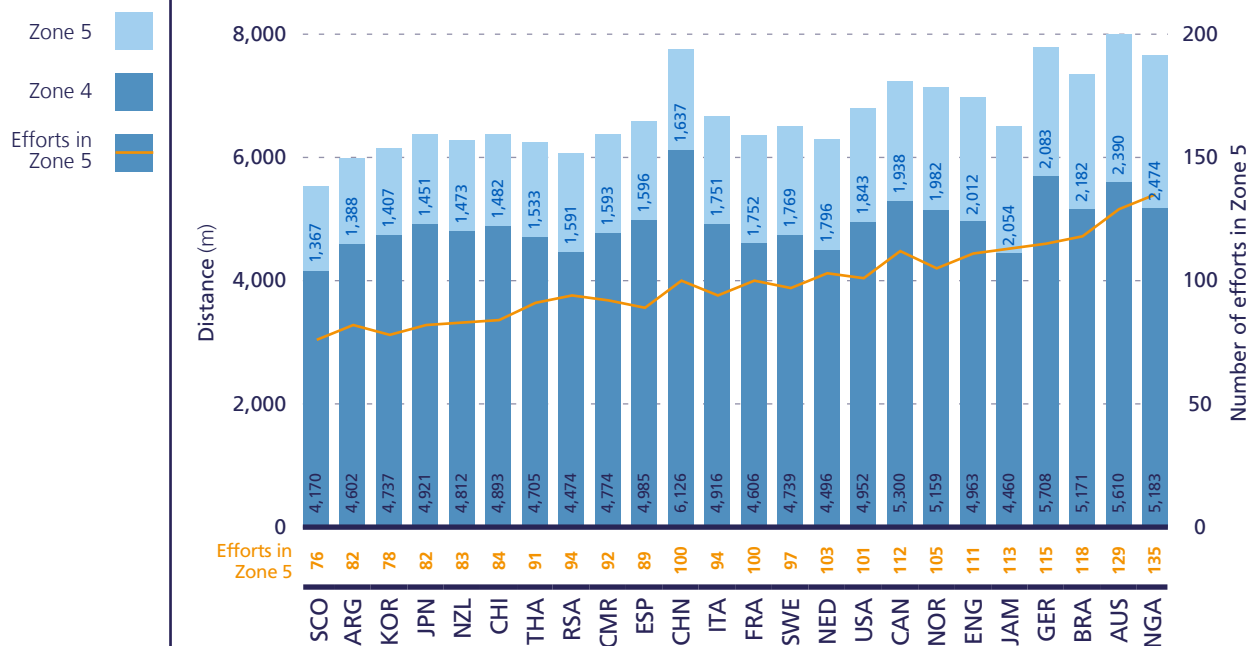


Figure 12. Analysis of the distances covered at >19km/h and efforts in Zone 5 at France 2019, ranked by Zone 5 distance

3.3.2 Analysis of distance covered in Zone 3

3
13-19km/h

Figure 13 shows the Zone 3 distance covered by each team during each half of the games and for each stage of the tournament, as well as the percentage difference from the first to the second half, at France 2019 only. The figure is ranked by the amount of distance covered in the first half, with the lowest values from left to right. Only seven of the 24 teams increased the amount of distance that they covered from the first to the second half, which could be the result of fatigue as well as changes in tactical focus/formation, amongst other factors. Cameroon and New Zealand (10%) had the joint-greatest increase in Zone 3 distance covered from the first to the second half, with Cameroon covering the second-lowest amount in the first half. China PR (-13%), who covered the most distance in the first half, had the greatest drop in distance covered. When looking at the differences depending on the stage of the tournament, on average, there was a small drop at all stages from the first to the second half: all games (AG; -3%), the group stage (GS; -2%) and the knockout rounds (KO; -2%).

Figure 14 shows the metrage in Zone 3 for each team during each half of the games and for each stage of the tournament, as well as the percentage difference from the first to the second half, at France 2019 only. The figure is ranked by the decrease in metrage from the first to the second half, with the greatest drop from left to right. Similar to the drop in absolute distance covered from the first to the second half (Figure 13), China PR (-16%) had the biggest drop in metrage from the first to the second half, although they also had the highest metrage (24.3m/min) in the first half. Cameroon (8%) had the biggest increase in metrage from the first to the second half, but also had the second-lowest metrage (18.1m/min) of all teams in the first half. The metrage for the group stage (21.4m/min) was higher than for the knockout stage (20.5m/min), while the metrage dropped more for the knockout stage compared to the group stage (-8% and -6% respectively).

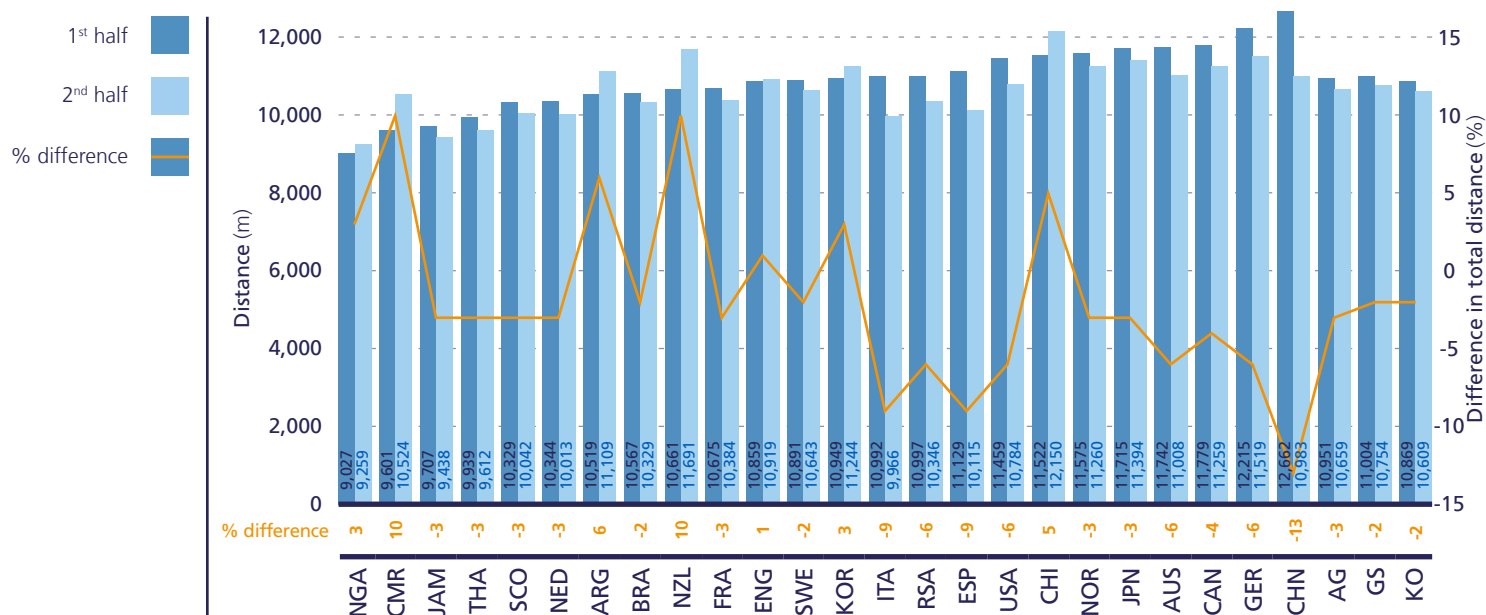


Figure 13. Analysis of the total distance covered by each team, and for each stage of the tournament, in Zone 3 during the first and second half of matches at France 2019

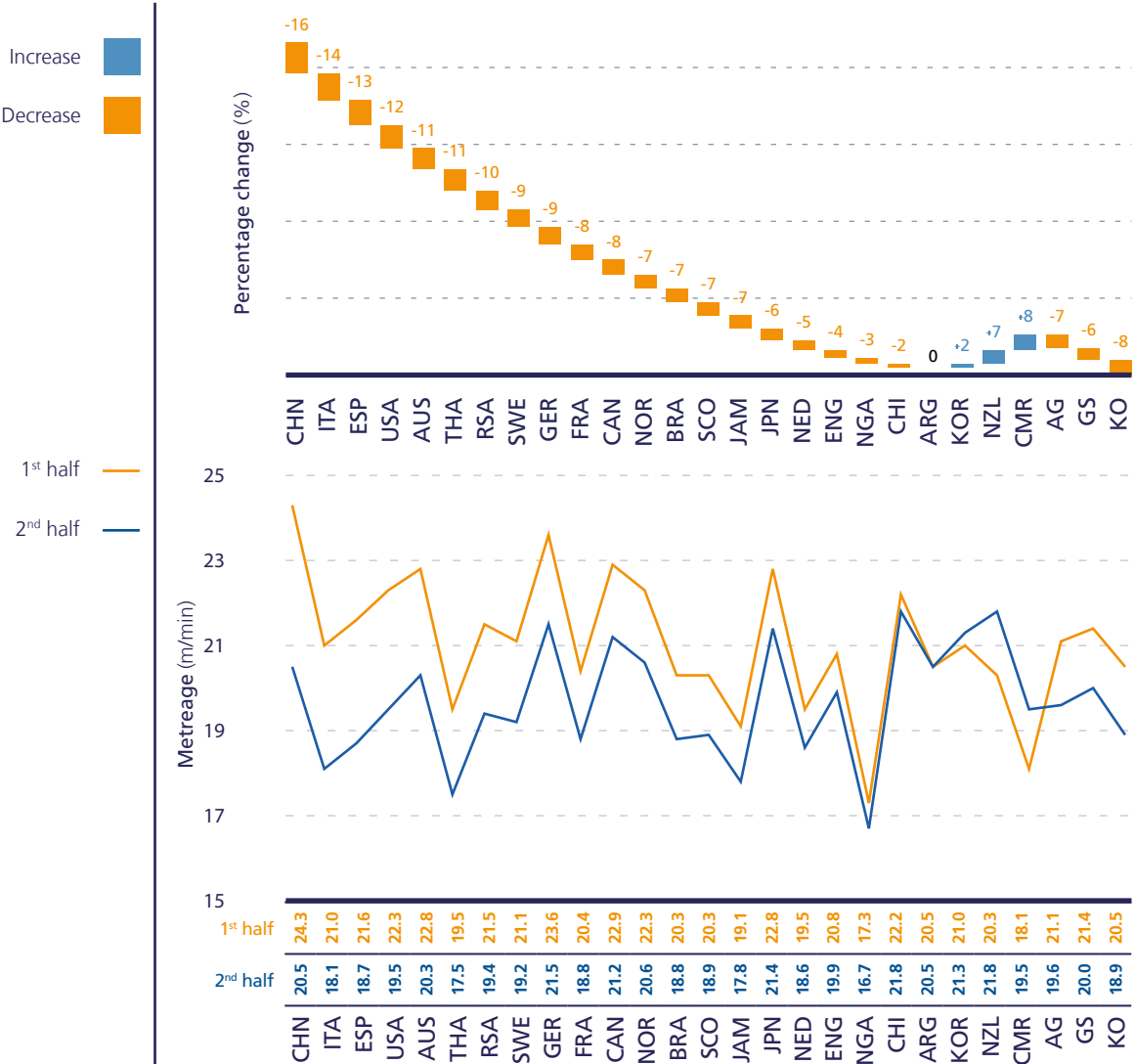


Figure 14. Comparison of the Zone 3 metrage during the first and second half of matches, and percentage change, for all teams and all stages of the tournament, at France 2019

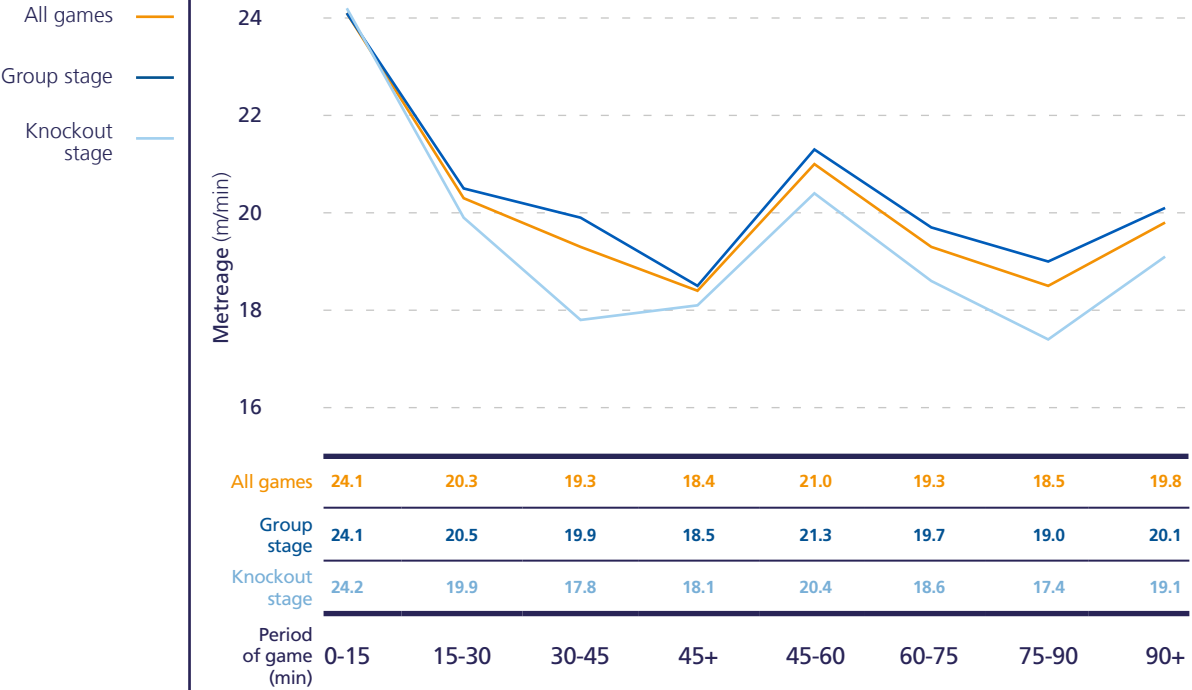


Figure 15. Comparison of the Zone 3 metrage for every 15-min interval, during all stages of the tournament, for France 2019

Figure 15 shows the metreage in Zone 3 for every 15-min period, across the stages of the tournament at France 2019 only. The metreage was highest for all three stages during 0-15min, and was very similar. The metreage for all stages declined as the half progressed, with the decreases being -24% (all games), -23% (group stage) and -25% (knockout stage) immediately before the end of the first half (45+min). During 45-60min, the metreage was higher than the end of the first half, but was lower than the first 15-min period of the game for all stages: all games (21.0m/min; -13%), the group stage (21.3m/min; -12%) and the knockout stage (20.4m/min; -16%). For all three stages of the tournament, the metreage then dropped before increasing during the final period of games (90+min), which could be due to the need to score/defend and more urgency around the game outcome during the latter stages of games. During 75-90min and 90+min, the metreage dropped from the first period of the game for all stages of the tournament – all games (-23%, -18%), the group stage (-21%, -17%) and the knockout stage (-28%, -21%) – with the metreage being the lowest in the knockout rounds for both of those periods in the game.

3.3.3 Analysis of distance covered in Zone 4

4

19-23km/h

Figure 16 shows the distance covered in Zone 4 for each team during each half of the games and for each stage of the tournament, as well as the percentage difference from the first to the second half, at France 2019 only. The figure is ranked by distance covered in the first half, with the lowest values from left to right. Compared to Zone 3, 14 of the 24 teams increased the amount of distance covered from the first to the second half at speeds in Zone 4; however, as highlighted earlier, there was only a moderate ($r=0.31$) correlation between distances in this zone and the final placing of the teams. Three of the five teams with the greatest increase from the first to the second half, Scotland (13%), South Africa (15%) and Cameroon (24%), were the three lowest-ranking sides for the amount of

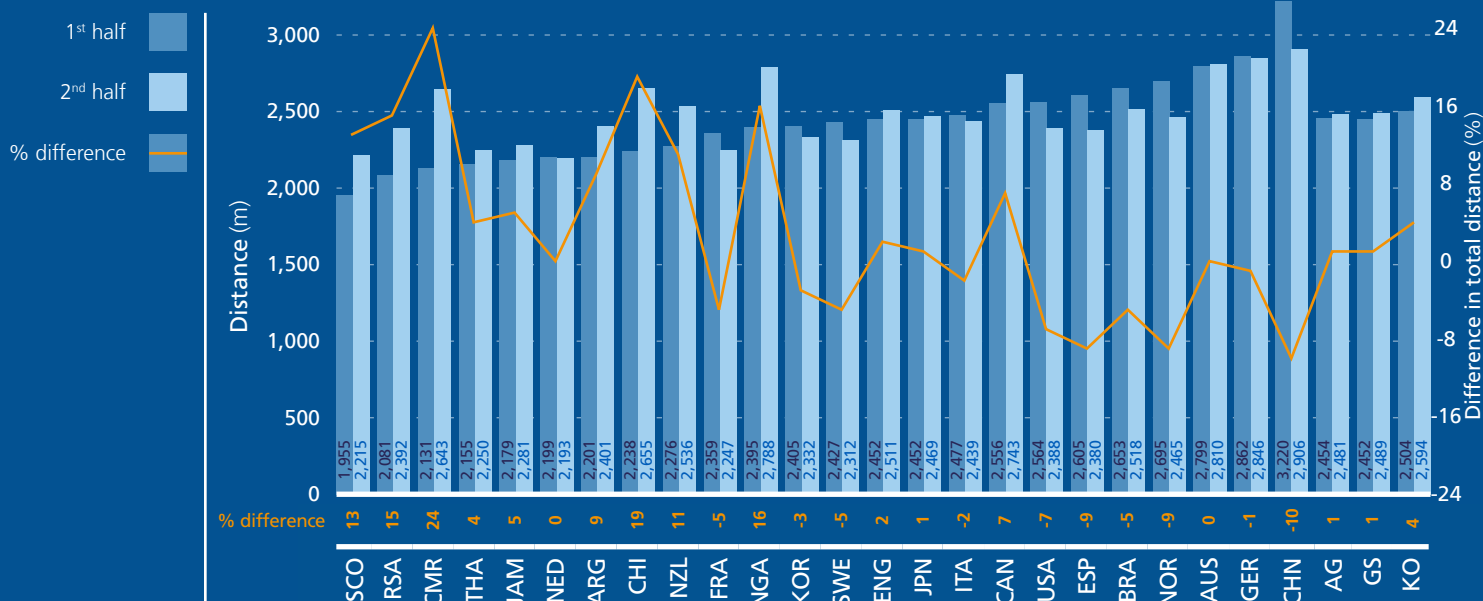


Figure 16. Analysis of the total distance covered by each team, and for each stage of the tournament, in Zone 4 during the first and second half of matches at France 2019

distance covered in the first half. Similar to the previous zone, China PR (-10%), who covered the most distance in the first half, had the greatest drop in distance covered in the second half. When looking at the differences depending on the stage of the tournament, on average there was an increase for all stages: all games (1%), the group stage (1%) and the knockout stage (4%); the higher increase for the knockout rounds could be due to teams needing to press more to force a goal and change the outcome of the game in the elimination stage.

Figure 17 shows the metrage in Zone 4 for each team during each half of the games and for each stage of the tournament, as well as the percentage difference from the first to the second half. The figure is ranked by the decrease in metrage from the first to the second half, with the greatest drop from left to right. Similar to the decline in absolute distance covered from the first to the second half (Figure 16), the USA, Norway and Spain (-13%) had the biggest drop in metrage from the first to the second half, with China PR and Sweden (-12%) having the next-biggest decrease, although China PR again also had the highest metrage (6.16m/min) in the first half. Cameroon (21%), again, had the biggest increase in metrage from the first to the second half (3.99 to 4.84m/min), but also had the second-lowest metrage of all teams in the first half. The metrage for the knockout stage (4.74m/min) was higher than for the group stage (4.62m/min), while the metrage dropped more for the knockout stage compared to the group stage (-7% and -3% respectively).

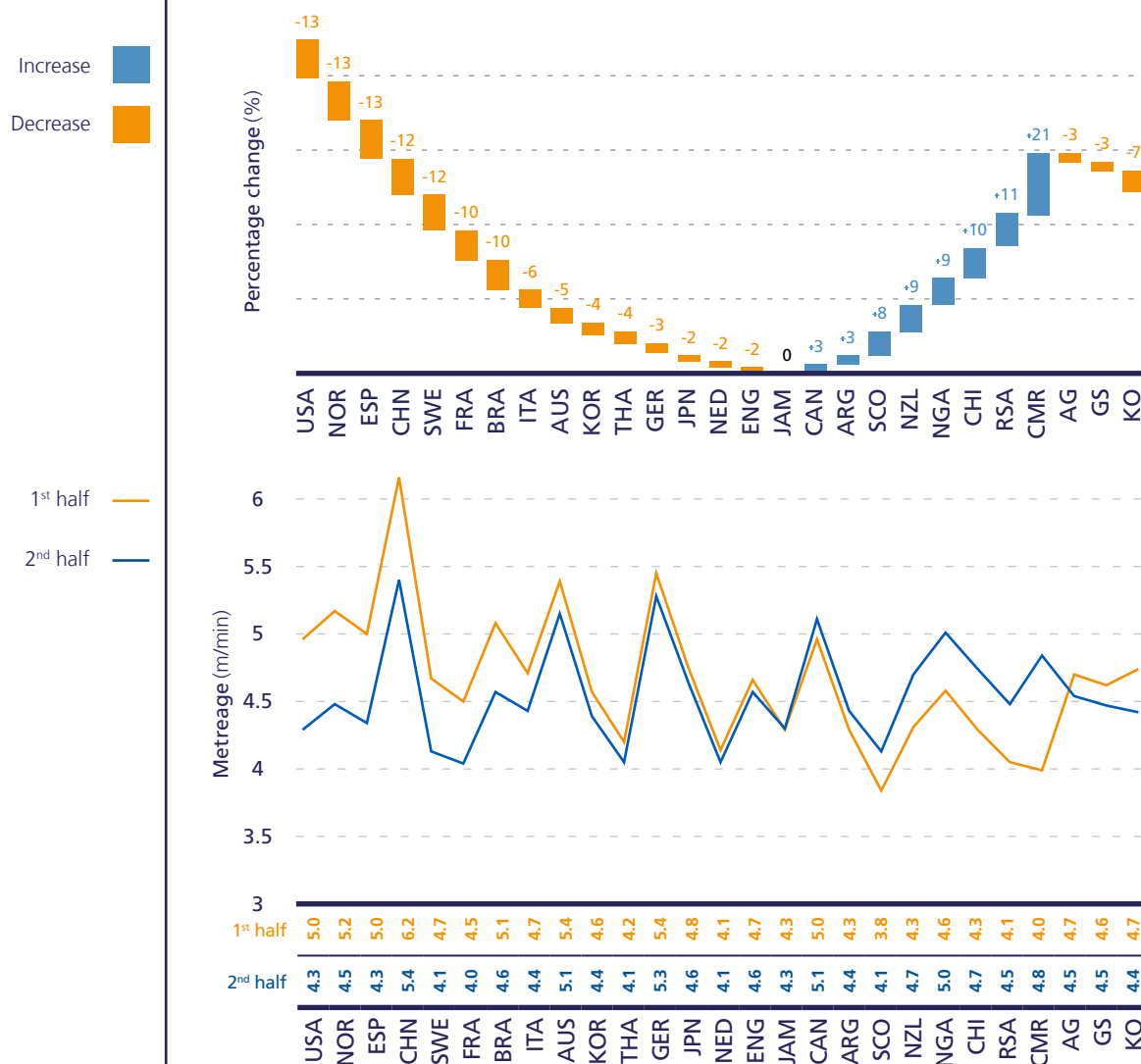


Figure 17. Comparison of the Zone 4 metrage during the first and second half of matches, and percentage change, for all teams and all stages of the tournament, at France 2019



Figure 18 shows the metreage in Zone 4 for every 15-min period, across the stages of the tournament. The metreage was highest for all three stages during 0-15min, and was highest for the knockout stage, 5.55m/min, compared to 5.27m/min during the group stage. The metreage for all stages decreased as the half progressed, doing so most sharply in the knockout stage, with the decreases being -19% (all games), -13% (group stage) and -32% (knockout stage) immediately before the end of the first half (45+min). At the start of the second half (45-60min), the metreage was higher than at the end of the first half, but was lower than in the first 15-min period of the game for all stages: all games (4.88m/min; -9%), the group stage (4.92m/min; -7%) and the knockout stage (4.78m/min; -14%). For all three stages of the tournament, the metreage then dropped before increasing during the final period of games (90+min), which again could be due to the need to score/defend and more urgency around the game outcome during the latter stages of games. During 75-90min and 90+min, the metreage dropped from the first period of the game for all stages of the tournament – all games (-21%, -15%), the group stage (-17%, -13%) and the knockout stage (-28%, -19%) – with the metreage being the lowest for the knockout stage for both of those periods in the game. This could in part be due to the extra games teams have accumulated once they reach the knockout stage of the tournament, and an increasing level of fatigue and inability to sustain higher-workload intensities.

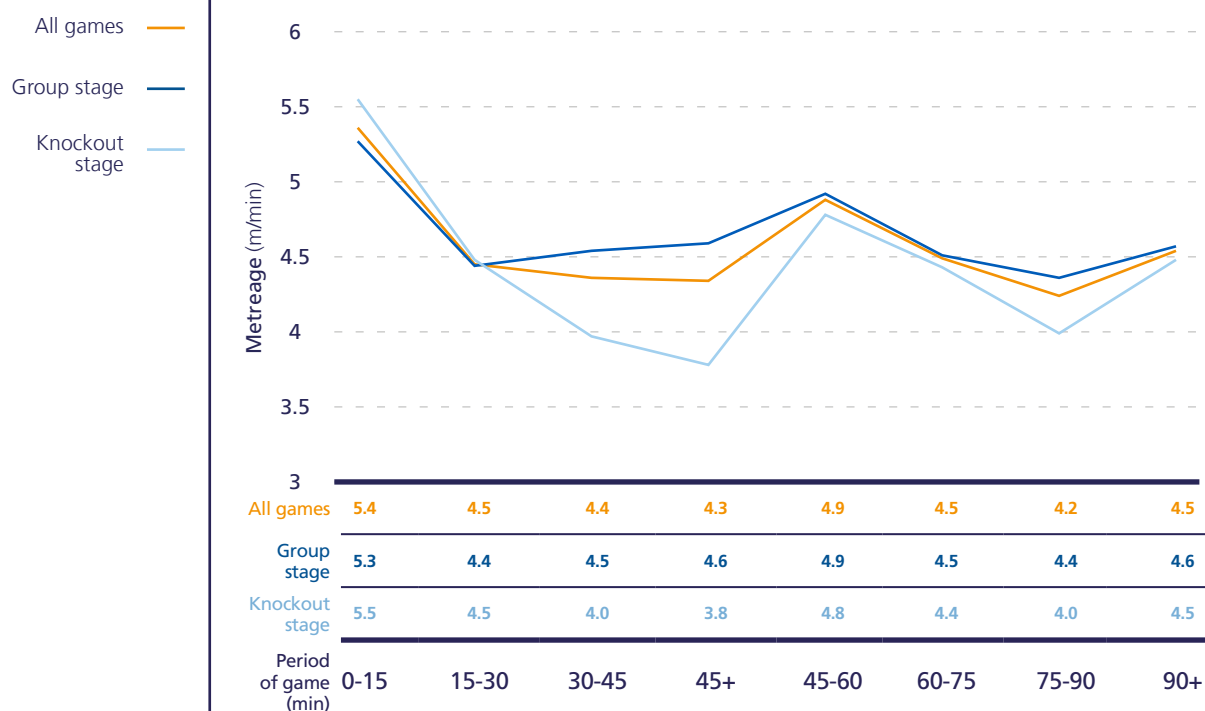


Figure 18. Comparison of the Zone 4 metreage for every 15-min interval, during all stages of the tournament, for France 2019



3.3.4 Analysis of distance covered in Zone 5

5
>23km/h

Figure 19 shows the Zone 5 distance covered for each team during each half of the games and for each stage of the tournament, as well as the percentage difference from the first to the second half, at France 2019 only. The figure is ranked by distance covered in the first half, with the lowest values from left to right. The majority of teams (15 of the 24) increased the amount of distance covered from the first to the second half. Scotland completed the least amount of distance in Zone 5 during the first half (576m) and increased this the most (37%) in the second half. Sweden, Norway (-16%) and the USA (-15%) decreased the amount of distance they covered from the first to the second half by the most. When looking at the differences depending on the stage of the tournament, on average, there was an increase for all stages: all games (1%), the group stage (1%) and the knockout stage (6%); the higher increase for the knockout stage could again be due to teams needing to press more to force a goal and change the outcome of the game in the elimination stage, and this metric had a strong correlation ($r=0.54$) with final placing in the tournament.

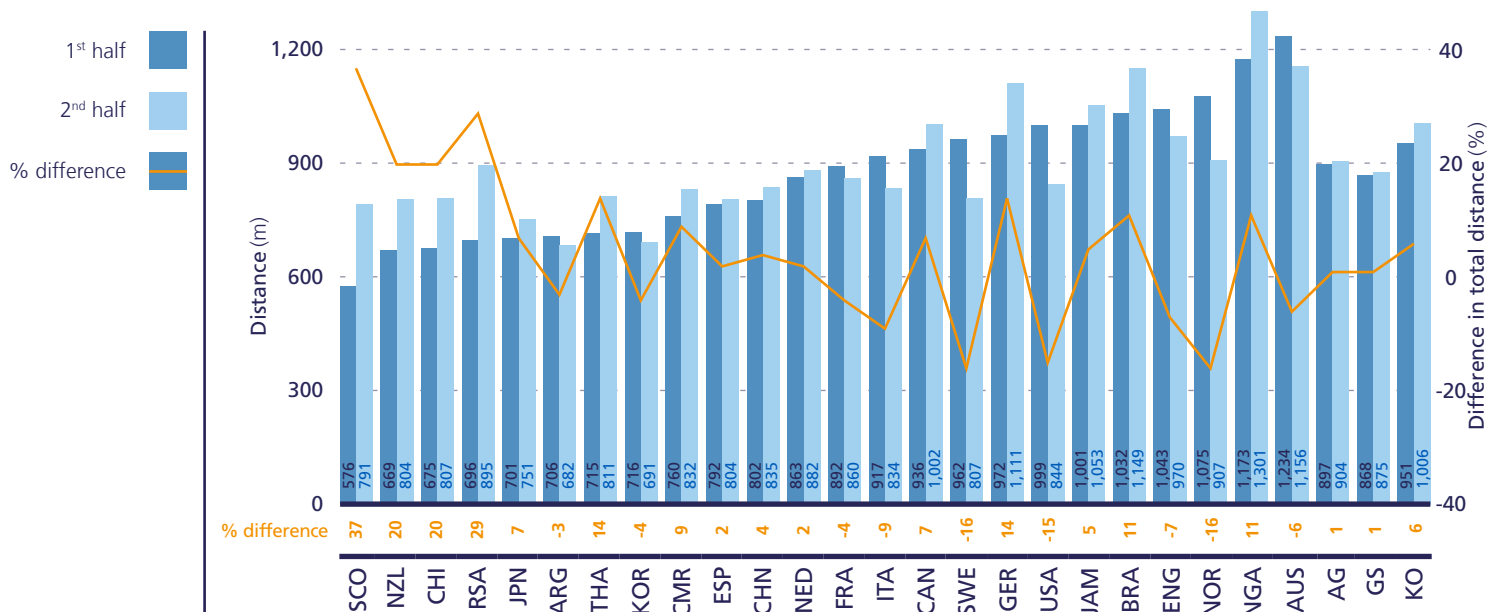


Figure 19. Analysis of the total distance covered in Zone 5 by each team, and for each stage of the tournament, during the first and second half of matches at France 2019

Figure 20 shows the metrage in Zone 5 for each team during each half of the games and for each stage of the tournament, as well as the percentage difference, at France 2019 only. The figure is ranked by the decrease in metrage from the first to the second half, with the greatest drop from left to right. Similar to the decline in absolute distance covered from the first to the second half (Figure 19), the USA, Sweden (-21%) and Norway (-20%) had the biggest drop in metrage from the first to the second half. Australia (2.38m/min) had the highest metrage in the first half, which dropped by 11% in the second half (2.11m/min). Nigeria (2.25m/min) had the second-highest metrage in the first half, and then increased that by 4% (2.34m/min) in the second half. Chile, New Zealand, South Africa and Scotland, who were all eliminated in the group stage, completed the lowest metrage in the first half of their games, and all had the highest increase in their metrage in the second half (12%, 18%, 24% and 31% respectively). This could be due to increased urgency in the second half to change the result in a game and avoid being eliminated in the group stage of the tournament. The metrage for all games, the group stage and the knockout stage in the first half was 1.72m/min, 1.81m/min and 1.68m/min respectively. This dropped in the second half for all games (-4%) and the group stage (-22%), but slightly increased for the knockout stage (3%).

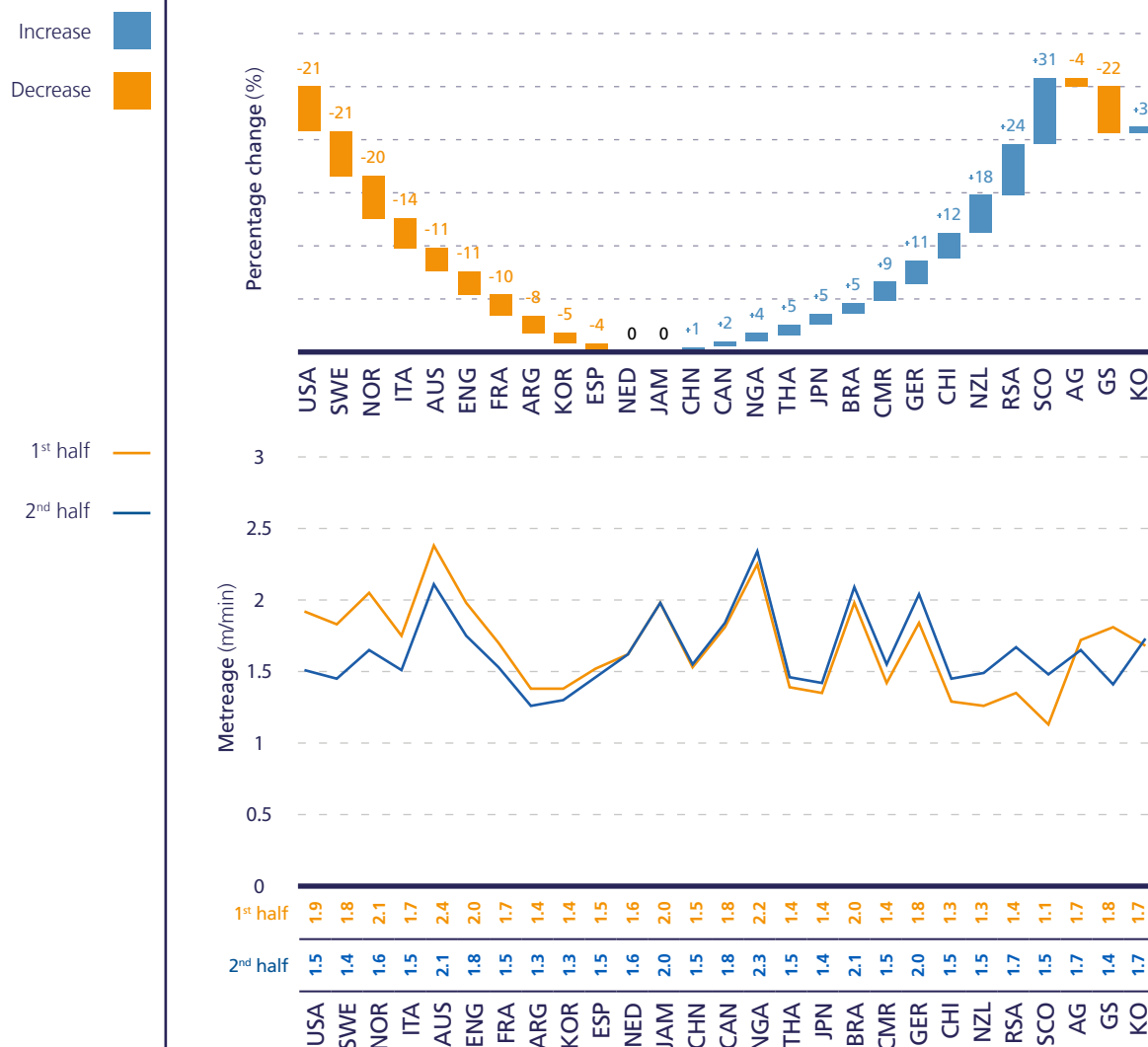


Figure 20. Comparison of the metrage in Zone 5 during the first and second half of matches, and percentage change, for all teams and all stages of the tournament, at France 2019

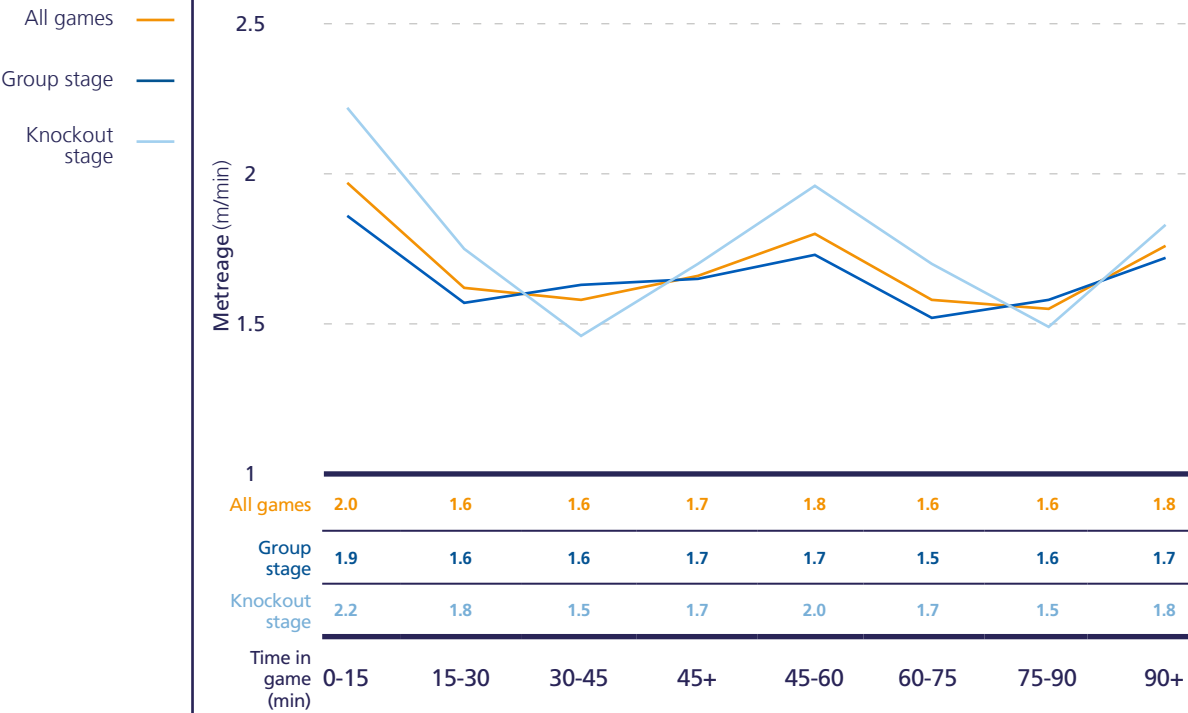


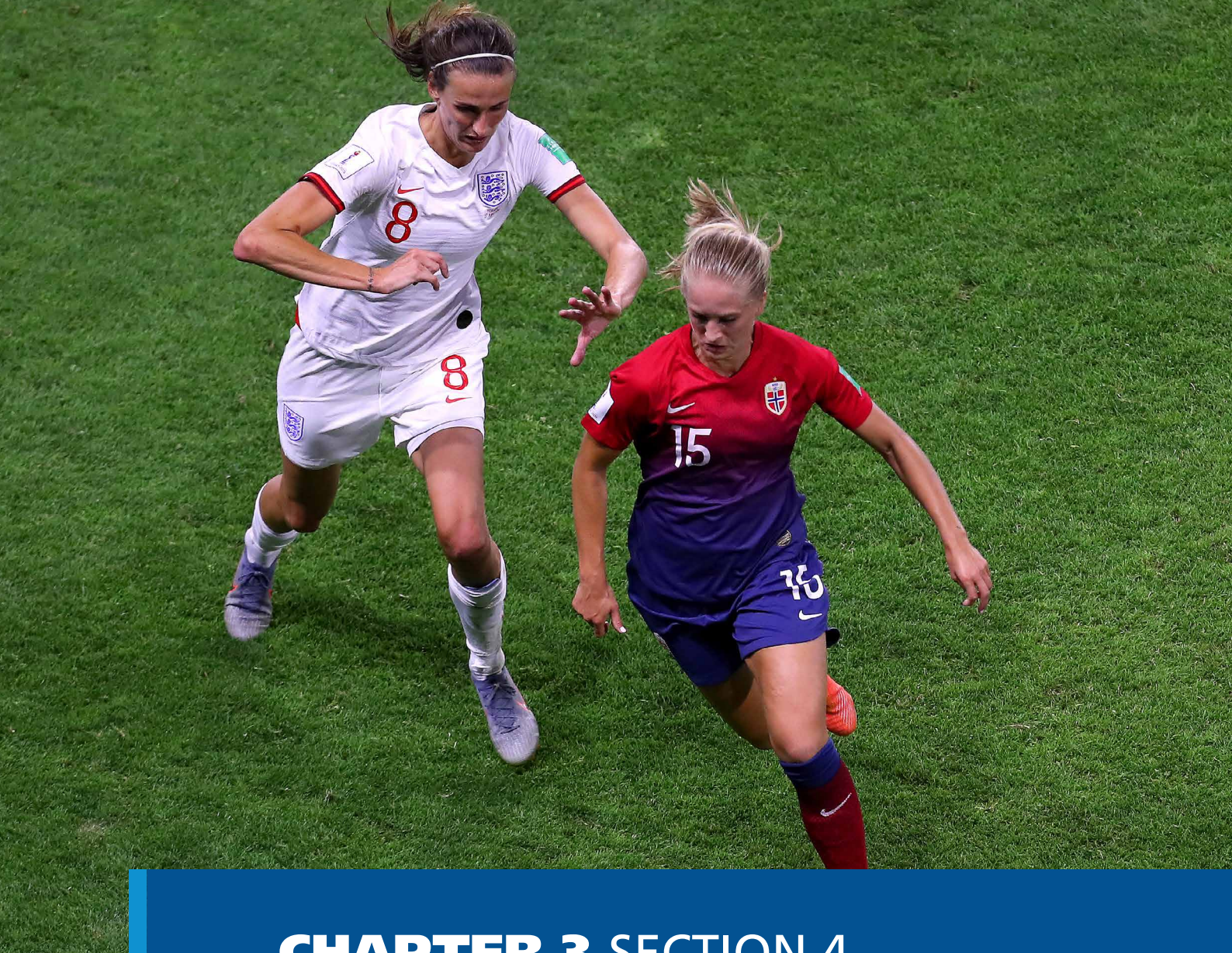
Figure 21. Comparison of the metreaage in Zone 5 for every 15-min interval, during all stages of the tournament, for France 2019



stages of the tournament, the metreage then dropped before increasing during the final period of games (90+min), which again could be due to the need to score/defend and more urgency around the game outcome during the latter stages of games. During 75-90min and 90+min, the metreage dropped from the first period of the game for all stages of the tournament – all games (-21%, -11%), the group stage (-15%, -8%) and the knockout stage (-33%, -18%) – with the metreage being the highest (1.83m/min) during the final period (90+min) of the game in the knockout stage.

3.3.5 Summary

- The amount of higher-speed activity (>13km/h) completed during the 2019 tournament was higher than in 2015, with an increase of 5%, 15% and 29% for distance in zones 3, 4 and 5 respectively. This alone reflects an increase in the intensity of the game demands for elite female players.
- In 2019, there was a stronger correlation between team ball possession and running at the higher speeds, suggesting that, even where teams are in possession of the ball, they are completing higher-intensity running as a team, on and off the ball, as part of their tactical strategy.
- In 2019, there was an increase in running and efforts in Zone 5 from the group stage to the knockout rounds, which again reflects an increase in the pace of the games in the later stages, contested by the higher-ranked teams, and an increased physical load on players to be successful.
- For the 2019 tournament, there was a moderate correlation between the final ranking of the team and the distance covered in Zone 4 ($r=0.31$). However, the correlation between final ranking and the number of efforts ($r=0.51$) and distance in Zone 5 ($r=0.54$) was much stronger, suggesting that distance covered, and efforts completed, in the top speed zone are a much stronger indicator of team success.
- The metreage for all of the higher speed zones in 2019 was highest during the first quarter of an hour of games, and then dropped as the game progressed. There was generally an increase in the work rate for these speed zones from 75-90min to 90+min, suggesting that teams were completing more high-intensity running in an attempt to protect or force a result based on their tactical strategy.
- Moreover, in 2019, during the first 15-min period of the second half, all teams covered less distance at the higher intensities than during the first 15-min period of the match, suggesting players were not physically prepared to start the second half of the match, as well as accumulated fatigue from the first half. With this in mind, trainers and coaches should review half-time strategies and then look to introduce a re-warm-up strategy (Lovell et al., 2007) that is optimal and appropriate for players starting the second half.
- Teams that tended to complete the lowest metreage (New Zealand, South Africa and Scotland) for the higher-speed activities in the first half of games in 2019 would make the biggest improvement in the second half, but would be less successful in the tournament and were generally eliminated in the group stage, suggesting that their tactical system was not optimal for game success.
- Conversely, also in 2019, the USA generally had the highest drop-off in the metreage for the higher-intensity running from the first to the second half of games; however, they also scored a goal during the first 15min of all of their first six games at the tournament, suggesting that this was part of their tactical strategy and game plan. Substitution plans and changes in tactical formation during the second half of games would also have a big impact on the metreage of these metrics as games progress.



CHAPTER 3 SECTION 4

Team analysis | Distances covered in ball-out-of-play situations, in and out of possession

3.4.1 Analysis of the distance covered in all three ball-related scenarios for all stages of the tournament

At any one point during a game, either the ball is out of play (BOOP) or a team is in possession of the ball (IP) or out of possession of the ball (OOP). The amount of distance that teams complete during each of those moments will largely depend on their tactical formation and their resulting shape and compactness, both in and out of possession of the ball, as well as their urgency (or not) to gain possession of the ball if there is a need to score a goal, depending on the stage of the game and the tournament. This will also be determined by the tactical understanding of each individual player, as well as the commitment to the formation and game plan developed by the head coach.



Figure 22 shows a comparison of the total distance covered in ball-out-of-play situations, in possession and out of possession, comparing the group stage, the knockout stage and all games throughout the tournament. When the ball was out of play, teams on average covered 27%, 28% and 27% of their total distance for the group stage, knockout stage and all games respectively. The greatest proportion of total distance was covered when out of possession, with teams respectively covering 38% (group stage), 37% (knockout stage) and 38% (all games) when attempting to regain the ball. For all stages of the tournament, teams on average covered 35% of their total distance when in possession of the ball.

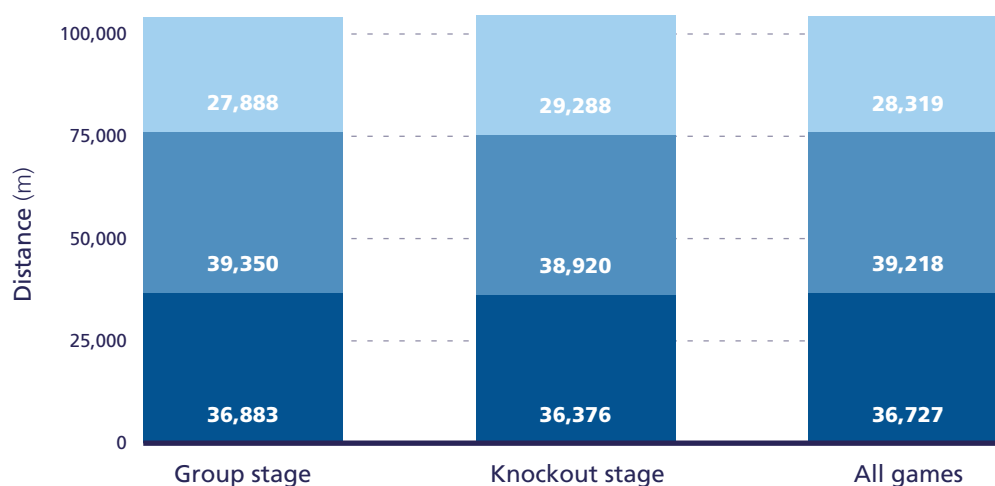
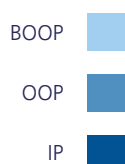


Figure 22. Summary of the total distance covered in ball-out-of-play situations and whilst in possession and out of possession of the ball across the stages of the tournament

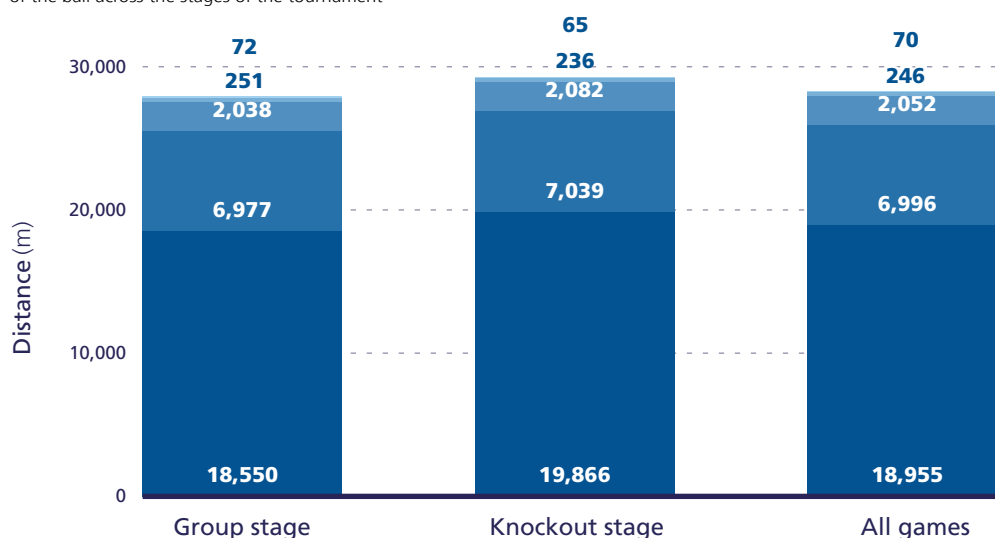
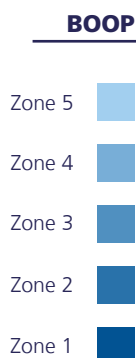


Figure 23. Summary of the distribution of the distance covered in the various speed zones in ball-out-of-play situations across the stages of the tournament



When looking at the distribution of the type of running that teams completed whilst in possession (Figure 24), for all phases of the tournament, the breakdown was again highly similar for all speeds, with 26%, 42%, 24%, 5% and 2% of the distance respectively being covered in the five increasing speed zones. As an absolute value, during the knockout stage, slightly more distance in Zone 5 (around 100m) was completed compared to the group stage. This could be due to teams being in control of the ball and the game, and thus retaining possession to secure a result; conversely, a team could need to attack to get a goal to prevent elimination from the tournament.



When looking at the distribution of the type of running that teams completed whilst out of possession (Figure 25), for all phases of the tournament, the breakdown was very similar for all speeds, with 23%, 41%, 28%, 7% and 2% of the distance respectively being covered in the five speed zones. Again, similar to the figures for distance whilst in possession, as an absolute value, during the knockout stage, slightly more distance in Zone 5 (approximately 100m) was completed compared to in the group stage. During the knockout rounds, this could be due to the need to regain possession of the ball in order to score a goal, thereby preventing elimination from the tournament.

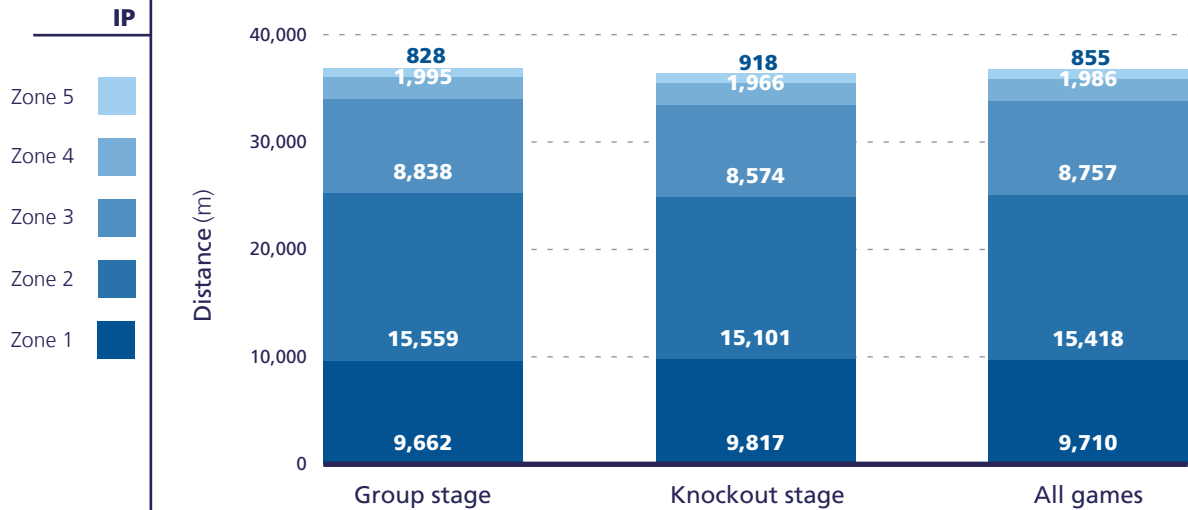


Figure 24. Summary of the distribution of the distance covered in the various speed zones whilst in possession across the stages of the tournament

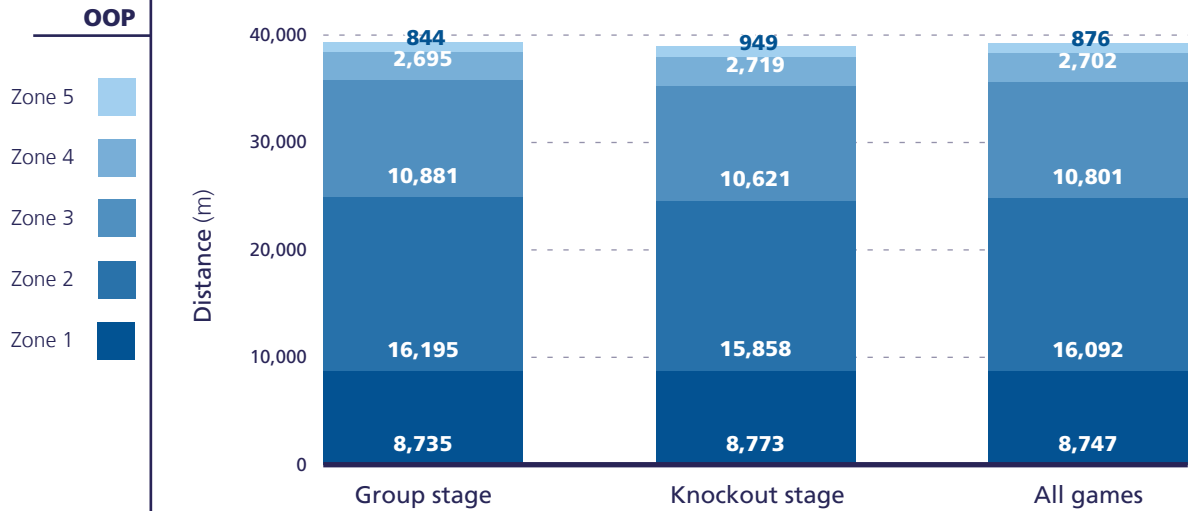


Figure 25. Summary of the distribution of the distance covered in the various speed zones whilst out of possession of the ball across the stages of the tournament

3.4.2 Analysis of the distance covered whilst in possession of the ball only



Figure 26 shows the relationship between the team total distance covered and the height, width and depth of the team shape whilst in possession of the ball. The figure is ranked by the total distance covered by the team whilst in possession, with the lowest values from left to right. Seven of the eight teams that covered the least total distance whilst in possession of the ball were eliminated in the group stage. There was a strong relationship between the total distance covered by teams and the height ($r=0.82$) and depth ($r=0.64$) of their formation whilst in possession of the ball. In other words, the higher up the pitch the team's final defender was, and the greater the distance between its last defender and most advanced forward, the more total distance it tended to cover when in possession of the ball.

As can be seen, Thailand had the lowest defensive line (24m) and also covered the least total distance when in possession of the ball. This could be due to the physical capabilities of the players, but also due to their tactical formation and ability to retain the ball when in possession. Indeed, throughout the tournament, Thailand (34%) averaged the lowest ball possession. When correlating the average team ball possession with the total distance covered by teams, there was a very strong relationship ($r=0.96$), meaning that teams that generally had more ball possession covered a greater total distance. Obviously, this has implications for the preparation of players and teams, as players must be primed for the physical demands that they will face based on the tactical strategies employed by their coach.

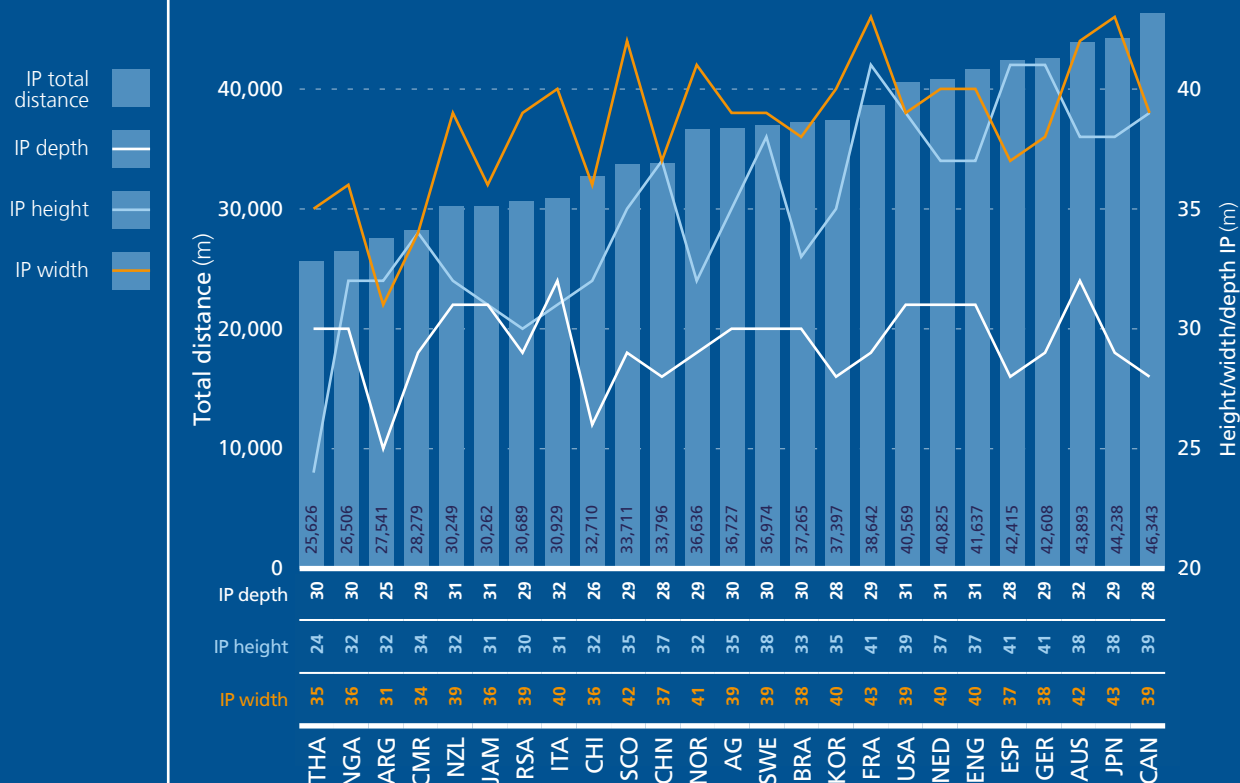


Figure 26. The relationship between the total distance covered and the height, width and depth of the team shape whilst in possession of the ball



Figure 27 shows the relationship between the team total distance covered and the compactness (for compactness, a higher distance means the team is more spread out, whereas a lower distance means the team has a tighter shape) of the team shape whilst in possession of the ball. The figure is ranked by the total distance covered by the team whilst in possession of the ball, with the lowest values from left to right. Australia (1,072m²) had the biggest shape (least compact) whilst in possession of the ball, whilst Argentina (569m²) had the narrowest team shape (most compact), on average, whilst in possession. There was a moderate ($r=0.54$) correlation between the total distance covered by teams and the size of their shape, meaning that teams that had a bigger shape generally covered more total distance compared to more compact teams (smaller shape). Again, this has implications for the physical load that players will face during games, and if the tactical strategy of the coach is to play out with a bigger shape, then the players will be required to cover a greater amount of total distance.

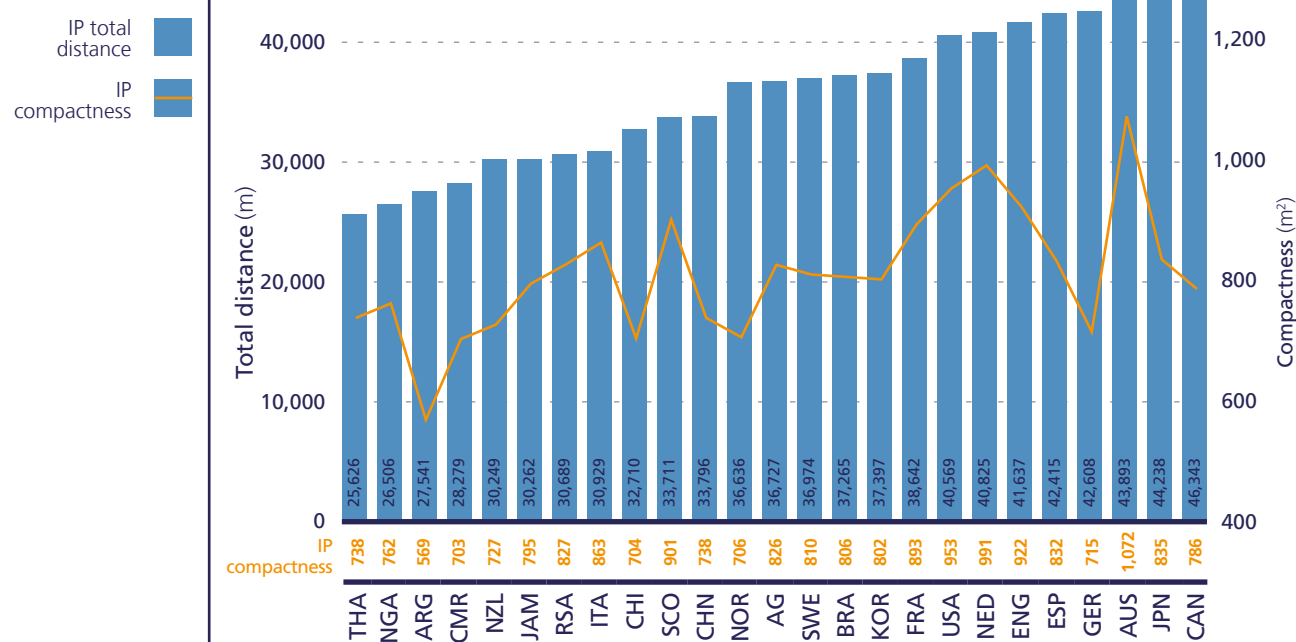


Figure 27. The relationship between team total distance and compactness whilst in possession of the ball

Figure 28 shows the relationship between the team distances covered in the higher speed zones and the height, width and depth of the team shape whilst in possession of the ball. The figure is ranked by the total distance covered at >19km/h by the team whilst in possession, with the lowest values from left to right. There was a strong relationship between distance covered by teams in Zone 4 and the height ($r=0.61$) of their formation whilst in possession of the ball, with a more moderate correlation with the width ($r=0.41$) of their formation. In other words, the higher up the pitch the team's last defender was, and the wider the team's shape, the more distance (Zone 4) the team tended to cover when in possession of the ball. A higher defensive line suggests that a team is more determined and prepared to attack, and with a wider shape, it would be anticipated that more space has been created and that players could potentially run into those spaces at a higher speed in an attempt to create an attack on the opposition goal.

Figure 29 shows the relationship between the team distances covered in the higher speed zones and the compactness of the team shape whilst in possession of the ball. The figure is ranked by the total distance covered at >19km/h by the team whilst in possession, with the lowest values from left to right. Australia (1,072m²) had the biggest shape (least compact) whilst in possession of the ball, whilst Argentina (569m²) had the narrowest team shape (most compact), on average, whilst in possession of the ball. There were small relationships between the distances covered in Zone 4 ($r=0.36$) and Zone 5 ($r=0.39$) and the size of teams' shape, meaning that teams that had a bigger shape generally covered more total distance compared to more compact teams (smaller shape). The strongest relationship in terms of running in the various zones whilst in possession of the ball was during activity at <13km/h ($r=0.55$), as can be seen in Figure 30.

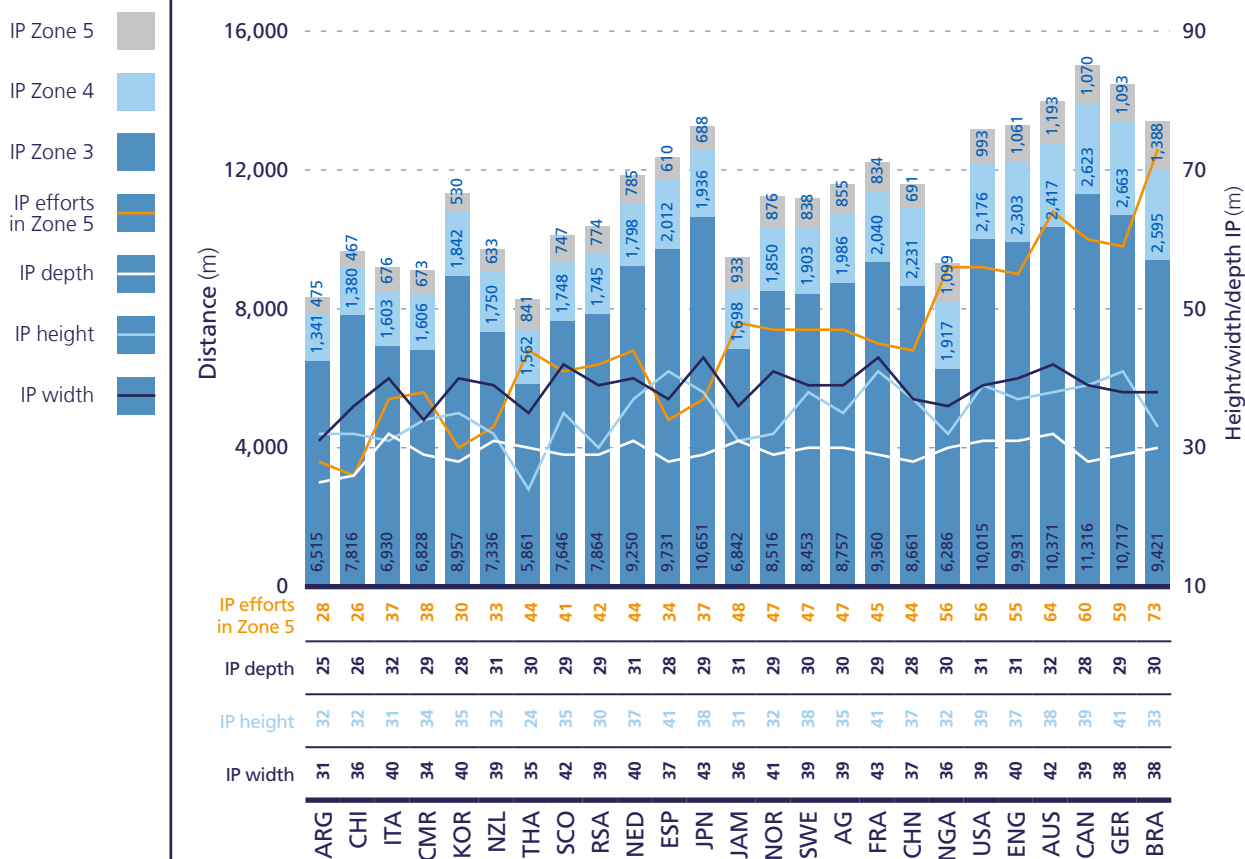


Figure 28. The relationship between team running in higher-speed activities (Zone 3, Zone 4 and Zone 5) and the height, width and depth of the team shape whilst in possession of the ball

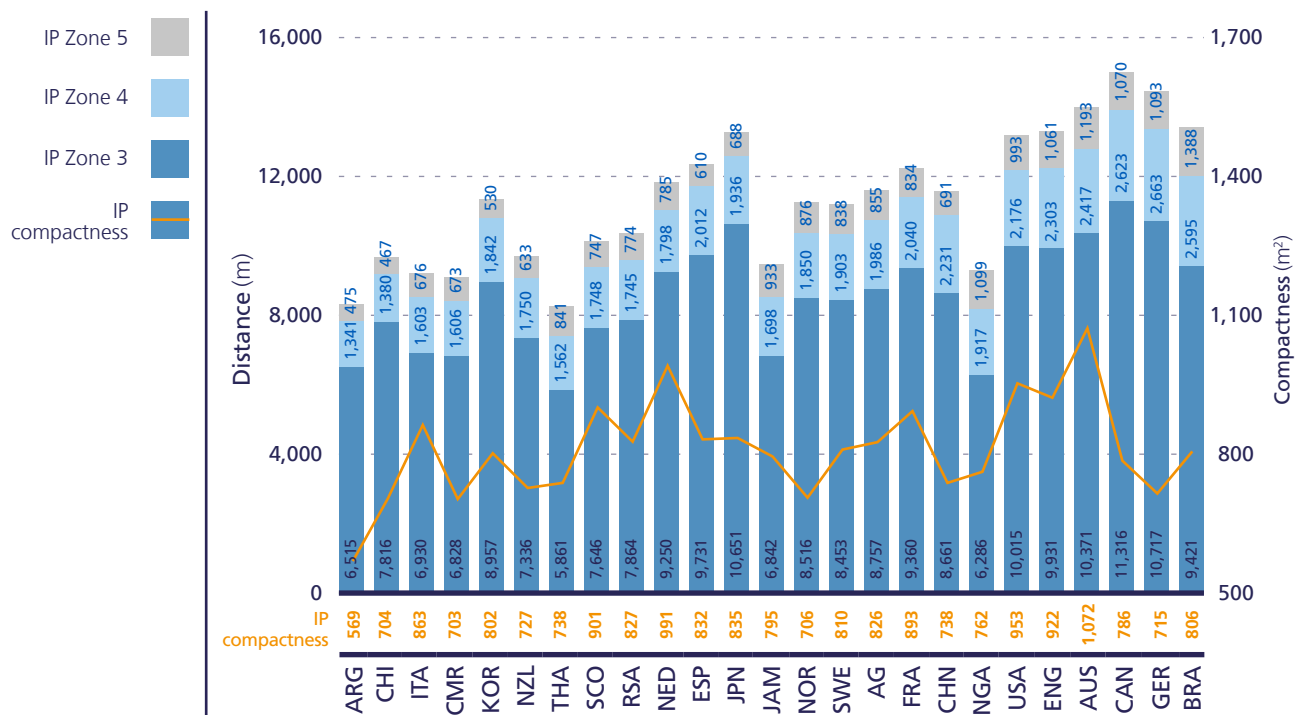


Figure 29. The relationship between team running in higher-speed activities (Zone 3, Zone 4 and Zone 5) and compactness whilst in possession of the ball

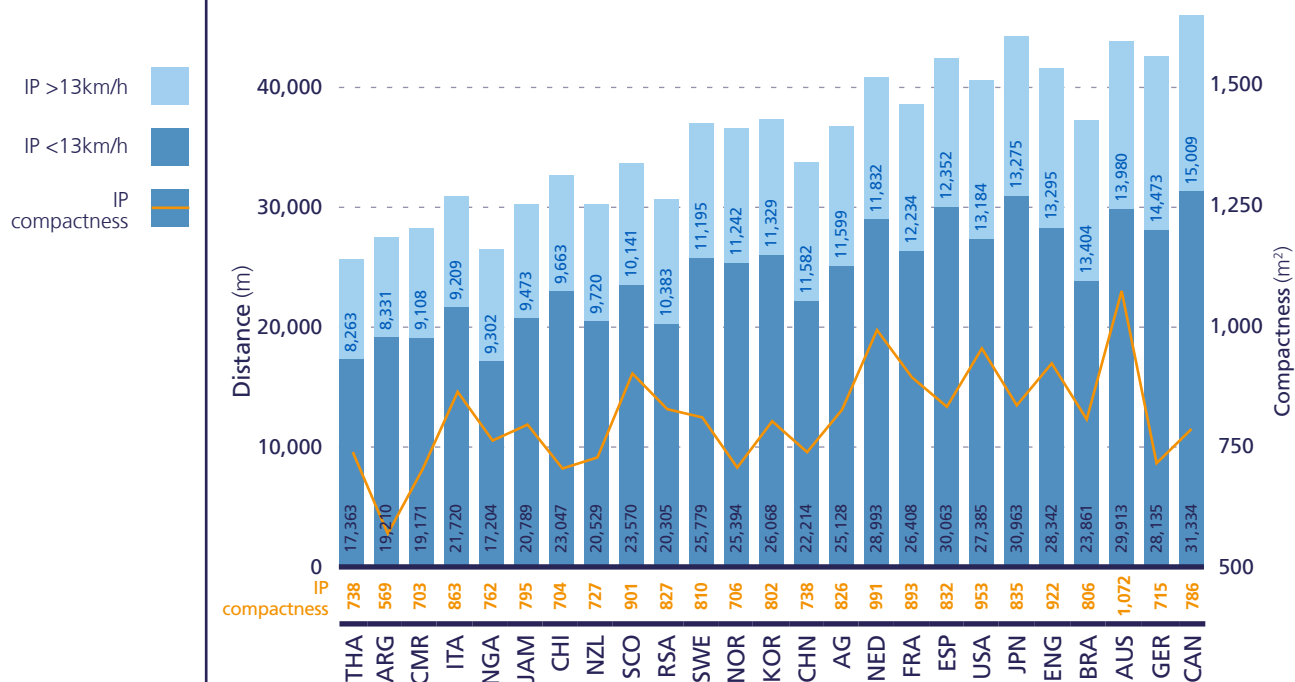


Figure 30. The relationship between team running at <13km/h and >13km/h and compactness whilst in possession of the ball

3.4.3 Analysis of distance covered whilst out of possession of the ball only



Figure 31 shows the relationship between the team total distance covered and the height, width and depth of the team shape whilst out of possession of the ball. The figure is ranked by the total distance covered by the team whilst out of possession, with the lowest values from left to right. Five of the six teams that covered the highest amount of total distance whilst out of possession of the ball were eliminated in the group stage. There was a strong inverse relationship between the total distance covered by team, and the height ($r=-0.79$) and depth ($r=-0.46$) of their formation whilst out of possession of the ball. In other words, teams that defended closer to their own penalty box, and to a lesser extent teams with the lowest distance between their last defender and most advanced forward, tended to cover the most total distance when out of possession of the ball.

As can be seen, Thailand had the lowest defensive line (25m), similar to their height when in possession of the ball, and also covered the highest total distance when out of possession of the ball, meaning that, due to their defensive shape, they had to run more to try to regain the ball. Again, this is also linked to Thailand having the lowest possession of all teams, and hence having to complete more running and total distance generally to try to prevent the opposition from scoring, and also ultimately to win back possession of the ball. Conversely, France (43m), Canada (41m), Spain (40m) and Australia (43m) were amongst the teams with the highest defensive line when out of possession of the ball, and covered the lowest total distance in such situations. Those four teams also averaged the highest possession of all teams at the tournament.

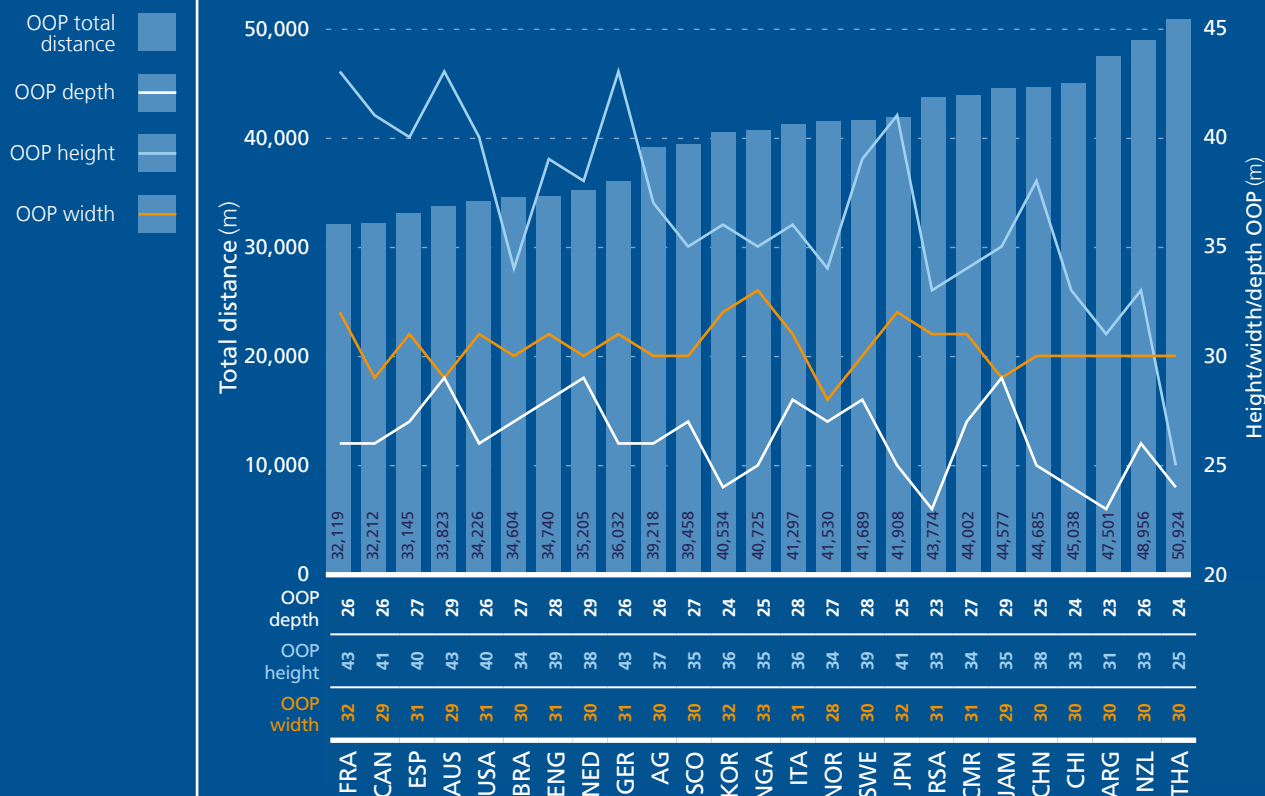


Figure 31. The relationship between the total distance covered and the height, width and depth of the team shape whilst out of possession of the ball

The tactical formation of the coach is key in terms of player positioning and the physical demands that players need to meet to be successful

Figure 32 shows the relationship between the team total distance covered and the compactness of the team shape whilst out of possession of the ball. The figure is ranked by the total distance covered by the team whilst out of possession, with the lowest values from left to right. The Netherlands (677m²) had the biggest shape (least compact) whilst out of possession of the ball, whereas New Zealand (479m²) had the narrowest team shape (most compact), on average, whilst out of possession. There was a strong inverse ($r=-0.71$) correlation between the total distance covered by teams and the size of their shape, meaning that teams with a smaller shape generally covered more total distance compared to less compact teams (bigger shape). The three teams that covered the most total distance whilst out of possession of the ball had the most compact formation, so they had to rack up more distance in an attempt to win the ball back. Being more compact when out of possession of the ball means that, when teams are attempting to win the ball back, they would generally have to cover more space to close players down and press the ball; this would also be largely related to the compactness of the team in possession of the ball. Again, the tactical formation of the coach is key in terms of player positioning and the physical demands that players need to meet to be successful.

Figure 33 shows the relationship between the team distances covered in the higher speed zones and the height, width and depth of the team shape whilst out of possession of the ball. The figure is ranked by the total distance covered at >19km/h by the team whilst out of possession, with the lowest values from left to right. The strongest relationship when out of possession of the ball was between the distance covered by teams in Zone 4 and the depth ($r=-0.37$) of their formation. This inverse relationship means that, when a team's depth (the distance between its last defender and most advanced forward) was

3.4

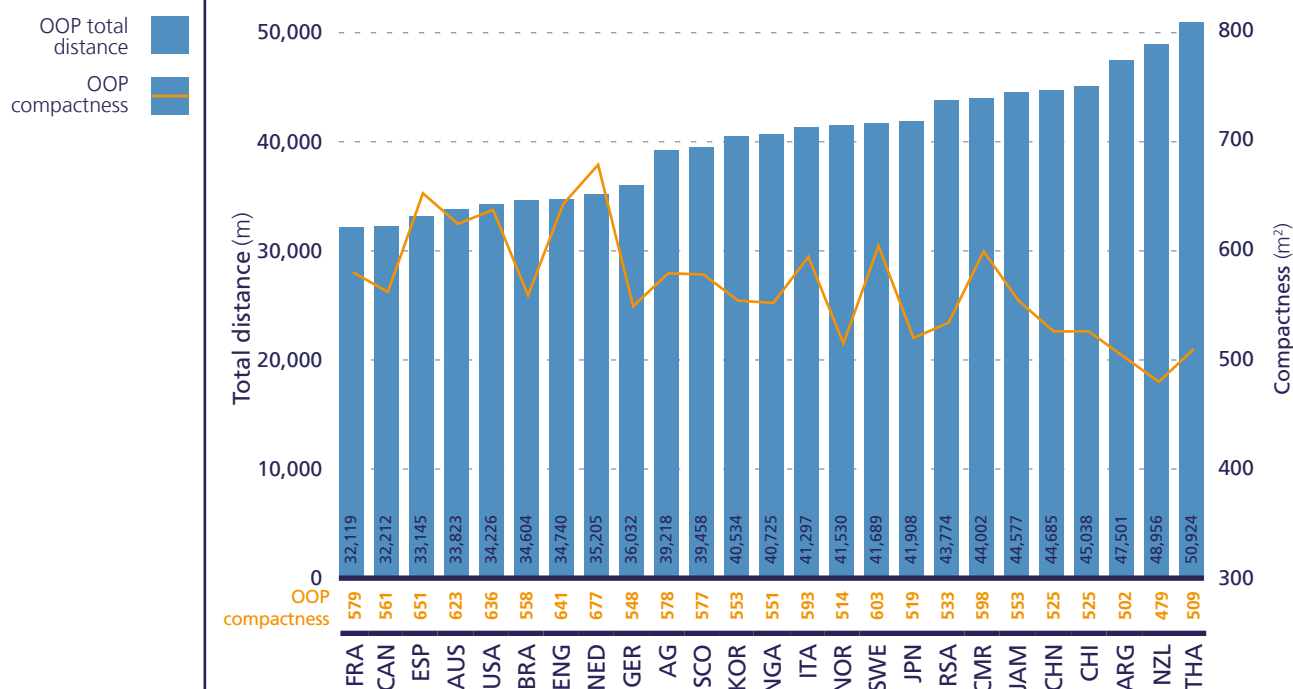


Figure 32. The relationship between team total distance and compactness whilst out of possession of the ball



low, then the team ran slightly more in Zone 4. This suggests that, due to a shallow shape when out of possession, teams need to cover more distance – and at higher speeds – to close down space and attempt to win the ball back.

Figure 34 shows the relationship between the team distances covered in the higher speed zones and the compactness of the team shape whilst out of possession of the ball. The figure is ranked by the total distance covered at >19km/h by the team whilst out of possession, with the lowest values from left to right. The Netherlands (677m²) and Spain (651m²) had the biggest shape (least compact) whilst out of possession of the ball. There was a moderate inverse relationship between the size of teams' shape and running in Zone 4 ($r=-0.43$), meaning that teams with a smaller shape had to complete more running in this speed zone to attempt to win the ball back.

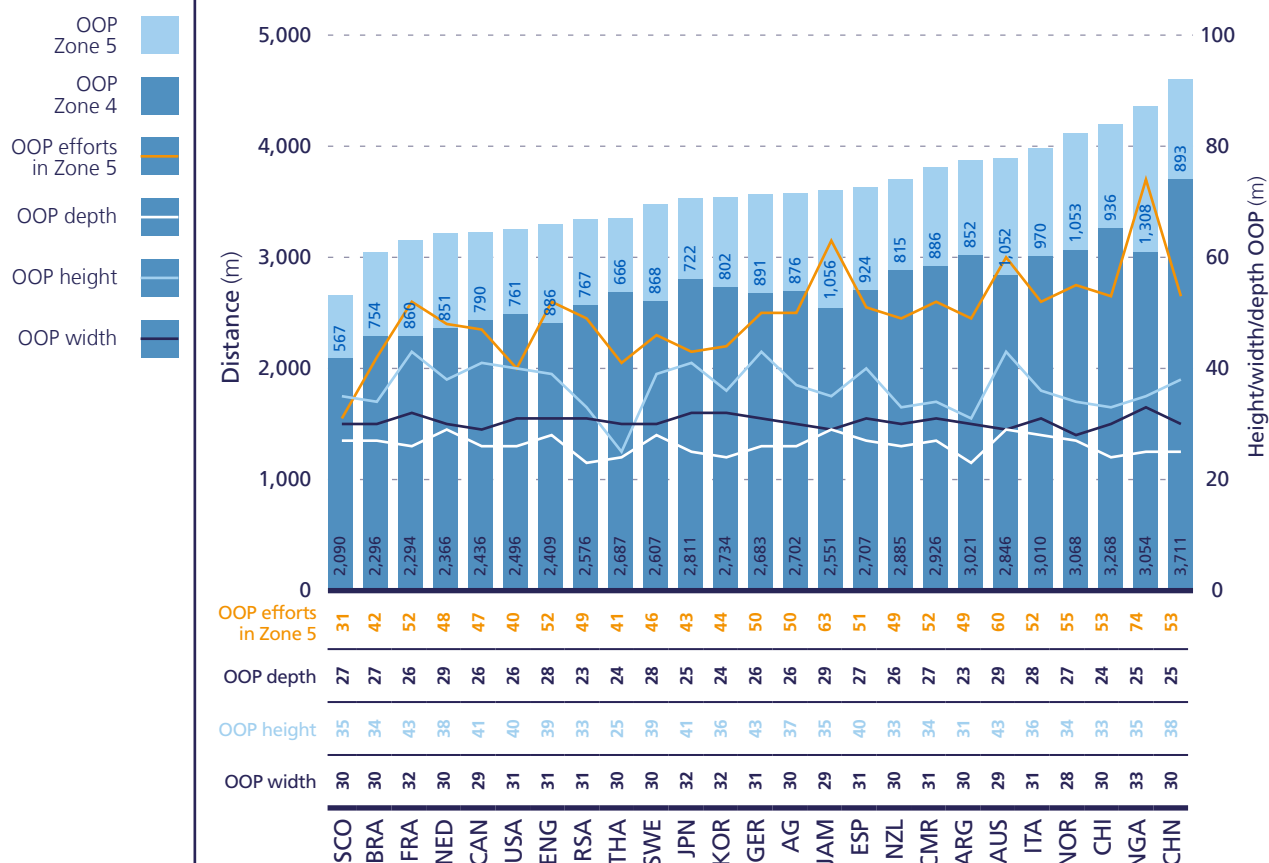


Figure 33. The relationship between team running in higher-speed activities (Zone 4 and Zone 5) and the height, width and depth of the team shape whilst out of possession of the ball

There was a strong inverse relationship ($r=-0.68$) between the running that teams completed at $>13\text{km/h}$ and the size of their shape whilst out of possession of the ball (Figure 35). This means that, when teams had a smaller shape, they completed more distance at $>13\text{km/h}$ in an attempt to win the ball back. Three of the five teams that were the most compact when out of possession of the ball were eliminated in the group stage.

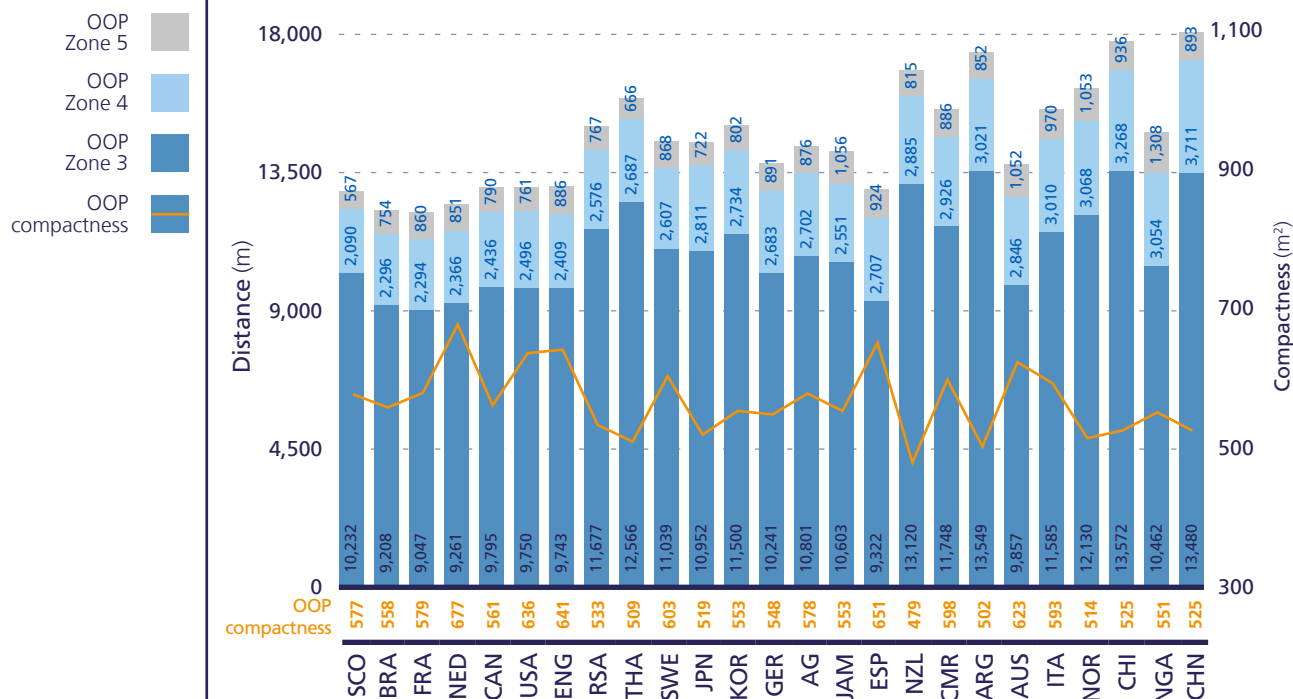


Figure 34. The relationship between team running in higher-speed activities (Zone 3, Zone 4 and Zone 5) and compactness whilst out of possession of the ball

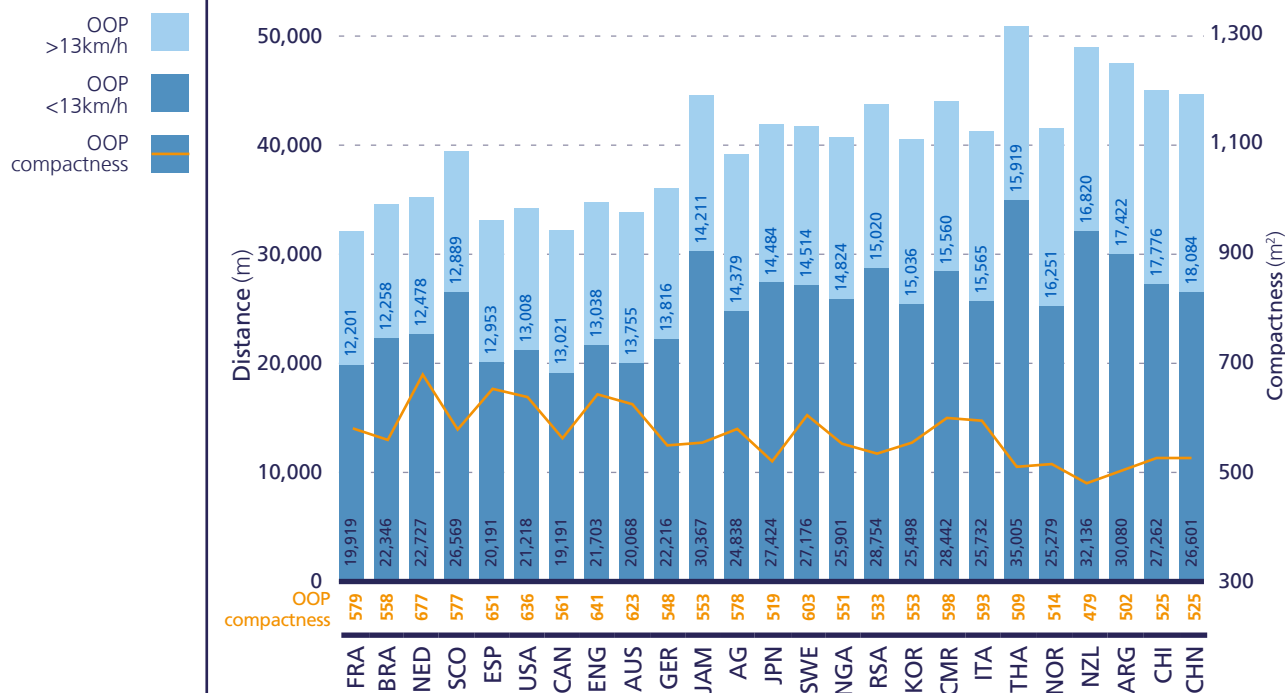
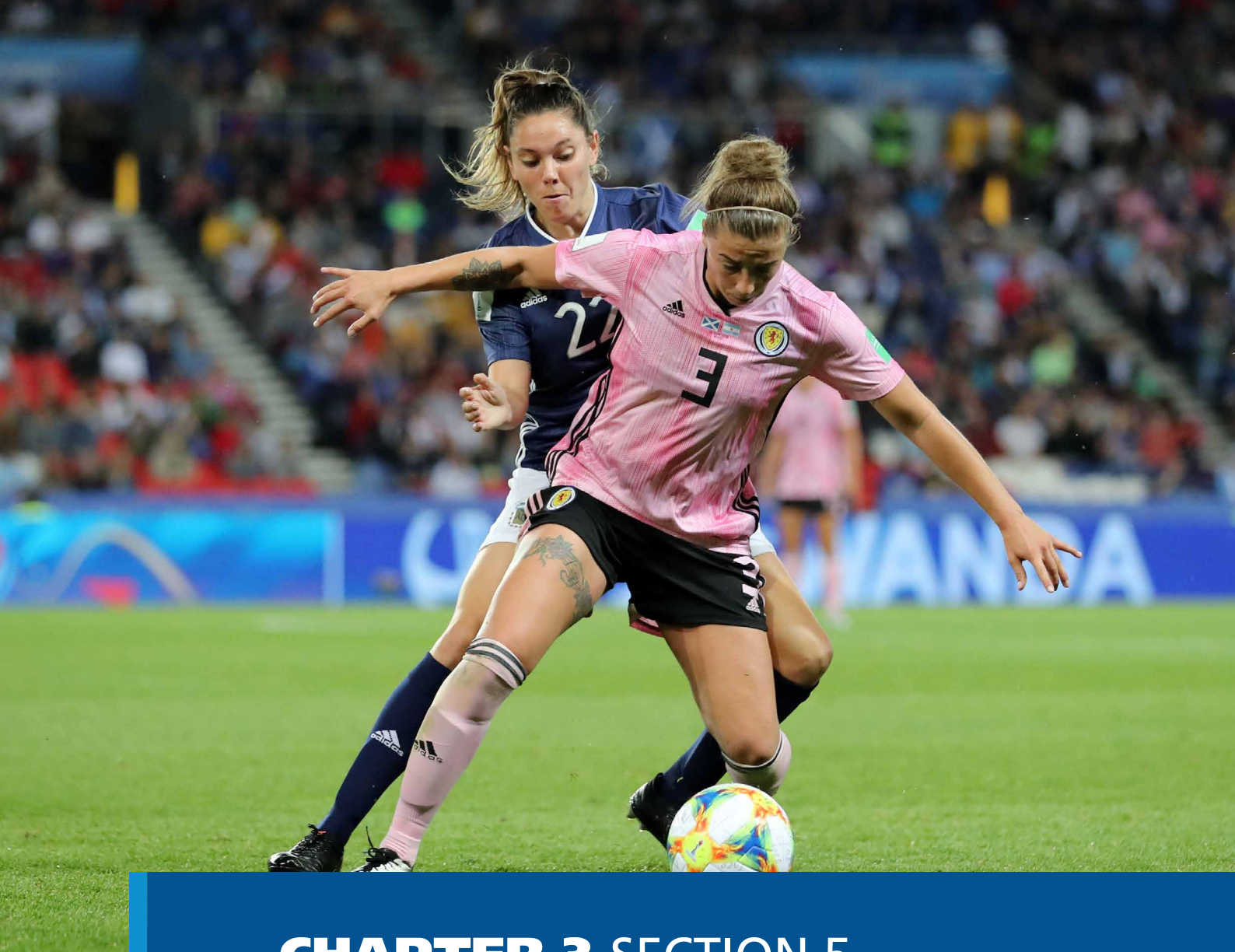


Figure 35. The relationship between team running at $<13\text{km/h}$ and $>13\text{km/h}$ and compactness whilst out of possession of the ball



3.4.4 Summary

- The tactical formation and organisation of teams can impact the amount and type of running that teams need to complete in and out of possession of the ball, and the coach should therefore take this into account when implementing a system of play.
- The greatest proportion of total distance is covered when teams are out of possession of the ball, compared to in possession and in ball-out-of-play situations, with a similar distribution throughout all stages of the tournament.
- Teams generally completed more distance at $>19\text{km/h}$ when out of possession of the ball, largely in an attempt to close the opposition down and win the ball back.
- First and foremost, the amount of ball possession will determine the amount of total distance that a team will complete in possession of the ball. Additionally, the amount of total distance that teams completed was strongly correlated with the height ($r=0.82$) and depth ($r=0.64$) of their formation whilst in possession. Having a high defensive line whilst in possession of the ball also meant that teams generally covered more distance in Zone 4.
- The strongest relationship between the compactness of teams and the speed at which running was completed in possession was with the distance covered at $<13\text{km/h}$ ($r=0.55$); running at the higher speeds was less correlated when teams were in possession of the ball. This suggests that teams that were more compact (smaller shape) completed less running whilst in possession of the ball – this would also be due to their lower ball possession, which was apparent for Thailand, Nigeria, Argentina, Cameroon, New Zealand, Jamaica and South Africa, who were amongst the teams with the lowest average ball possession.
- There was a strong inverse relationship between the total distance covered by teams and the height ($r=-0.79$) and depth ($r=-0.46$) of their formation whilst out of possession of the ball. This means that teams that defended closer to their own penalty box, and to a lesser extent teams with the lowest distance between their last defender and most advanced forward, tended to cover the highest total distance when out of possession of the ball.
- The strongest relationship between the size of teams' shape and the speed at which running was completed out of possession was with the distance covered at $>13\text{km/h}$ ($r=-0.68$), with the strongest correlation being with Zone 3 ($r=-0.72$), compared to running in Zone 4 ($r=-0.43$) and Zone 5 ($r=-0.08$). These relationships suggest that teams that had a smaller shape (more compact) whilst out of possession of the ball completed more running, particularly in Zone 3, in an attempt to close the opponent down and win the ball back.



CHAPTER 3 SECTION 5

Team analysis | Distances covered in relation to contextual factors

Many factors can impact the physical output of players during football matches, such as environmental conditions, accumulated game time, lack of fitness, team ranking and tactical formation; moreover, the physical output of players can also impact the game outcome (Trewin et al., 2018a, 2018b). This section analyses the distances covered by teams and the relation to the game outcome, round of game, number of days between games, tactical formation and confederation.

3.5.1 Team distance covered and game outcome

Figure 36 shows a comparison of the percentage of total distance covered at above and below 13km/h when teams won, lost or drew. The percentage of the distance at <13km/h (73%) and >13km/h (27%) was identical for all three match outcomes. In absolute terms, there was a minimal difference between the distance covered at >13km/h and match outcome, although this was lowest on average for a loss, with 101m more for a draw compared to a win, 827m more for a win compared to a loss, and 928m more for a draw compared to a loss.

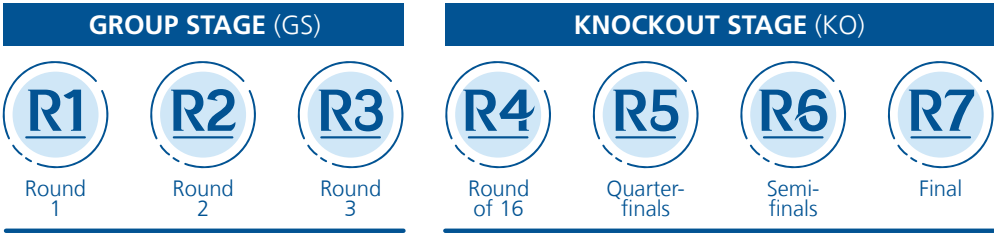


Figure 37 shows a comparison between the distances covered and efforts completed at the higher speeds (>19km/h) and the match outcome. The total distance covered and efforts completed by teams at >19km/h were slightly higher for a win compared to a draw (275m; 14 efforts) and a loss (241m; 19 efforts). When looking at distance and efforts in Zone 4, for a win compared to a loss, teams averaged 3% more distance and 4% more efforts. Similarly, for Zone 5, teams that won covered 4% more distance and completed 6% more efforts on average compared to teams that lost. These findings suggest that winning teams, on average, did complete more higher-speed activities.

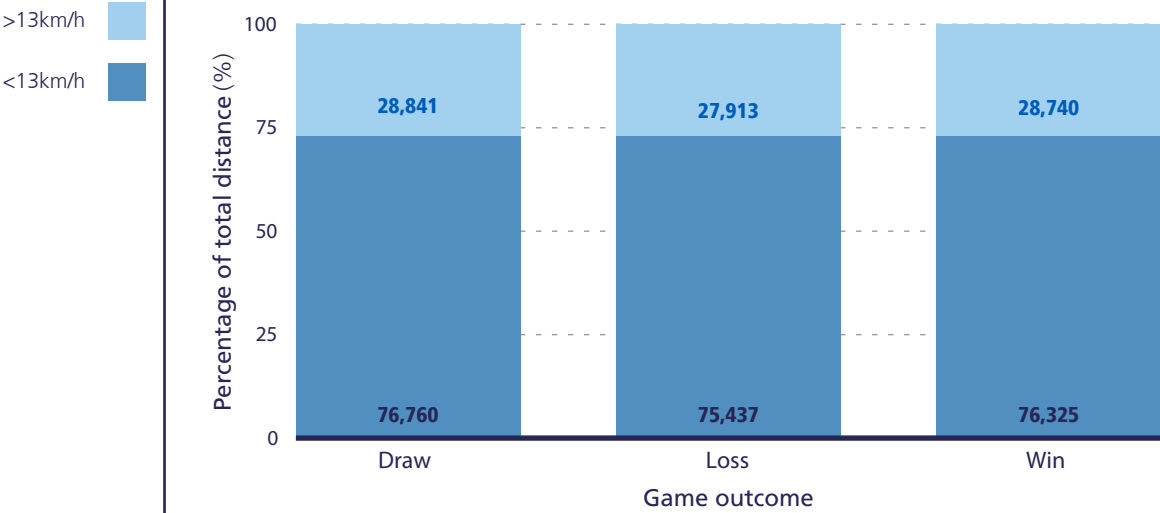


Figure 36. Summary of the total distance covered at <13km/h and >13km/h according to the game outcome

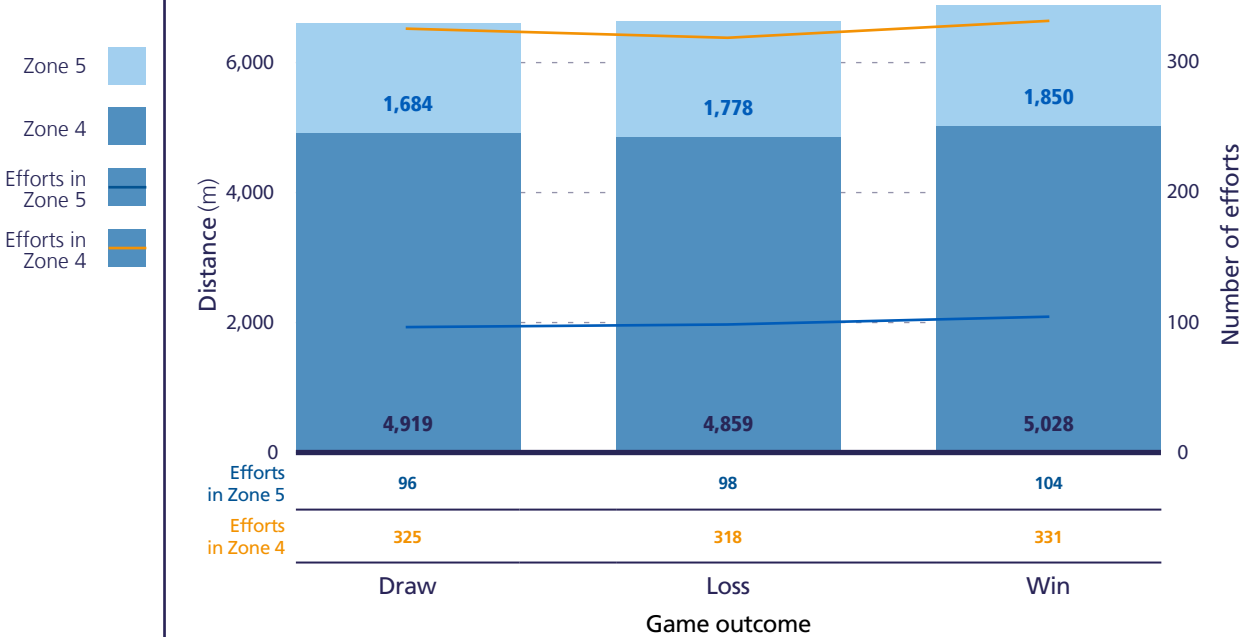


Figure 37. Summary of the total distance covered and efforts completed at >19km/h according to the game outcome



3.5.2 Team distance covered and round of game

Figure 38 shows a comparison of the percentage of total distance covered at above and below 13km/h and the round of the game. As the tournament progresses and teams advance, players will be accumulating more playing time, and the chances of accumulated fatigue having an impact on the physical and technical output of players increases. Obviously, there are more match observations in rounds 1-3 (48 apiece for each of those rounds), compared to the knockout rounds of the tournament (32 in round 4, 16 in round 5 and eight in both rounds 6 and 7), which would impact the average and range of values observed. The percentage of the distance at <13km/h (73%) and >13km/h (27%) was identical for the first five rounds of games. For rounds 6 and 7, the distance at <13km/h increased to 74% and 75% respectively. As an absolute value, on average, the distance at >13km/h was highest during round 4 and lowest during round 7 (7% lower in comparison to round 1).

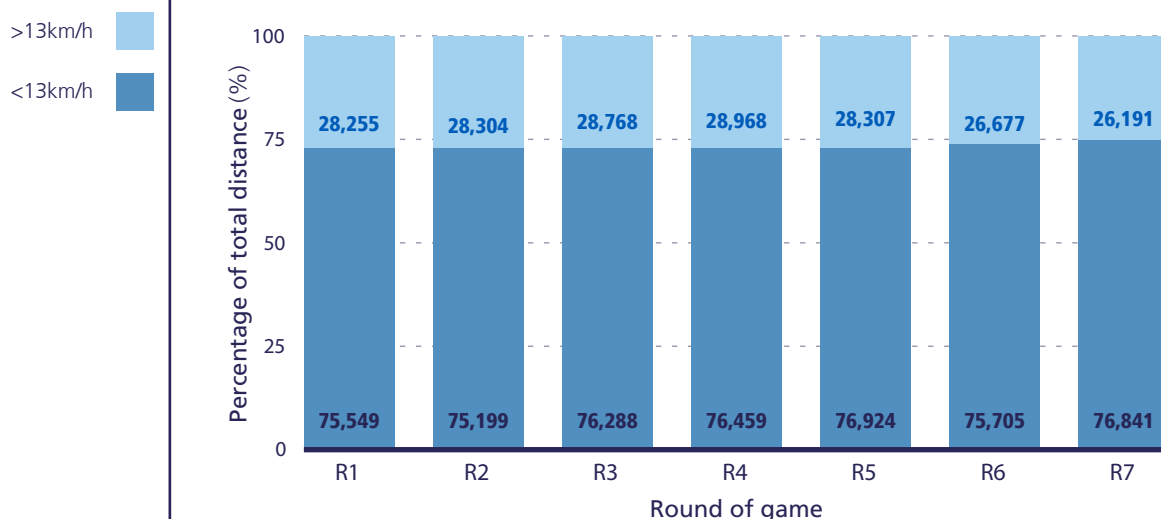


Figure 38. Summary of the total distance covered at <13km/h and >13km/h according to the game round



There was minimal difference (<1%) between the total distance covered during the first and second half of games for rounds 1-4, with the highest total distance on average being during round 4. For rounds 5 and 6 respectively, there was a decrease of 3% and 6% in total distance from the first to the second half. For round 7, similar to rounds 1-4, there was a slight difference (1%) in total distance from the first to the second half of the games. See Figure 39.

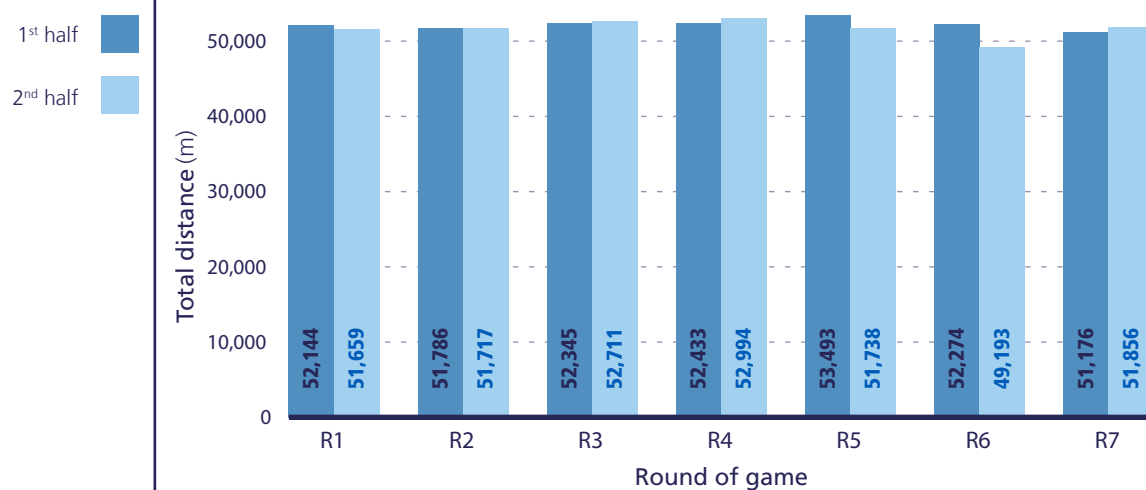


Figure 39. Summary of the total distance covered during the first and second half according to the game round

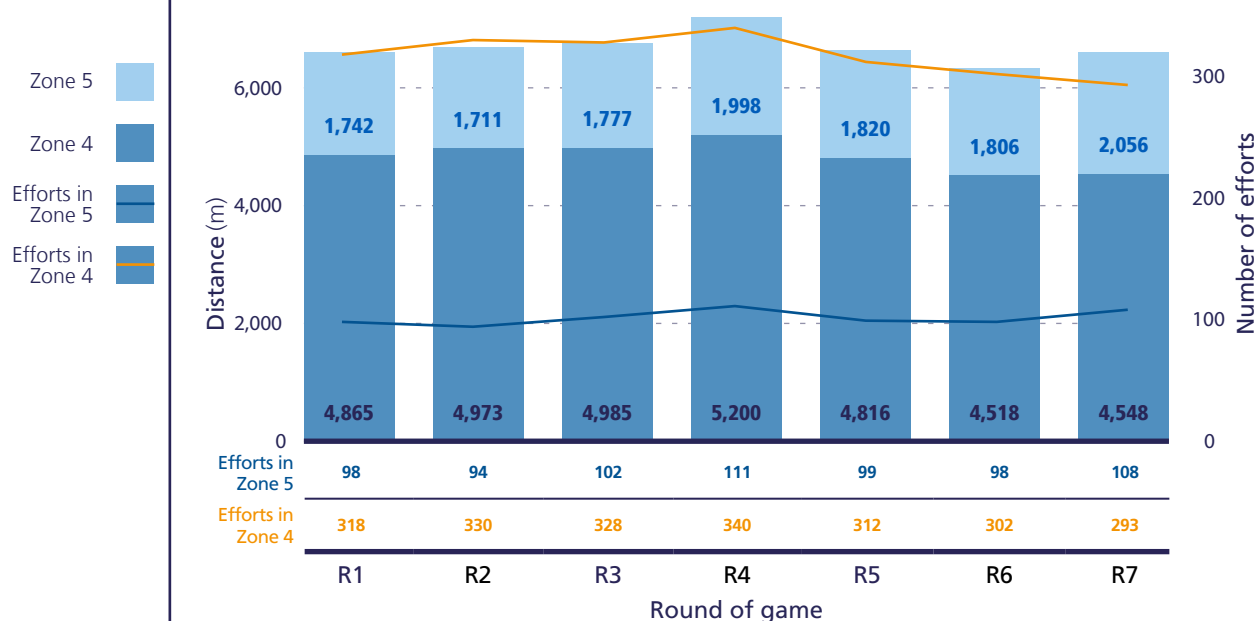


Figure 40. Summary of the total distance covered and efforts completed at >19km/h according to the game round



Figure 40 shows a comparison between the distances covered and efforts completed at the higher speeds (>19km/h) and the round of the game. The total distance covered and efforts completed by teams at >19km/h were highest during round 4 (7,198m; 450 efforts), which in part could be due to this being the start of the knockout stage and teams facing elimination if they failed to win, and therefore needing to press for a goal. The lowest figures for distance covered and efforts completed at >19km/h came during round 6 (6,324m; 400 efforts), which only comprised eight match observations, compared to 32 for round 4. The distance at >19km/h in round 7 was very similar to round 1, whilst the number of efforts at >19km/h was 15 (-4%) lower during the last round of games. However, the distance covered and efforts completed in Zone 4 were respectively 317m (-7%) and 25 (-8%) lower in round 7 compared to the first round of games, when you would expect players to be at their freshest, with an optimal ability to complete physical outputs. Conversely, the distance covered and efforts completed in Zone 5 were respectively 314m (18%) and 10 (10%) higher in round 7 compared to the first round of games, which means that the teams in those games were able to complete more running and efforts in the highest speed zone during the last round of matches.

There was minimal difference between the distance covered and efforts completed at >19km/h for the first and second half of games during rounds 1-3. During round 4, there was the biggest increase in distance (7%) and efforts (9%) at >19km/h from the first to the second period. Conversely, round 7 saw the biggest reduction in distance (488m; -14%) and efforts (14; -7%) at >19km/h from the first to the second half of the games, which could in part be due to accumulated fatigue by that stage of the tournament. This notwithstanding, the absolute distance in Zone 5 (Figure 40) was actually highest in round 7, suggesting that this could rather have been a tactical ploy by teams to slow down the play.

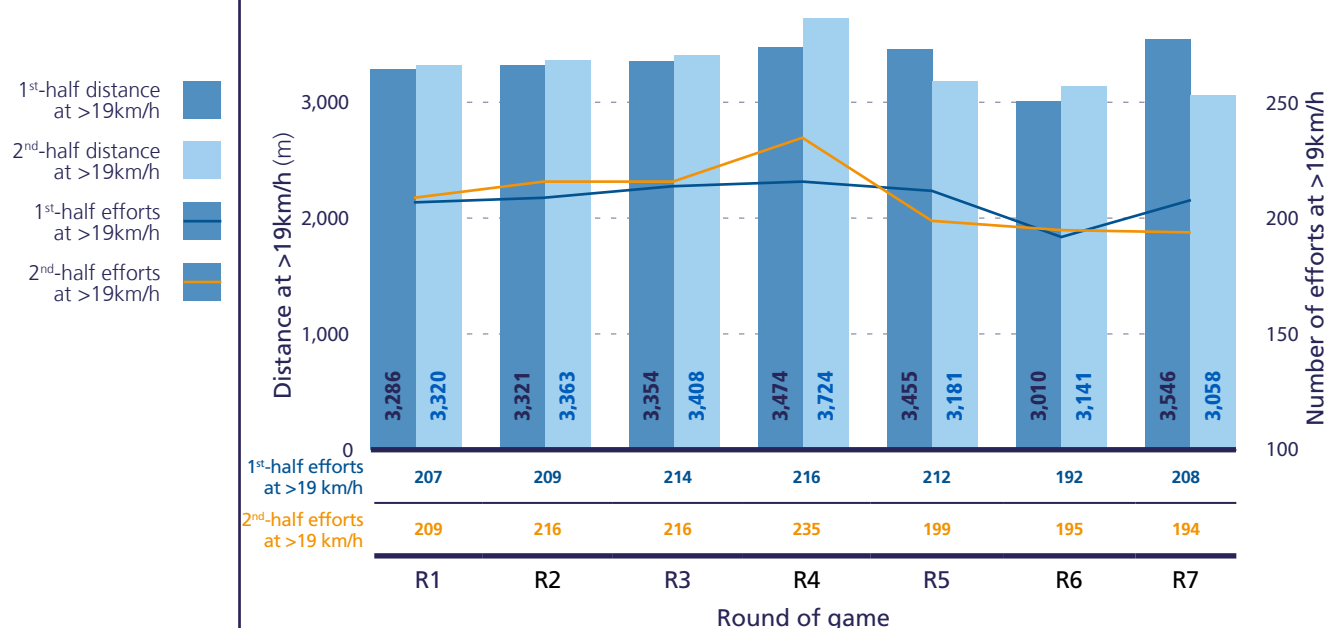


Figure 41. Summary of the total distance covered and efforts completed at >19km/h during the first and second half according to the game round

The highest overall total distance was covered when there were six days between games

3.5.3 Team distance covered and number of days since last game

Figure 42 shows a comparison of the percentage of total distance covered at above and below 13km/h and the number of days since the teams' last game. Zero days refers to the first game for each team in the tournament, which is the key focus for teams when preparing for the competition, and you would assume that players and teams should be the most rested and prepared going into that game. Depending on their draw, every team has a unique path for both the group stages and for the latter stages in the case of the teams that progress. Generally, the number of days between games for teams varied from three days (two match observations) to eight days (one match observation), with only one team (China PR) having eight days between matches – specifically, this came between their final group game and their round-of-16 encounter. There were more match observations with four days (30) and five days (42) between the games. Other than three days (75% and 25% respectively), the percentage of the distance at <13km/h (72-73%) and >13km/h (27-28%) was extremely similar for all of the other intervals between games. As an absolute value, the highest overall total distance was covered when there were six days between games (108,697m), whilst the lowest was during the first round of games (zero days, 103,803m). For distance at <13km/h, the highest value was for three days between games (78,546m), whilst the lowest was also during the first round of games (75,549m). For distance at >13km/h, the highest value was with six days (30,637m) between matches, with the lowest value being with three days (26,461m; 14% lower than six days) between games.

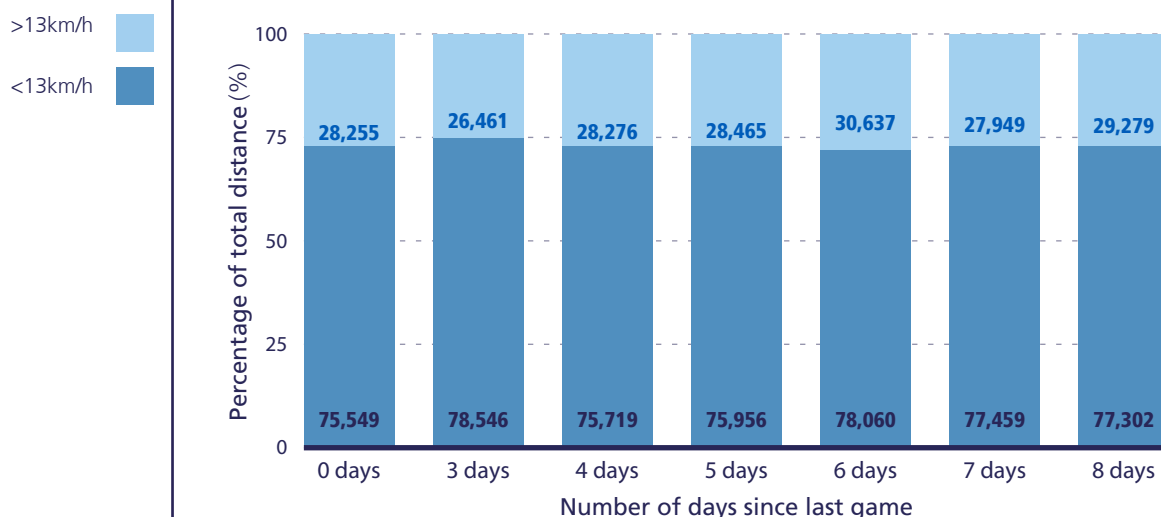


Figure 42. Summary of the total distance covered at <13km/h and >13km/h according to the number of days since the teams' last game

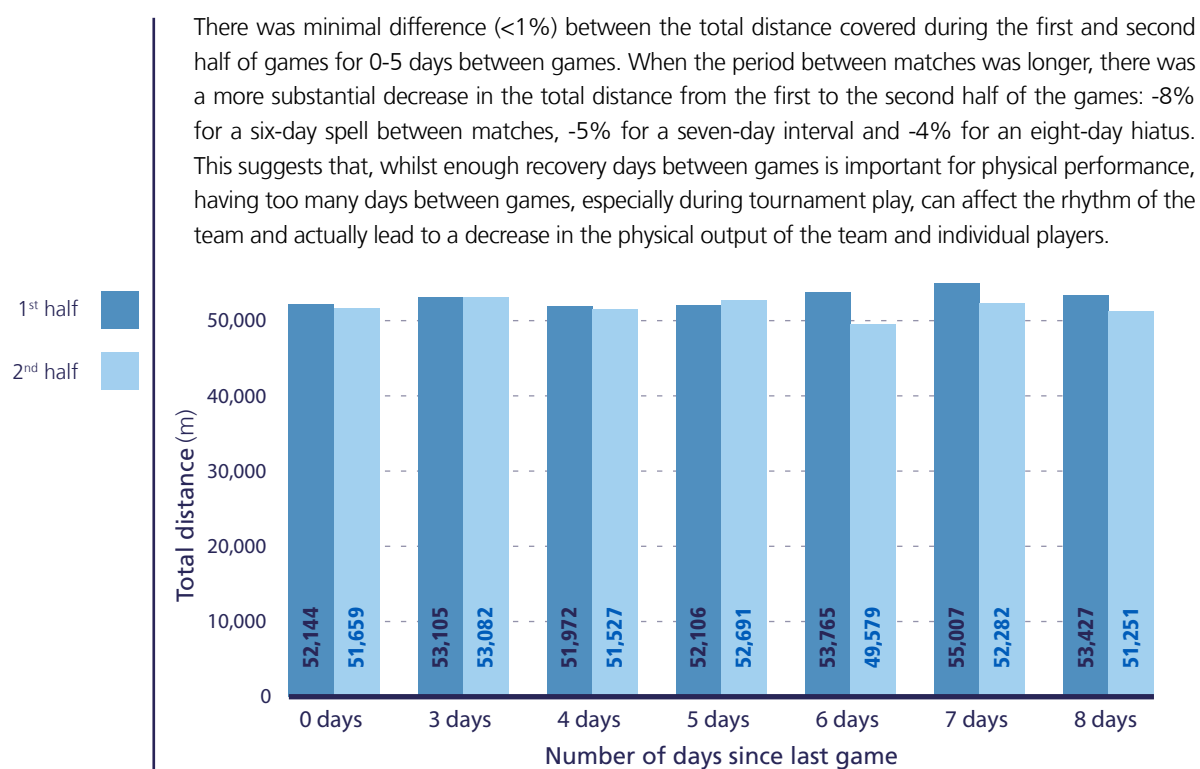


Figure 43. Summary of the total distance covered during the first and second half according to the number of days since the teams' last game

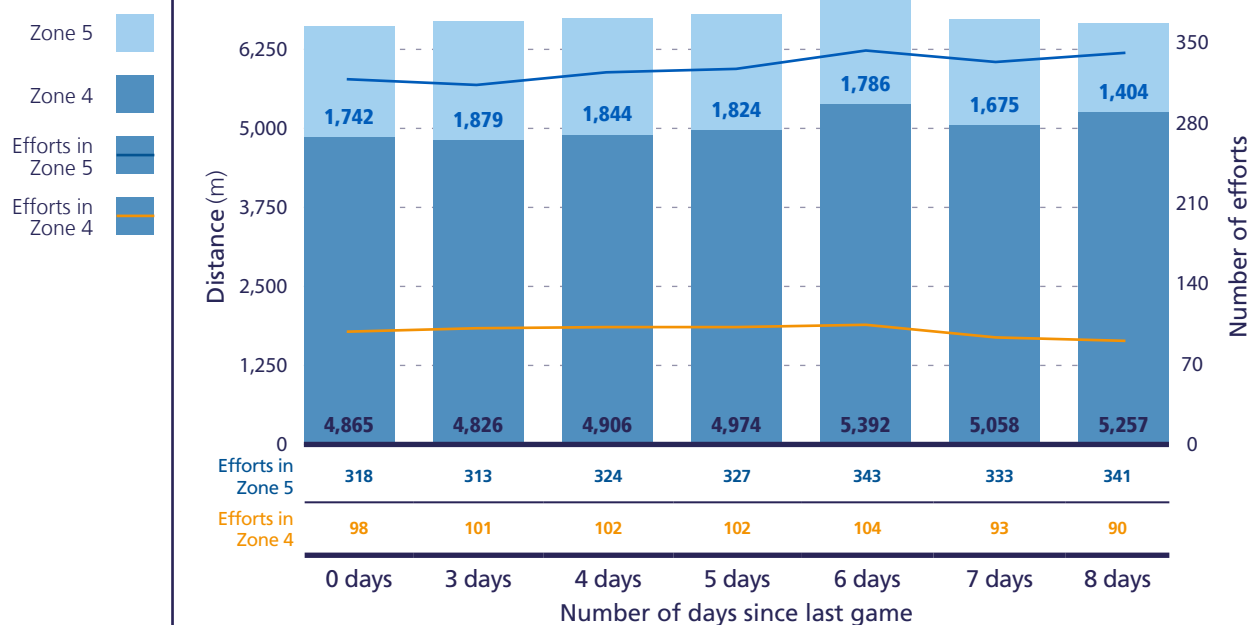


Figure 44. Summary of the total distance covered and efforts completed at >19km/h according to the number of days since the teams' last game

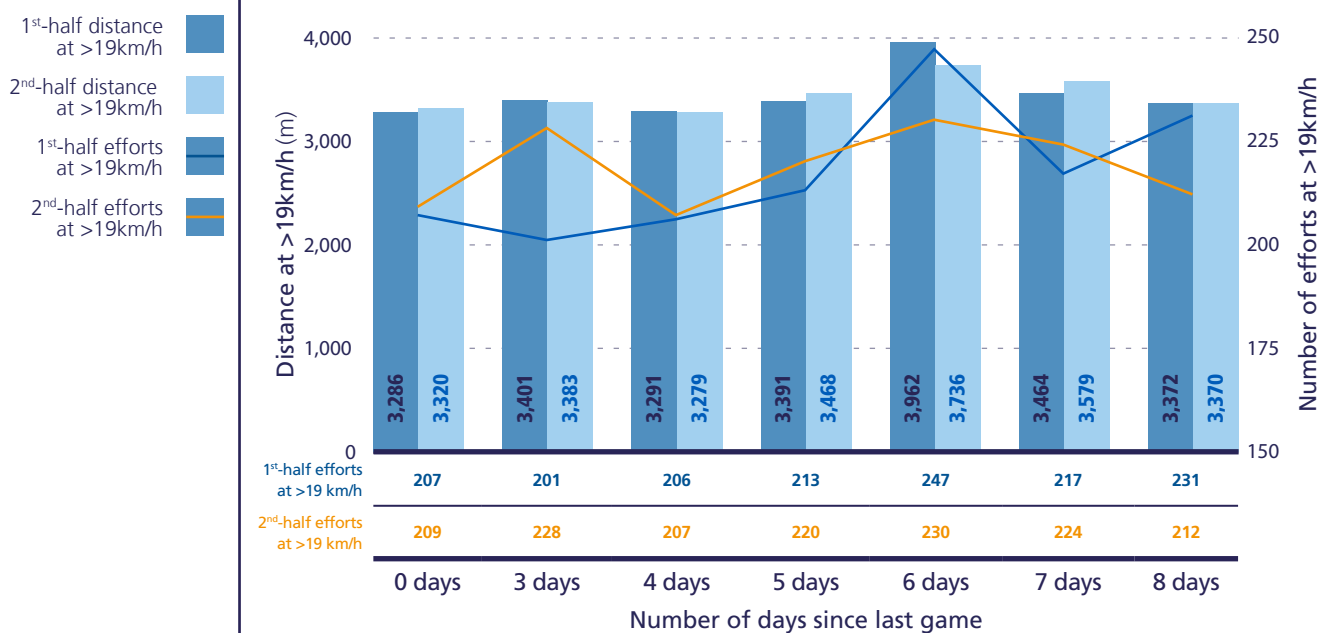


Figure 45. Summary of the total distance covered and efforts completed at >19km/h during the first and second half according to the number of days since the teams' last game

of working in the highest speed zone with fewer recovery days. The most efforts in Zone 4 and Zone 5 both occurred with six days between games, with the least for Zone 4 being with a three-day gap and the least for Zone 5 coming after an eight-day interval; nonetheless, it must be remembered that only one team had eight days between games.

There was minimal difference between the distance covered at >19km/h for the first and second half of games during the first round of games (zero days), and when there were three, four, five and eight days between matches; with six days between games, such distance decreased by 6%. The key differences for efforts at >19km/h included a 13% increase from the first to the second half following three days between games, as well as decreases when there were six days (-7%) and eight days (-8%) between games. While it is once more necessary to be mindful of the different number of match observations for each case, this again suggests that, whilst there can be too little time between games, having too many days between games can disrupt match rhythm and players' physical preparation.

3.5.4 Team distance covered and tactical formation

Figure 46 shows a comparison of the percentage of total distance covered at above and below 13km/h based on the tactical formation at the start of a game, as defined by the FIFA Technical Study Group. The number of match observations for each formation varied and that is indicated in brackets next to the formation on the graphs. As can be seen, there was only one match observation for three of the formations (1-3-5-2, 1-4-4-1-1 and 1-5-4-1), which should be considered when interpreting the data. The percentage of the distance at <13km/h was highest for 1-3-5-2 (75%) and lowest for 1-5-4-1 (71%). The amount of distance – relative to total distance – covered at above and below 13km/h was similar for all of the other formations. In absolute terms, the distance covered at <13km/h was similar and highest for 1-4-4-1-1 and 1-4-4-2, with the most distance at >13km/h also whilst in a 1-4-4-2 formation. The lowest distance at >13km/h was whilst in a 1-4-4-1-1 formation, but only one team played that formation (Scotland), and in one match only.

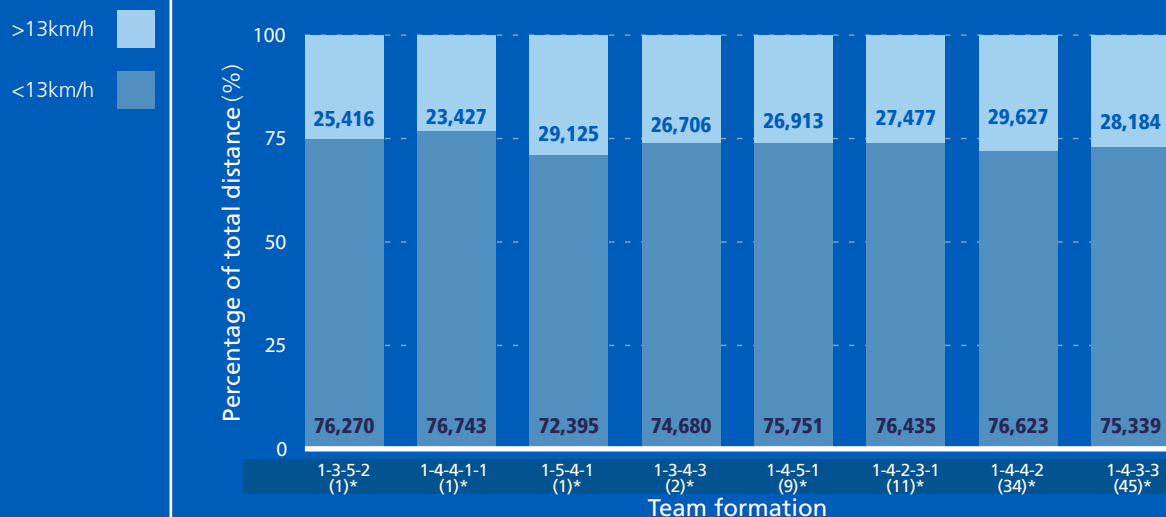


Figure 46. Summary of the total distance covered at <13km/h and >13km/h according to the tactical formation. * (x) is the number of occasions that the formation was used in the tournament (only the starting formations for each match were computed).

Figure 47 shows a comparison between the distances covered and efforts completed at the higher speeds (>19km/h) and the tactical formation. The total distance covered and efforts completed at >19km/h were generally highest for teams that set up in a 1-4-4-2 formation. The team that set up in a 1-4-4-1-1 formation completed the least distance and fewest efforts at >19km/h, although again, this was only one team and in one match, but their distance at >19km/h was 33% lower than teams competing in a 1-4-4-2 formation, and they completed 37% and 32% fewer efforts in Zone 4 and Zone 5 respectively compared to teams in a 1-4-4-2. Such findings are important so that coaches have a good understanding of the physical demands of the tactical formation that they wish to employ and, along with the fitness coach, can then prepare the players optimally for those demands.

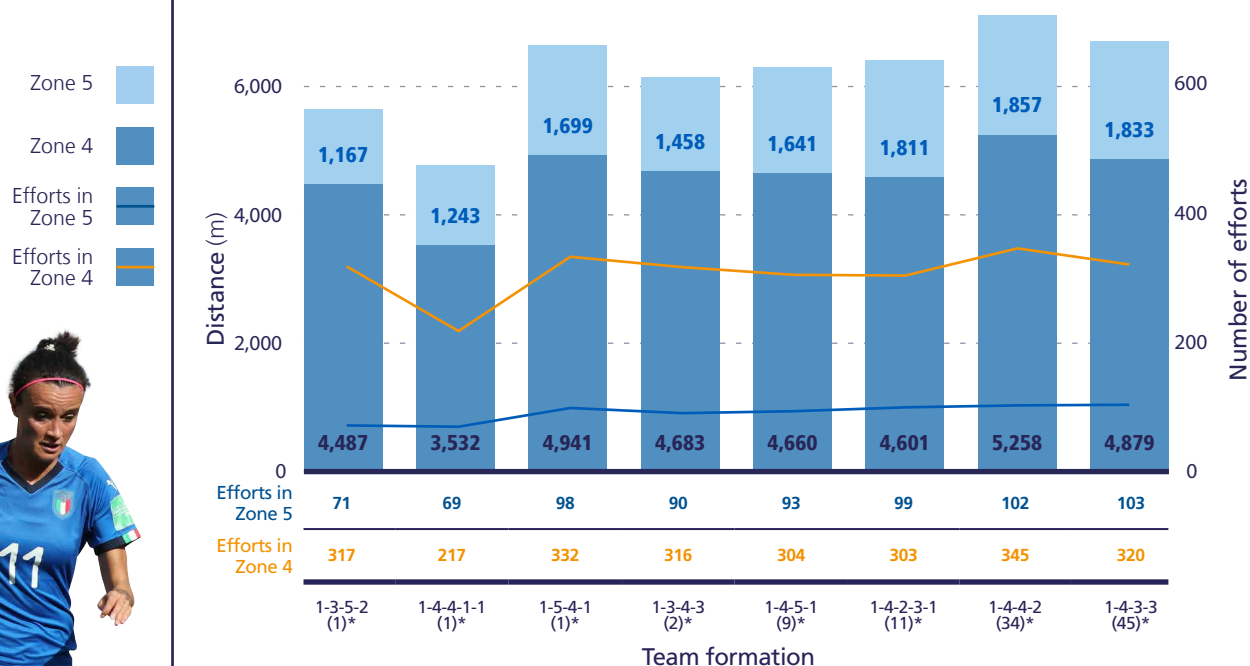


Figure 47. Summary of the total distance covered and efforts completed at >19km/h according to the tactical formation. *(x) is the number of occasions that the formation was used in the tournament (only the starting formations for each match were computed).



3.5.5 Team distance covered and confederation

A comparison of the total distance covered at <13km/h and >13km/h by the teams representing the respective confederations at Canada 2015 (Figure 48) and France 2019 (Figure 49) can be seen below. As was outlined in the methods, the OFC (1) was represented by the lowest number of teams, whilst UEFA (9) had the greatest number of representatives, and this should be considered when interpreting the data. In 2015, the amount of distance completed at <13km/h, as a proportion of total distance, ranged from 72% (the OFC) to 76% (CONMEBOL). This means that teams from CONMEBOL covered the lowest proportion of distance at >13km/h. In absolute terms, in 2015, UEFA teams completed the highest overall distance, and the most distance at <13km/h (84,199m) and >13km/h (27,796m).

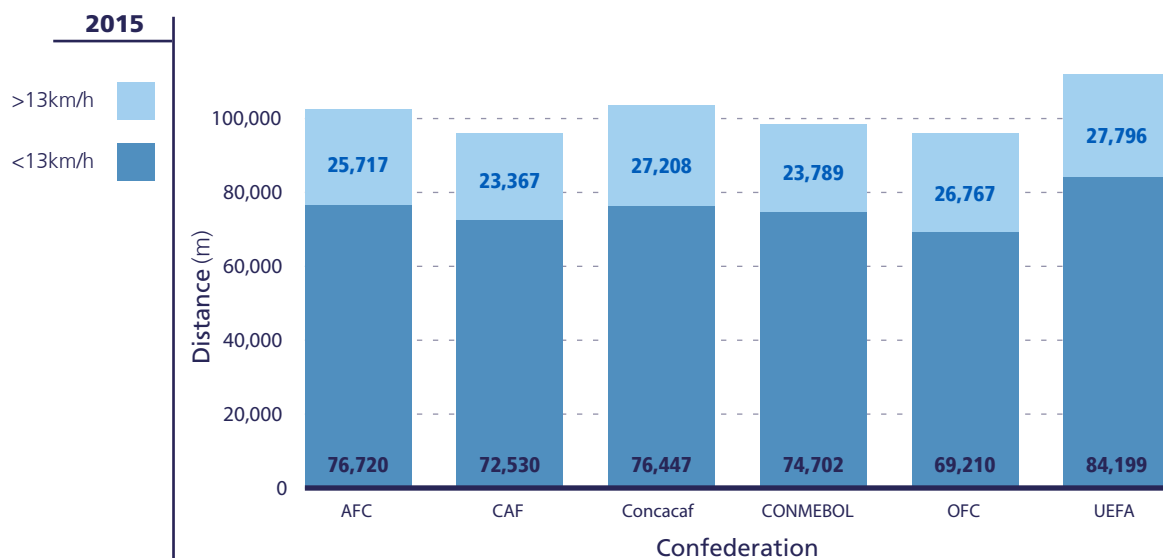


Figure 48. Summary of the total distance covered at <13km/h and >13km/h per confederation at Canada 2015

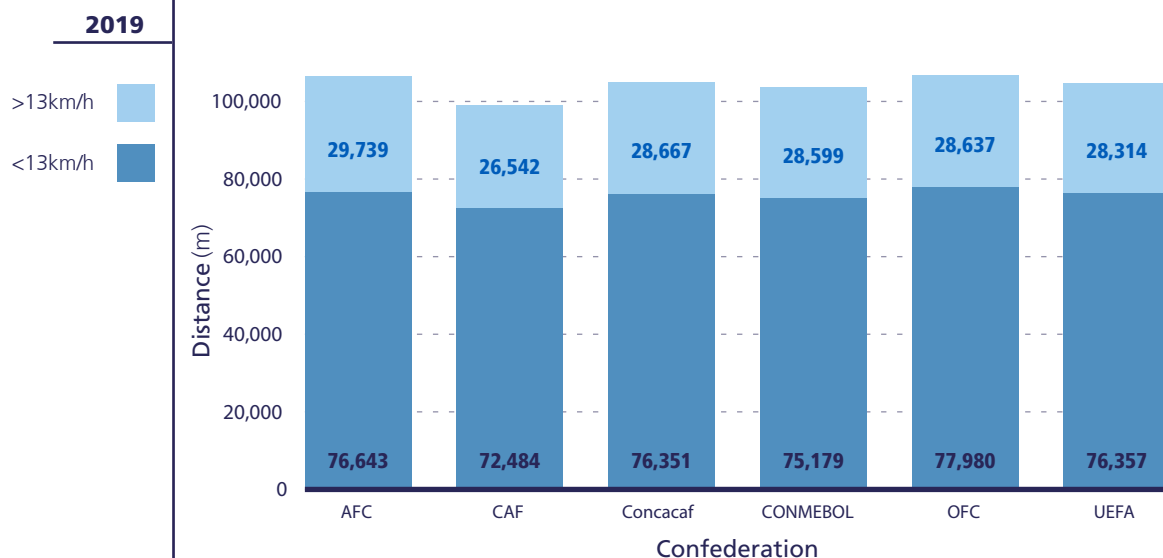


Figure 49. Summary of the total distance covered at <13km/h and >13km/h per confederation at France 2019

In 2019, teams from all confederations covered a very similar proportion of distance at <13km/h (72/73%). In other words, teams in 2019 broadly covered a higher proportion of total distance at >13km/h, as has already been highlighted. Overall, the change in total distance went from -7% (UEFA) to an increase of 11% (the OFC) from 2015 to 2019. When looking at the distance at <13km/h, the comparison ranged from -9.3% (UEFA) to an increase of 12.7% (the OFC) in 2019. For distance at >13km/h, CONMEBOL (20.2%) had the biggest increase, followed by the AFC (15.6%) and CAF (13.6%); UEFA teams (1.9%) had the lowest increase for this higher-speed running compared to 2015.

A comparison of the total distance covered and efforts completed in the higher speed zones (>19km/h) by the teams representing the respective confederations at Canada 2015 (Figure 50) and France 2019 (Figure 51) can be seen below. Teams from all confederations increased the amount of distance completed at >19km/h, ranging from an increase of 1.2% (the OFC) to 30.1% (CONMEBOL/CAF). In 2015, the OFC team, on average, covered the greatest distance at >19km/h, whereas in 2019, AFC teams covered the most distance above that threshold. When breaking it down into distance covered in Zone 4, AFC teams (5,309m) again covered the most distance in 2019, whilst the OFC team (4,812m) managed the least distance and the AFC contingent (28.7%) had the greatest increase from 2015 to 2019.

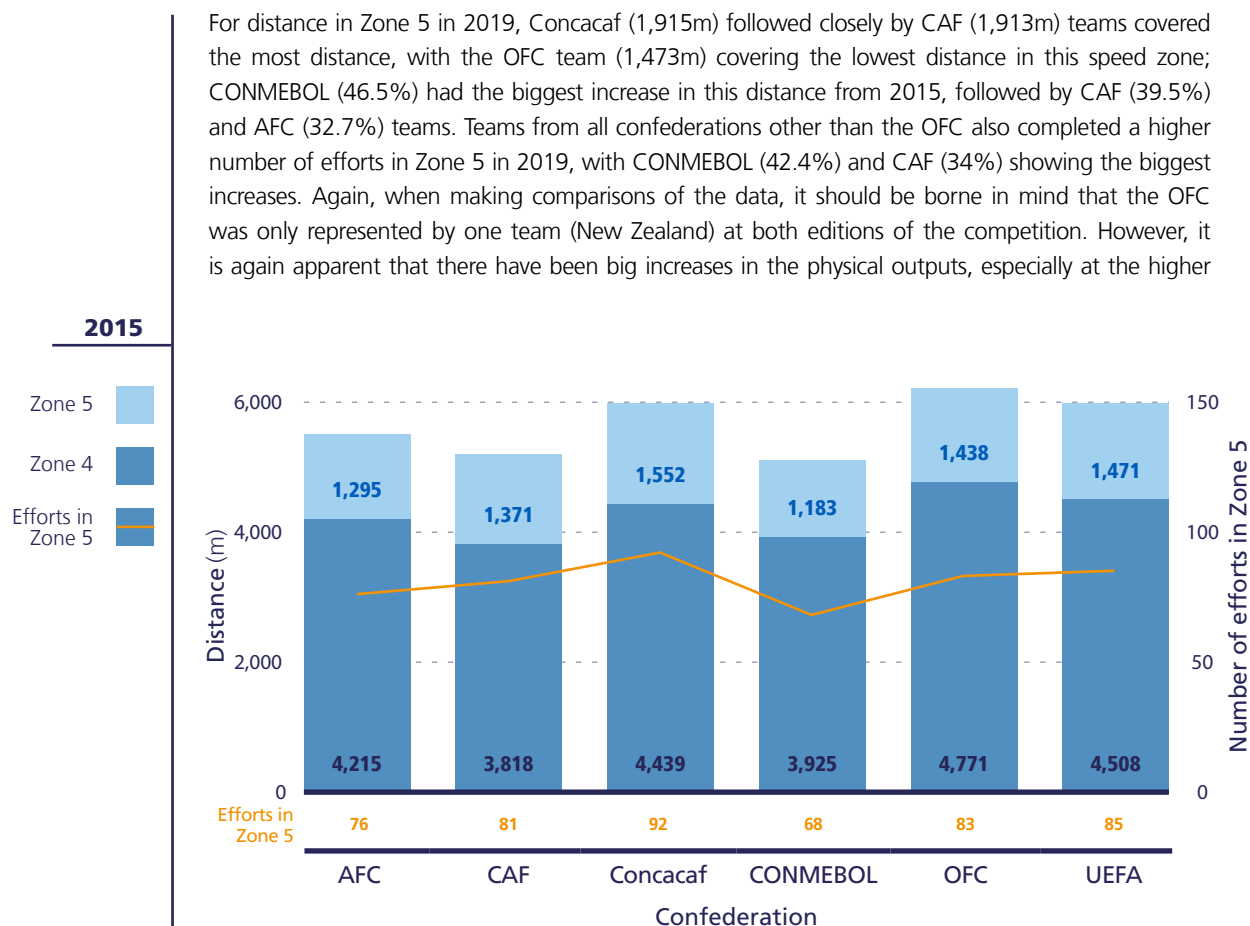


Figure 50. Summary of the total distance covered and efforts completed at >19km/h per confederation at Canada 2015

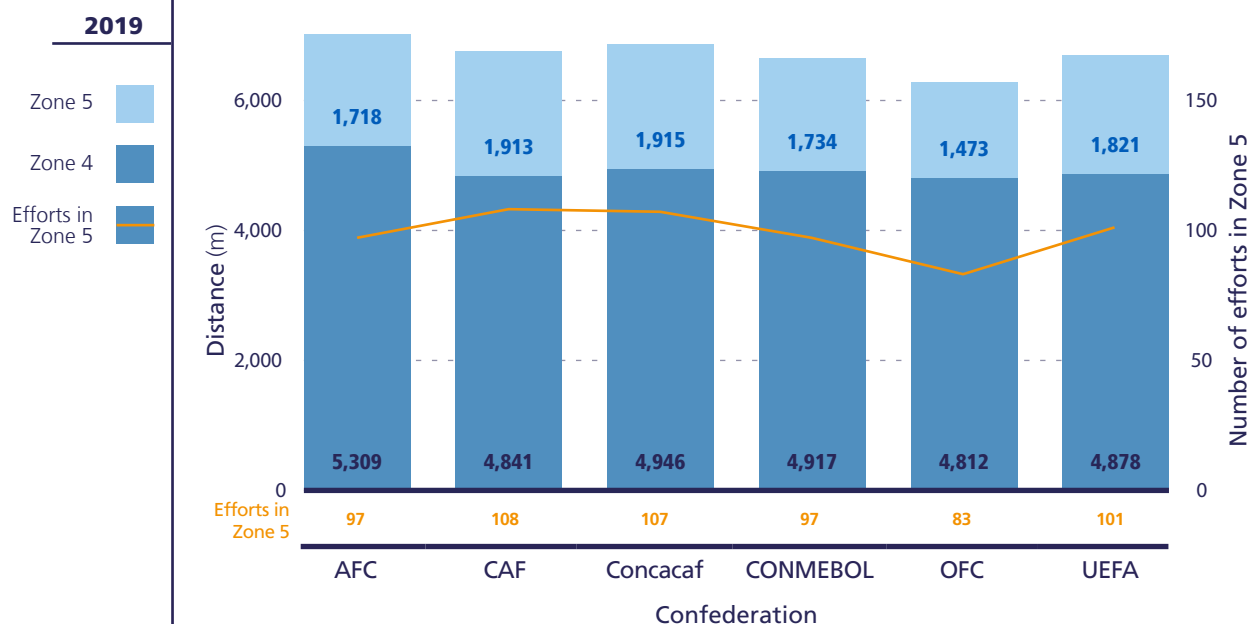
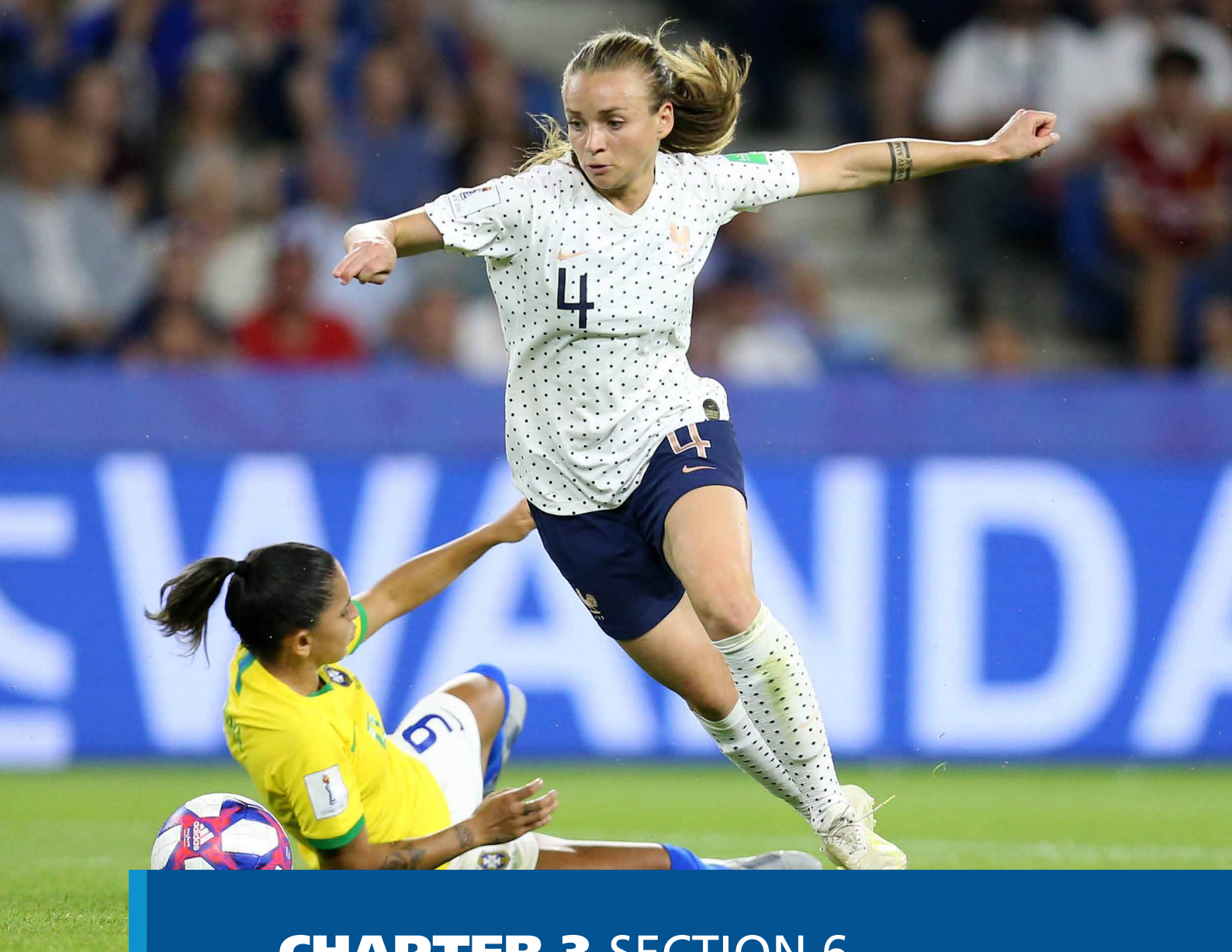


Figure 51. Summary of the total distance covered and efforts completed at >19km/h per confederation at France 2019

intensities, by teams from the CONMEBOL and CAF regions, which have historically been lower-ranked teams eliminated during the group stage or in the early knockout rounds, so it is pleasing to see the increases for those regions. Conversely, the improvements from the UEFA teams were evident, but less pronounced, which could be a reflection of the current development of those teams and many of those countries already having professional environments and leagues to develop their players. In addition, seven of the eight quarter-finalists were from UEFA, again highlighting the strength of the teams in that confederation.

3.5.6 Summary

- The physical loads completed by teams were very similar, regardless of the match outcome, with a slightly higher distance covered at >19km/h (4%) by teams that won compared to teams that lost.
- When comparing the physical outputs to the round of the game, on average, the loads were very similar for rounds 1-3, and generally the highest for the distance and efforts at >19km/h in round 4, the first knockout round. The distance covered and efforts in Zone 5 were higher in round 7 compared to the first round of games, which means that the teams in those games were able to complete more running and efforts in the highest speed zone during their final fixture. However, there was a reduction in such high-speed running from the first to the second half of the games in round 7, which could have been a tactical ploy by teams in those games to slow down play.
- The number of days between games is important for player recovery and subsequent preparation, physically and tactically, for the next game and opponent. Throughout the 2019 tournament, that interval varied from three to eight days. One of the main findings was that some of the distances and efforts at the higher speeds (>19km/h) were lower with more days between games, although there were also fewer match observations. However, whilst having too little time between games will hinder players' recovery, having too many days can also disrupt the match rhythm, meaning that the physical preparation of players with a greater hiatus can be more challenging. For tournament play, it is important to take this into consideration and prepare players optimally for the game schedule that they will face.
- Throughout France 2019, eight different tactical formations, as defined by the FIFA Technical Study Group at the start of games, were used by coaches, although three of the formations were only used by one team and for one match. The lowest overall total distance and distance at >19km/h were completed by the team that lined up in a 1-4-4-1-1 formation. Generally, teams using a 1-4-4-2 formation covered the most total distance, and racked up the most distance and efforts at >19km/h. Such findings are important so that coaches have a good understanding of the physical demands of the tactical formation that they wish to employ, and along with the fitness coach, can then prepare the players optimally for those demands.
- When comparing the physical output of teams from the different confederations, compared to 2015, the majority of the confederations registered substantial upturns. For distances at >13km/h specifically, CONMEBOL (20.2%) had the biggest increase, followed by the AFC (15.6%) and CAF (13.6%). Those confederations also had the biggest increase from 2015 for the distances and efforts completed at >19km/h. It is apparent that there have been big increases in the physical outputs, especially at the higher intensities, by teams from the CONMEBOL and CAF regions, which have historically been lower-ranked teams eliminated during the group stage or in the early knockout rounds, so it is pleasing to see the increases for those regions. Conversely, the improvements from the UEFA teams were evident, but less pronounced, which could be a reflection of the current development of those teams and many of those countries already having professional environments and leagues to develop their players.



CHAPTER 3 SECTION 6

Team analysis | Final four teams: distances, passes, possession and compactness

3.6.1 Comparison with their output at Canada 2015

Figure 52 shows a comparison of the average distances covered at $<13\text{km/h}$ and $>13\text{km/h}$, and the average number of passes made per game, by the final four teams at the 2019 tournament and the same four teams at Canada 2015. The USA and England both reached the final four in 2015 as well, whereas both the Netherlands and Sweden were eliminated in the round of 16, meaning that they only completed four games each in that tournament. Sweden completed the overall highest distance of the four teams in both of the tournaments: 108,763m in 2015, which decreased slightly in 2019 (-1%). The USA's total distance was almost identical across both tournaments, whilst England had a

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2% increase in total distance (1,573m) and the Netherlands posted a 1% increase (762m) from 2015 to the 2019 edition. As an absolute value, all four teams covered a similar distance at <13km/h across the tournaments, with Sweden covering the highest amount and England the lowest. For distance covered at >13km/h, Sweden were the only team with a decrease (-5%) from 2015 to 2019; the three other teams increased their distance above this threshold, with England showing the greatest increase (9%). In terms of efforts at >19km/h, all teams increased their average number of efforts from 2015 to 2019, with the USA (11; 3%) showing the lowest increase and England (65; 17%) the greatest. In absolute terms, in 2019, England (437) completed the most efforts at >19km/h on average throughout the tournament out of the final four. With regard to technical elements, when looking at the average number of passes per game, England again had the highest overall total in 2019 (573) and the biggest increase (74%) from 2015. The USA also had a large increase (43%) in total passes from 2015, whilst Sweden had the lowest number out of the four teams in 2019 (443) and actually registered a decrease (-2%) in their average number of passes with respect to 2015.

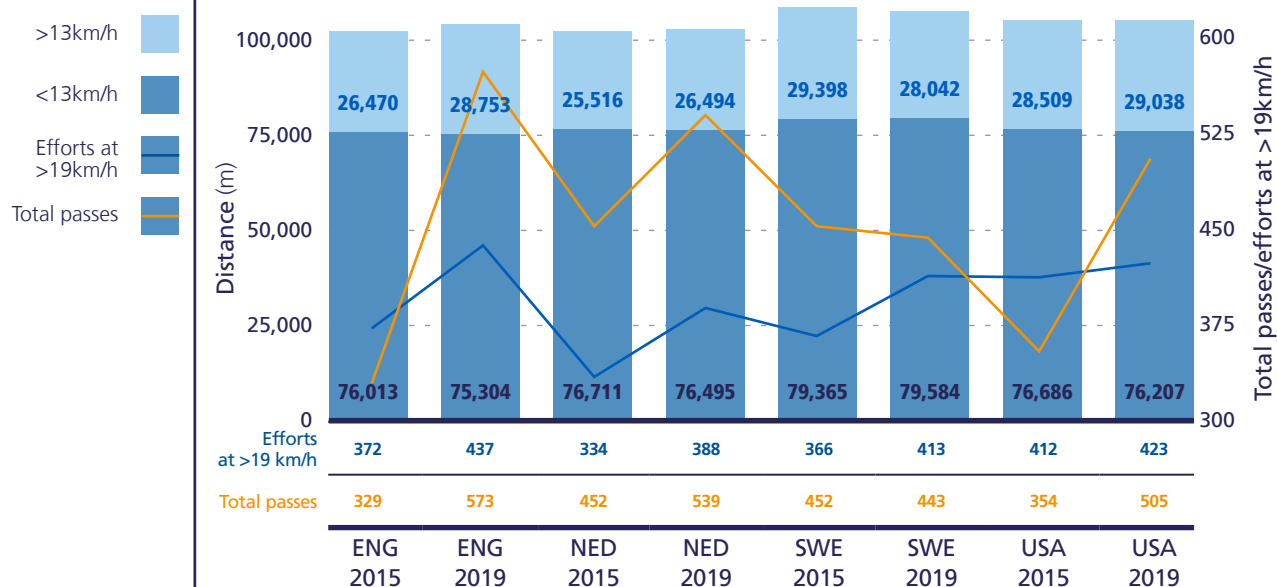


Figure 52. Comparison of the distances covered at <13km/h and >13km/h, efforts at >19km/h and total team passes for the final four teams at France 2019, alongside their Canada 2015 output

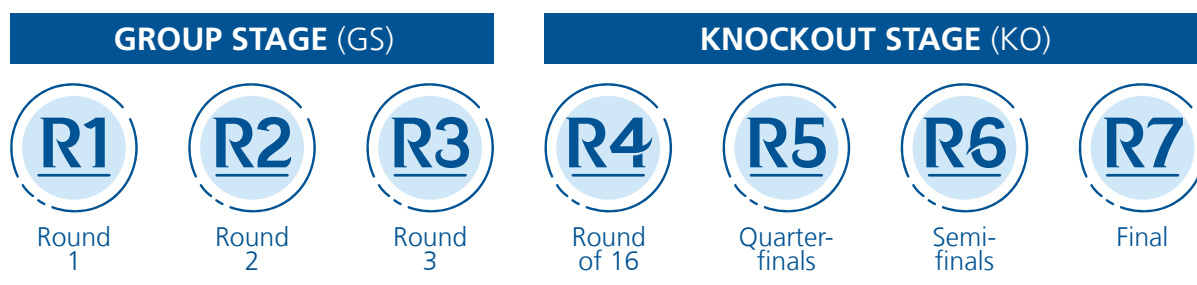


Figure 53 shows a comparison of the average distances covered at >19km/h, Zone 5 efforts completed and ball possession recorded by the final four teams at the 2019 tournament, compared to their output in 2015. When looking at the overall distance at >19km/h, England (6,975m) followed by the USA (6,795m) covered the most ground in 2019; England (1,023m; 17%) also had the biggest increase from 2015. When looking at distance covered in Zone 4 only, England (4,963m) and the USA (4,952m) again covered the highest absolute distance in 2019, with England (13%) having the biggest increase from 2015 and the USA (5%) the lowest. For distance and efforts in Zone 5, England completed the most distance (2,012m) and efforts (111) in 2019, whilst Sweden had the biggest increase in distance (41%) and efforts (33%) from 2015. All four teams increased their distance and efforts completed in the highest speed zone compared to 2015, with the USA having the smallest increase on both fronts (9% and 1% respectively). When looking at ball possession, England again had the highest increase (24%) from 2015, whilst Sweden's average ball possession decreased (-4%) from 2015 to 2019. Overall, England (57%) and the Netherlands (56%) had the greatest ball possession out of the semi-finalists during the 2019 tournament. These findings demonstrate that whilst all four teams increased their physical outputs – especially in the highest speed zones – from 2015 to 2019, the USA had the lowest increases, meaning that their physical output was very similar for the 2015 and 2019 tournaments; England, on the other hand, had by far the biggest increases in both technical elements and the highest-intensity distances and efforts completed during games. Such findings are in keeping with earlier sections of this report showing that total distance was consistent across the 2015 and 2019 tournaments, but that whilst some of the lower-speed distances and efforts decreased, distances and efforts at the higher speeds increased, reflecting a higher-paced game at the elite level.

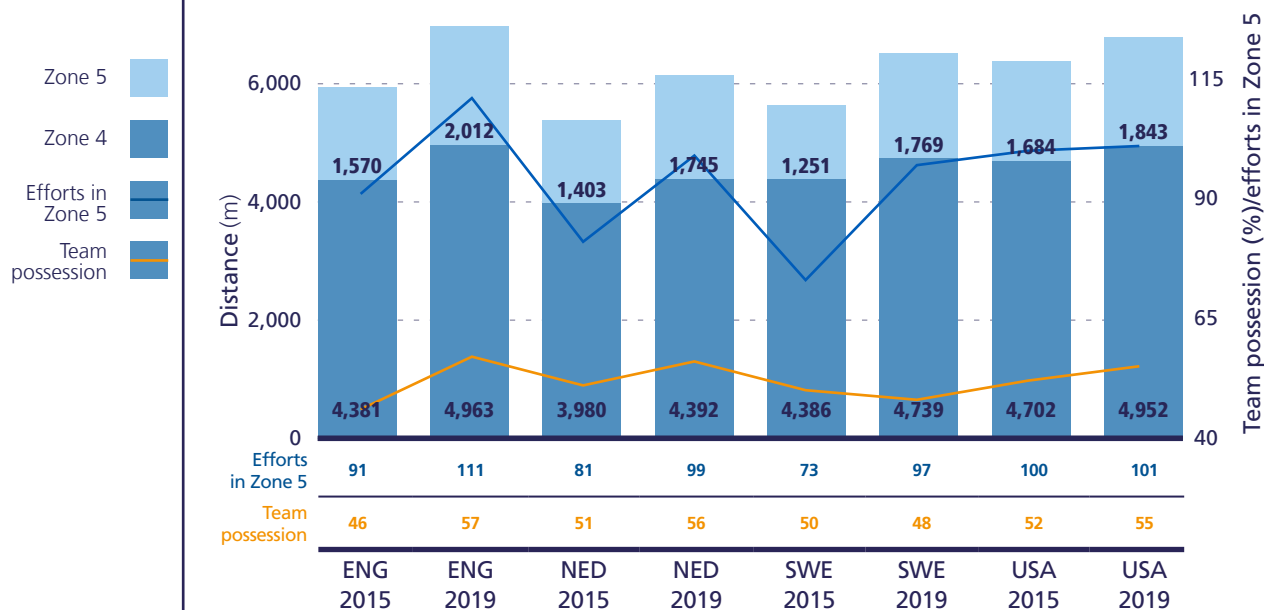


Figure 53. Comparison of the distances covered at >19km/h, efforts in Zone 5 and average ball possession for the final four teams at France 2019, set against their Canada 2015 output

3.6.2 Output in 2019 only and breakdown by the stage of the tournament

Figure 54 shows a comparison of the average distances covered at <13km/h and >13km/h, and the average number of passes played per game, by the final four teams at the 2019 tournament only, broken down by the stage of the tournament (group stage and knockout rounds). Of the four semi-finalists, Sweden covered the most distance at <13km/h in both the group stage (79,426m) and the knockout rounds (79,703m). England (74,354m) and the USA (74,920m) respectively covered the least distance at such speeds during the group stage and the knockout rounds. The USA (-4%) notably decreased the amount of distance they covered at <13km/h from group to knockout action, whilst the other teams had minimal change. When looking at distance covered at >13km/h, the USA covered the most during the group stage (30,811m), whilst England led the way during the knockout phase (29,290m). England increased (4%) the distance that they covered from the group stage to the knockout rounds, whilst the other three teams decreased their distance covered at >13km/h, with the USA (-10%) having the biggest decrease. Sweden (447) registered the most efforts at >19km/h during the group stage, whilst England (453) completed the most during the knockout rounds; England also increased (9%) the number from the group stage, whilst all other teams produced fewer in the knockout rounds compared to the group stage, Sweden (-13%) having the biggest drop. All four teams decreased their number of total passes from the group stage to knockout action; ball possession also decreased for every team (Figure 55), with the USA (-26%) and Sweden (-23%) having the biggest reductions. The big drops in the number of passes and amount of higher-speed running observed for both Sweden and the USA from the group phase to the knockout rounds could in part be due to the other two teams in their group being amongst the lowest-ranked of the 24 teams in the tournament, and Sweden and the USA therefore being technically and physically dominant against those teams prior to facing stronger opposition in the latter stages of the tournament.

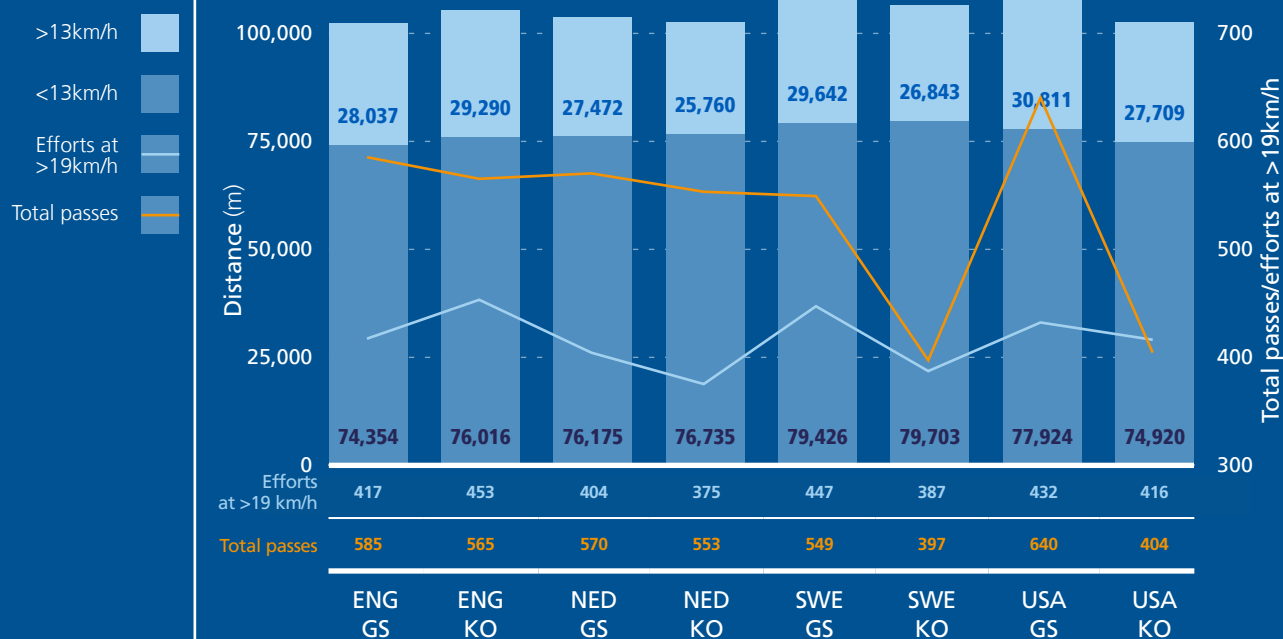


Figure 54. Comparison of the distances covered at <13km/h and >13km/h, efforts at >19km/h and total number of passes for the final four teams, for the group stage and knockout rounds



Figure 55 shows a comparison of the average distances covered at >19km/h and efforts completed in Zone 5 by the final four teams during the group stage and knockout rounds at the 2019 tournament only, alongside their ball possession. The USA (6,896m) completed the most distance at >19km/h during the group stage, whilst England (7,307m) completed the most distance at >19km/h during the knockout rounds. England (12%) were the only of the semi-finalists to increase the amount of distance at >19km/h from group to knockout action, with Sweden (-10%) having the biggest decline out of the other three teams. For distance covered in Zone 4 only, the USA (5,142m) and England (5,064m) respectively covered the most during the group stage and knockout phase, with England again being the only of the semi-finalists with an increase from group to knockout action (5%). For distance in Zone 5, Sweden (1,802m) completed the most in the group stage, whilst England completed the lowest amount in the group stage (1,704m), but the most in the knockout rounds (2,243m), thereby registering the greatest increase (32%) from the group stage to the knockout phase. The USA (9%) also increased the amount of distance they completed in Zone 5, whilst both Sweden and the Netherlands did less such running (-3%) during the knockout rounds. The Netherlands (100) completed the most Zone 5 efforts during the group stage, whilst England (120) completed the most during the knockout rounds; England (21%) and the USA (9%) both increased their number of such efforts in the knockout phase, whilst the Netherlands (-2%) and Sweden (-3%) both posted decreases. Finally, similar to the total passes completed, each of the four teams' ball possession decreased from the group stage to the knockout rounds, with the USA (-26%) and Sweden (-23%) having a greater decline. Again, this could be the result of playing stronger opponents during the latter stages of the tournament.

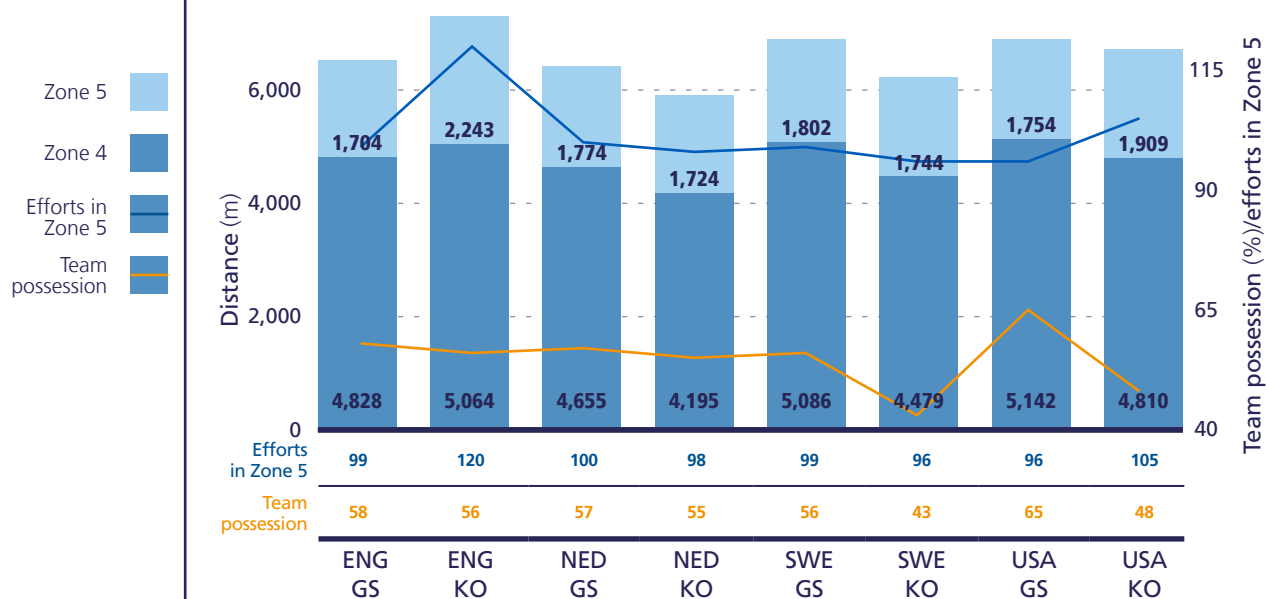


Figure 55. Comparison of the distances covered at >19km/h, efforts in Zone 5 and average team ball possession for the final four teams

Data indicates that England were able to sustain their physical capacity as a team across their seven games

3.6.3 Comparison of output against each opponent

Figure 56 shows a comparison of the average distances covered and efforts completed at >19km/h, alongside total passes, for England against their seven opponents at the 2019 tournament only. England completed their lowest distance and fewest efforts at >19km/h in their first game against Scotland, which they won 2-1. As can be seen, England recorded their highest figures for distance and efforts at >19km/h in their fifth game of the tournament against Norway, which were respectively 45% and 43% higher than their output during their first game against Scotland. Moreover, in the Norway game, England had their lowest possession (50%) of all of their games, and similarly had their second-lowest number of passes. All of this suggests that the Norwegians made England work harder to win the ball back. England then completed much less distance (-26%) and fewer efforts (-27%) at >19km/h in their next game, game six against the USA. Although their overall distance at >19km/h was lower in games six and seven, their proportion of distance in Zone 5 (48%) was highest in those final two games. Such data indicates that England were able to sustain their physical capacity as a team across their seven games, albeit their physical output peaked during game 5, and in fact, it is more likely that the level of the opposition and their tactical formation and tendencies influenced the physical output of the English players and team.

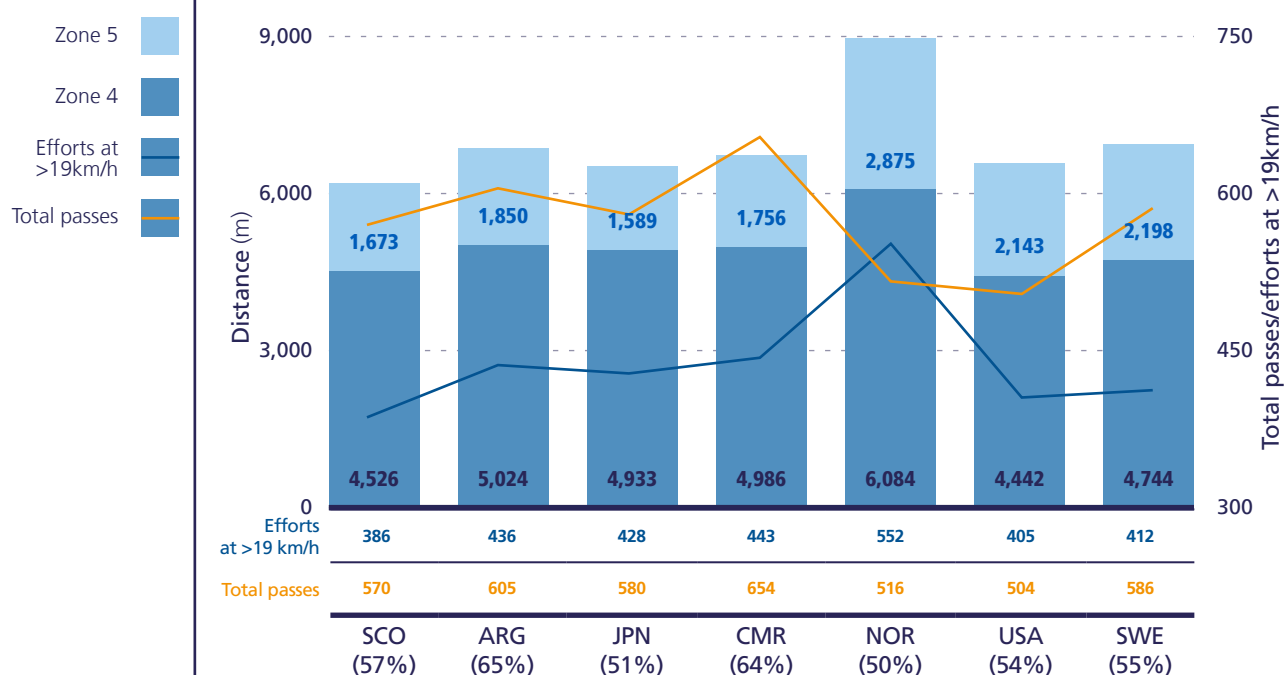


Figure 56. Comparison of the distances covered at >19km/h, efforts at >19km/h, average team passes and ball possession (%) for England in each of their games



Figure 57 shows a comparison of the average distances covered and efforts completed at >19km/h, alongside total passes, for Sweden against their seven opponents at the 2019 tournament only. Sweden completed their lowest distance and fewest efforts at >19km/h in their second game against Thailand, a game they won 5-1, in which they had their greatest ball possession and total passes. As can be seen, they recorded their highest figures for distance and efforts at >19km/h in their third game of the tournament, against the USA, which were respectively 52% and 56% higher than the output during their previous game against Thailand; incidentally, the Americans also registered their most distance and efforts at >19km/h in that game against the Swedes (Figure 59). Sweden's proportion of distance in Zone 5 was lowest (28%) for their second game against Thailand, which was likely due to them having so much possession and not being forced to exert themselves at the highest speeds. Their highest proportion of distance in Zone 5 (43%) was in their final game against England. Again, these results show that Sweden were able to sustain their physical capacity as a team across their seven games, as evidenced by the consistency of their physical output in the higher speed zones, and in fact, it is more likely that the level of the opposition and their tactical formation and tendencies influenced the physical output of the Swedish players and team.

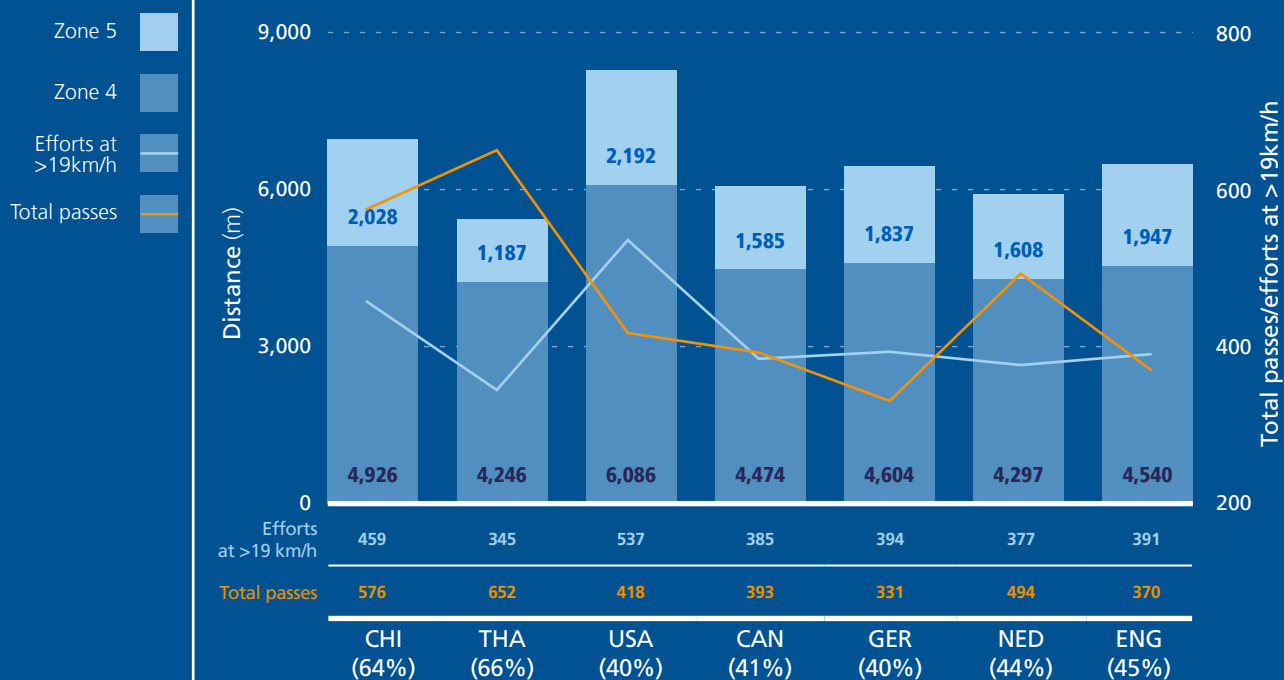


Figure 57. Comparison of the distances covered at >19km/h, efforts at >19km/h, average team passes and ball possession (%) for Sweden in each of their games



Figure 58 shows a comparison of the average distances covered and efforts completed at >19km/h, alongside total passes, for the Netherlands against their seven opponents at the 2019 tournament only. The Netherlands completed their lowest distance and fewest efforts at >19km/h in their fifth game against Italy, a game they won 2-0 and in which they also had their second-highest amount of ball possession (60%). As can be seen, they recorded their highest figures for distance and efforts at >19km/h in their previous game, against Japan, with a drop in distance and efforts at >19km/h (-35% and -33% respectively) in that game against Italy. That could imply that they were not able to sustain the work rate that they put in against Japan; however, they did still beat Italy, so it must be remembered that physical output alone is not a determinant of match outcome in football. Their proportion of distance in Zone 5 was lowest (33%) in that game against Italy; however, their highest proportion of distance in Zone 5 (50%) came in their final game against the USA, suggesting that they were able to produce a higher physical output when required, which may have been dictated by the physical output of the opposition and the need to complete that kind of running in a defensive capacity.

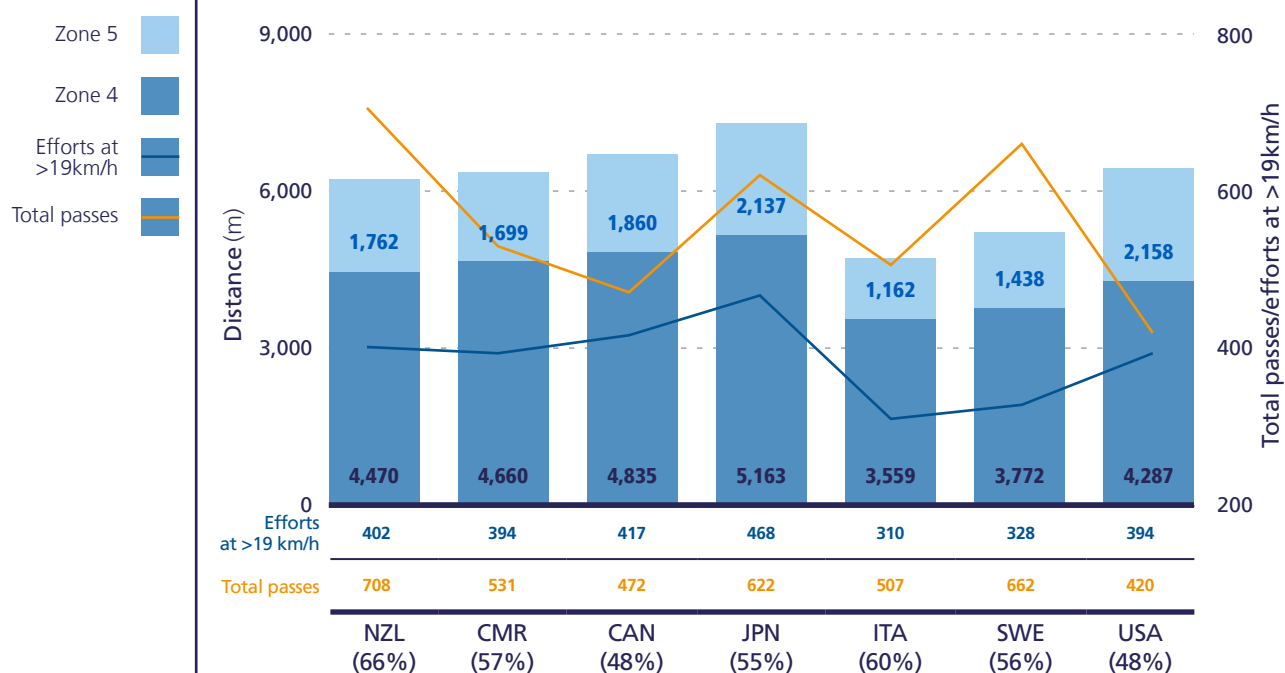


Figure 58. Comparison of the distances covered at >19km/h, efforts at >19km/h and average team passes and ball possession (%) for the Netherlands in each of their games



Figure 59 shows a comparison of the average distances covered and efforts completed at >19km/h, alongside total passes, for the USA against their seven opponents at the 2019 tournament only. The USA completed their lowest distance and fewest efforts at >19km/h in their opening group game against Thailand, a game they won 13-0 and in which they had their greatest ball possession (69%) and total passes (696), hence the team did enough physical work to ease to victory. As can be seen, they completed their highest figures for distance and efforts at >19km/h in their third game of the tournament, against Sweden (whose performance above this threshold also peaked in that match – Figure 57), which were respectively 41% and 36% higher than their output during that first game against Thailand. The USA's proportion of distance in Zone 5 was lowest (29%) in that game against Thailand, which was likely due to them having so much possession and not having to cover distance in the highest speed zone. Their highest proportion of distance in Zone 5 came in their fourth game against Spain (45%), followed by their final game against the Netherlands (42%). It was very apparent that the USA's technical output was highest in their three group games, in which they played two of the lower-ranked teams, with their distance at >19km/h and specifically in Zone 5 being lowest for those two games, suggesting that those opponents were not able to match the USA. These results show that the USA were able to sustain their physical capacity, as a team, across their seven games, as evidenced by the consistency of their physical output in the higher speed zones, and in fact, it is more likely that the level of the opposition and their tactical formation and tendencies influenced the physical output of the US players and team.

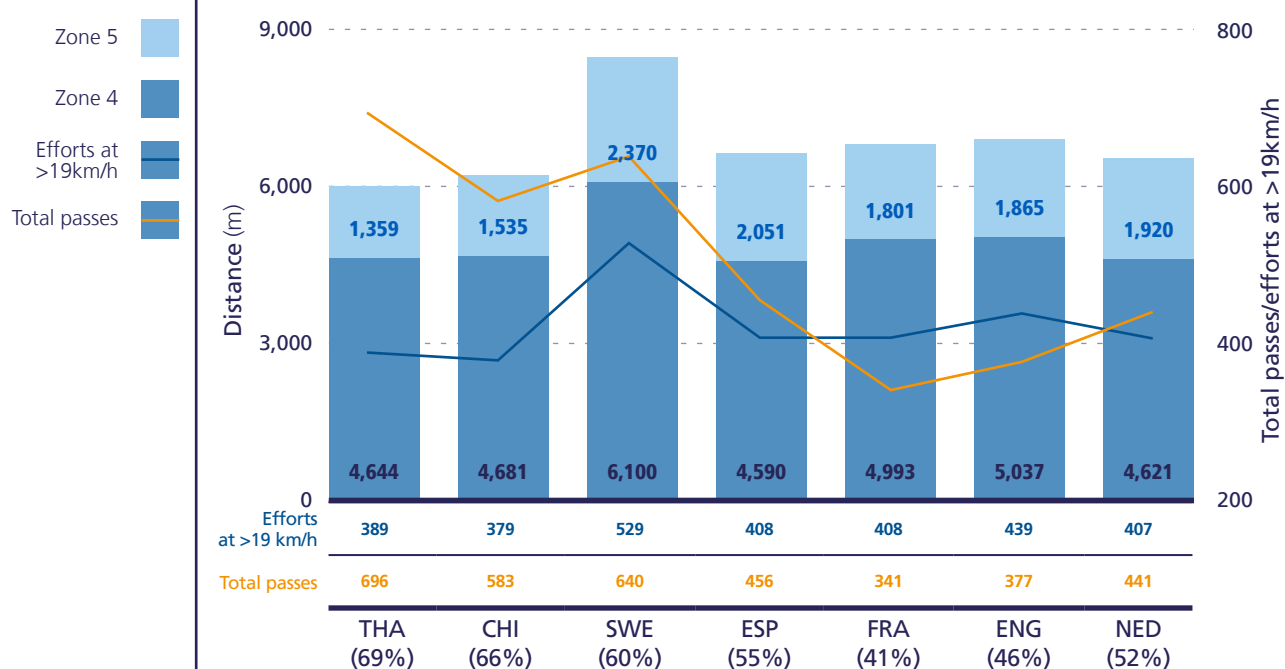


Figure 59. Comparison of the distances covered at >19km/h, efforts at >19km/h, average team passes and ball possession (%) for the USA in each of their games

Figure 60 shows the total distance covered by each of the final four teams across each game of the tournament, as well as a comparison with the average for all games in the tournament. As can be seen, Sweden (115,239m) and the USA (114,021m) both covered their highest total distance in their third game of the tournament, which was against each other. This implies that the higher physical output was necessary for each team in that game, to be able to compete against each other. England (99,837m) completed their lowest total distance in their first game of the tournament, their highest in game 5 (111,312m) and more in game 7 than in game 1 (105,250m; 5% increase). The USA completed less total distance in game 7 (100,264m; -7%) compared to game 1; however, they won both games, which highlights that physical output alone is not an indicator of performance or game success. Throughout the tournament, on average, the total distance for round 1 of games (103,803m) was similar to round 7 (103,032m).

Figure 61 shows the total distance covered at >19km/h by each of the final four teams across each game of the tournament, as well as a comparison with the average for all games in the tournament. Again, the USA (8,470m) and Sweden (8,278m) completed their highest distance at >19km/h in game 3, in which they competed against each other, whilst England completed their highest amount in game 5 (8,960m), which was 6% more than the amount completed by the USA in game 3. Compared to game 1, Sweden (-7%) completed less distance at >19km/h in game 7, whilst the Netherlands (3%), the USA (9%) and England (12%) covered more such distance in game 7 compared to game 1. The Netherlands completed their lowest amount of distance at >19km/h (4,720m) in their fifth game, having just recorded their highest distance at such speeds (7,300m) in their previous match. This sizeable drop could have been the result of accumulated fatigue and a lack of recovery, or it could also have been linked to the tactics of the opponent and doing what was necessary, given they won both of those games. Such findings again suggest that the teams have the physical capacity to complete high workloads over successive games, and it is more that the output varies depending on the opponent and their formation, as well as the tactical strategy and game plan to beat that opponent. On average for all games, teams completed a similar amount of distance at >19km/h in the first round of games and in round seven.

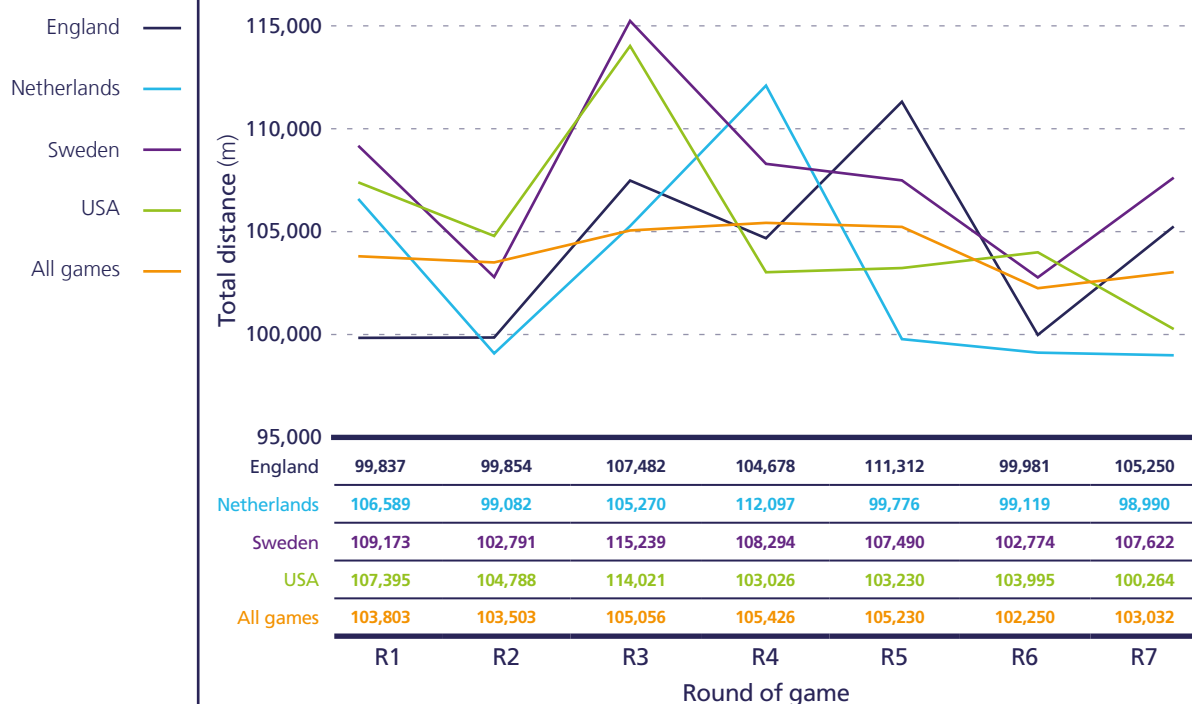


Figure 60. Comparison of the total distance covered by each of the final four teams, and the average for all games, according to the game round

Figure 62 shows the metrage for total distance for the final four teams across each 15-min period and during added time at the end of each half, as well as a comparison with the average for all games in the tournament. Generally, Sweden – other than 45-60min and 90+min – had the highest metrage of the final four teams for each period of games. Their metrage at the start of games was the highest, 117m/min, with the Netherlands (108m/min) having the lowest team work rate early in matches. All four teams generally had their lowest metrage during the final periods of games, 75-90min and 90+min, with Sweden (-21%) having the biggest decline compared to the first period and England (-4%) having

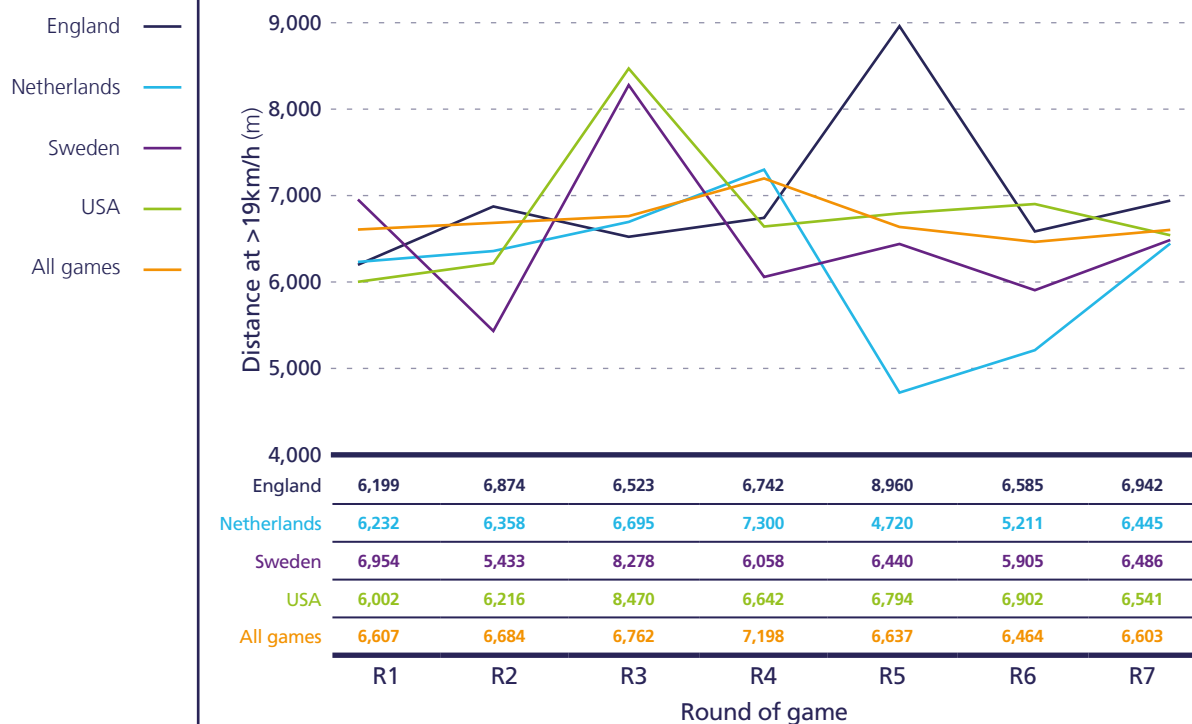


Figure 61. Comparison of the total distance covered at >19km/h by each of the final four teams, and the average for all games, according to the game round

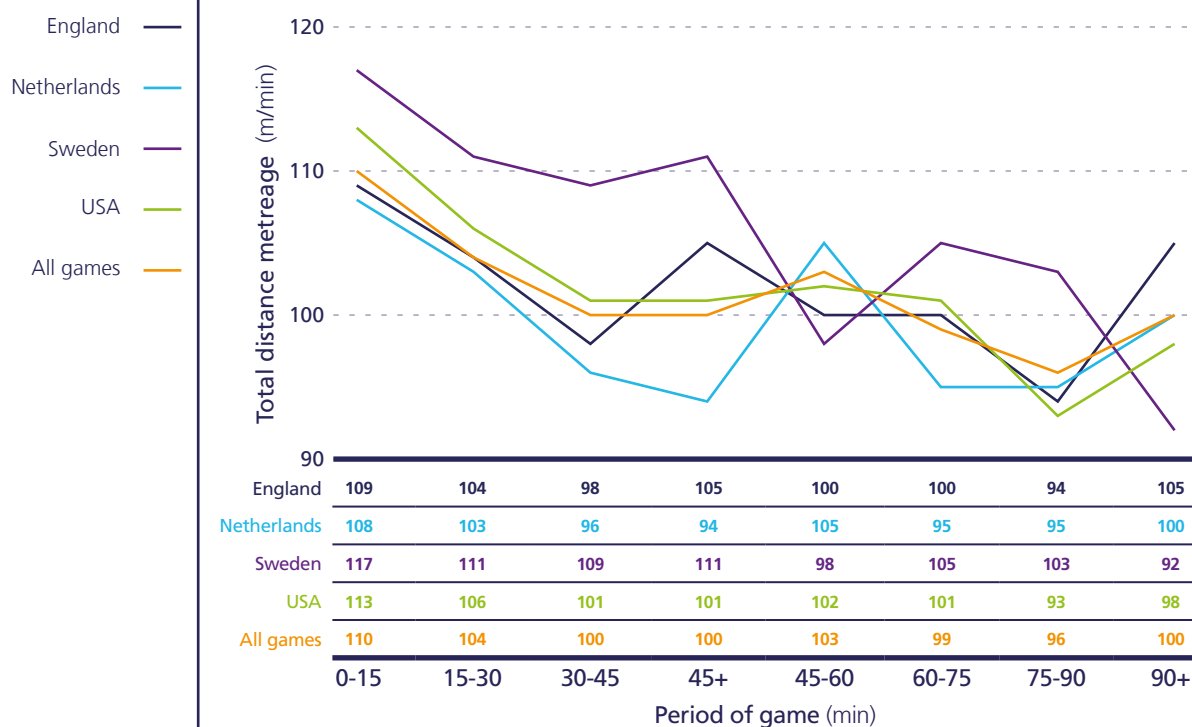


Figure 62. Comparison of the metrage by each of the final four teams, and the average for all games, for each 15-min period of the game

the lowest such decrease. All four teams generally had their highest work rate in the opening quarter of an hour of games, before having a decrease in work rate through to 30-45min, with England and Sweden then having an increase in the 45+min period immediately before half-time. England (31%) and the USA (23%) both scored their highest proportion of goals (Figure 63A) during the first 15-min period, which could have been the result of the higher work rate and a strategy by those teams to start off at a high pace in order to pressure the opposition. As some teams were then able to increase their work rate during 45+min (England, Sweden), this suggests that whilst there will still be some accumulated fatigue from the first 45-min of the game, players still have the capacity to increase their physical output if necessary. At the start of the second half, all four of the teams had a lower work rate than at the start of the game, with Sweden (-16%) having the biggest decrease and the Netherlands the smallest (-3%), although the Dutch also had the lowest overall work rate at the start of games. Tactical and physical preparation work during half-time is important in getting players ready for the start of the second half, and research has shown (Lovell et al., 2007; Towlson et al., 2013) that a re-warm-up protocol during half-time can enhance players' physical output during the second half of games, particularly during 45-60min, which was a period when the USA (Figure 63A: 19%) and teams overall (Figure 63B; 18%) scored a highly substantial proportion of their goals.

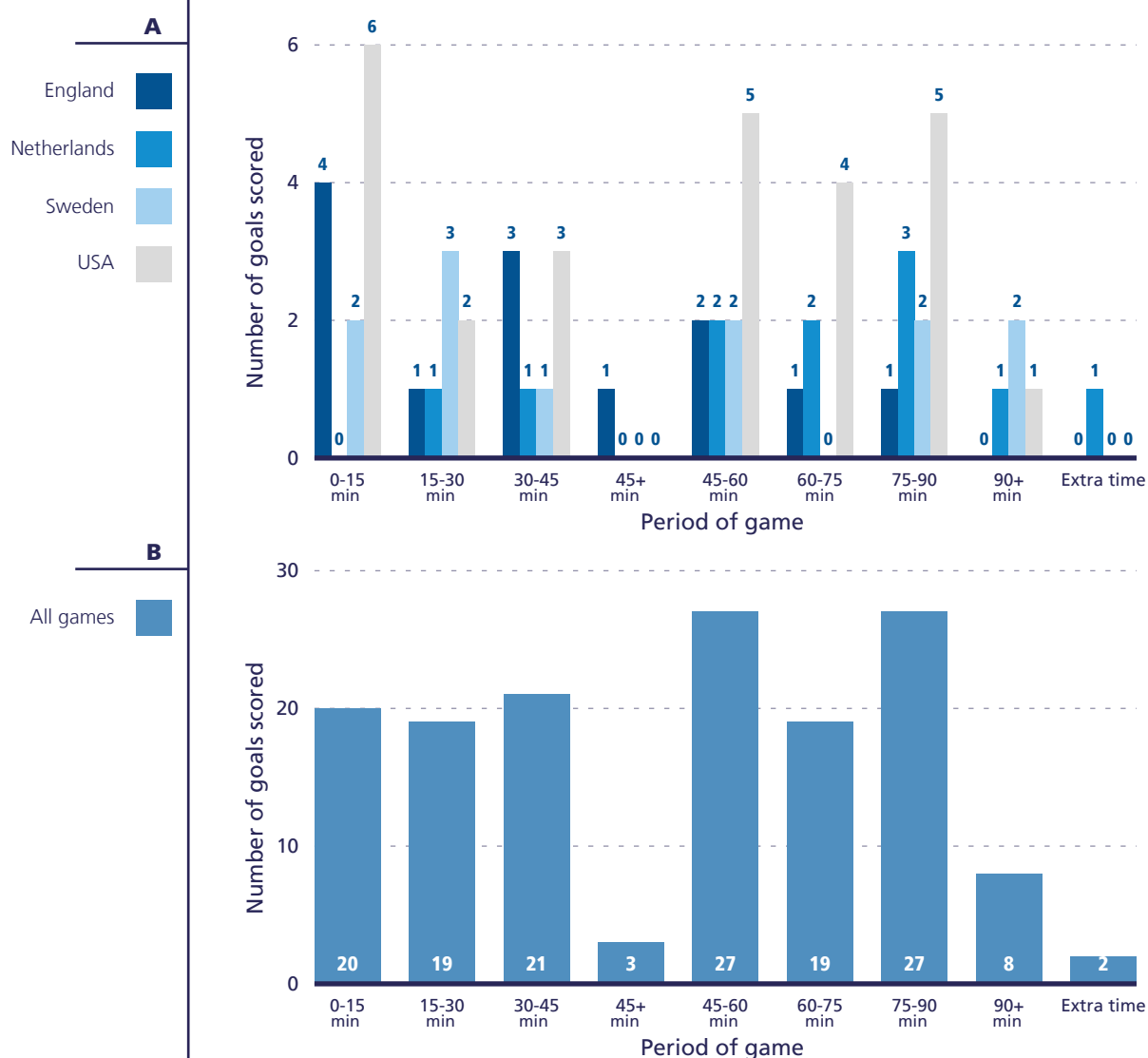


Figure 63. Comparison of the number of goals scored in each 15-min period of the game: (A) by the final four teams and (B) across all games of the tournament

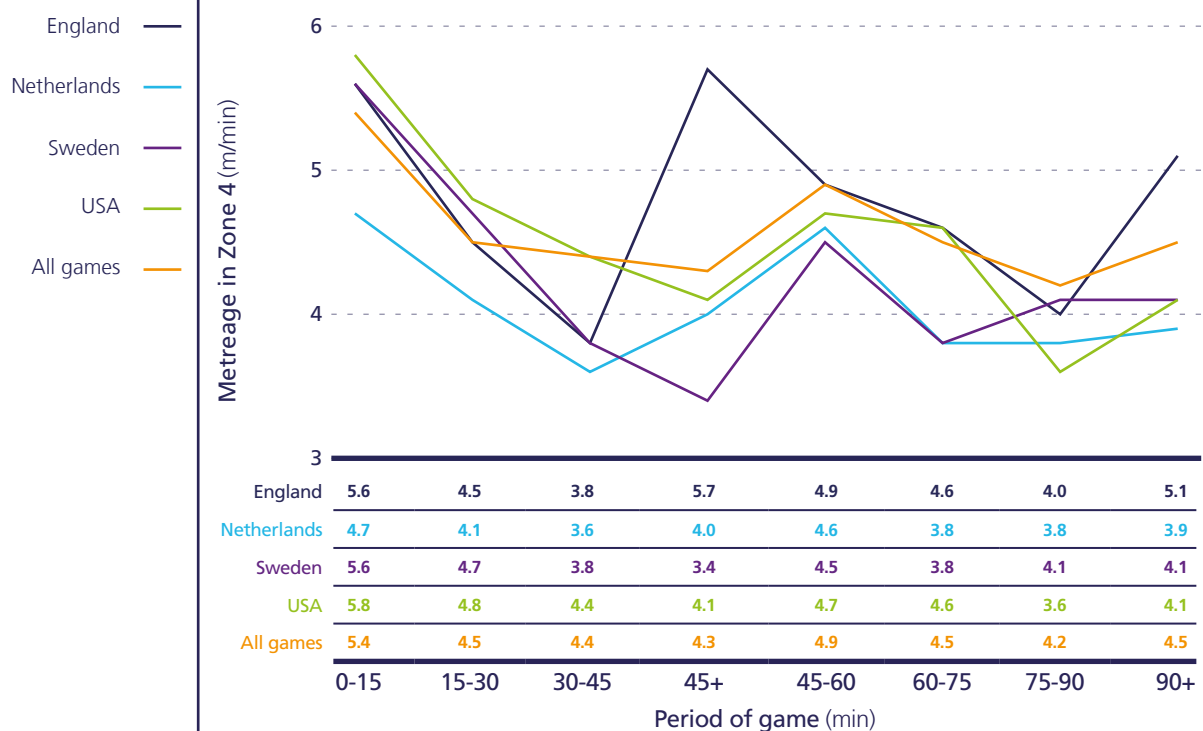


Figure 64 shows the metreage for distance covered in Zone 4 for the final four teams across each 15-min period and during added time at the end of each half, as well as a comparison with the average for all games in the tournament. Sweden had the largest decline in metreage in Zone 4 from the start of the game to 45+mins (-39%). The USA (5.8m/min) started with the highest metreage at these speeds, which had dropped by 29% by the period immediately before half-time. England completed their lowest metreage at these speeds (3.8m/min) during 30-45min, which is also when they scored their second-highest proportion of goals (3; 23%); this again highlights that physical output alone does not determine success in football. Following that lowest period, England then completed their highest metreage in Zone 4 (5.7m/min) in the period immediately before half-time. All teams decreased their metreage from the start to the end of the game, with England (-9%) having the lowest decrease.

Figure 65 shows the metreage for distance covered in Zone 5 for the final four teams across each 15-min period and during added time at the end of each half, as well as a comparison with the average for all games in the tournament. Out of the four semi-finalists, England (2.4m/min) started games with the highest metreage in Zone 5 and showed the lowest decline from the start to the end of the game (-8%). Sweden had the biggest decline from the start (2.1m/min) of the game to 45+min (1.2m/min; -43%), which could be a tactical ploy or could imply fatigue as the first half progressed. Conversely, the USA had a higher metreage in Zone 5 during the period immediately before half-time (2.2m/min) as compared to the start of the game (2.0m/min; 10%), which suggests a good physical capacity to increase their work rate at the highest speeds during the latter stages of the first half of games.

Figure 64. Comparison of the metreage in Zone 4 by each of the final four teams, and the average for all games, for each 15-min period of the game

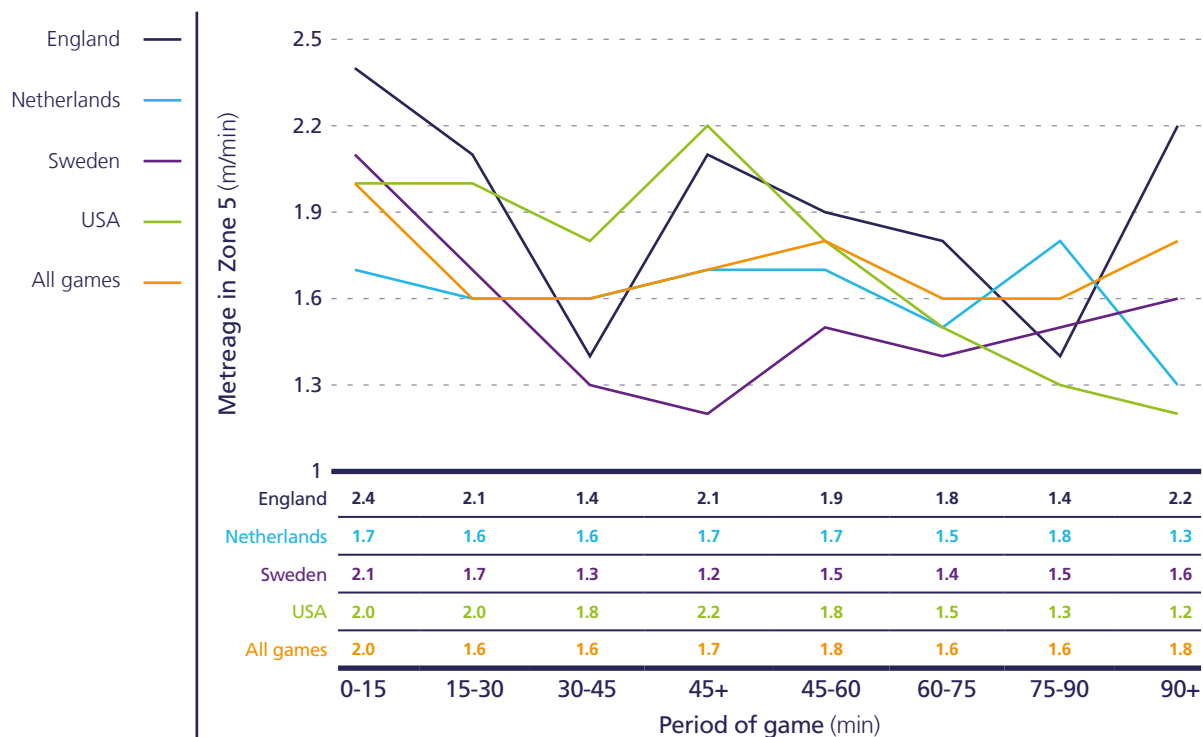


Figure 65. Comparison of the metreage in Zone 5 by each of the final four teams, and the average for all games, for each 15-min period of the game

3.6.4 Comparison of the distances covered by and spatial positioning of the final four teams whilst in possession of the ball, overall and against each opponent



Table 5 shows the total distance and the distances covered at <13km/h and >13km/h for the final four teams whilst in possession of the ball, alongside the teams' average ball possession. As can be seen, England averaged the highest overall ball possession out of the four, and concurrently covered the highest total distance (41,637m) whilst in possession. Although the Netherlands covered the second-highest total distance whilst in possession, they also did the smallest proportion of that running at >13km/h (29%). Similarly, whilst in possession of the ball, England (206) completed the most efforts at >19km/h, with the Netherlands completing the fewest (164); such efforts are largely related to movements off the ball in a bid to create and attack space when attempting to score.

Table 5. Summary of the average total distance, distance covered at <13km/h and >13km/h and efforts at >19km/h for the final four teams whilst in possession of the ball, alongside their average ball possession

Team	Total distance at <13km/h (m) IP	Total distance at >13km/h (m) IP	Total distance (m) IP	Efforts at >19km/h IP	Ball possession (%)
England	28,342	13,295	41,637	206	57
Netherlands	28,993	11,832	40,825	164	56
Sweden	25,779	11,195	36,974	175	49
USA	27,385	13,184	40,569	195	56



Figures 66-69 show the distances covered at <13km/h and >13km/h, as well as the height, width and depth of formation, for the final four teams whilst in possession of the ball during each of their games at the tournament. The strongest relationship overall was between distance covered at <13km/h and the height of the defensive line. From these figures alone, it is apparent that the distances covered, as well as the spatial positioning of the teams, vary greatly based on the opponent and their individual tactical strategy. England (Figure 66) had their highest defensive line (45m) in their second game, against Argentina, in which they also recorded their highest ball possession, total distance in possession of the ball and formation width. Their formation depth with the ball only varied by 4m across their seven games. In their sixth game, against the USA, they covered their lowest amount of total distance in possession of the ball; that match also saw their second-lowest defensive line (32m) in possession, behind only their game against Japan (31m).

Sweden (Figure 67) had their highest defensive line (49m) in their second game against Thailand, in which they recorded their biggest win and their highest ball possession; their formation width was also their second-highest in this game. In contrast, in their third game, against the USA, their defensive line with the ball was 17m lower (32m), although their depth was the same, and they had their lowest ball possession (40%). Their depth whilst in possession hardly varied across all seven of their games, whilst their defensive height and formation width were very similar from their third game onwards, suggesting that they were very consistent in their tactical strategy across those games.

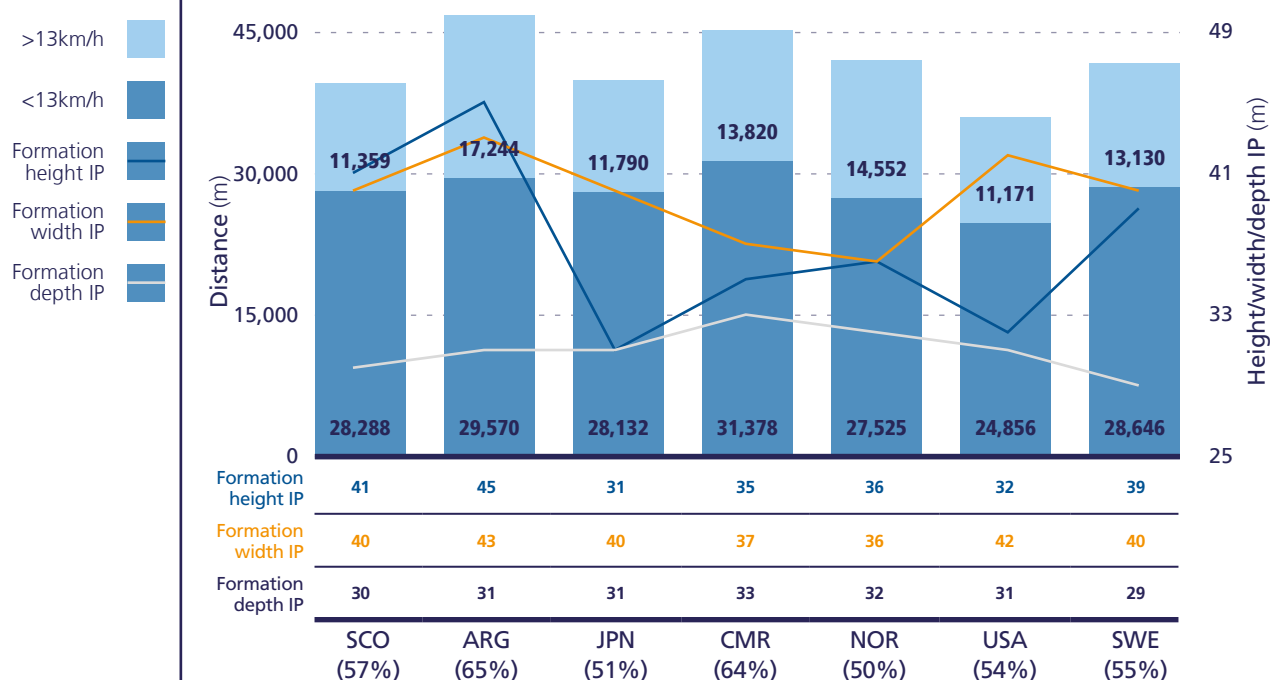


Figure 66. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for England when in possession of the ball, alongside their ball possession (%) in each of their games

The Netherlands (Figure 68) had their highest defensive line (40m) in their first game, against New Zealand, in which they also recorded their highest ball possession and total distance in possession of the ball and second-highest formation width. Their formation width was pretty similar across their first six games, but much narrower (36m) in their final game, against the USA. Similarly, whilst in possession of the ball, their defensive height was lowest against the USA and they covered their lowest amount of total distance; this would suggest that they set up in a more compact and defensive shape in an attempt to nullify the USA's attacking threat.

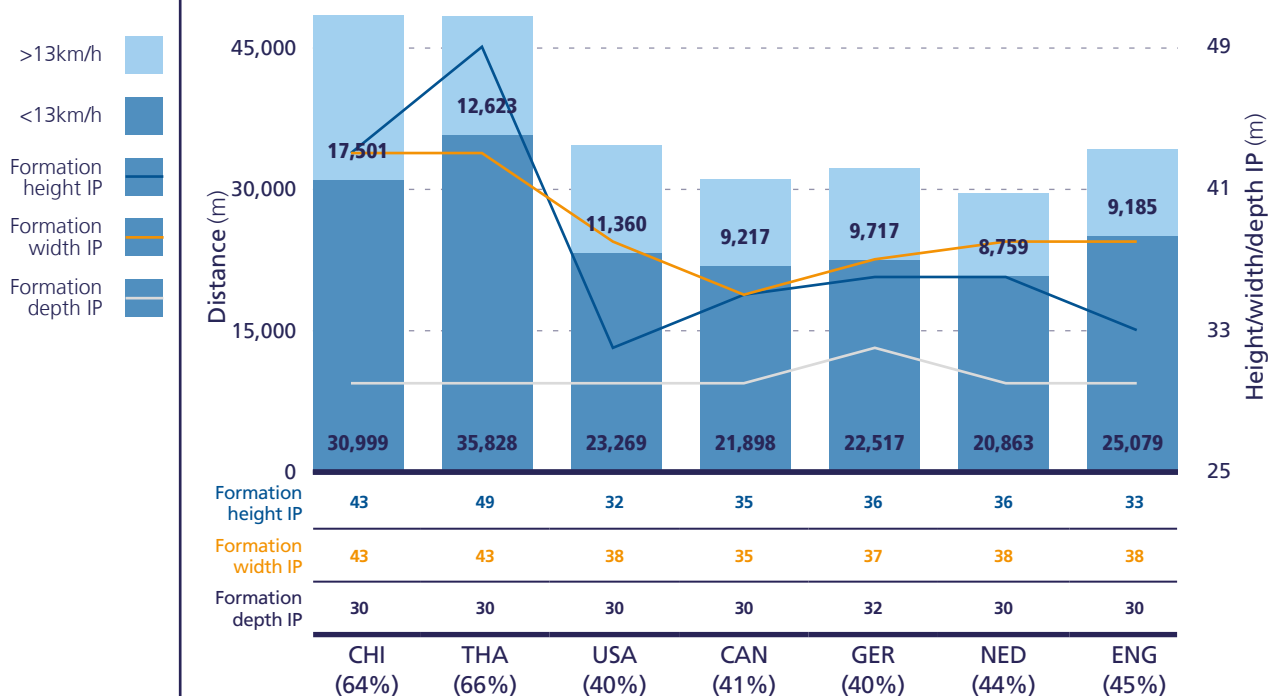


Figure 67. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for Sweden when in possession of the ball, alongside their ball possession (%) in each of their games

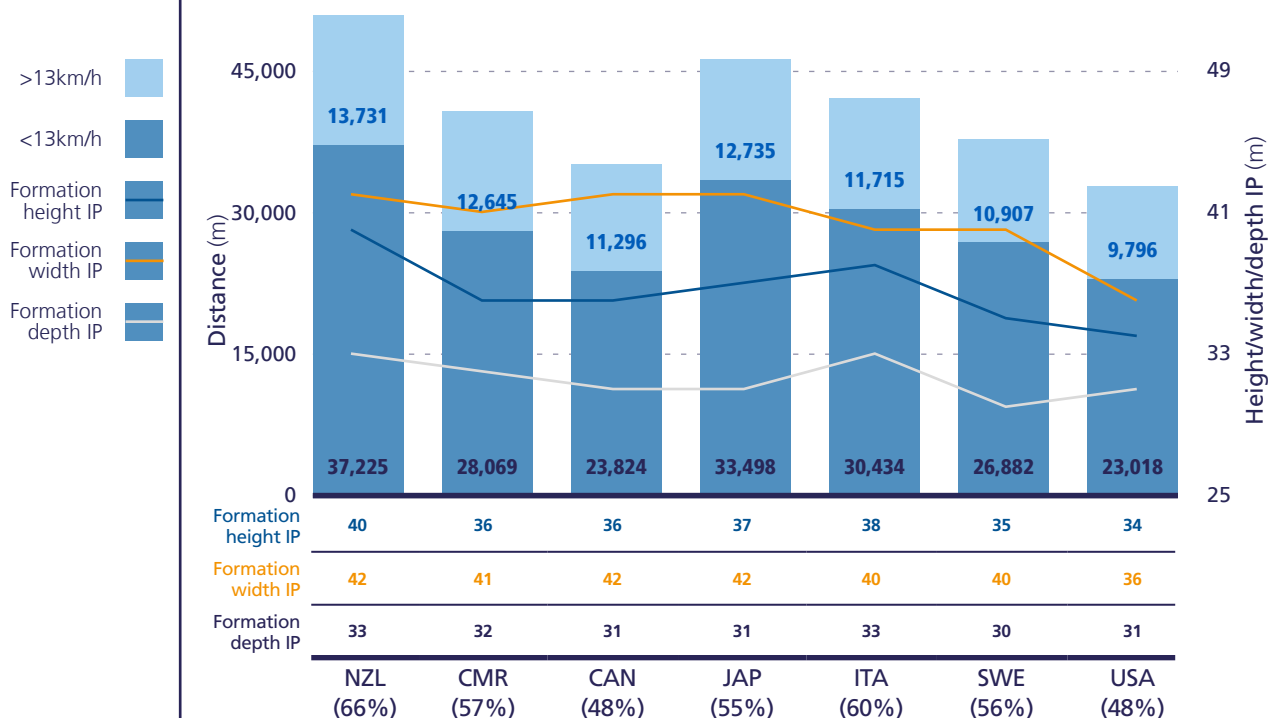


Figure 68. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for the Netherlands when in possession of the ball, alongside their ball possession (%) in each of their games

The USA (Figure 69) had their highest defensive line (47m and 46m respectively) in their first two games, in which they also recorded their highest ball possession, and which were against two teams who were amongst the lowest-ranked in the tournament. Such a high defensive line in those first two games resulted in the USA being extremely dominant with the ball and covering amongst their highest distances whilst in possession. Conversely, their defensive height was the lowest (30m) in their fifth game, against France, which was also the match in which they had the least ball possession (41%) and covered the least amount of distance both overall and at <13km/h and >13km/h in possession of the ball. The USA were generally consistent with their formation width and depth; it was more the height of their defensive line that varied in relation to their opponent.

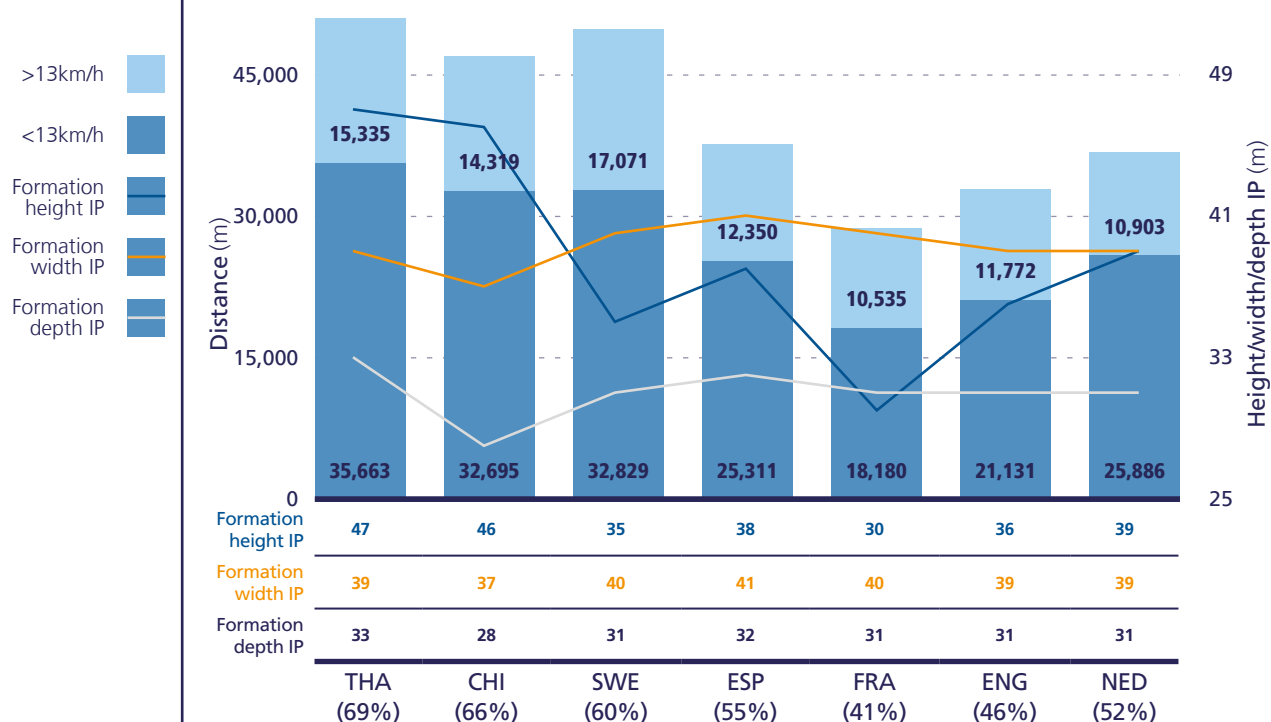


Figure 69. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for the USA when in possession of the ball, alongside their ball possession (%) in each of their games

3.6.5 Comparison of the distances covered by and spatial positioning of the final four teams whilst out of possession of the ball, overall and against each opponent



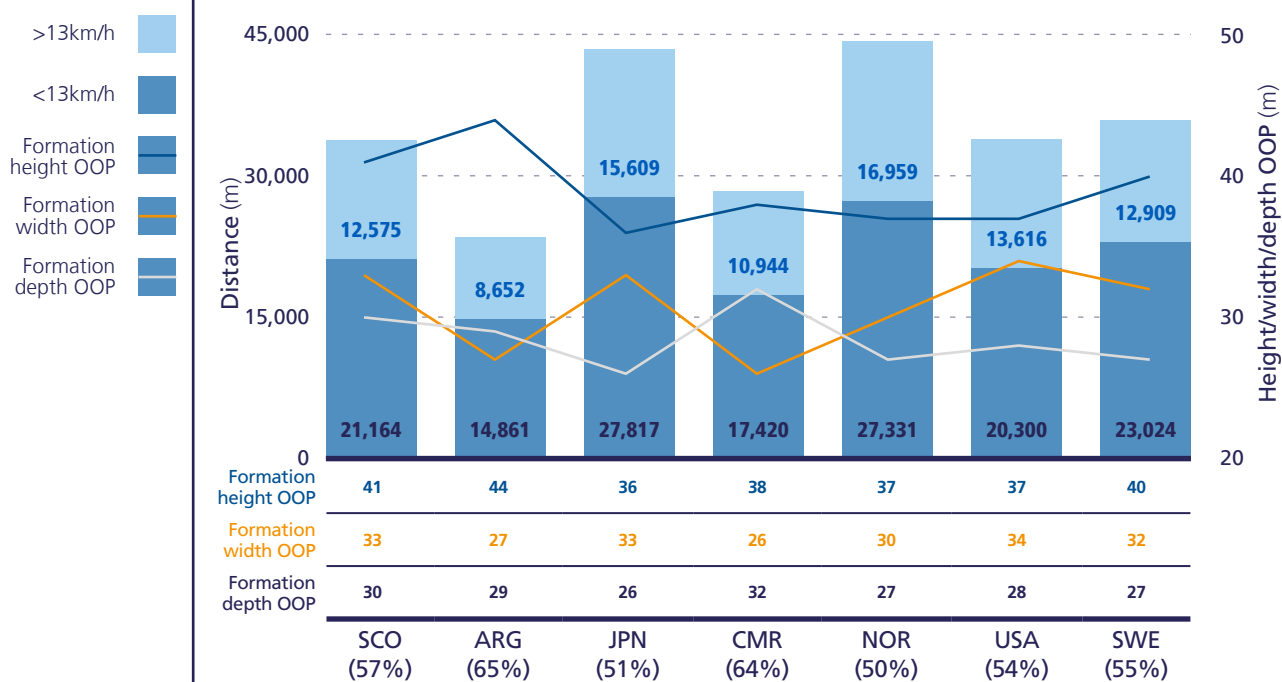
Table 6 shows the total distance and the distances covered at <13km/h and >13km/h for the final four teams whilst out of possession of the ball, alongside the teams' average ball possession. Sweden were out of possession of the ball, on average, the most out of the four and so, as would be expected, also covered the highest total distance (41,689m) whilst out of possession. The other three teams had a similar amount of ball possession and also covered a similar amount of total distance without the ball.

Table 6. Summary of the average total distance, distance covered at <13km/h and >13km/h and efforts at >19km/h for the final four teams whilst out of possession of the ball, alongside their average ball possession

Team	Total distance at <13km/h (m) OOP	Total distance at >13km/h (m) OOP	Total distance (m) OOP	Efforts at >19km/h OOP	Ball possession (%)
England	21,703	13,038	34,740	211	57
Netherlands	22,727	12,478	35,205	202	56
Sweden	27,176	14,514	41,689	220	49
USA	21,218	13,008	34,226	205	56

England and the USA covered a similar proportion (38%) of their total distance at >13km/h, whilst Sweden and the Netherlands both completed 35% of their total distance at >13km/h. Sweden also completed the most efforts at >19km/h; again, since they had more time out of possession of the ball, it follows that they had to complete more running and thus efforts in the higher speed zones in an attempt to win the ball back.

Figures 70-73 show the distances covered at <13km/h and >13km/h, as well as the height, width and depth of formation, for the final four teams whilst out of possession of the ball during each of their games at the tournament, together with their ball possession. The strongest relationship overall was between distance covered at <13km/h and the height of the defensive line. From these figures alone, it is apparent that – similar to whilst in possession of the ball – the distances covered, as well as the spatial positioning of the teams, vary greatly based on the opponent and their individual tactical strategy. England (Figure 70) covered their greatest distances whilst out of possession of the ball in games three and five, in which they had their lowest figures for ball possession; they also covered

**Figure 70.** Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for England when out of possession of the ball, alongside their ball possession (%) in each of their games

Sweden covered their greatest distances whilst out of possession of the ball in games three, four and five, in which they had their lowest figures for ball possession

their highest amount of out-of-possession distance at >13km/h in these matches, when they would have been working hard to regain the ball. During their first two games, when they had plenty of ball possession, they had their highest defensive line whilst out of possession, obviously highlighting a strategy to attempt to win the ball back higher up the pitch. In game four, they also enjoyed a lot of ball possession; however, they had a lower defensive line and greater depth whilst out of possession, suggesting a more stretched defensive formation. This could also have been dictated by the opponent's formation in possession of the ball. England's width of formation whilst out of possession of the ball varied from 26m (v. Cameroon) to 34m (v. the USA), which, again, may have been dictated by the opposition formation and positioning, and what England needed to do to win the ball back.

Sweden (Figure 71) covered their greatest distances whilst out of possession of the ball in games three, four and five, in which they had their lowest figures for ball possession; they also completed their highest amount of out-of-possession distance at >13km/h in these matches (peaking in the USA game), when they would have been working hard to regain the ball. During their first two games, when they had the most ball possession, they had their highest defensive line whilst out of possession, obviously highlighting a strategy to attempt to win the ball back higher up the pitch in games that they were dominating. Generally, their width and depth of formation whilst out of possession of the ball did not vary greatly across their games, especially from game four onwards; as was the case for their shape in possession of the ball, this suggests a consistent formation and strategy regardless of the opponent.

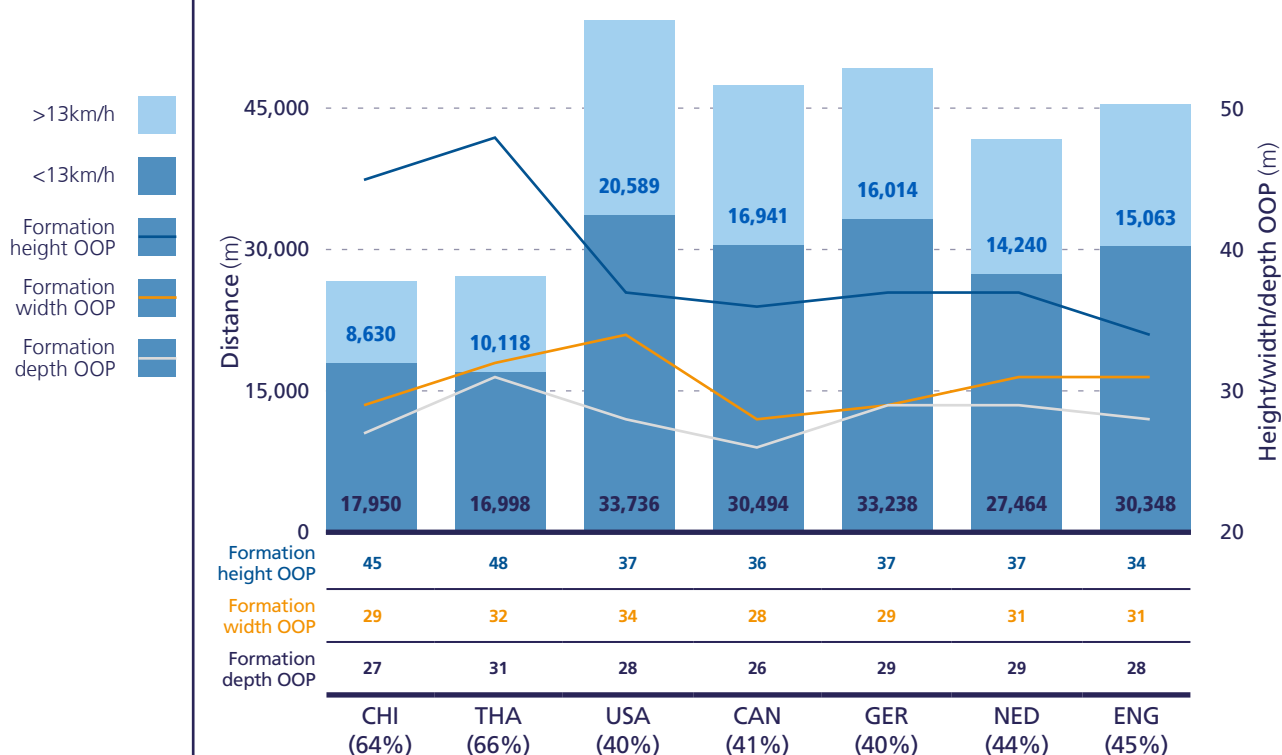


Figure 71. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for Sweden when out of possession of the ball, alongside their ball possession (%) in each of their games

The Netherlands (Figure 72) covered their greatest overall distance and distance at >13km/h whilst out of possession of the ball in game four against Japan; this game was also when they had one of their highest defensive lines (40m), which could reflect a strategy to attempt to win the ball back higher and prevent the opposition from getting into attacking areas. In their final game, against the USA, they generally had a more compact shape (height, depth and width) when trying to win the ball back. Their width and depth of formation did not tend to vary in the rest of their games, and they were by far dominant in terms of ball possession in five of their seven matches.

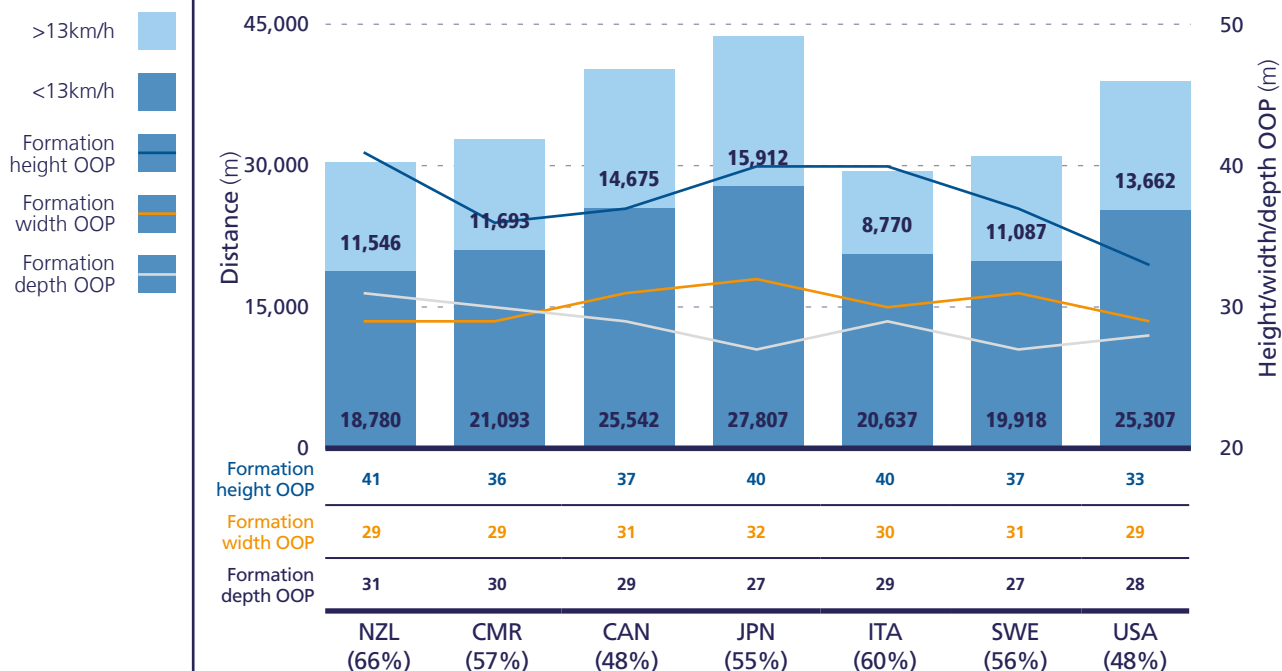


Figure 72. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for the Netherlands when out of possession of the ball, alongside their ball possession (%) in each of their games

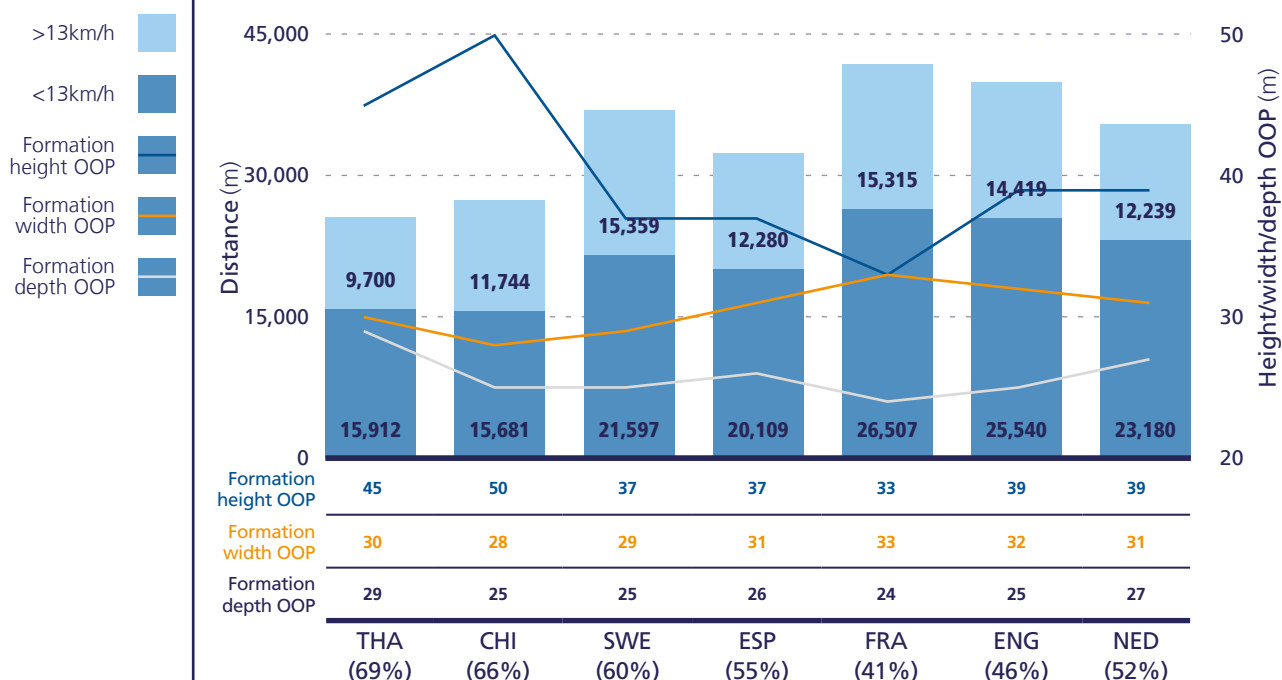


Figure 73. Comparison of the distances covered at <13km/h and >13km/h with the height, width and depth of formation for the USA when out of possession of the ball, alongside their ball possession (%) in each of their games

The USA (Figure 73) covered their greatest distances whilst out of possession of the ball in games five and six, in which they had their lowest ball possession; two of their highest figures for out-of-possession distance at >13km/h also came in those matches (although they peaked on this front in game three against Sweden), when they would have been working hard to regain the ball. During their first two games, when they enjoyed the most ball possession, they had their highest defensive line whilst out of possession, obviously highlighting a strategy to attempt to win the ball back higher up the pitch in games that they were dominating. Their formation depth was the lowest of all of the final four teams, again suggesting a more compact shape without the ball and all lines working together in an attempt to win back possession. Similarly, their width of formation whilst out of possession did not vary greatly across their games, especially from game three onwards, which suggests a consistent defensive formation and strategy to win back the ball, regardless of the opponent.

3.6.6 Comparison of the total distance covered at >19km/h by and compactness of the final four teams against each opponent

Figures 74-77 show the total distance covered at >19km/h and the compactness for the final four teams whilst in and out of possession of the ball during each of their games at the tournament, together with their ball possession. England (Figure 74) were their most compact in possession (761m²) in their final game, against Sweden, in which they also had their second-most-compact shape out of possession (566m²). Conversely, against the USA, they were in their biggest shape both in possession (1,001m²) and out of possession of the ball (732m²), which, again, could have been a tactical ploy and/or a spur-of-the-moment response to the shape of their opponent. The Norway game was when they covered their highest total distance at >19km/h (8,960m), and their compactness in and out of possession of the ball was similar in that game to in three of their other matches. Other than in that game against Norway, their compactness with and without the ball was seemingly correlated in that when one increased or decreased, then so did the other one.

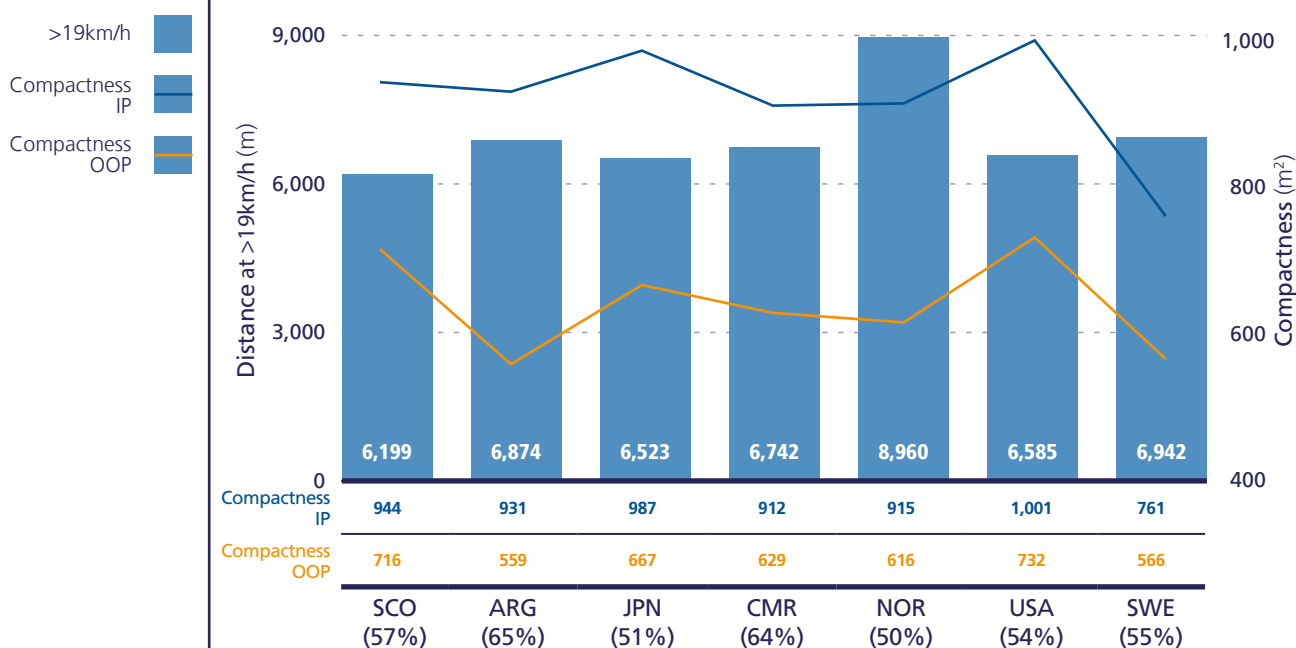


Figure 74. Comparison of the total distance covered at >19km/h and compactness for England when in and out of possession of the ball, alongside their ball possession (%) in each of their games

Sweden (Figure 75) were their most compact in possession (667m²) and out of possession (448m²) in their fourth game, against Canada, in which they also had a low amount of ball possession (41%). Against Chile, in their opening game, they had a big shape in possession (881m²), but were much more compact (566m²) when out of possession of the ball. From their third game onwards, their compactness in and out of possession was seemingly correlated in that when one increased or decreased, then so did the other one. Of the final four teams, Sweden were the most compact overall when in possession (810m²) and out of possession (603m²) of the ball, which could be a reflection of their 1-3-5-2 formation and tactical strategy.

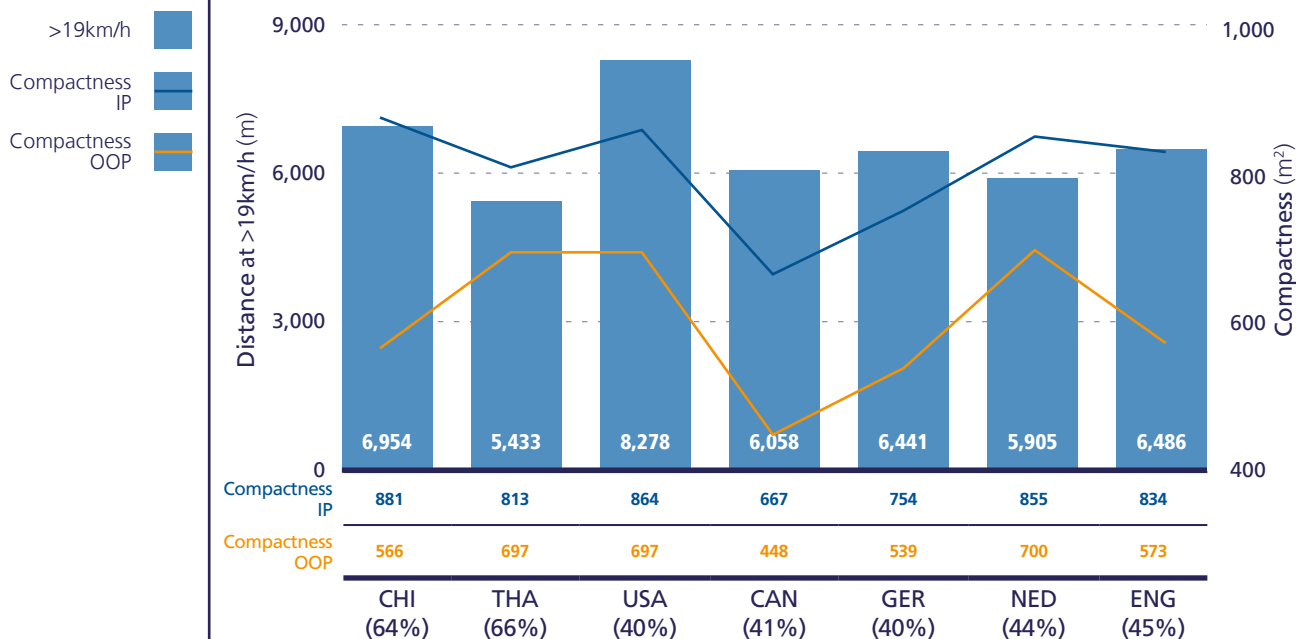


Figure 75. Comparison of the total distance covered at >19km/h and compactness for Sweden when in and out of possession of the ball, alongside their ball possession (%) in each of their games

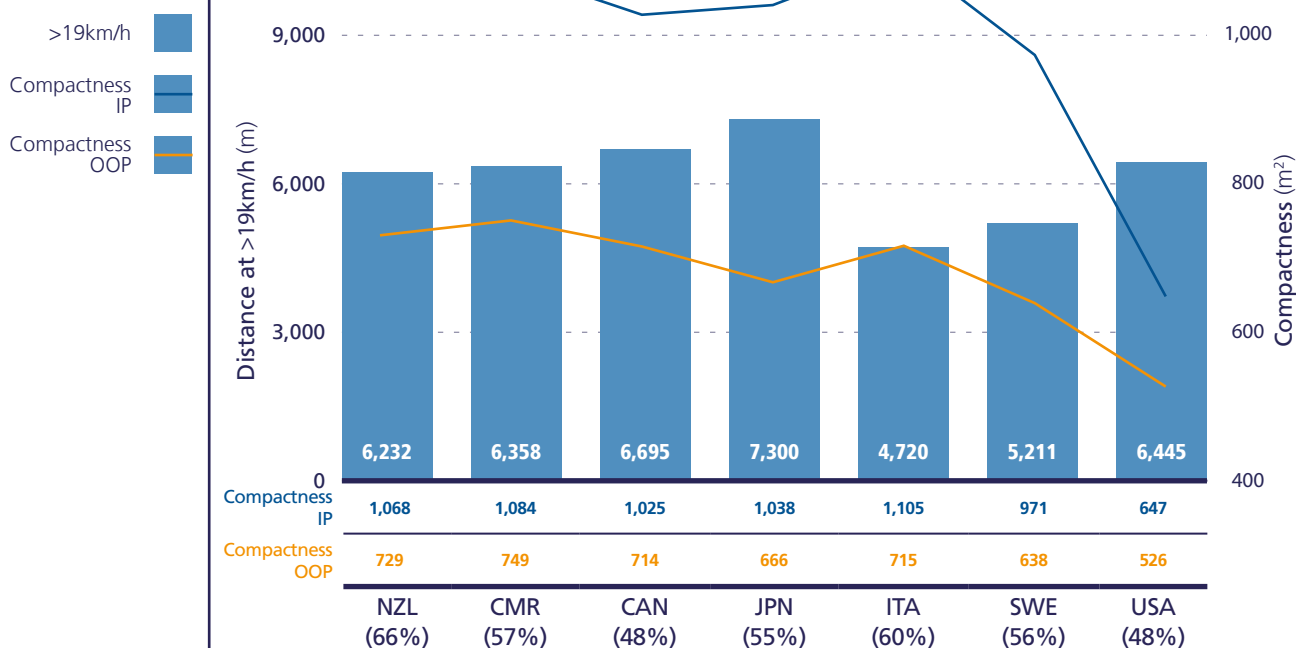


Figure 76. Comparison of the total distance covered at >19km/h and compactness for the Netherlands when in and out of possession of the ball, alongside their ball possession (%) in each of their games



The Netherlands' (Figure 76) compactness out of possession ($666\text{--}749\text{m}^2$) and in possession ($1,025\text{--}1,105\text{m}^2$) of the ball was very similar for their first five games of the tournament. In game six, they were more compact both in possession (971m^2) and out of possession (638m^2), which, again, could have been a strategy to defeat the opponent. In their final game, against the USA, they were even more compact both in possession (647m^2) and without the ball (526m^2), which was 41% and 30% more compact than the biggest shape they had in their previous games. Again, this would suggest a concerted effort to tighten up in an attempt to counteract their opponent.

The USA (Figure 77) were their most compact (568m^2) out of possession in their third game, against Sweden, which was likely a tactical ploy due to the Swedes also being compact. They were their most compact in possession of the ball (809m^2) in their second game, against Chile, in which they played a very different line-up than in their first game and indeed than in the rest of the tournament. They were their least compact ($1,072\text{m}^2$) in possession of the ball in their fourth game, against Spain, which was likely a tactical strategy to stretch the Spaniards while the latter attempted to win the ball back. Their compactness in possession ($919\text{--}1,072\text{m}^2$) and out of possession ($600\text{--}665\text{m}^2$) of the ball was very similar during their final four games of the tournament. This suggests that the USA had a strategy that they felt was optimal for their line-up and formation to be successful and did not deviate from this.

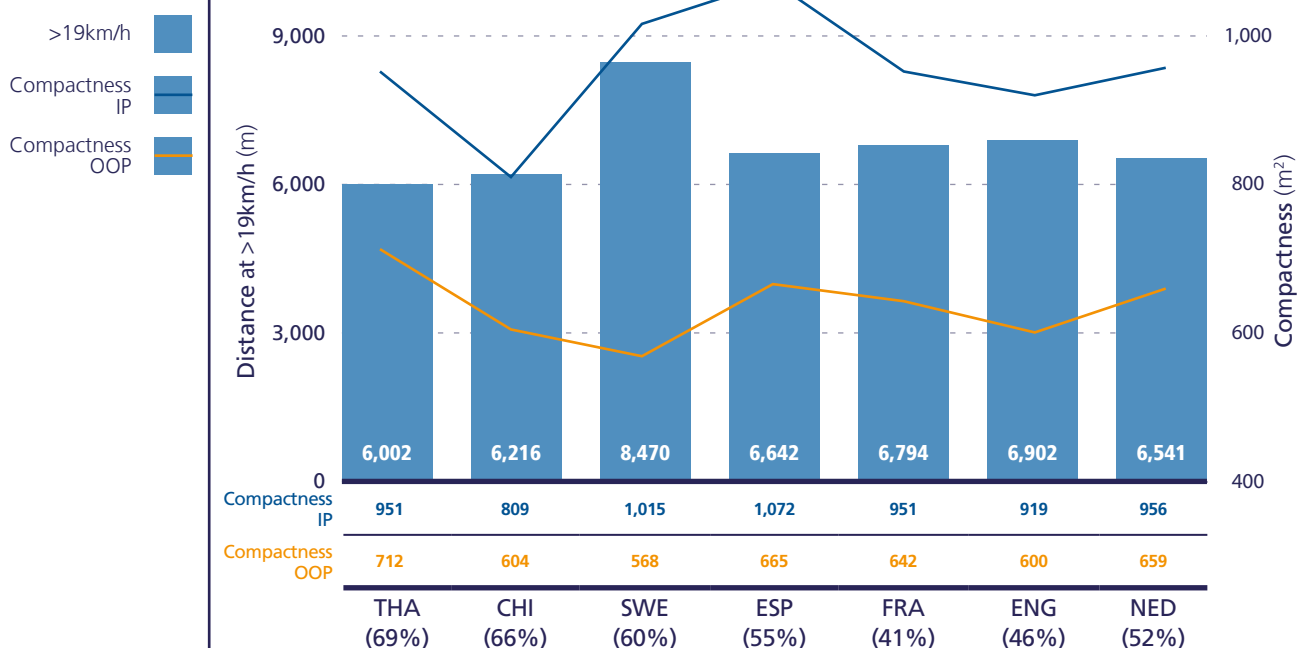


Figure 77. Comparison of the total distance covered at >19km/h and compactness for the USA when in and out of possession of the ball, alongside their ball possession (%) in each of their games



3.6.7 Comparison of the distances covered at >19km/h by and compactness of the final four teams whilst in and out of possession of the ball, overall and against each opponent

Table 7 shows the semi-finalists' average total distance at >19km/h as well as their average compactness whilst in and out of possession of the ball. England (3,364m) had the highest distance at >19km/h whilst in possession of the ball, whilst Sweden (3,475m) recorded the highest distance at >19km/h whilst out of possession of the ball. Sweden were the most compact (810m²) whilst in possession of the ball, whilst the Netherlands (991m²) were the most spread out. Out of possession of the ball, Sweden (603m²) again had the most compact shape and the Netherlands (677m²) again had the biggest, although the range between the teams was much lower, 74m² without the ball compared to 181m² in possession. This suggests that the four teams were more similar when defending and trying to regain the ball, whilst they were more variable when attacking and being creative.

Table 7. Summary of the average total distance at >19km/h and compactness in and out of possession of the ball for the final four teams

Team	In possession				Out of possession			
	ToDi Zone 4 (m)	ToDi Zone 5 (m)	ToDi >19km/h (m)	Compactness (m ²)	ToDi Zone 4 (m)	ToDi Zone 5 (m)	ToDi >19km/h (m)	Compactness (m ²)
England	2,303	1,061	3,364	922	2,409	886	3,295	641
Netherlands	1,798	785	2,582	991	2,366	851	3,217	677
Sweden	1,903	838	2,741	810	2,607	868	3,475	603
USA	2,176	993	3,169	953	2,496	761	3,258	636

Figures 78-81 show the distances covered at >19km/h and compactness a) in possession and b) out of possession of the ball for each game played by the final four teams. Such information evidences how the distance that each team covered in and out of possession of the ball and the compactness of their shape varied according to the opposition. England (Figure 78A) were their most compact in possession (761m²) in their final game, against Sweden, whilst in their other six games, their compactness with the ball only varied by 89m². They covered their highest distance at >19km/h in possession in their second game, against Argentina, which is also when they had their highest ball possession (65%). Their shape in possession of the ball was biggest for their game against the USA (1,001m²), in which their shape out of possession (Figure 78B) was also the most stretched (732m²). They covered their highest distance in Zone 5 in their game against Norway, both in possession (1,452m) and out of possession (1,370m) of the ball. They covered their lowest distance in Zone 5 in possession in the game against Japan (680m), whilst their out-of-possession distance in Zone 5 was lowest in their match against Cameroon (632m), in which they posted their second-highest figure for possession.

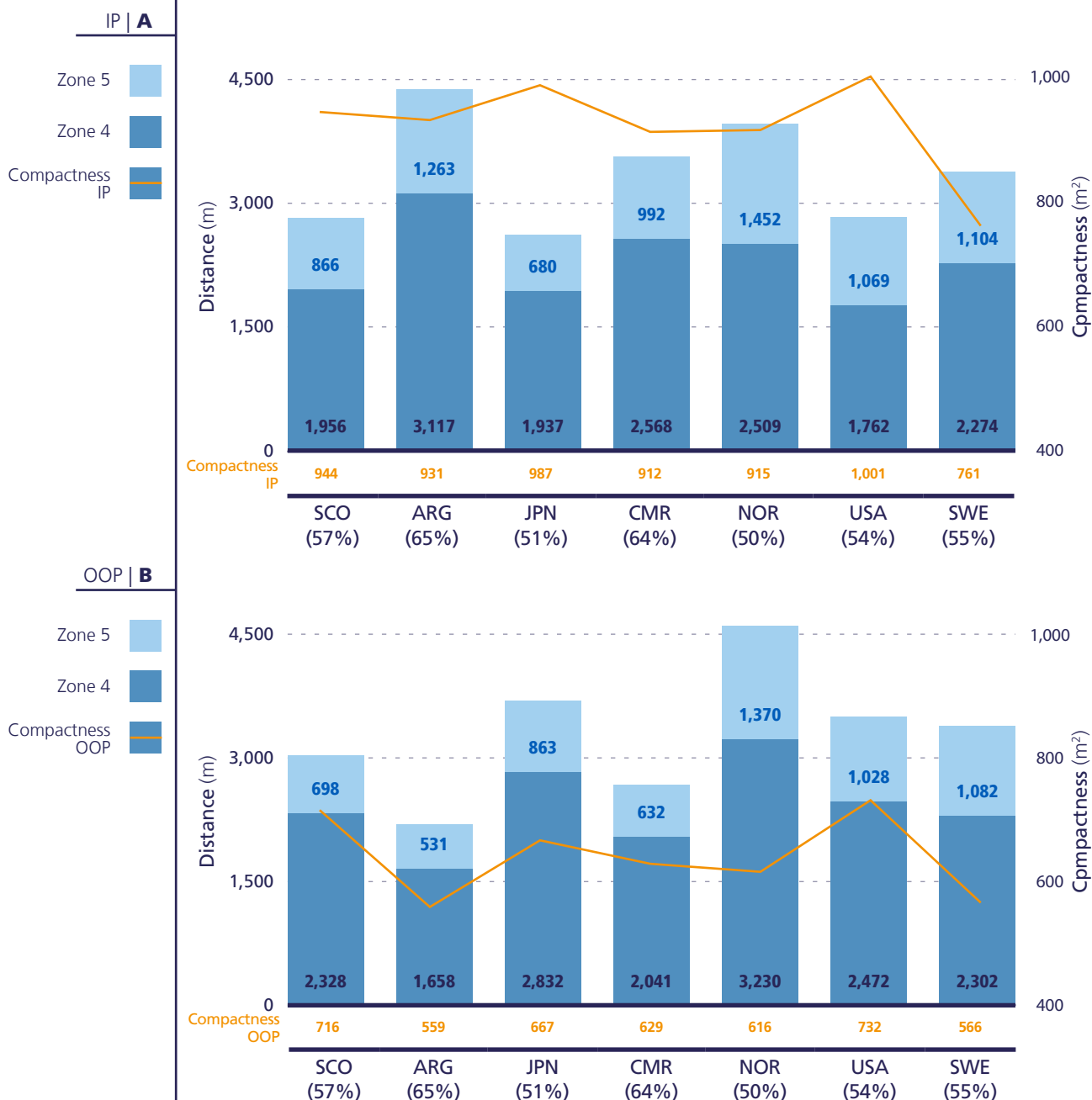


Figure 78. Comparison of total distance covered at >19km/h and compactness for England when A) in possession and B) out of possession of the ball against each opponent, alongside their ball possession (%)

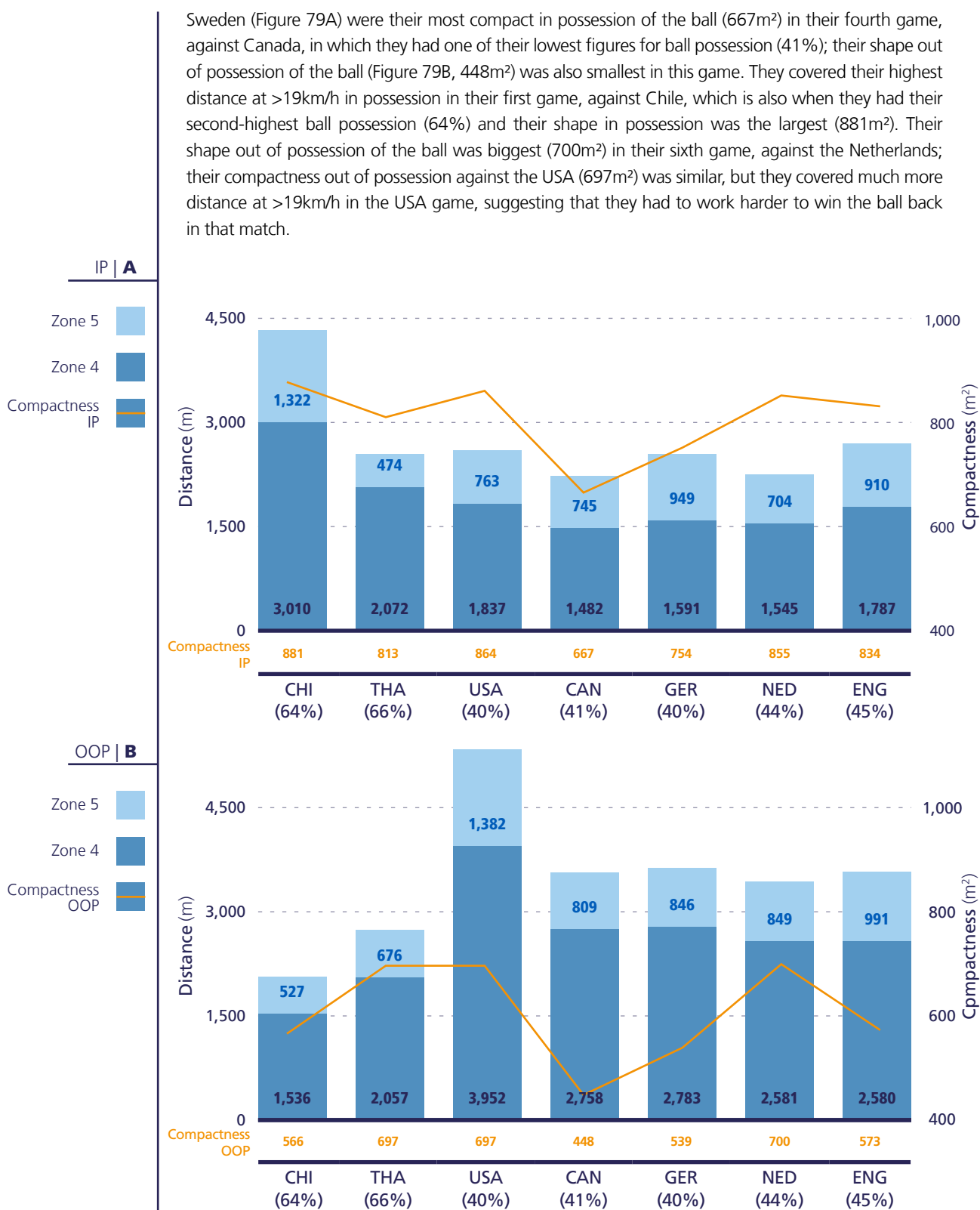


Figure 79. Comparison of total distance covered at >19km/h and compactness for Sweden when A) in possession and B) out of possession of the ball against each opponent, alongside their ball possession (%)

The Netherlands' (Figure 80A) compactness whilst in possession of the ball was very similar for their first six games, whilst their distance covered at >19km/h with the ball was fairly consistent across each of their matches. Nevertheless, it was evident that in their final game, against the USA, they were much more compact whilst in possession, which may have been a tactical strategy for that specific game. Furthermore, whilst out of possession of the ball (Figure 80B), their compactness was similar for their first five games, and a similar distance at >19km/h was covered, except for their game against Italy, in which they covered much less ground. However, for their final two games, they became more compact, with a small shape whilst out of possession of the ball, namely 638m² and 526m² respectively for the matches against Sweden and the USA. Moreover, in the final against the USA, they covered their highest distance out of possession in Zone 5 (1,241m), which suggests that this was necessary in order for them to close down space and pressure the Americans in an attempt to win the ball back. Again, such results highlight the different strategies and physical demands that teams and individual players face depending on the opposition, as well as the variability in their own system, strategy and physical qualities.

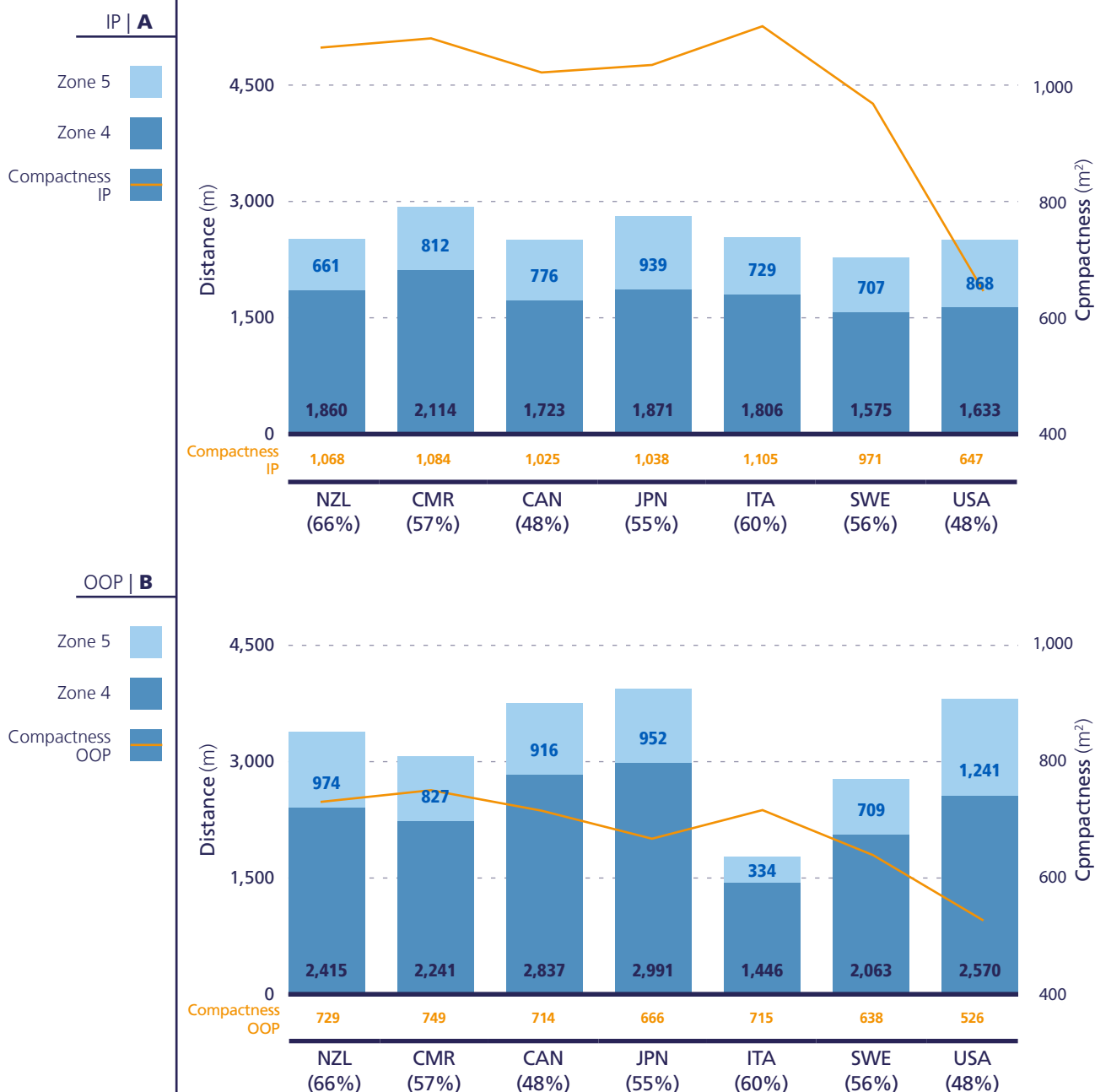


Figure 80. Comparison of total distance covered at >19km/h and compactness for the Netherlands when A) in possession and B) out of possession of the ball against each opponent, alongside their ball possession (%)

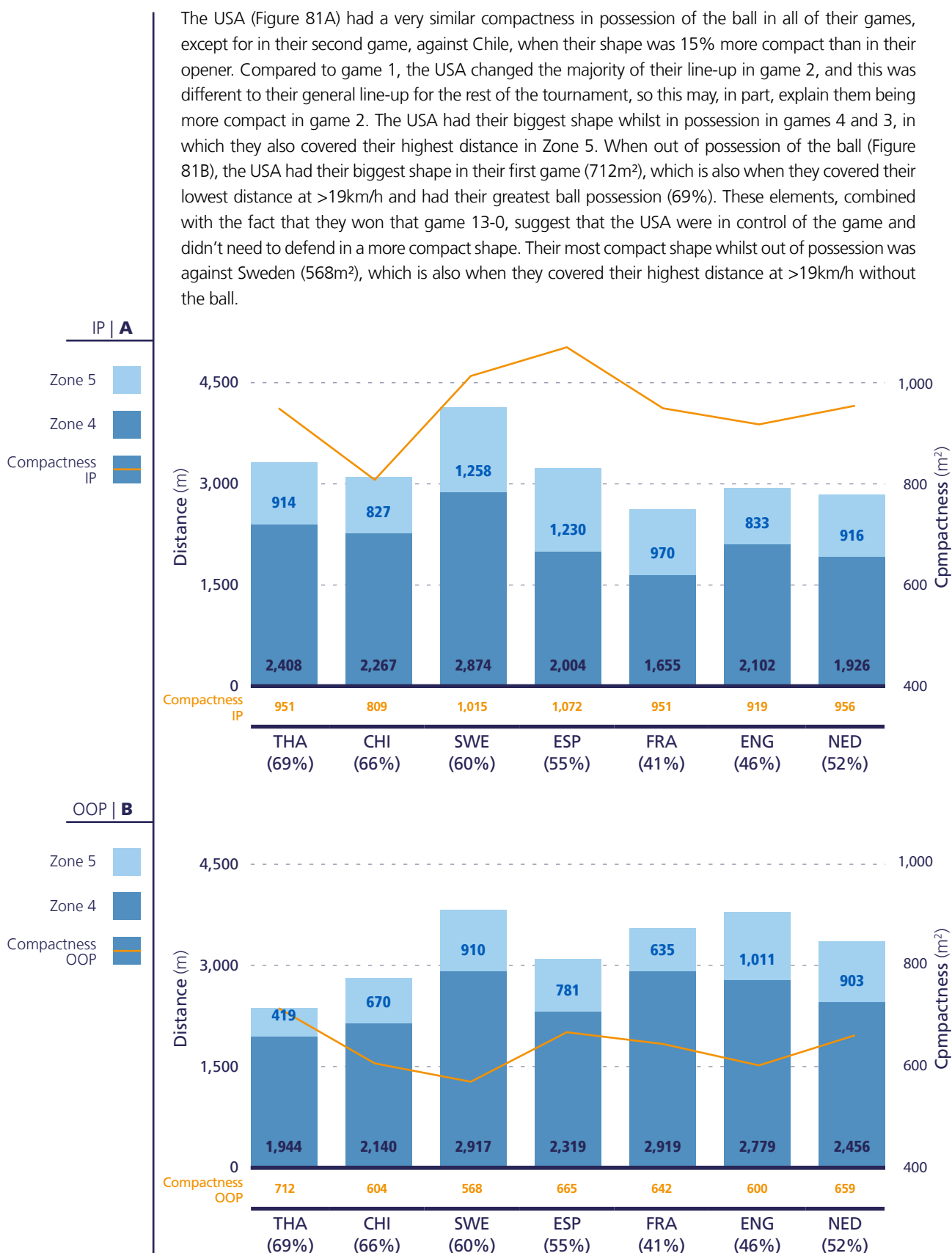


Figure 81. Comparison of total distance covered at >19km/h and compactness for the USA when A) in possession and B) out of possession of the ball against each opponent, alongside their ball possession (%)

3.6.8 Summary

- When comparing the 2015 and 2019 tournaments, the total distance posted by England, the Netherlands, Sweden and the USA – the final four teams in 2019 – was very similar to in the 2015 edition; however, the number of higher-intensity outputs and some technical elements was distinctly greater in 2019. For distance covered at >13km/h, Sweden were the only team with a decrease (-5%) from 2015, with England showing the greatest increase (9%). In terms of efforts at >19km/h, all four teams increased their average number of efforts from 2015 to 2019, with the USA (11; 3%) showing the lowest increase and England (65; 17%) the greatest. When looking at the average number of passes per game, England again had the highest overall total in 2019 (573) and the biggest increase (74%) from 2015. The USA also had a large increase (43%) in total passes from 2015, whilst Sweden had the lowest number out of the four teams in 2019 (443) and actually registered a decrease (-2%) in their average number of passes with respect to 2015.
- When looking at the overall distance at >19km/h, England (6,975m) followed by the USA (6,795m) covered the highest amount in 2019; England (1,023m; 17%) also had the biggest increase from 2015.
- When looking at the 2019 tournament only, the USA (6,896m) completed the most distance at >19km/h during the group stage, whilst England (7,307m) completed the most distance at >19km/h during the knockout rounds. England (12%) were the only of the semi-finalists to increase the amount of distance at >19km/h from group to knockout action, with Sweden (-10%) having the biggest decline out of the other three teams. Since the USA and Sweden both faced lower-ranked teams in the group stage, this suggests that their loads were higher against those teams due to being more dominant in those matches, compared to against their more challenging and higher-ranked opponents in the knockout rounds.
- All of the final four teams were able to complete high physical loads in repeated games, and regardless of the round of the game, which suggests that they were able to sustain their physical capacity, as a team, across their seven matches. In fact, it is more likely that the opposition and their tactical formation and tendencies influenced the variance in the semi-finalists' physical output, both individually and as a team, for each game.
- Whilst in possession of the ball, England (206) completed the most efforts at >19km/h, with the Netherlands completing the fewest (164); such efforts are largely related to movements off the ball in a bid to create and attack space when attempting to score.
- Sweden were the most compact (810m²) whilst in possession of the ball, whilst the Netherlands (991m²) were the most spread out. Out of possession of the ball, Sweden (603m²) again had the most compact shape and the Netherlands (677m²) again had the biggest, although the range between the teams was much lower, 74m² without the ball compared to 181m² in possession. This suggests that the four teams were more similar when defending and trying to regain the ball, whilst they were more variable when attacking and being creative.
- By looking at the shape and compactness of the final four teams in each of their seven games during the 2019 tournament, it is possible to identify the differences and modifications depending on the actual opponent. Again, such results highlight the different strategies and physical demands that teams and individual players face depending on the opposition, as well as the variability in their own system, strategy and physical qualities. This once again reinforces the fact that, as the women's game continues to progress and grow, the technical and physical aspects of game performance are equally important to determine game success.



CHAPTER 3 SECTION 7

Positional analysis | Absolute distance and frequency of actions in various speed zones

3.7.1 **Positional trends**

Physical characteristics in relation to tactical role

One of the most consistent trends within the football science area is positional differences in physical characteristics and performance. Thus, this section will detail the positional analyses in relation to descriptive characteristics such as age, height and body mass in addition to match running performances across multiple variables. These types of analyses are especially important as they not only report common trends (e.g. wide midfielders cover more Zone 4 distance than central defenders) but also longitudinal changes across different FIFA Women's World Cups due to the evolution of the game (e.g. wide midfielders covered more Zone 5 distance at France 2019 compared to Canada 2015). Specifically identifying such positional trends provides insight to coaches and practitioners about specific training recommendations that replicate the match physical performance of these positions. The playing positions used in the analyses below were based on the following classifications: goalkeepers (GK), full-backs (FB), central defenders (CD), central midfielders (CM), wide midfielders (WM) and forwards (FW).

**ALL** All positions

Descriptive characteristics of age, height and body mass

The positional trends for descriptive data such as age, height and body mass of players who recorded official game time at both Canada 2015 and France 2019 can be found in Table 8 below. Consistent trends were found across both Women's World Cup competitions, with goalkeepers being older, taller and heavier than all other playing positions. In relation to outfield player trends across the last two competitions, it was clear that central defenders were the tallest and heaviest players followed by forwards and central midfielders, with similar characteristics for wide players like full-backs and wide midfielders. Although most descriptive characteristics across positions for both competitions showed some minor changes, most of these were not practically meaningful. Interestingly, goalkeepers and central defenders were on average 1.0-1.3kg heavier in 2019 compared with the 2015 competition.

Match physical performances in relation to tactical role

Match physical performance data presented below is only from players who completed all of their team's regular-time matches at Canada 2015 and France 2019. The tactical role of each player corresponded to the main positional role for each of them during each match. Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

Table 8. Positional trends in age, height and body mass across Canada 2015 and France 2019

Playing position	Players (n)		Age (yr)		Height (cm)		Body mass (kg)	
	2015	2019	2015	2019	2015	2019	2015	2019
GK	33	29	28.9±4.3	28.6±5.0	173.6±4.9	174.4±5.1	67.0±5.2	68.3±5.8
OP	405	407	25.7±3.9	26.1±3.9	166.4±6.6	166.7±6.3	59.8±6.1	60.2±6.0
ALL	438	436	25.9±4.0	26.3±4.0	167.0±6.7	167.3±6.5	60.3±6.3	60.7±6.3
CD	66	62	26.5±4.0	27.5±3.8	170.5±5.1	170.9±5.5	62.8±5.8	63.8±5.5
FB	72	74	25.3±3.7	26.0±3.5	165.3±5.9	165.5±5.0	59.0±6.1	58.9±4.9
CM	112	110	25.2±4.1	26.4±4.1	166.0±6.6	165.5±6.6	59.7±5.9	59.7±6.1
WM	95	101	25.4±3.7	25.1±3.5	164.7±6.6	165.7±6.0	57.9±6.1	58.8±5.7
FW	60	60	26.5±3.9	26.1±4.3	166.9±6.9	168.1±6.7	60.6±5.8	61.4±6.5

Data is presented as an average and spread (mean ± standard deviation).

Please note: the physical characteristics above were submitted by each of the registered national teams according to articles 25 and 26 of the competition regulations. Thus, the above data was not measured for the purposes of this report and could be subject to accuracy variations based on the procedures used by each national team. The age, height and body mass of each player was matched to the playing positions assigned to them for each match. If a player competed in two different roles across the competition, then the position that was most common and/or had accumulated the most game minutes was selected.



3.7.2 Absolute total distance covered

General positional trends and tournament comparison

The average and data spread of the total distance covered by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 82A (2015) and Figure 82B (2019).

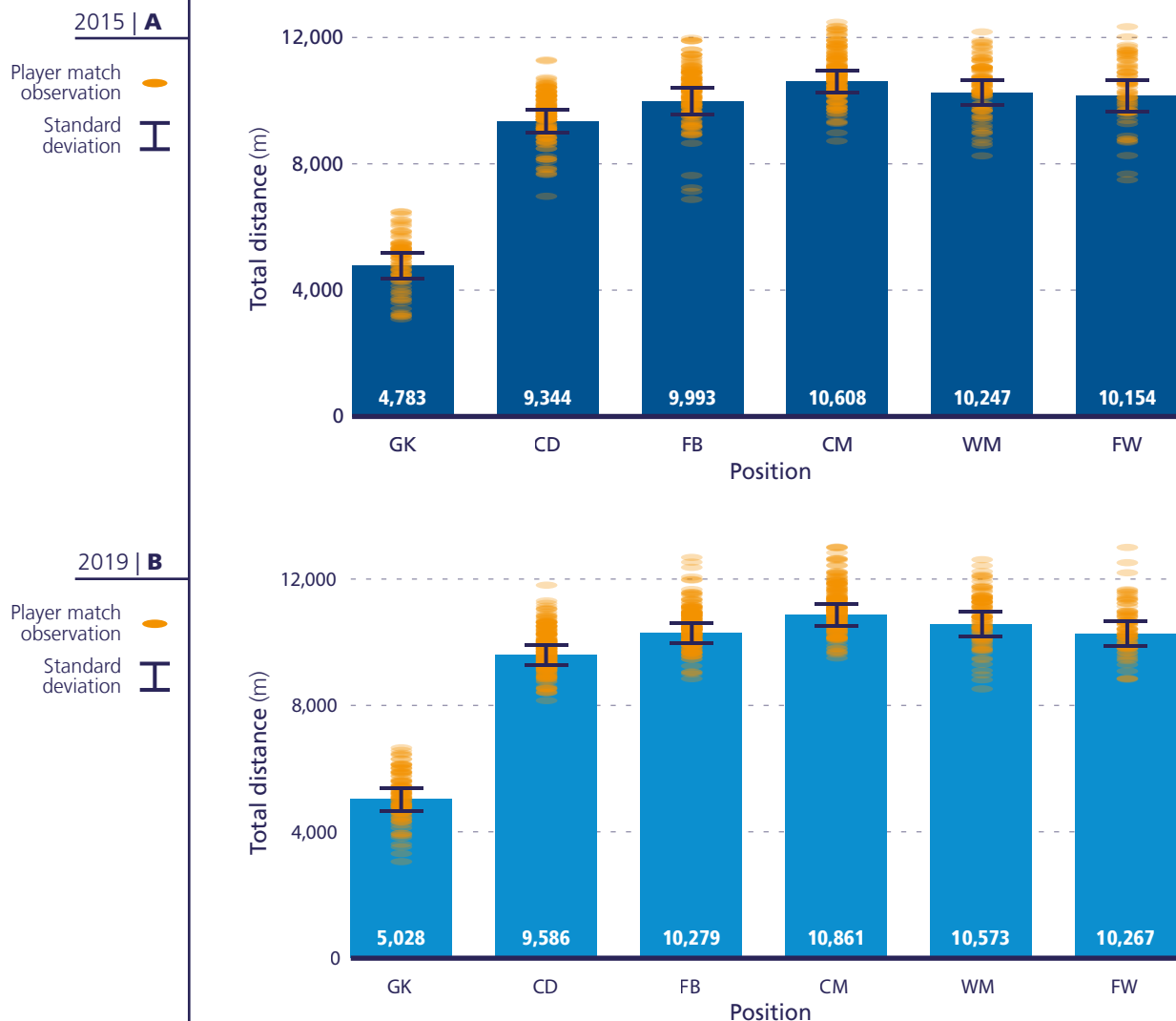


Figure 82. Averages and data spread across various positional subsets in the absolute total distance covered in a match for (A) Canada 2015 and (B) France 2019. Each individual dot equates to a player match observation (bars = mean; T above and below bars = standard deviation).

As expected, goalkeepers covered lower absolute total distances than all outfield players across both competitions. Regarding outfield positions, central defenders covered the lowest overall distance while central midfielders and wide midfielders covered the greatest distance, with full-backs and forwards falling somewhere between these two extremes. The lowest total distance covered was recorded by a full-back (6,738m) in 2015 and a central defender in 2019 (7,991m), while the highest was from a central midfielder (12,231 and 12,750m) in 2015 and 2019, respectively. The dots in both Figures 82A and 82B indicate individual player observations and you can visualise the ranges clearly. The range for goalkeepers was 3,034-6,361m and 3,001-6,527m, while the ranges for outfield positions were 6,738-12,231m and 7,991-12,750m for the 2015 and 2019 competitions, respectively. This spread as a percentage (e.g. coefficient of variation) indicated that across the 2015 and 2019 tournaments, goalkeepers demonstrated the most variation in total distance covered (15-17%), with similar variations for outfield positions such as central defenders (7-8%), full-backs (6-9%), central midfielders (6-7%), wide midfielders (7-8%) and forwards (8-10%).

A comparative illustration of the absolute total distance covered by various positional subsets at Canada 2015 (dark blue) and France 2019 (light blue) can be found in Figure 83. Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments. It was evident that all playing positions covered more total distance at France 2019 than at Canada 2015. Although the magnitude of the increase across tournaments was only small for most outfield positions (percentage increase from 2015 to 2019: central defenders=2.6%, full-backs=2.9%, central midfielders=2.4%), this percentage increase was more pronounced for wide midfielders (3.2%; 10,247 v. 10,573m) and least evident for forwards (1.1%; 10,154 v. 10,267m). The total distance for goalkeepers was substantially lower than for outfield players but the percentage increase from Canada 2015 to France 2019 was 5.1%. This overall trend could have been related to much more consistent total distances, as evidenced by more variability across most positions in Canada 2015 (Figure 82A) compared to France 2019 (Figure 82B). For instance, the percentage variance in 2019 was approximately 2-3% lower than in 2015 for goalkeepers, full-backs and forwards, highlighting more consistent total distances across each position in the modern game.

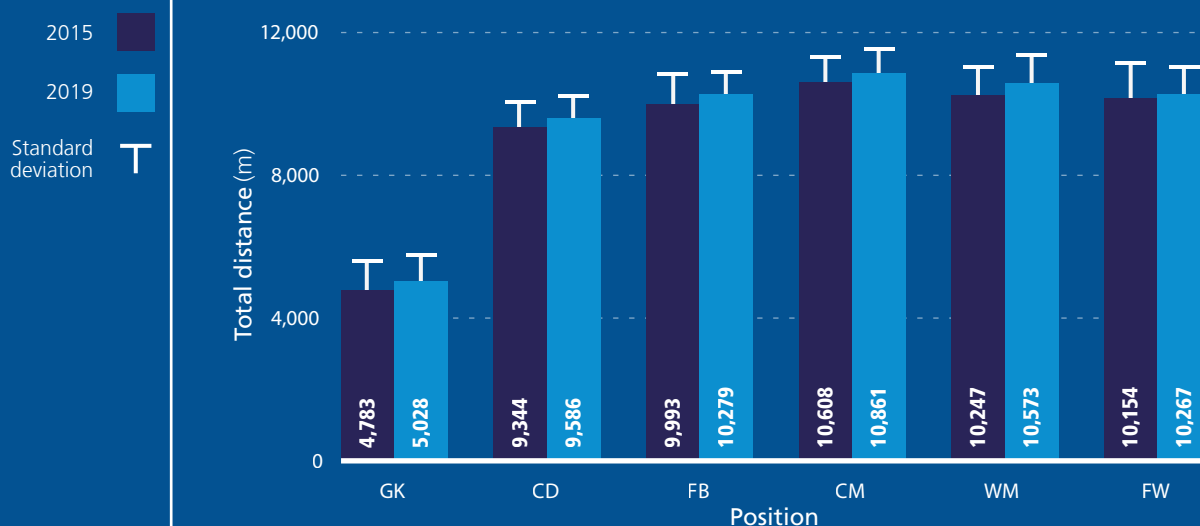


Figure 83. Comparison of the absolute total distances covered by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.



3.7.3 Absolute distance covered in various speed zones

General positional trends and tournament comparison

As there is no general consensus across studies regarding the speed zones of elite women's football players, it was decided that no attempt would be made to link speed zones to movement categories (e.g. jogging, running and sprinting). However, Zone 1 and Zone 2 could be classified as low intensity, while Zone 3, Zone 4 and Zone 5 could be classified as moderate to high intensity. The average absolute distance covered by playing positions in various speed zones during regular-time matches of Canada 2015 and France 2019 can be found in Table 9 and Figures 84-91.



Zone 1 and Zone 2

For zones 1 and 2, goalkeepers covered the highest proportion of their total distance in zones 1 (77-78%) and 2 (17-19%) compared to all outfield positions (37% and 37-38%) across the two tournaments. For the absolute distance covered in Zone 1, most playing positions covered similar distances across positions at both the 2015 (3,527-3,755m) and 2019 World Cups (3,670-3,894m). However, in Zone 2, central midfielders covered more distance than other outfield positions in the 2015 and 2019 tournaments (4,283 and 4,134m).

Table 9. Positional trends in the distance covered in zones 1 and 2 at Canada 2015 and France 2019

Playing position	Zone 1 (m)		Zone 1: percent (% ToDi)		Zone 2 (m)		Zone 2: percent (% ToDi)	
	2015	2019	2015	2019	2015	2019	2015	2019
GK	3,658±484	3,894±428	77±6	78±5	910±334	896±292	19±4	17±4
OP	3,681±281	3,754±300	37±5	37±5	3,864±630	3,815±538	38±4	37±4
ALL	3,639±324	3,771±321	41±14	42±14	3,571±1,115	3,457±1,088	37±7	35±8
CD	3,704±272	3,745±231	40±5	39±4	3,711±496	3,693±417	40±3	39±3
FB	3,527±334	3,706±276	36±4	36±4	3,852±549	3,810±472	39±3	37±4
CM	3,556±267	3,670±305	34±4	34±4	4,283±492	4,134±502	40±3	38±3
WM	3,755±314	3,840±342	37±5	37±5	3,809±600	3,692±645	37±4	35±5
FW	3,688±275	3,979±304	37±5	39±5	3,833±634	3,524±538	38±4	34±4

Data is presented as an average and spread (mean ± standard deviation) and as a percentage of the total distance covered (ToDi).

3

13-19km/h

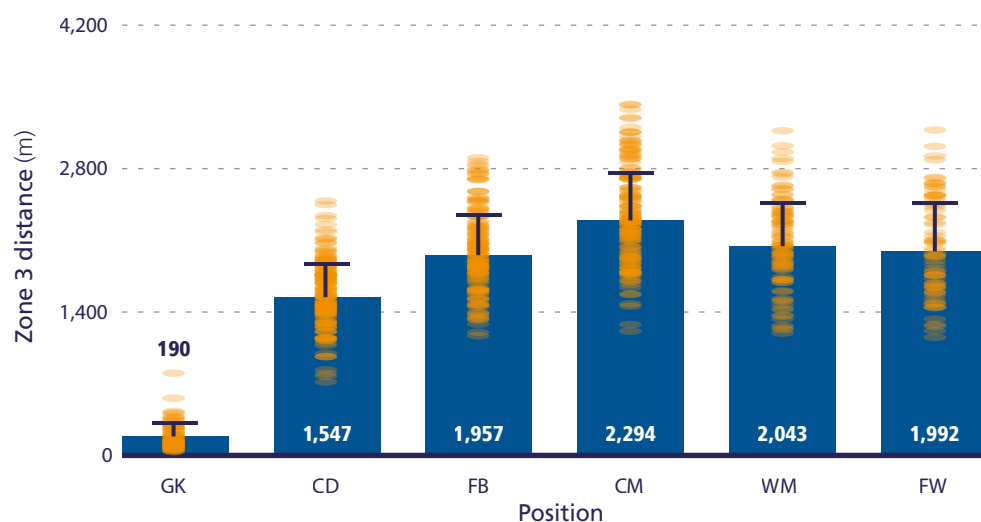
2015 | A

Player match observation
Standard deviation

A comparison of the distance covered in zones 1 and 2 by various positional subsets at Canada 2015 and France 2019 can be found in Table 9. It was evident that all playing positions covered marginally more Zone 1 distance at France 2019 than at Canada 2015. Although the magnitude of the increase across tournaments was only small for most outfield positions (percentage increase from 2015 to 2019: full-backs=5.1%, central midfielders=3.2%, wide midfielders=2.3%), this percentage increase was the most pronounced for forwards (7.9%) and least evident in central defenders (1.1%). In 2019 compared to 2015, there was a tendency for Zone 2 distance to stay stable (percentage decrease from 2015 to 2019: goalkeepers=1.5%, central defenders=0.5%, full-backs=1.1%) or decrease for selected positions (central midfielders=3.5%, wide midfielders=3.1%, forwards=8.1%).

Zone 3

The average and data spread of the absolute distance covered in Zone 3 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 84A (2015) and Figure 84B (2019).



2019 | B

Player match observation
Standard deviation

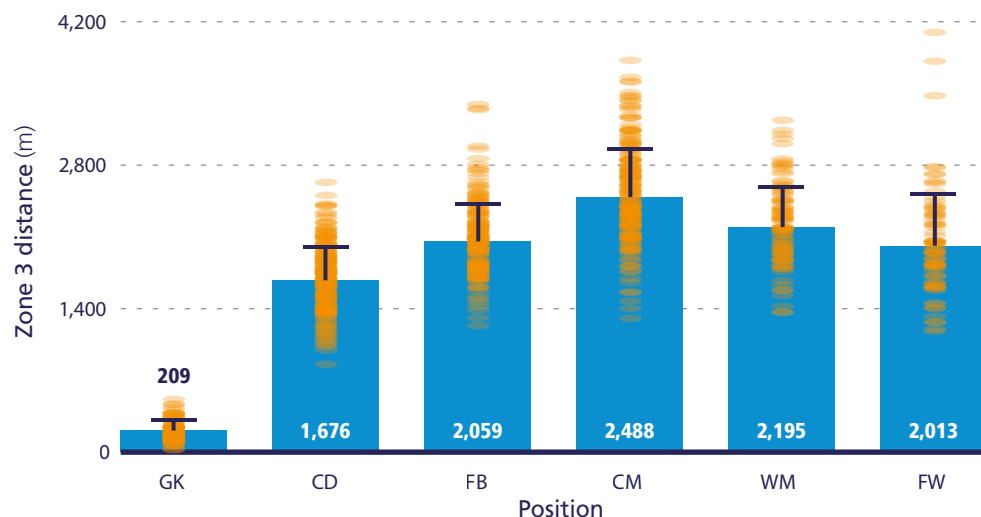


Figure 84. Averages and data spread across various positional subsets in the absolute distance covered in Zone 3 for (A) Canada 2015 and (B) France 2019. Each individual dot equates to a player match observation (bars = mean; T above bars = standard deviation).

The Zone 3 distance was substantially higher for central midfielders than for all other outfield positions

Regarding Zone 3, goalkeepers covered substantially lower distances (190 and 209m) compared to all outfield positions at both the 2015 (1,946m) and 2019 tournaments (2,080m). Additionally, the Zone 3 distance was substantially higher for central midfielders (2,294 and 2,488m) than for all other outfield positions, with central defenders producing the lowest Zone 3 distance (1,547 and 1,676m). However, similar distances were covered by full-backs (1,957 and 2,059m), wide midfielders (2,043 and 2,195m) and forwards (1,992 and 2,013m) across both tournaments. The dots in both Figures 84A and 84B indicate individual player observations and you can visualise the Zone 3 ranges clearly. The range for goalkeepers was 38-790m and 26-507m, while the ranges for outfield positions were 705-3,359m and 841-4,013m for the 2015 and 2019 competitions, respectively. This spread as a percentage (e.g. coefficient of variation) indicated that across the 2015 and 2019 tournaments, goalkeepers demonstrated the most variation in Zone 3 distance (49-66%) with similar variations for most outfield positions such as central defenders (20-21%), full-backs (18-20%), central midfielders (19-20%), and wide midfielders (18-21%). However, forwards displayed more spread (24-25%), indicating less consistent Zone 3 distances in matches.

A comparative illustration of the distance covered in Zone 3 by various positional subsets at Canada 2015 (dark blue) and France 2019 (light blue) can be found in Figure 85. Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments. It is clear that all playing positions covered more Zone 3 distance at France 2019 than at Canada 2015. Although the magnitude of the increase across tournaments was only small to moderate for most outfield positions (percentage increase from 2015 to 2019: full-backs=6.4%, wide midfielders=7.4%), this increase was more pronounced for central defenders (8.4%; 1,547 v. 1,676m) and central midfielders (8.4%; 2,294 v. 2,488m) and least pronounced for forwards (1.1%; 1,992 v. 2,013m). Despite the very low absolute Zone 3 distance covered by goalkeepers, they still demonstrated a 9.9% increase in distance from 2015 to 2019. This overall trend could have been related to much more consistent Zone 3 distances, as evidenced by more variability across most positions at Canada

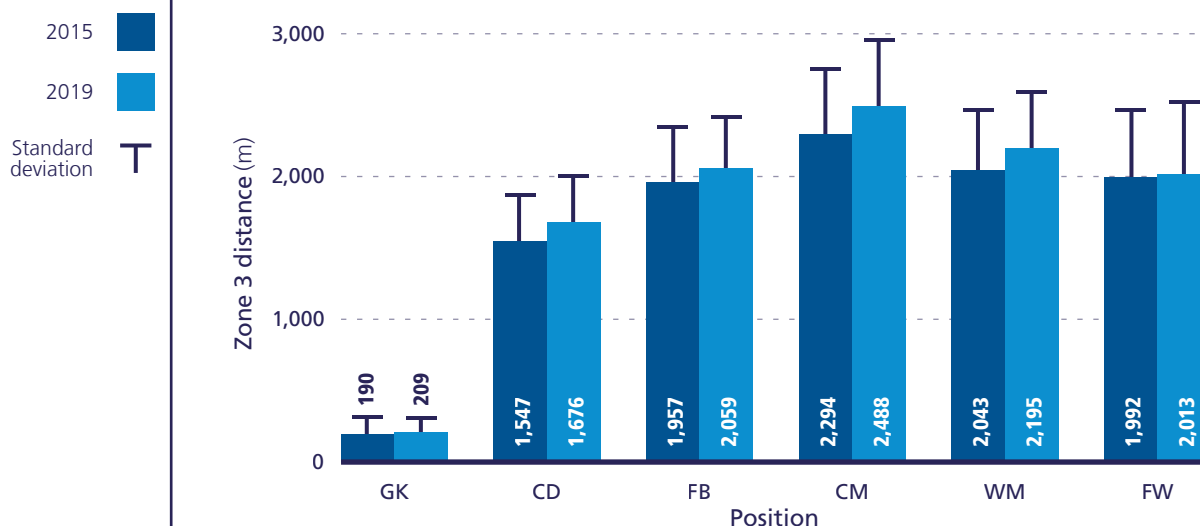


Figure 85. Comparison of the distances covered in Zone 3 by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

4

19-23km/h

2015 (Figure 84A) compared to France 2019 (Figure 84B). For instance, this spread as a percentage (e.g. coefficient of variation) was higher in 2015 compared with 2019 for goalkeepers (66 v. 49%), full-backs (20 v. 18%) and wide midfielders (21 v. 18%), while for central defenders (21 v. 20%), central midfielders (20 v. 19%) and forwards (24 v. 25%) it was similar. This generally highlights more consistent Zone 3 distances across some positions in the modern game.

Zone 4

The average and data spread of the distance covered in Zone 4 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 86A (2015) and Figure 86B (2019). In Zone 4, goalkeepers covered only 21-24m in matches, with approximately 29-38% of all goalkeeper match observations producing <10m in Zone 4 across the 2015 and 2019 competitions. More distance was covered across the 2015 and 2019 competitions by full-backs (449 and 501m), wide midfielders (467 and 591m) and forwards (468 and 530m) compared to central defenders (292 and 349m) and central midfielders (382 and 460m). In both 2015 and 2019, the lowest distance recorded for an outfield player was from a central defender (109 and 146m), while the highest value in 2015 was from a forward (795m) and in 2019 it was from a wide midfielder (1,009m).

In Figures 86A and 86B you can observe the dots that represent individual player observations, and this provides the reader with insight into the spread of the Zone 4 distances for each position. The range for goalkeepers was 0-107 and 0-132m, while the ranges for outfield positions were 109-795m and 146-1,009m for the 2015 and 2019 competitions, respectively. The percentage spread (e.g. coefficient of variation) was 22-29% for central defenders, full-backs, wide midfielders and forwards, with central midfielders displaying the highest Zone 4 spread (32-33%) for outfield positions in both the 2015 and 2019 competitions. Goalkeepers demonstrated a spread of 89-105% for Zone 4 distances across tournaments.

A comparative illustration of the distance covered in Zone 4 by various positional subsets at Canada 2015 (dark blue) and France 2019 (light blue) can be found in Figure 87. It is clear that all outfield playing positions covered substantially more Zone 4 distance at France 2019 than at Canada 2015.



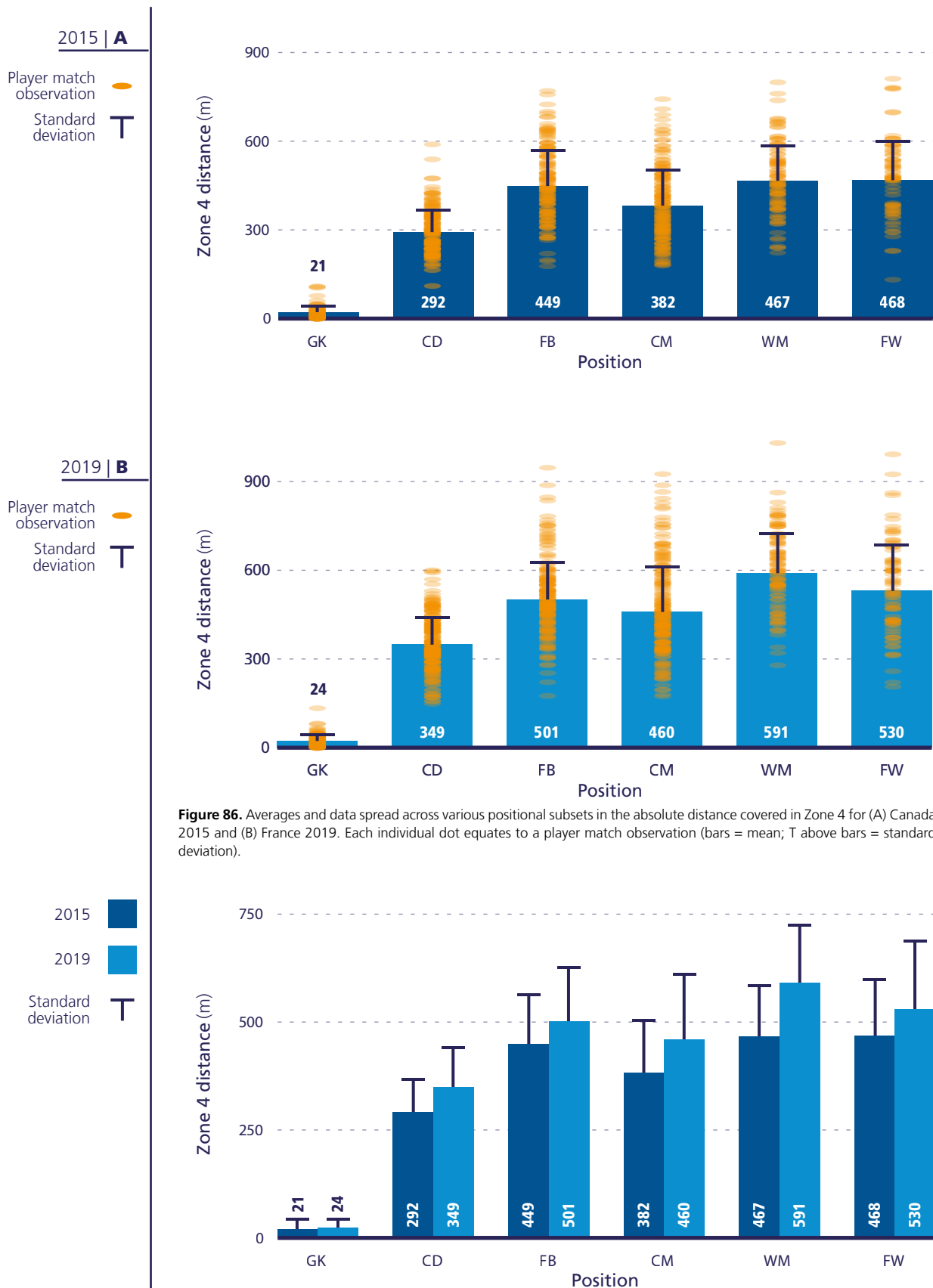


Figure 86. Averages and data spread across various positional subsets in the absolute distance covered in Zone 4 for (A) Canada 2015 and (B) France 2019. Each individual dot equates to a player match observation (bars = mean; T above bars = standard deviation).

Figure 87. Comparison of the distances covered in Zone 4 by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

5
 >23km/h

2015 | **A**

Player match
 observation 
 Standard
 deviation **T**

Although the magnitude of the increase across tournaments varied, it was generally large for most outfield positions (percentage increase from 2015 to 2019: central defenders=19%, central midfielders=20.4%, forwards=13.3%). This percentage increase was more pronounced for wide midfielders (26.6%; 467 v. 591m) and least pronounced for full-backs (11.6%; 449 v. 501m). Despite the very low absolute Zone 4 distance covered by goalkeepers, they still demonstrated a 12.3% increase in Zone 4 distance from 2015 to 2019. This overall trend could have been related to more consistent Zone 4 distances, as evidenced by more variability across most positions at Canada 2015 (Figure 86A) compared to France 2019 (Figure 86B). For instance, this spread as a percentage (e.g. coefficient of variation) was higher in 2015 compared with 2019 for goalkeepers (105 v. 89%), full-backs (27 v. 25%) and wide midfielders (25 v. 23%), while for central defenders (26 v. 26%), central midfielders (32 v. 33%) and forwards (28 v. 29%) it was similar. This generally highlights more consistent Zone 4 distances across selected positions in the modern game.

Zone 5

The average and data spread of the absolute distance covered in Zone 5 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 88A (2015) and Figure 88B (2019). In relation to Zone 5, the positional trends are very distinct, with full-backs (157 and 204m), wide midfielders (173 and 255m) and forwards (174 and 220m) producing more distance than central defenders (91 and 123m) and central midfielders (93 and 111m) across Canada 2015 and France 2019, respectively.

2019 | **B**

Player match
 observation 
 Standard
 deviation **T**

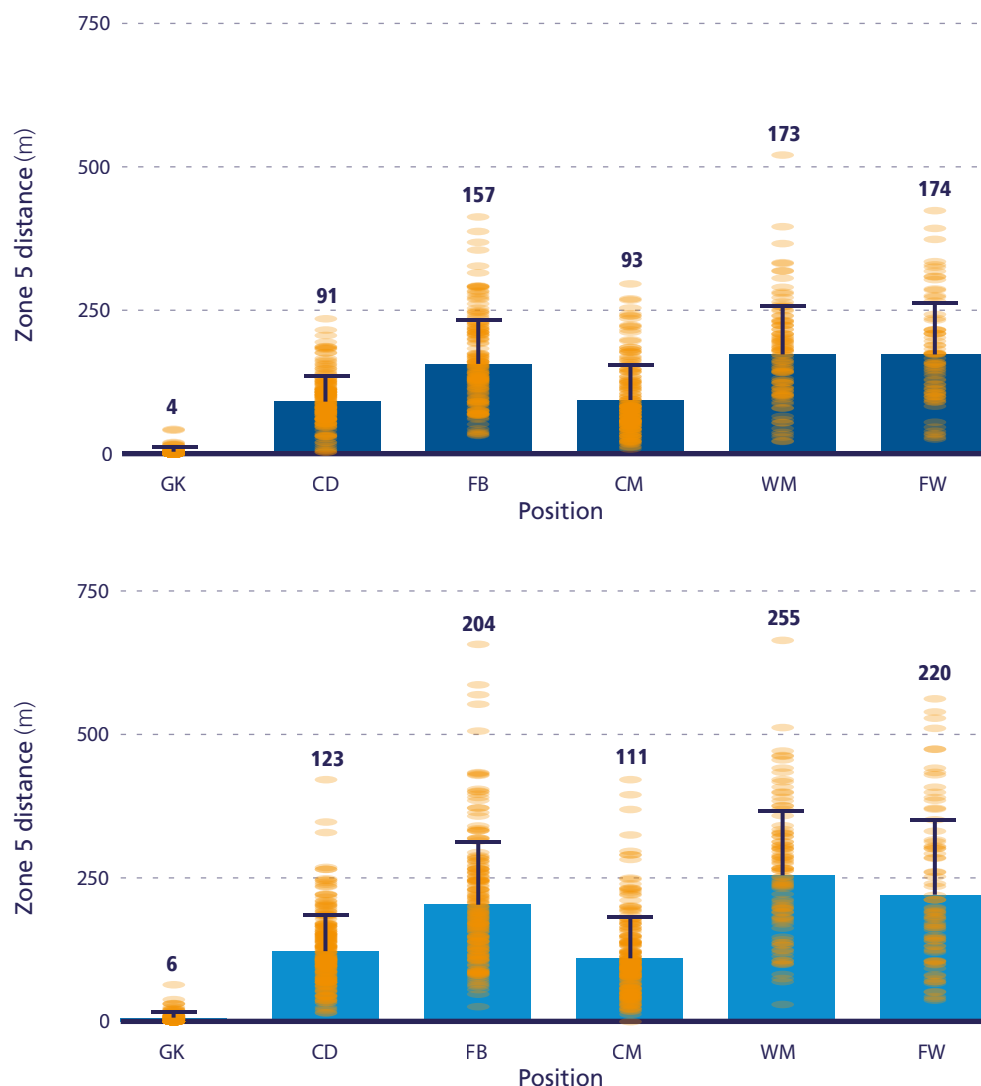


Figure 88. Averages and data spread across various positional subsets in the distance covered in Zone 5 for (A) Canada 2015 and (B) France 2019. Each individual dot equates to a player match observation (bars = mean; T above bars = standard deviation).



As expected, goalkeepers covered only 4-6m in Zone 5 across matches, with approximately 44-61% of all goalkeeper match observations producing 0m in Zone 5 across the 2015 and 2019 competitions. The lowest Zone 5 distance recorded for an outfield player was from a central defender (3m) in 2015 and a central midfielder in 2019 (0m), while the highest values in both the 2015 and 2019 competitions were from a wide midfielder (510 and 651m).

In Figures 88A and 88B you can observe the dots that represent individual player observations, and this provides the reader with insight into the spread of the Zone 5 distances for each position. The range for goalkeepers was 0-42 and 0-63m, while the ranges for outfield positions were 3-510 and 0-651m for the 2015 and 2019 competitions, respectively. The percentage spread (e.g. coefficient of variation) demonstrated that the most consistent Zone 5 distance was from wide midfielders (44-49%) and the most variable Zone 5 distances during matches were from central midfielders (64-66%) across Canada 2015 and France 2019, respectively. Central defenders (48-51%), full-backs (49-54%) and forwards (52-60%) were somewhere between these extremes. Goalkeepers demonstrated a spread of 154-212% for Zone 5 distances across tournaments.

A comparative illustration of the distance covered in Zone 5 by various positional subsets at Canada 2015 (dark blue) and France 2019 (light blue) can be found in Figure 89. Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments. It is clear that all playing positions covered more Zone 5 distance at France 2019 than at Canada 2015. Although the magnitude of the increase across tournaments varied, it was generally large for most outfield positions (percentage increase from 2015 to 2019: central defenders=35.7%, full-backs=30.1%, forwards=26.9%). This percentage increase was more pronounced for wide midfielders (47.3%; 173 v. 255m) and least pronounced for central midfielders (18.6%; 93 v. 111m).

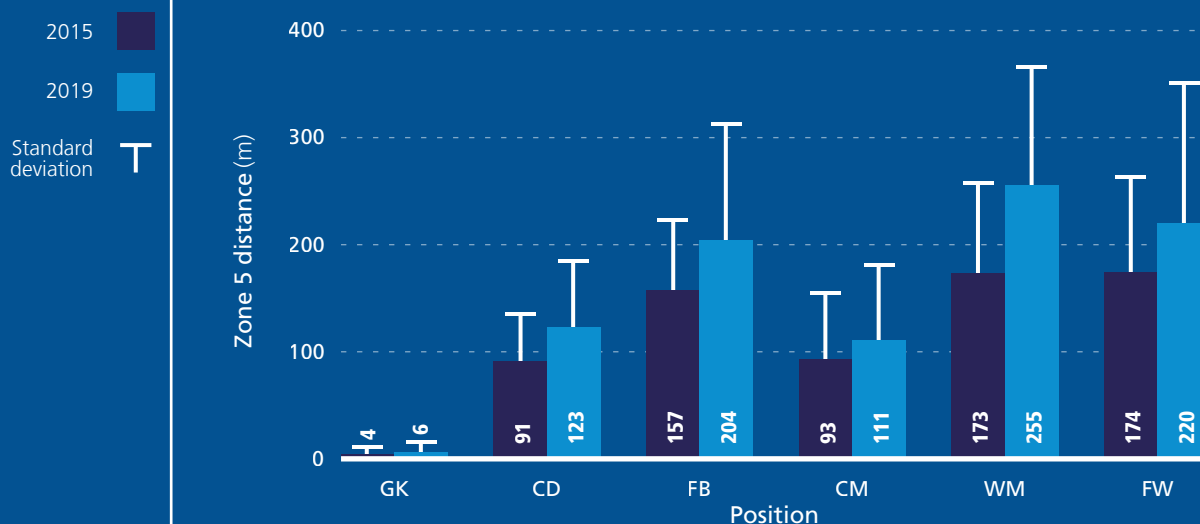


Figure 89. Comparison of the distances covered in Zone 5 by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

4

19-23km/h

5

>23km/h

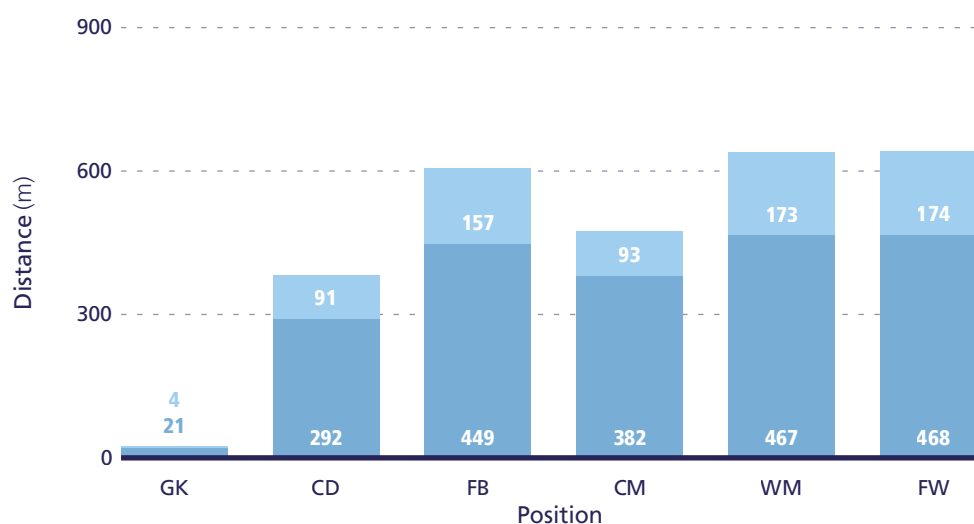
2015 | A

Zone 5

Zone 4

Combined zones 4 and 5

The average of the combined absolute distance covered in zones 4 and 5 by position during all regular-time matches of Canada 2015 and France 2019 is summarised in Figure 90A (2015) and Figure 90B (2019). Please note that these two upper speed zones generally represent the high-intensity running profile of players, and thus combining them provides more insight on intense activity from a positional perspective. At both Canada 2015 and France 2019, wide midfielders, forwards and full-backs covered more combined zone 4 and 5 distance than central defenders and central midfielders. In 2015, wide midfielders and forwards produced very similar combined zone 4 and 5 distances, but in 2019 this increased in wide midfielders due to an elevation in Zone 5 distance.



2019 | B

Zone 5

Zone 4

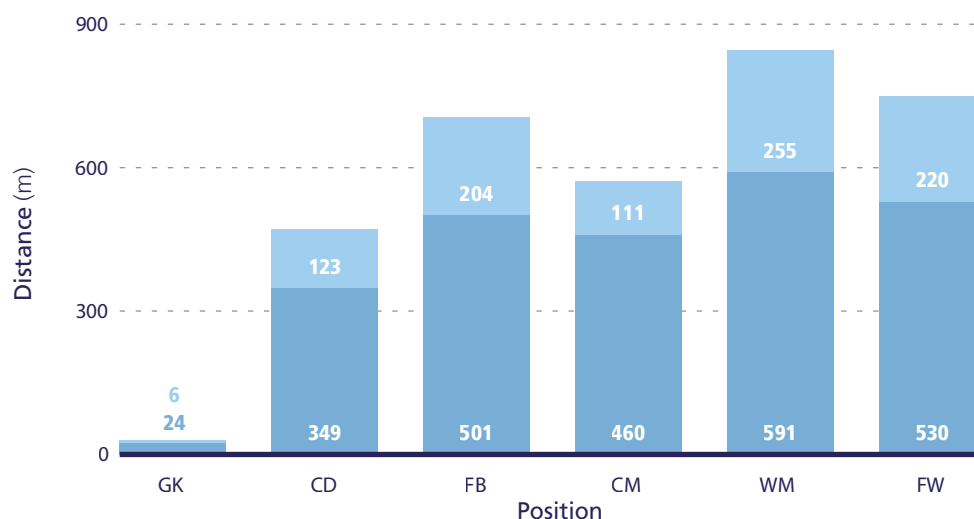


Figure 90. Averages across various positional subsets in the combined distance covered in zones 4 and 5 for (A) Canada 2015 and (B) France 2019



Although the absolute distance covered demonstrates differences across positions, the relative composition of Zone 4 and Zone 5 in the total high-intensity running profile is very similar across positions and tournaments. For instance, central defenders (Zone 4 = 76-74%; Zone 5 = 24-26%), full-backs (Zone 4 = 75-71%; Zone 5 = 25-29%), wide midfielders (Zone 4 = 73-70%; Zone 5 = 27-30%) and forwards (Zone 4 = 73-71%; Zone 5 = 27-29%) illustrate similar relative proportions from zones 4 and 5 in relation to the total high-intensity running distance across the 2015 and 2019 competitions, respectively. However, central midfielders indicated a much higher proportion from Zone 4 than Zone 5 (Zone 4 = 80-81%; Zone 5 = 20-19%). For goalkeepers, only a minimal amount of combined Zone 4 and 5 distance was covered, but the relative proportion of each to the total high-intensity distance was 86-79% from Zone 4 and 14-21% from Zone 5 across the 2015 and 2019 competitions, respectively.

A comparative illustration of the combined absolute distance covered in zones 4 and 5 by various positional subsets at Canada 2015 (dark blue) and France 2019 (light blue) can be found in Figure 91. Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments. It is clear that all playing positions covered substantially more combined distance in zones 4 and 5 at France 2019 than at Canada 2015. Although the magnitude of the increase across tournaments varied, it was generally large for most positions (percentage increase from 2015 to 2019: goalkeepers=22.0%, central defenders=23.4%, central midfielders=20.1%, forwards=17.0%). This percentage increase was more pronounced for wide midfielders (32.2%; 640 v. 846m) and least pronounced for full-backs (16.4%; 606 v. 705m).

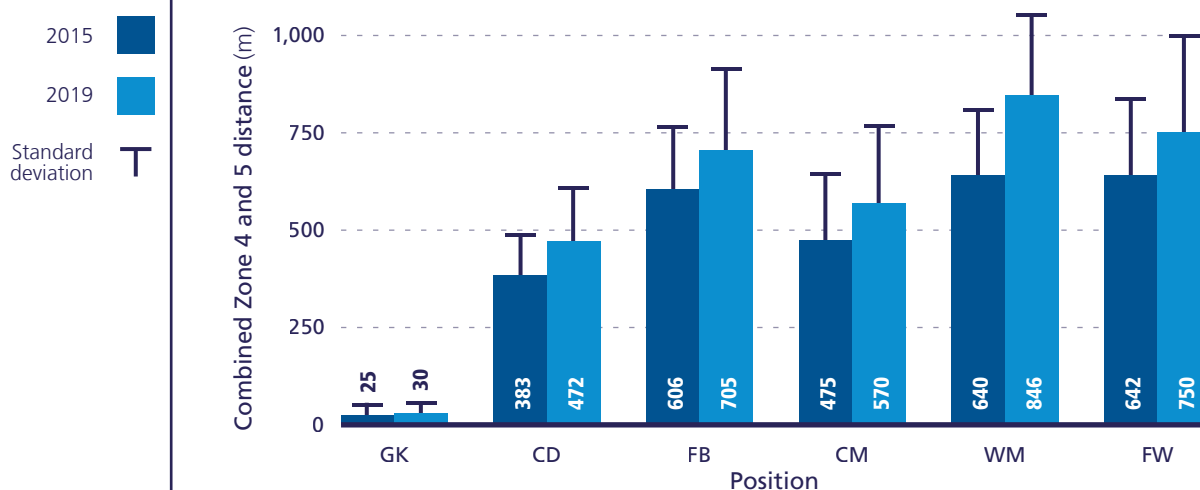


Figure 91. Comparison of the combined distances covered in zones 4 and 5 by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

3.7.4 Frequency of actions and average distance per bout in various zones

General positional trends and tournament comparison

The average and data spread of the frequency of actions in zones 1-5 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Table 10. As expected, goalkeepers produced the lowest frequency of combined actions across zones 1-2, lower than all outfield players, across both competitions (297-336 v. 801-902 bouts). Regarding outfield positions, central midfielders produced the highest number of combined Zone 1 and 2 efforts compared to all other positions across both Canada 2015 and France 2019. The average distance travelled per bout in Zone 1 for goalkeepers (18-23m per bout) was substantially higher than for outfield players (8-10m per bout) in both tournaments. All outfield positions produced similar distances per bout in Zone 1 (central defenders=8; full-backs=8; central midfielders=8; wide midfielders=9; forwards=9m per bout). Zone 2 distance travelled per bout was similar across all positions (7-10m per bout) at both Canada 2015 and France 2019. Goalkeepers typically produced a substantially lower Zone 3 frequency (18-20 bouts) than outfield positions (168-172 bouts). The frequency of occurrence of Zone 3 actions across tournaments was lowest for central defenders (140-145 bouts) and highest for central midfielders (198-201 bouts), with full-backs, wide midfielders and forwards demonstrating a similar number of actions (167-180 bouts). The average distance travelled per bout in Zone 4 was very similar across all positions for Canada 2015 and France 2019, respectively (goalkeepers=11 and 11; central defenders=11 and 12; full-backs=12 and 12; central midfielders=12 and 12; wide midfielders=12 and 12; forwards=12 and 12m per bout).

Table 10. Positional trends for the frequency of actions in various zones across Canada 2015 and France 2019

Playing position	Zone 1 and 2		Zone 3		Zone 4		Zone 5	
	2015	2019	2015	2019	2015	2019	2015	2019
GK	336±114	297±83	18±12	20±10	1.3±1.9	1.4±1.6	0.2±0.5	0.3±0.6
OP	902±116	801±95	168±41	172±38	27.9±10.2	30.6±10.3	7.9±4.9	9.4±5.6
ALL	843±217	739±190	152±62	154±61	23.4±11.9	27.0±13.6	6.7±4.8	8.3±6.1
CD	897±117	806±96	140±29	145±28	19.2±6.0	23.0±6.4	6.0±2.7	7.3±3.6
FB	883±108	811±87	167±31	170±26	30.0±8.0	32.7±8.6	9.1±3.7	11.2±5.5
CM	968±105	831±82	198±37	201±37	25.4±8.3	30.8±10.6	5.6±3.7	6.3±3.8
WM	881±115	767±102	173±36	180±31	31.3±8.8	38.2±9.4	9.9±4.7	14.1±5.8
FW	887±120	740±95	174±43	166±40	30.4±9.2	34.8±10.7	10.0±5.3	12.0±6.8

Data is presented as an average and spread (mean ± standard deviation). Zones 1-3 are reported as integers due to the large frequency of them. However, zones 4 and 5 are reported as decimals due to the low occurrence of these actions and to inform the reader of the precise value. Please note that the refiltering of the data could have impacted the accuracy of the frequency counts and the average-distance-per-bout calculations, particularly for zones 4 and 5.

The frequency of Zone 4 actions was much higher across the 2015 and 2019 competitions by full-backs (30 and 33 bouts), central midfielders (25 and 31 bouts), wide midfielders (31 and 38 bouts) and forwards (30 and 35 bouts) compared to central defenders (19 and 23 bouts). The average distance travelled per bout in Zone 4 was very similar across all outfield positions for Canada 2015 and France 2019, respectively (central defenders=15 and 15; full-backs=15 and 15; central midfielders=15 and 15; wide midfielders=15 and 15; forwards=15 and 15m per bout). The frequency of Zone 5 actions was much higher across the 2015 and 2019 competitions by full-backs (9 and 11 bouts), wide midfielders (10 and 14 bouts) and forwards (10 and 12 bouts) compared to central defenders (6 and 7 bouts) and central midfielders (6 and 6 bouts). The average distance travelled per bout in Zone 5 was very similar across all outfield positions for Canada 2015 and France 2019, respectively (central defenders=17 and 17; full-backs=17 and 18; central midfielders=17 and 18; wide midfielders=18 and 18; forwards=17 and 18m per bout).

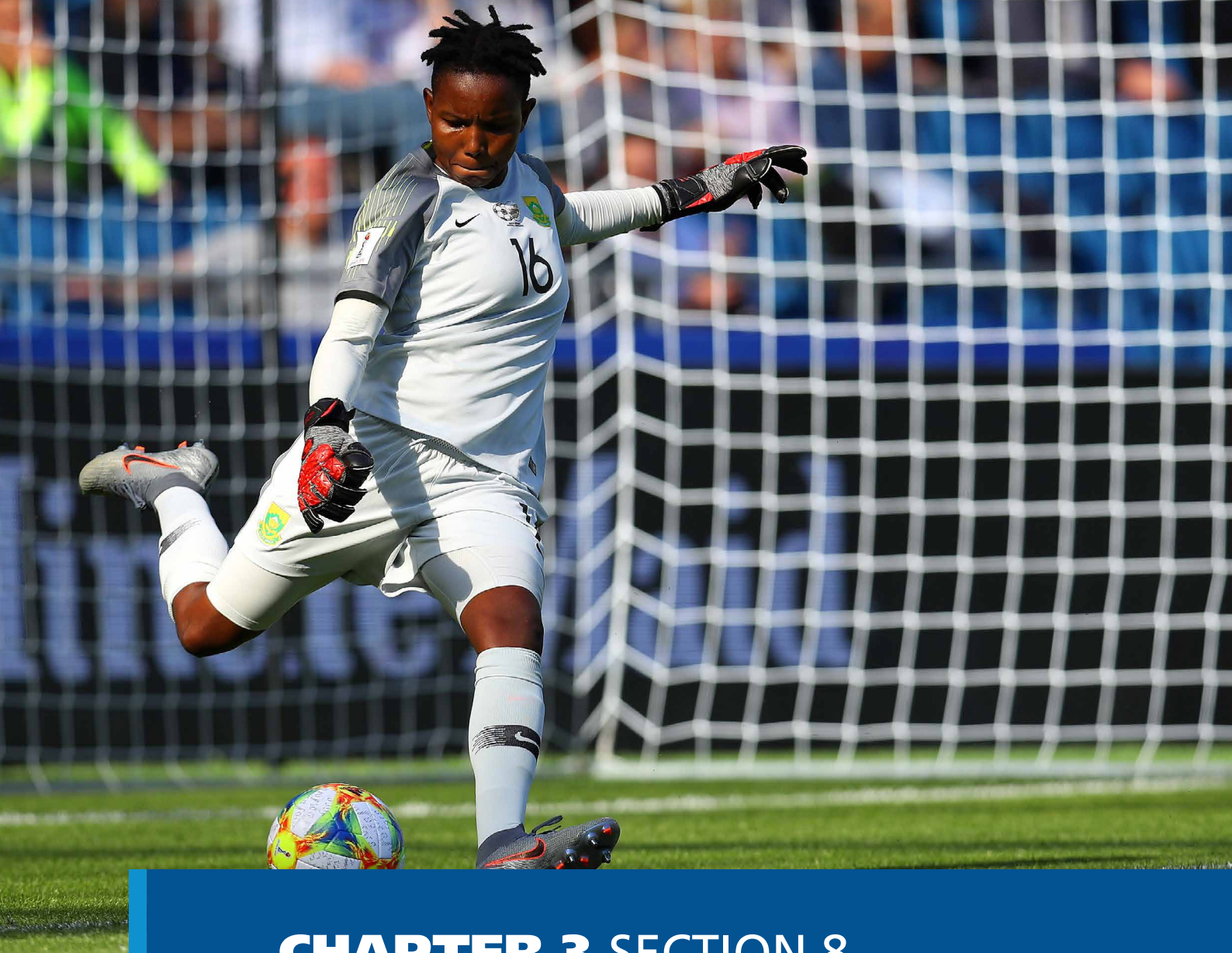
Table 10 also compares the frequency of actions in various zones at both Canada 2015 and France 2019. Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments. All positions produced a lower number of bouts in zones 1-2 at France 2019 compared to Canada 2015 (percentage decrease from 2019 to 2015: goalkeepers=11.6%; central defenders=10.2%; full-backs=8.2%; central midfielders=14.2%; wide midfielders=12.9%; forwards=16.6%). However, most outfield playing positions produced more bouts in zones 3-5 at France 2019 than at Canada 2015. Although the magnitude of the increase across tournaments for zones 3-5 varied, it was generally moderate to large for most positions (percentage increase across zones 3-5 from 2015 to 2019: goalkeepers Z3=11.1%, Z4=7.7%, Z5= 50%; central defenders Z3=3.6%, Z4=19.8%, Z5=21.7%; full-backs Z3=1.8%, Z4=9.0%, Z5=23.1%; central midfielders Z3=1.5%, Z4=21.3%, Z5=12.5%; and wide midfielders Z3=4.1%, Z4=22%, Z5=42%). Although forwards produced more bouts in zones 4 and 5 in 2019 than in 2015 (Z4=14.5%, Z5=20%), they actually produced 4.6% fewer Zone 3 actions.





3.7.5 Summary

- Central defenders covered the lowest overall distance amongst outfield players, while central midfielders and wide midfielders covered the greatest distance, with full-backs and forwards falling somewhere between these two extremes.
- It was evident that all playing positions covered slightly more total distance at France 2019 than at Canada 2015, although the magnitude of the increase across tournaments was only small.
- Zone 3 distance was substantially higher in central midfielders than all other outfield positions, with central defenders producing the lowest distance. Similar distances were covered by full-backs, wide midfielders and forwards across both tournaments.
- All playing positions covered more Zone 3 distance at France 2019 than at Canada 2015.
- Full-backs, wide midfielders and forwards covered more Zone 4 distance across the 2015 and 2019 competitions than central defenders and central midfielders.
- All outfield playing positions covered substantially more Zone 4 distance at France 2019 than at Canada 2015, although this was particularly evident for wide midfielders.
- Zone 5 distance was substantially higher for full-backs, wide midfielders and forwards than for central defenders and central midfielders across Canada 2015 and France 2019, respectively.
- Zone 5 distance was 18.6-47.3% higher at France 2019 than at Canada 2015 across positions, although this was especially evident for wide midfielders.
- The frequency of actions in zones 3 and 4 was higher in full-backs, central midfielders, wide midfielders and forwards compared with central defenders.
- The number of Zone 5 actions was greater across the 2015 and 2019 competitions for full-backs, wide midfielders and forwards compared to central defenders and central midfielders.
- More actions were performed in zones 3-5 at France 2019 than at Canada 2015.
- Finally, the overall trend above could have been related to much more consistent distances covered/frequency of actions overall and in selected zones at France 2019 than at Canada 2015 across positions.



CHAPTER 3 SECTION 8

Positional analysis | Relative distance and distance covered in both halves in various speed zones

3.8.1 **Positional trends: relative distance covered in total and in various speed zones**

General positional trends and tournament comparison

In previous sections, the absolute distance was calculated in total and in various speed zones. However, this next section will analyse the data trends when the distance is normalised for the duration of the match (e.g. m/min). The use of video assistant referees (VARs) at France 2019 changed the average match duration compared to Canada 2015. Thus, a more appropriate comparison of the physical demands across position and tournament can be established through relative analyses.



Relative total distance covered

The average and data spread of the total distance covered relative to the duration of the match by position during all regular-time matches of Canada 2015 (dark blue) and France 2019 (light blue) are summarised in Figure 92. For outfield players, when accounting for the duration of the match, central defenders covered the lowest overall relative distance (98m/min) whilst central midfielders (111-112m/min) covered the greatest relative distance, with full-backs (104-105m/min), wide midfielders (108m/min) and forwards (106-107m/min) falling somewhere between these two extremes across both tournaments. Goalkeepers covered substantially lower relative distances than all outfield players across both competitions (50-52m/min). A comparative analysis of the last two tournaments revealed that all playing positions covered marginally more absolute total distance at France 2019 than at Canada 2015 (1.1-3.2% more in 2019 than in 2015). However, the relative trends in Figure 92 demonstrated no meaningful differences across the tournaments for all positions when match duration is accounted for.

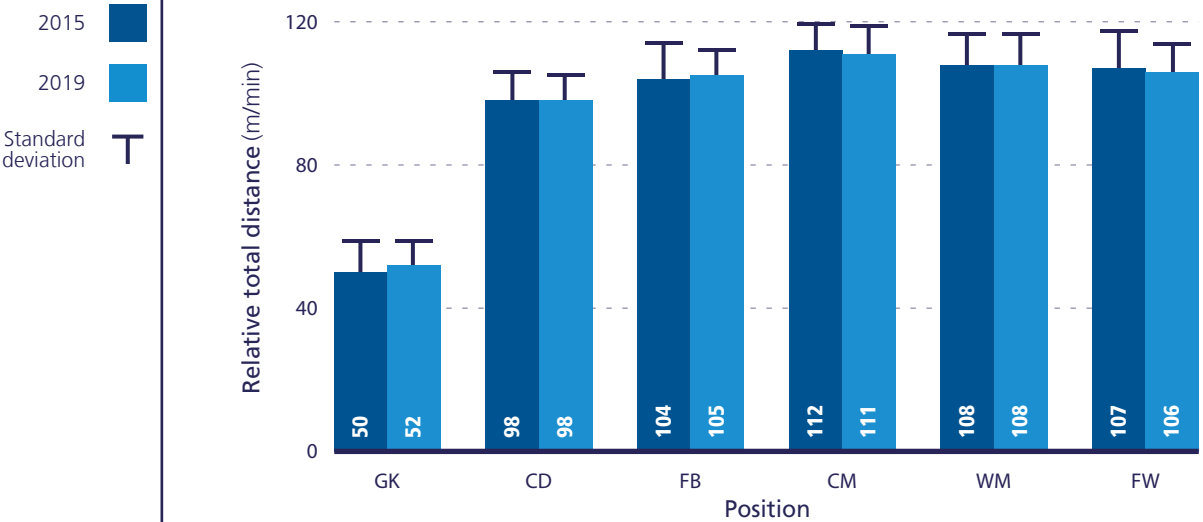


Figure 92. Comparison of the total relative distance covered by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

SPEED ZONES



1
0-7km/h

2
7-13km/h

Zones 1 and 2

In Zone 1, most playing positions covered similar relative distances at both the 2015 (37.0-39.5m/min) and 2019 World Cups (37.6-40.9m/min). For Zone 2, relative distance was generally higher for central midfielders (45.0 and 42.3m/min) than for other outfield positions in the 2015 and 2019 tournaments (39.0-40.5 and 36.3-39.0m/min). A comparison of the relative distance covered in zones 1 and 2 by various positional subsets at Canada 2015 and France 2019 can be found in Table 11. It was evident that all playing positions covered similar Zone 1 relative distances across tournaments, with forwards and goalkeepers being the only exceptions with a 3.6-5.4% increase from Canada 2015 to France 2019. In 2019 compared to 2015, there was a tendency for relative Zone 2 distance to stay stable (percentage decrease from 2015 to 2019: goalkeepers=4.2%, central defenders=2.8%, full-backs=3.7%) or decrease for selected positions (central midfielders=6.0%, wide midfielders=5.7%, forwards=9.9%).

Table 11. Positional trends in the relative distance covered in zones 1 and 2 at Canada 2015 and France 2019

Playing position	Zone 1 (m/min)		Zone 2 (m/min)	
	2015	2019	2015	2019
GK	38.5±5.1	39.9±4.2	9.6±3.5	9.2±3.0
OP	38.3±3.0	38.5±3.0	40.3±6.7	39.1±5.7
ALL	38.2±3.4	38.6±3.2	37.5±11.8	35.4±11.2
CD	38.9±2.8	38.4±2.2	39.0±5.4	37.9±4.5
FB	37.0±3.5	37.9±2.8	40.5±6.0	39.0±5.0
CM	37.3±2.7	37.6±3.2	45.0±5.4	42.3±5.4
WM	39.5±3.1	39.3±3.4	40.1±6.5	37.8±6.7
FW	38.8±2.9	40.9±2.9	40.3±6.7	36.3±5.8

Data is presented as an average and spread (mean ± standard deviation).



3

13-19km/h

Zone 3

The average and data spread of the relative distance covered in Zone 3 by position during all regular-time matches of Canada 2015 (dark blue) and France 2019 (light blue) are summarised in Figure 93. In Zone 3, goalkeepers covered substantially lower relative distances (2.0 and 2.1m/min) compared to all outfield positions in both the 2015 (20.3m/min) and 2019 tournaments (21.3m/min). Relative Zone 3 distance was substantially higher in central midfielders (24.1 and 25.5m/min) than all other outfield positions, with central defenders producing the lowest Zone 3 distance (16.3 and 17.2m/min). However, similar distances were covered by full-backs (20.3 and 21.1m/min), wide midfielders (21.5 and 22.5m/min) and forwards (21.0 and 20.7m/min) across both tournaments.

It is clear that most playing positions covered more relative Zone 3 distance at France 2019 than at Canada 2015. Accounting for the match duration led to a less pronounced difference between tournaments compared to the trends for the absolute distance. Although the magnitude of the increase across tournaments was still small for most outfield positions (percentage increase from 2015 to 2019: full-backs=3.7%, wide midfielders=4.7%), this percentage increase was more pronounced for central defenders (5.7%) and central midfielders (5.8%), with forwards illustrating hardly any difference at all. Despite the very low relative Zone 3 distance covered by goalkeepers, they still demonstrated a 6.5% increase in Zone 3 distance from 2015 to 2019.

2015
2019
Standard deviation

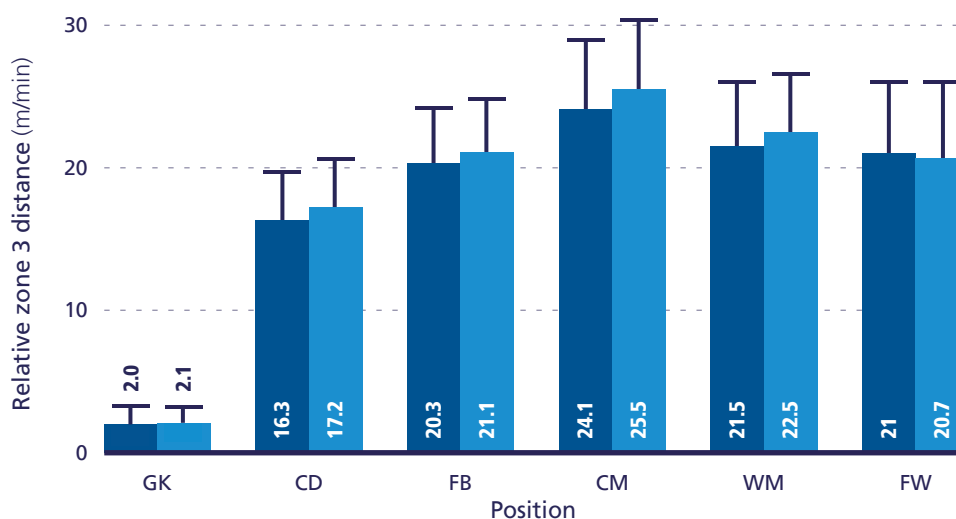


Figure 93. Comparison of the relative Zone 3 distance covered by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.



4

19-23km/h

Zone 4

The average and data spread of the relative distance covered in Zone 4 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 94. More relative Zone 4 distance was covered across the 2015 and 2019 competitions by full-backs (4.7 and 5.1m/min), wide midfielders (4.9 and 6.0m/min) and forwards (4.9 and 5.4m/min) compared to central defenders (3.1 and 3.6m/min) and central midfielders (4.0 and 4.7m/min).

All playing positions covered more relative Zone 4 distance at France 2019 than at Canada 2015. Accounting for the match duration led to a less pronounced difference between tournaments compared to the trends for the absolute distance. Although the magnitude of the increase across tournaments varied, it was generally moderate to large for most outfield positions (percentage increase from 2015 to 2019: central defenders=16.6%, central midfielders=17.5%, forwards=10.6%). This percentage increase was more pronounced for wide midfielders (23.0%) and least pronounced for full-backs (8.2%). Despite the very low relative Zone 4 distance covered by goalkeepers, they still demonstrated a 9.1% increase in Zone 4 distance from 2015 to 2019 (0.22 v. 0.24m/min).

2015
2019
Standard deviation

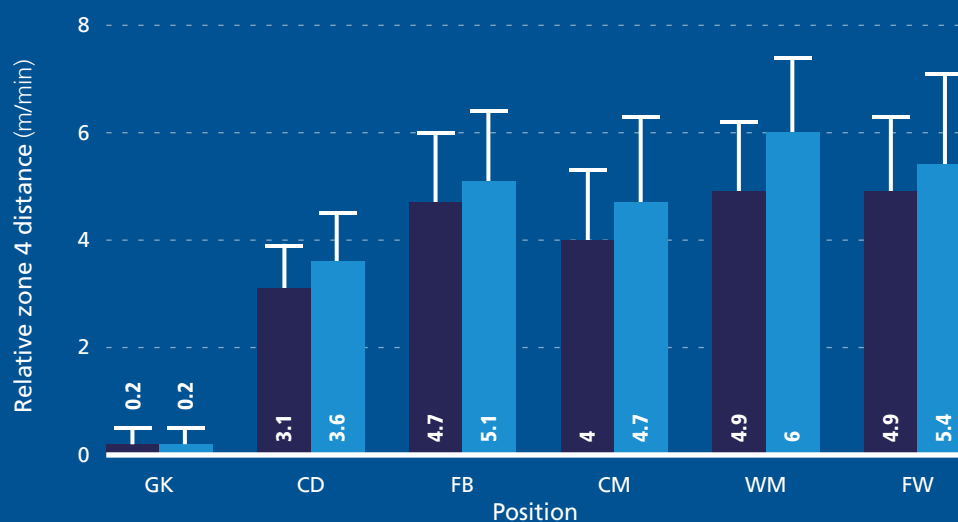


Figure 94. Comparison of the relative Zone 4 distance covered by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the re-referring of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.



5

>23km/h

Zone 5

The average and data spread of the relative distance covered in Zone 5 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 95. In relation to Zone 5, the positional trends are very distinct, with full-backs (1.6 and 2.1m/min), wide midfielders (1.8 and 2.6m/min) and forwards (1.8 and 2.3m/min) producing more relative distance than central defenders (1.0 and 1.3m/min) and central midfielders (1.0 and 1.1m/min) across Canada 2015 and France 2019, respectively.

Accounting for the match duration led to a less marked difference between tournaments compared to the trends for the absolute Zone 5 distance. Although the magnitude of the increase across tournaments varied, it was generally large for most outfield positions (percentage increase from 2015 to 2019: central defenders=32.6%, full-backs=29.0%, forwards=23.5%). This percentage increase was more pronounced for wide midfielders (43.4%) and least evident for central midfielders (15.3%). Despite the very low relative Zone 5 distance covered by goalkeepers, they still demonstrated a 50% increase in Zone 5 distance from 2015 to 2019.

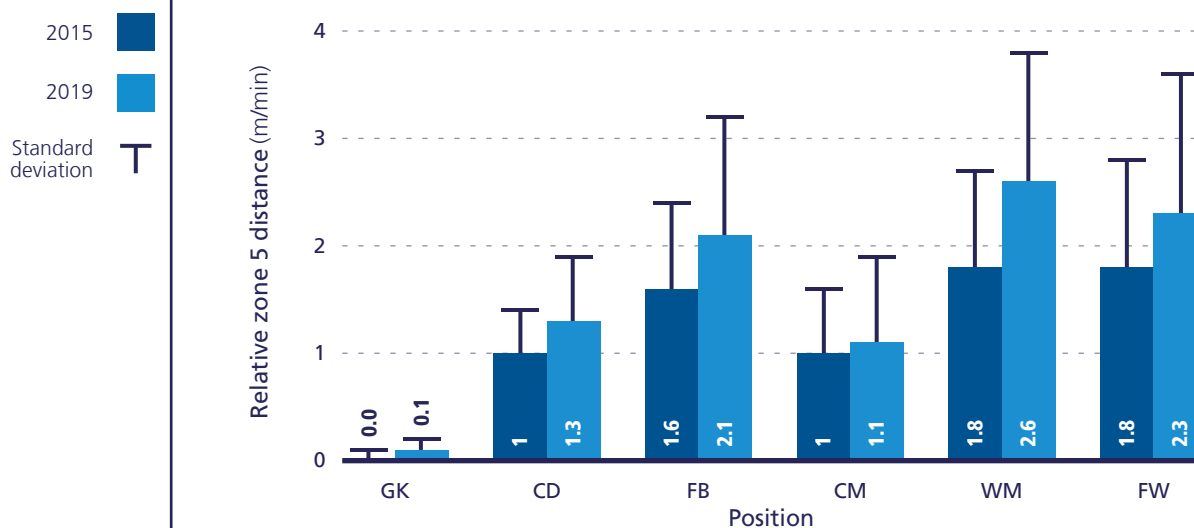


Figure 95. Comparison of the relative Zone 5 distance covered by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

Although the magnitude of the increase across tournaments varied, it was generally large for most outfield positions

4

19-23km/h

5

>23km/h

Combined zones 4 and 5

The average and data spread of the relative combined distance covered in zones 4 and 5 by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 96. Please note that these two upper speed zones generally represent the high-intensity running profile of players, and thus combining them provides more insight on intense activity from a positional perspective. At both Canada 2015 and France 2019, wide midfielders (6.7 and 8.7m/min), forwards (6.8 and 7.7m/min) and full-backs (6.4 and 7.2m/min) covered more relative combined zone 4 and 5 distance than central defenders (4.0 and 4.8m/min) and central midfielders (5.0 and 5.8m/min). In 2015, wide midfielders and forwards produced very similar combined zone 4 and 5 distances (wide midfielders=6.7 and forwards=6.8m/min). Although this increased substantially for both positions in 2019, the increase was more pronounced in wide midfielders (8.7m/min) than in forwards (7.7m/min).

A comparative analysis of the combined relative distance covered in zones 4 and 5 by various positional subsets at Canada 2015 (dark blue) and France 2019 (light blue) can be found in Figure 96. It is clear that all playing positions covered more combined distance in zones 4 and 5 at France 2019 than at Canada 2015. Accounting for the match duration led to a less marked difference between tournaments compared to the trends for the absolute distance. Although the magnitude of the increase across tournaments varied, it was generally moderate to large for most positions (percentage increase from 2015 to 2019: goalkeepers=19.2%, central defenders=20.4%, central midfielders=17.0%, forwards=14.1%). This percentage increase was more pronounced for wide midfielders (28.5%) and least pronounced for full-backs (13.5%).

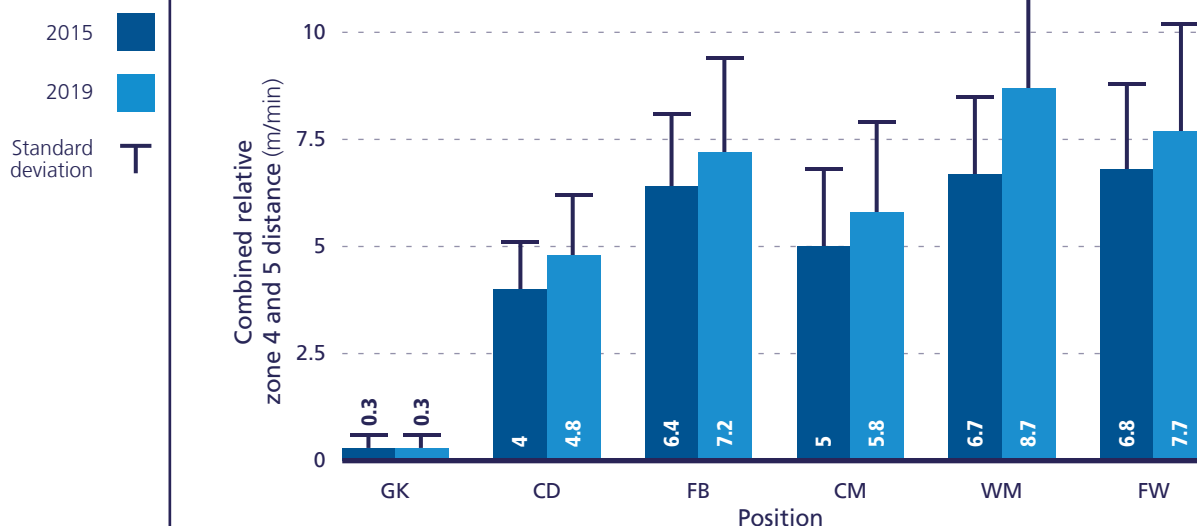


Figure 96. Comparison of the relative combined Zone 4 and 5 distance covered by various positional subsets at Canada 2015 and France 2019. Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

3.8.2 First- and second-half distance covered in total and in various speed zones

General positional trends and tournament comparison

Half-by-half match physical performances can provide added insight to the demands placed on players across major segments of the game. It is important to note that fluctuations in running profiles across these periods are extremely complex and can be related to a multitude of factors (e.g. fatigue, tactics, game tempo and scoreline to name just a few). Thus, the reader should be mindful of these factors before interpreting the trends below.

Half-by-half total distance covered

The average and data spread of the total distance covered in each half by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 97A and 97B. The total distance covered was highest in central midfielders in the first (5,332 and 5,480m) and second half (5,276 and 5,382m), and lowest (for the outfield players) in central defenders for the first (4,649 and 4,823m) and second half (4,695 and 4,762m) across Canada 2015 and France 2019, respectively. At Canada 2015, most positions produced similar total distance in the second half compared with

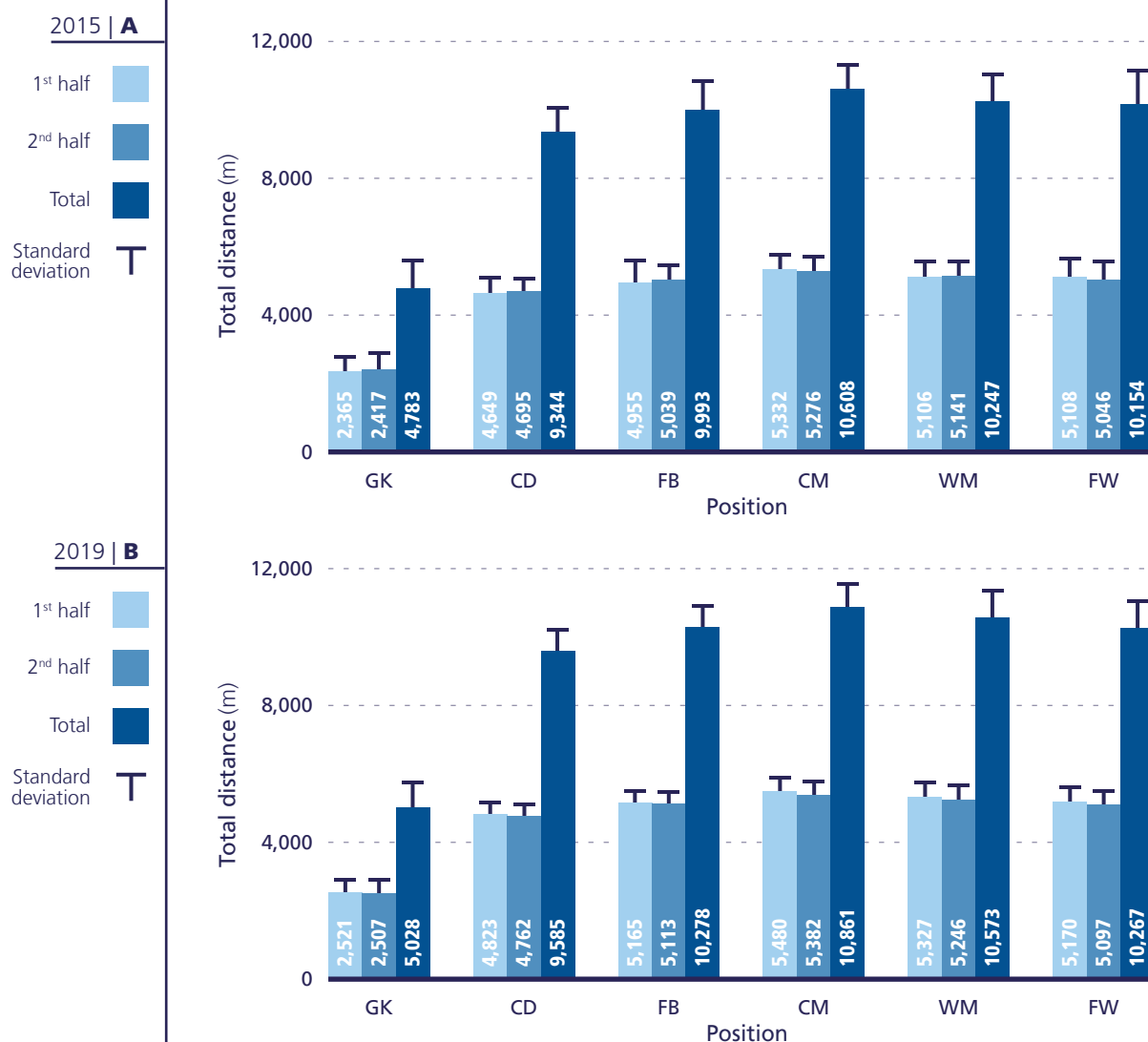


Figure 97. Comparison of the half-by-half total distance covered by various positional subsets at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.



the first half, with small reductions in central midfielders and forwards (percentage decrease of 1.1-1.2%). In 2019, all positions illustrated a small reduction in the total distance covered in the second compared with the first half: (percentage decrease: goalkeepers=0.6%, central defenders=1.3%, full-backs=1.0%, central midfielders=1.8%, wide midfielders=1.5%, forwards=1.4%). A comparative analysis across tournaments demonstrates that first-half total distances were higher for all positions in 2019 compared with 2015 (percentage increase: goalkeepers=6.6%, central defenders=3.7%, full-backs=4.2%, central midfielders=2.8%, wide midfielders=4.3%, forwards=1.2%). However, the difference between 2015 and 2019 was less pronounced in the second-half total distances (percentage increase: goalkeepers=3.7%, central defenders=1.4%, full-backs=1.5%, central midfielders=2.0%, wide midfielders=2.0%, forwards=1.0%).

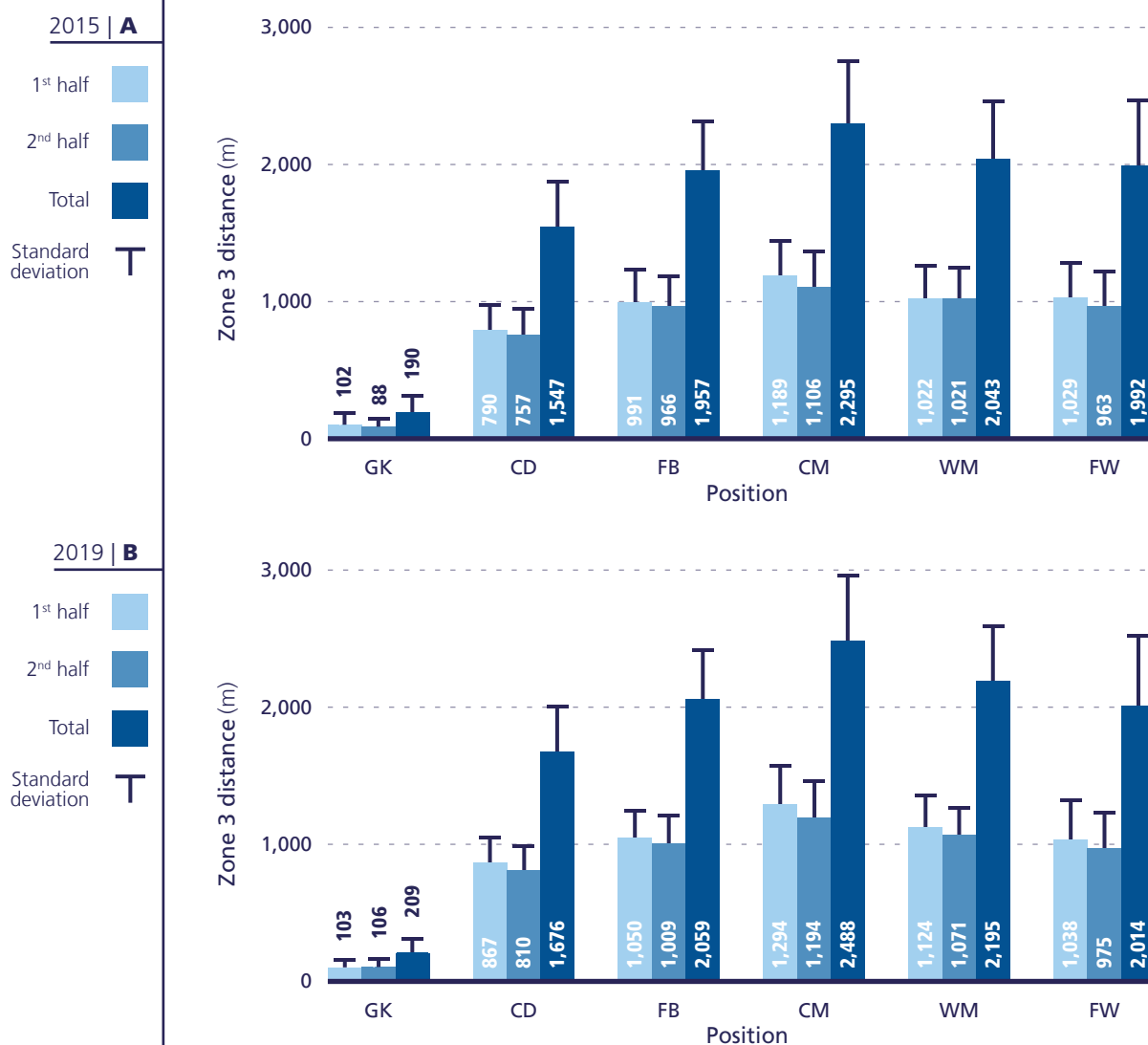


Figure 98. Comparison of the half-by-half distance covered in Zone 3 by various positional subsets at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

At France 2019, all outfield positions demonstrated a reduction in Zone 3 distance covered in the second compared with the first half

3 13-19km/h

Half-by-half Zone 3

The average and data spread of the Zone 3 distance covered in each half by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 98A and 98B. For outfield players, the Zone 3 distance was highest in central midfielders in the first (1,189 and 1,294m) and second half (1,106 and 1,194m), and lowest in central defenders for the first (790 and 867m) and second half (757 and 810m) across Canada 2015 and France 2019, respectively.

At Canada 2015, most positions produced either similar (percentage decrease: wide midfielders=0.1%) or reduced Zone 3 distances in the second half compared with the first half (percentage decrease: goalkeepers=14.0%, central defenders=4.3%, full-backs=2.5%, central midfielders=7.0%, forwards=6.4%). At France 2019, all positions demonstrated a reduction in Zone 3 distance covered in the second compared with the first half (central defenders=6.6%, full-backs=3.9%, central midfielders=7.7%, wide midfielders=4.7%, forwards=6.1%), with goalkeepers the only exception with a 2.4% increase in the second half. A comparative analysis across tournaments demonstrates that first-half Zone 3 distances were higher for all positions in 2019 compared with 2015 (percentage increase: goalkeepers=1.0%, central defenders=9.7%, full-backs=6.0%, central midfielders=8.8%, wide midfielders=9.9%, forwards=0.9%). However, the difference between 2015 and 2019 was less pronounced in the second-half total distances for most positions (percentage increase: central defenders=7.0%, full-backs=4.5%, central midfielders=8.0%, wide midfielders=4.9%), with the exception of goalkeepers and forwards.

4 19-23km/h

Half-by-half Zone 4

The average and data spread of the Zone 4 distance covered in each half by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 99A and 99B. In the first half, for the outfield positions, Zone 4 distance was highest for full-backs (226 and 255m), wide midfielders (234 and 305m) and forwards (243 and 267m), and lowest for central defenders (147 and 174m) across Canada 2015 and France 2019, respectively. At Canada 2015, all positions produced reduced Zone 4 distances in the second half compared with the first half but this varied in magnitude for selected positions (percentage decrease: goalkeepers=11.4%, central defenders=1.8%, full-backs=1.3%, central midfielders=6.6%, forwards=7.4%). Wide midfielders were the only exception, as they maintained their Zone 4 distance in the second half (percentage decrease: 0.4%). At France 2019, some outfield positions demonstrated a reduction in Zone 4 distance covered in the second compared with the first half (full-backs=3.5%, central midfielders=3.0%, wide midfielders=6.3%, forwards=1.5%), with central defenders producing comparable half-by-half distances (percentage



decrease: 0.2%). Goalkeepers actually covered 5.2% more distance in the second half than in the first half. A comparative analysis across tournaments demonstrates that first-half Zone 4 distances were higher for all positions in 2019 compared with 2015 (percentage increase: goalkeepers=3.6%, central defenders=18.4%, full-backs=12.8%, central midfielders=18.3%, wide midfielders=30.3%, forwards=9.9%). Players also covered more Zone 4 distance in the second half of matches at France 2019 than at Canada 2015 (percentage increase: goalkeepers=23.5%, central defenders=20.8%, full-backs=10.3%, central midfielders=22.8%, wide midfielders=22.8%, forwards=16.9%).

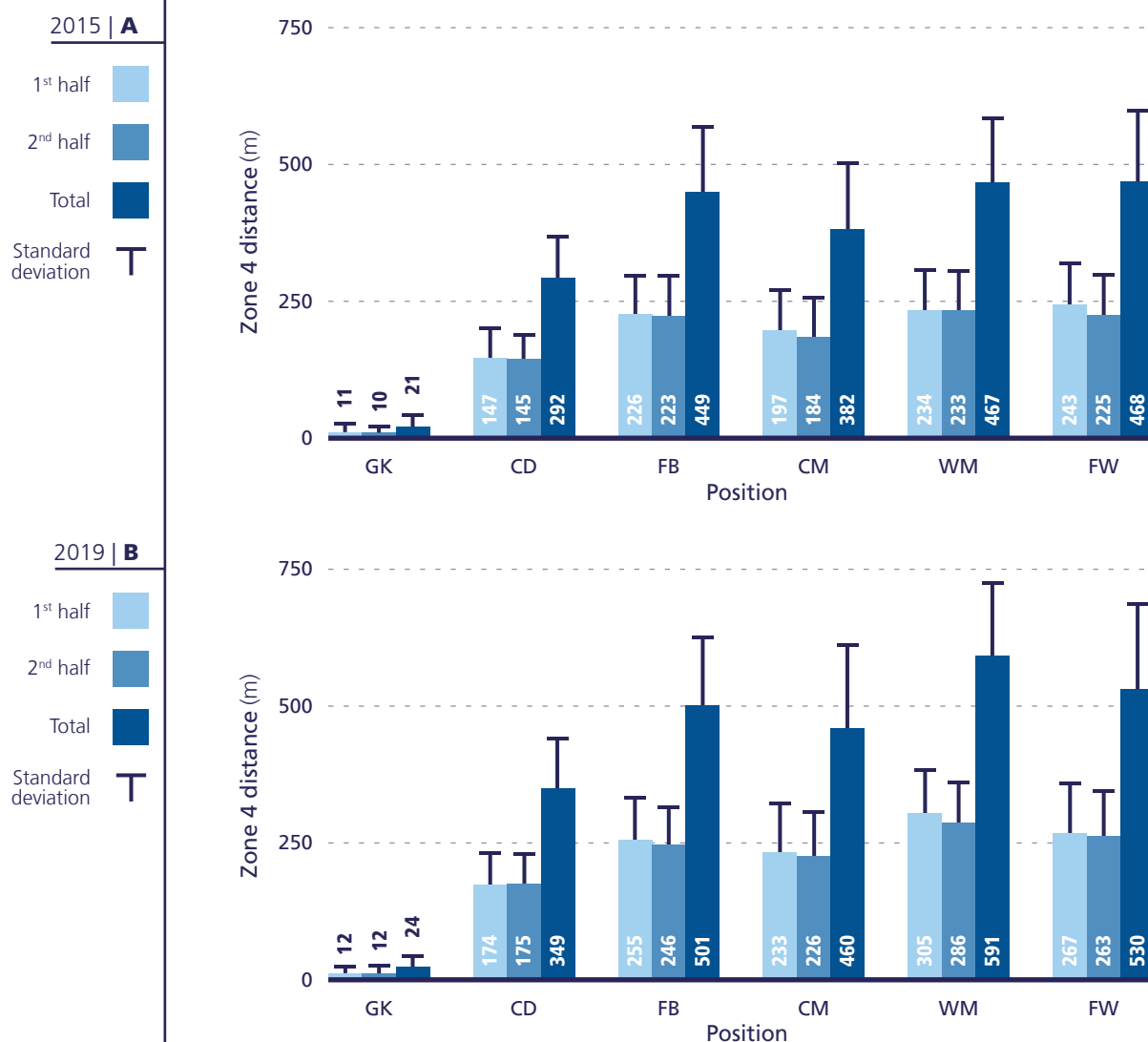


Figure 99. Comparison of the half-by-half distance covered in Zone 4 by various positional subsets at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

5

>23km/h

2015 | **A**

1st half

2nd half

Total

Standard deviation

2019 | **B**

1st half

2nd half

Total

Standard deviation

Half-by-half Zone 5

The average and data spread of the Zone 5 distance covered in each half by position during all regular-time matches of Canada 2015 and France 2019 are summarised in Figure 100A and 100B. In the first half, for the outfield positions, Zone 5 distance was highest for full-backs (79 and 105m), wide midfielders (95 and 132m) and forwards (92 and 115m), and lowest for central defenders (45 and 60m) and central midfielders (48 and 56m) across Canada 2015 and France 2019, respectively.

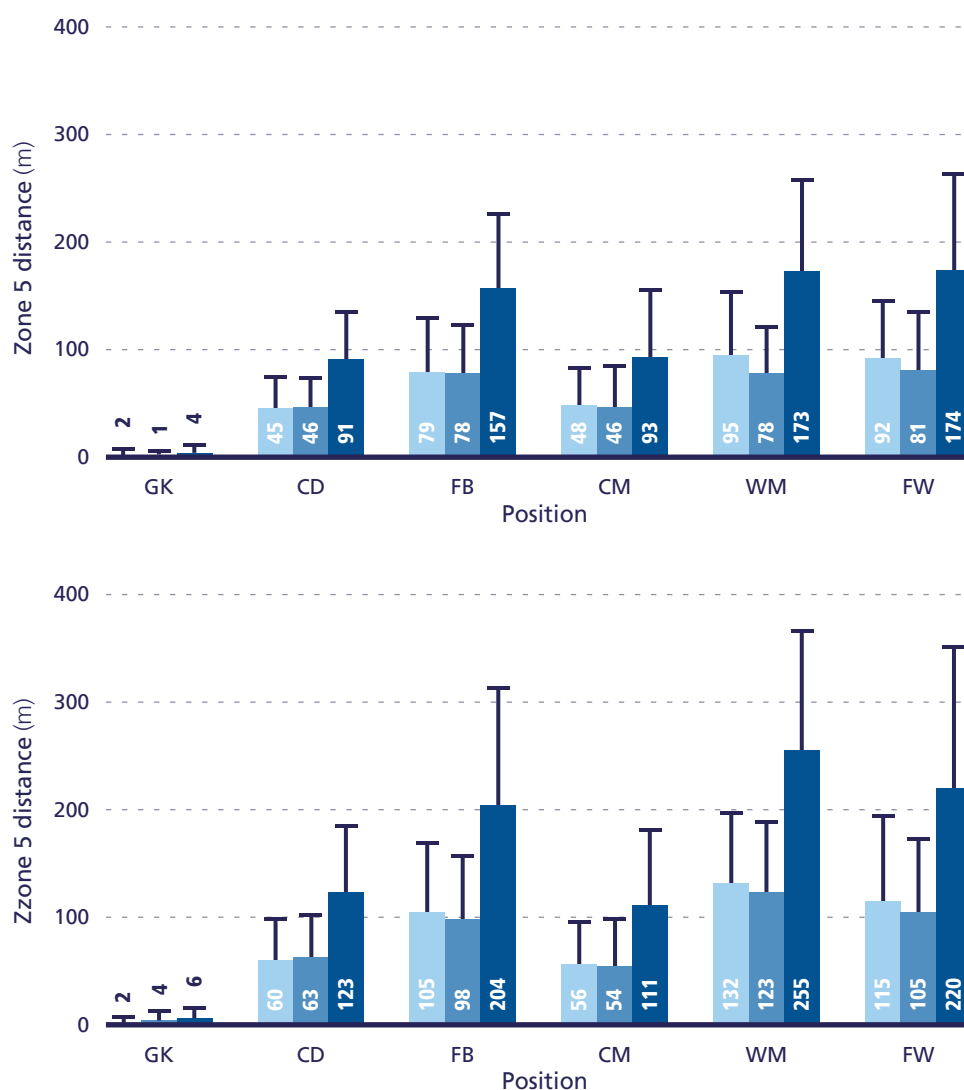


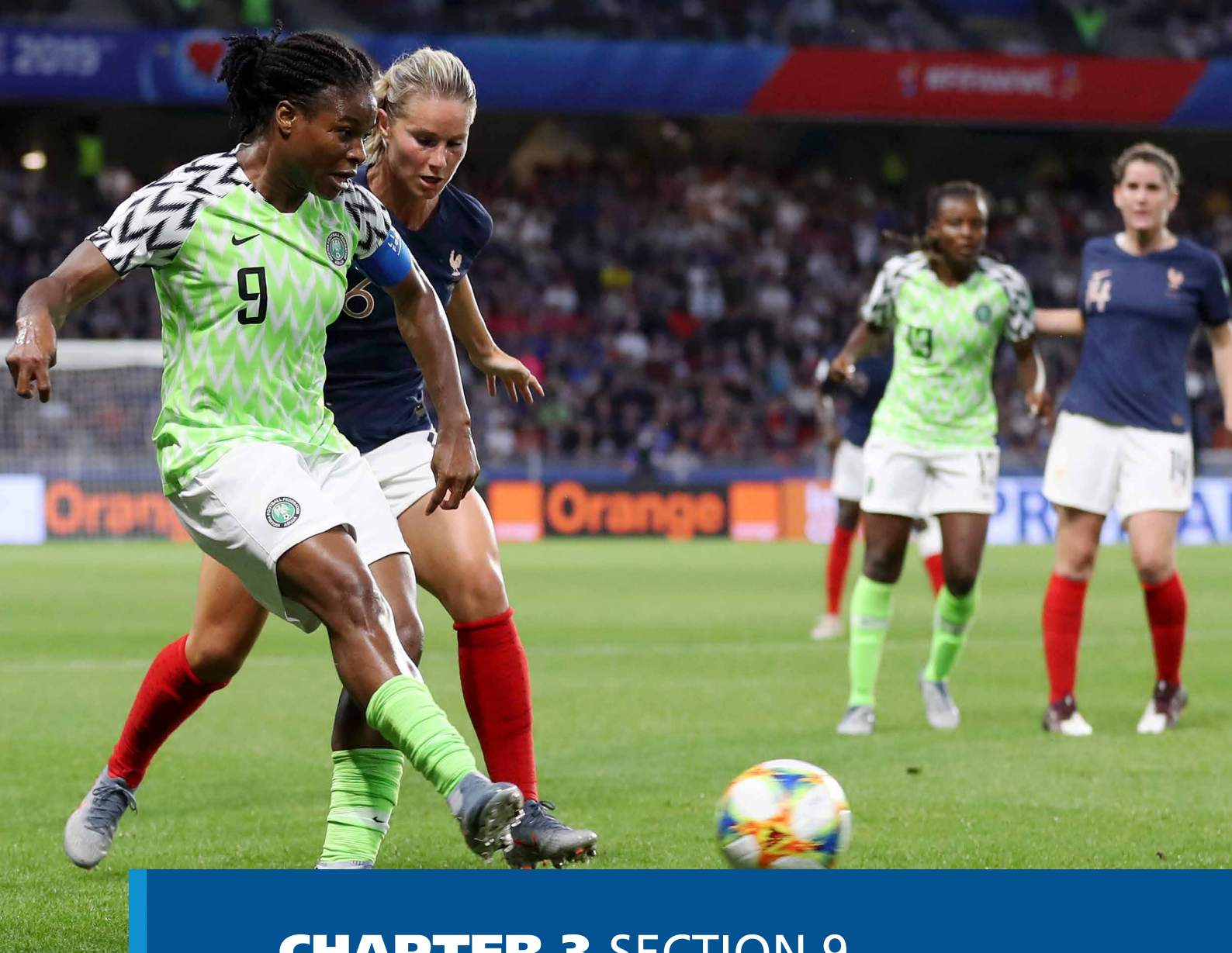
Figure 100. Comparison of the half-by-half distance covered in Zone 5 by various positional subsets at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

At Canada 2015, first-half Zone 5 distances were similar to second-half Zone 5 distances for central defenders, full-backs and central midfielders, but wide midfielders and forwards demonstrated second-half reductions of 12.0-17.9%. At France 2019, Zone 5 distances in the second half were maintained compared to the first half in central defenders and central midfielders, but full-backs, wide midfielders and forwards demonstrated second-half reductions of 6.7-8.7%. A comparative analysis across tournaments demonstrates that first-half Zone 5 distances were higher for all outfield positions in 2019 compared with 2015 (percentage increase: central defenders=34.8%, full-backs=32.9%, central midfielders=18.7%, wide midfielders=38.9%, forwards=25.0%). More Zone 5 distance was also covered in the second half of matches at France 2019 than at Canada 2015 (percentage increase: central defenders=36.6%, full-backs=25.6%, central midfielders=18.6%, wide midfielders=57.7%, forwards=29.6%).



3.8.3 Summary

- For outfield players, when accounting for the duration of the match, central defenders covered the lowest overall relative distance, whilst central midfielders covered the greatest relative distance in m/min.
- All playing positions covered marginally more absolute total distance at France 2019 than at Canada 2015 (1.1-3.2% more in 2019 than in 2015). However, the relative distance trends in m/min demonstrated no meaningful differences across tournaments for all positions when match duration was accounted for.
- Relative Zone 3 distance in m/min was substantially higher in central midfielders than all other positions, with central defenders producing the lowest Zone 3 distance in m/min for the outfield positions across both tournaments.
- Accounting for the match duration led to a less pronounced difference in relative Zone 3 distance between tournaments compared to the trends for the absolute Zone 3 distance.
- More relative Zone 4 distance in m/min was covered across the 2015 and 2019 competitions by full-backs, wide midfielders and forwards compared to central defenders and central midfielders.
- All playing positions covered more relative Zone 4 distance at France 2019 than at Canada 2015, and this increase was much more pronounced for wide midfielders. Although normalising the data for match duration led to less pronounced differences across tournaments versus absolute distances, most positions still demonstrated an 8-23% increase in relative Zone 4 distance at France 2019 compared to Canada 2015.
- In relation to relative Zone 5 distance in m/min, the positional trends were distinct for the outfield positions, with full-backs, wide midfielders and forwards producing more relative distance than central defenders and central midfielders across Canada 2015 and France 2019, respectively. All positions covered much more relative Zone 5 distance at France 2019 than at Canada 2015. This increase was more pronounced for wide midfielders (43.4%) and less marked for central midfielders (15.3%).
- The total distance covered was highest in central midfielders but lowest (for the outfield positions) in central defenders in the first and second half across Canada 2015 and France 2019, respectively.
- At Canada 2015, most positions produced similar total distances in the second half compared with the first half. In 2019, all positions illustrated a small reduction in the total distance covered in the second compared with the first half.
- Comparative analysis across tournaments demonstrated that first-half total distances were much higher for all positions in 2019 compared with 2015, but this difference was less pronounced in the second half.
- In the first half of matches, Zone 4 and Zone 5 distances were highest for full-backs, wide midfielders and forwards, and lowest (for the outfield positions) for central defenders across Canada 2015 and France 2019, respectively.
- At Canada 2015 and France 2019, most positions produced reduced Zone 4 distances in the second half compared with the first half.
- A comparative analysis across tournaments demonstrated that first- and second-half Zone 4 distances were higher for all positions in 2019 compared with 2015.
- At Canada 2015, first-half Zone 5 distances were similar to second-half Zone 5 distances for central defenders, full-backs and central midfielders, but wide midfielders and forwards demonstrated second-half reductions. At France 2019, Zone 5 distances in the second half were maintained compared to the first half in central defenders and central midfielders, but full-backs, wide midfielders and forwards demonstrated second-half reductions.



CHAPTER 3 SECTION 9

Positional analysis | Absolute distances in all three ball-related scenarios

3.9.1 **In possession, out of possession and ball out of play: absolute distance covered**

General positional trends and tournament comparison

In previous sections, the absolute and relative distance was calculated without considering the possession status of the team. However, this next section will analyse the data trends in relation to this. The data provider splits distance into: in possession of the ball, out of possession of the ball or ball out of play. Thus, a more appropriate comparison of the physical demands across these three distinct elements will be presented below.

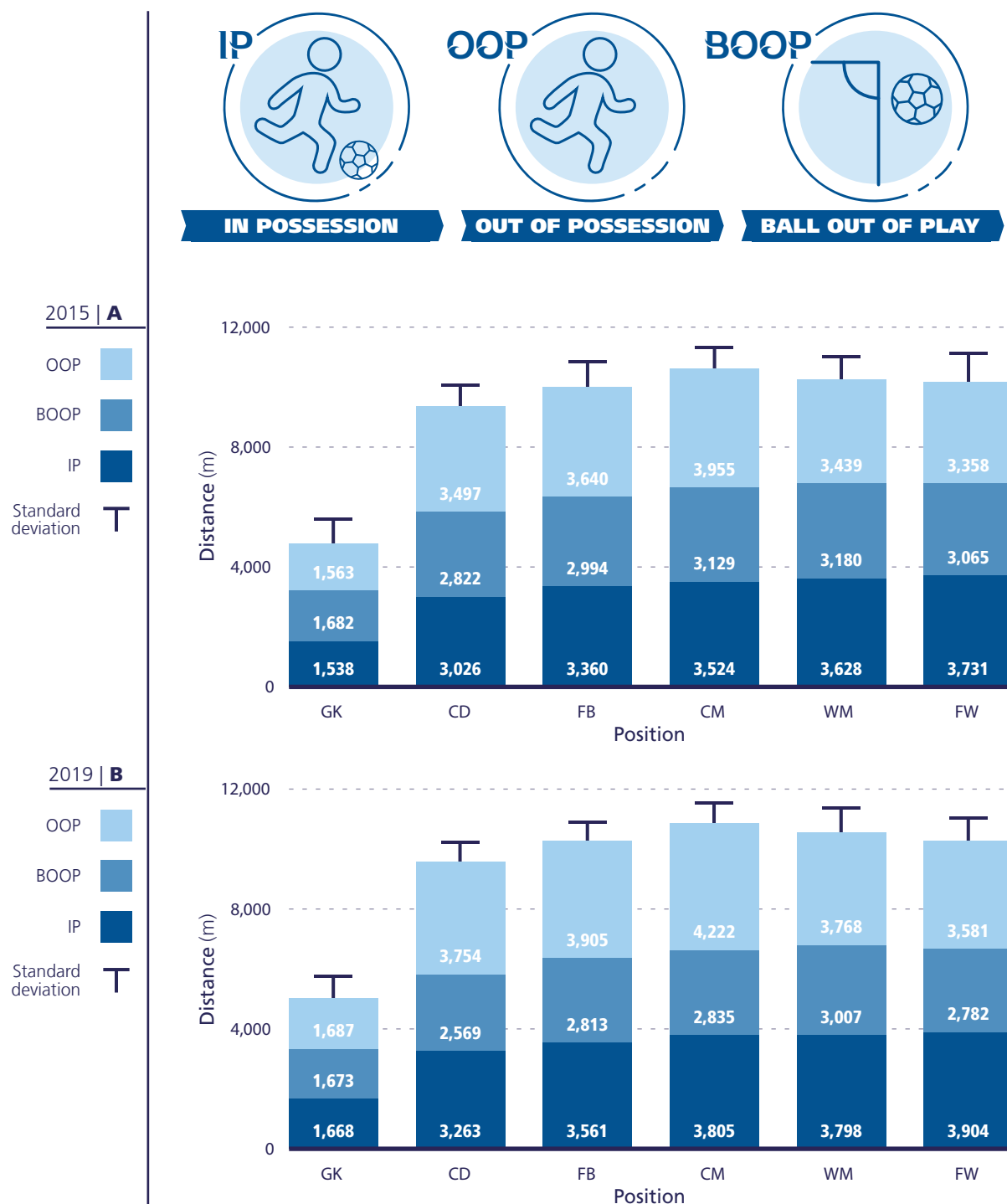


Figure 101. Comparison of the total absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.



Total absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations

The average and data spread of the total absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position during all regular-time matches of Canada 2015 (A) and France 2019 (B) are summarised in Figure 101. At both Canada 2015 and France 2019, players who had a more attacking role in the team, such as central midfielders (3,524m and 3,805m or 33% and 35% of total distance covered), wide midfielders (3,628m and 3,798m or 35% and 36% of total distance covered) and forwards (3,731m and 3,904m or 37% and 38% of total distance covered) covered more distance whilst in possession of the ball than players who had a more defensive role, like central defenders (3,026m and 3,263m or 32% and 34% of total distance covered). At both Canada 2015 and France 2019, central midfielders covered the most distance whilst out of possession of the ball (3,955m and 4,222m or 37% and 39% of total distance covered), while forwards covered the least distance whilst out of possession (3,358m and 3,581m or 33% and 35% of total distance covered). At both Canada 2015 and France 2019, distance covered in ball-out-of-play situations was highest for wide midfielders (3,180m and 3,007m or 28% and 31% of total distance covered) and lowest for central defenders (2,822m and 2,569m or 30% and 27% of total distance covered). Goalkeepers produced substantially lower values than all outfield players in all three categories (in possession, out of possession, ball out of play). Goalkeepers produced similar distances whilst in possession (1,538m and 1,668m or 32% and 33% of total distance covered), whilst out of possession (1,563m and 1,687m or 33% and 33% of total distance covered) and in ball-out-of-play situations (1,682m and 1,673m or 35% and 33% of total distance covered) across Canada 2015 and France 2019.

Interestingly, distance covered in ball-out-of-play situations actually decreased for all positions at France 2019 compared to Canada 2015 (percentage decrease: central defenders=9.0%, full-backs=6.1%, central midfielders=9.4%, wide midfielders=5.4% and forwards=9.2%). By contrast, distance covered whilst in possession increased for all positions at France 2019 compared to Canada 2015 (percentage increase: central defenders=7.8%, full-backs=6.0%, central midfielders=8.0%, wide midfielders=4.7% and forwards=4.7%). Similarly, distance covered whilst out of possession increased for all positions at France 2019 compared to Canada 2015 (percentage increase: central defenders=7.3%, full-backs=7.2%, central midfielders=6.8%, wide midfielders=9.6% and forwards=6.6%).



3

13-19km/h

Zone 3: in possession, out of possession and ball out of play

The average and data spread of the Zone 3 absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position during all regular-time matches of Canada 2015 (A) and France 2019 (B) are summarised in Figure 102. Across both Canada 2015 and France 2019, Zone 3 distance covered whilst in possession of the ball was greatest for central midfielders (850m and 965m or 37% and 39% of Zone 3 distance), wide midfielders (932m and 1,008m or 46% and 46% of Zone 3 distance) and forwards (969m and 968m or 49% and 48% of Zone 3 distance) but lowest for central defenders (510m and 587m or 33% and 35% of Zone 3 distance). At both Canada 2015 and France 2019, central midfielders covered the most Zone 3 distance whilst out of possession (1,217m and 1,350m or 53% and 54% of Zone 3 distance) while forwards covered the least distance whilst out of possession (787m and 850m or 40% and 42% of Zone 3 distance). Zone 3 distance covered when the ball was out of play was similar across outfield positions at both Canada 2015 (203-261m) and France 2019 (173-226m). Goalkeepers produced more Zone 3 distance whilst out of possession (80m and 96m or 42% and 46% of Zone 3 distance) than whilst in possession (59m and 67m or 31% or 32% of Zone 3 distance) and in ball-out-of-play situations (52m and 46m or 27% and 22%



1

0-7km/h

2

7-13km/h

3

13-19km/h

4

19-23km/h

5

>23km/h

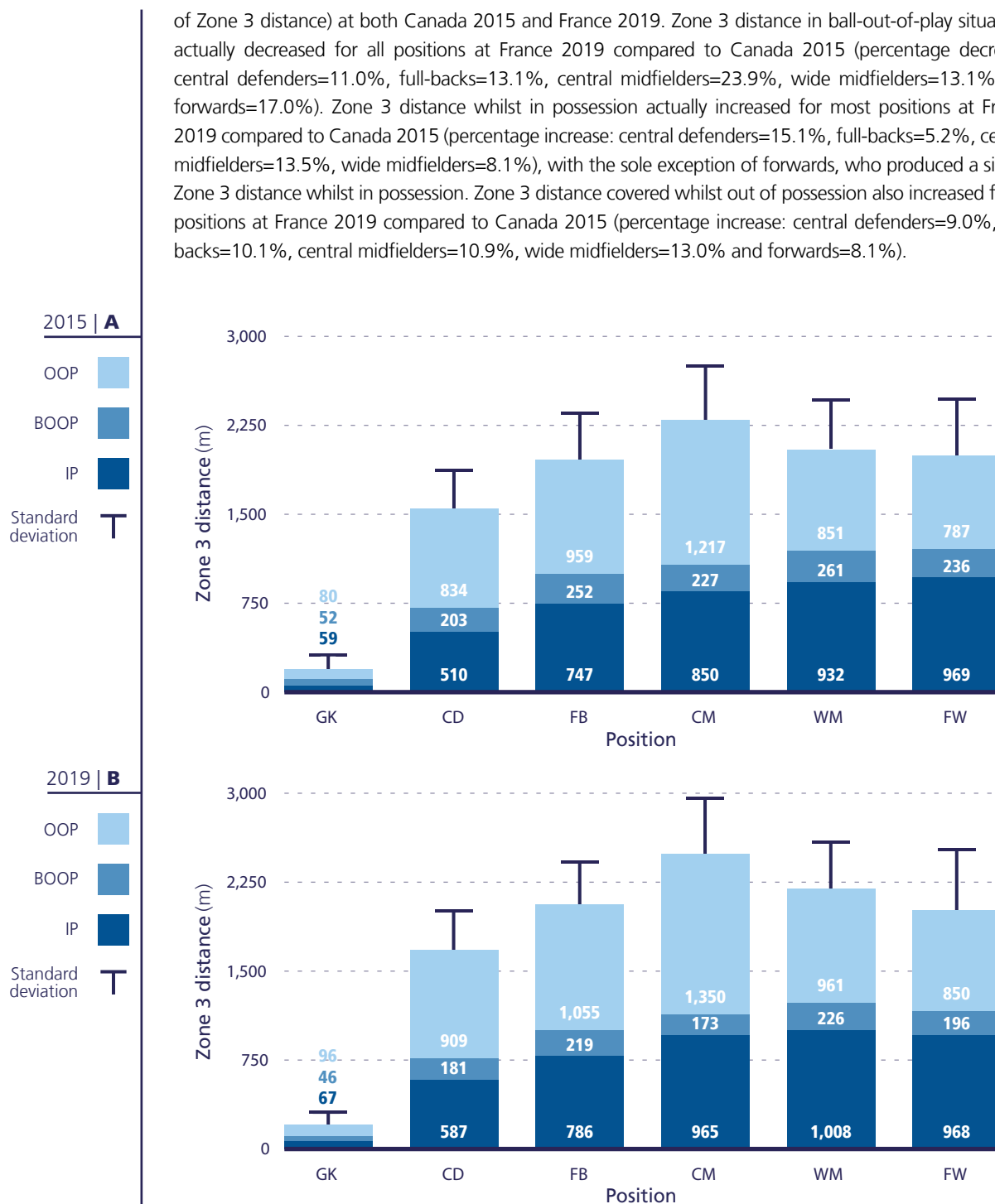


Figure 102. Comparison of the Zone 3 absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position during all regular-time matches at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

4

19-23km/h

Zone 4: in possession, out of possession and ball out of play

The average and data spread of the Zone 4 absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position during all regular-time matches of Canada 2015 (A) and France 2019 (B) are summarised in Figure 103. Across both Canada 2015 and France 2019, Zone 4 distance covered whilst in possession was greatest for wide midfielders (251m and 317m or 54% and 54% of Zone 4 distance) and forwards (270m and 300m or 58% and 57% of Zone 4 distance) but lowest for central defenders (60m and 59m or 21% and 17% of Zone 4 distance).

Across both Canada 2015 and France 2019, Zone 4 distance covered whilst out of possession was greatest for full-backs (251m and 297m or 56% and 59% of Zone 4 distance) and central midfielders (236m and 289m or 62% and 63% of Zone 4 distance) but lowest for forwards (168m and 210m or 36% and 40% of Zone 4 distance). Zone 4 distance covered when the ball was out of play was similar across outfield positions at both Canada 2015 (21-30m) and France 2019 (20-28m), with the

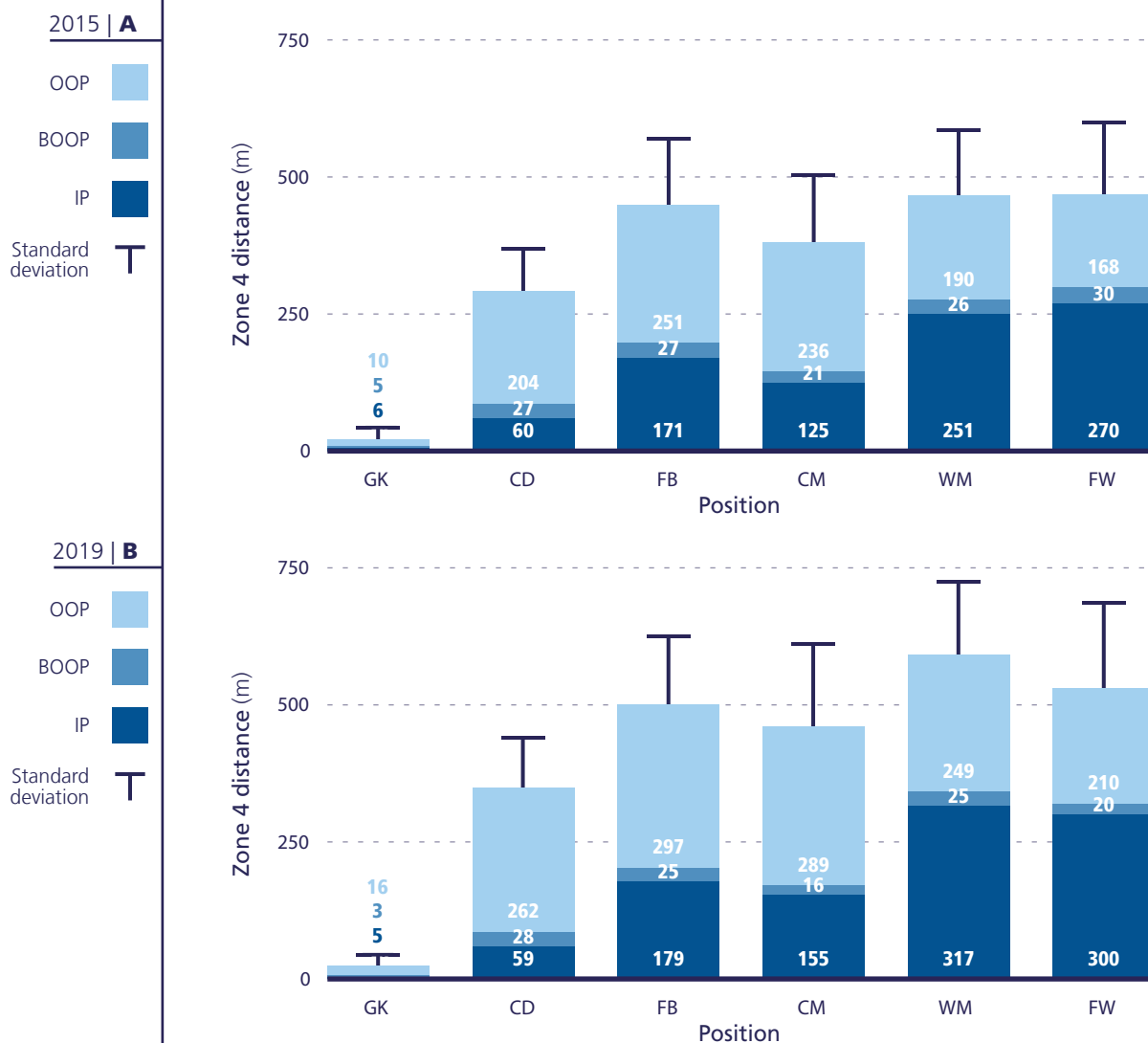


Figure 103. Comparison of the Zone 4 absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position during all regular-time matches of Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

sole exception of central midfielders, who only covered 16m in ball-out-of-play situations at France 2019. Zone 4 distance covered when the ball was out of play actually remained very stable for all positions across France 2019 and Canada 2015, with the sole exception of central midfielders, who illustrated a 25.2% reduction at France 2019 compared to Canada 2015. Zone 4 distance covered whilst in possession actually increased for most outfield positions at France 2019 compared to Canada 2015 (percentage increase: full-backs=4.4%, central midfielders=23.9%, wide midfielders=26.5%, forwards=11.1%), with the sole exception of central defenders, who produced a similar Zone 4 distance whilst in possession. Distance covered whilst out of possession also increased for all positions at France 2019 compared to Canada 2015 (percentage increase: central defenders=28.3%, full-backs=18.5%, central midfielders=22.8%, wide midfielders=30.7% and forwards=24.7%).

5

>23km/h

Zone 5: in possession, out of possession and ball out of play

The average and data spread of the Zone 5 absolute distance covered whilst in possession of the ball, whilst out of possession of the ball and in ball-out-of-play situations by position during all regular-time matches of Canada 2015 (A) and France 2019 (B) are summarised in Figure 104.

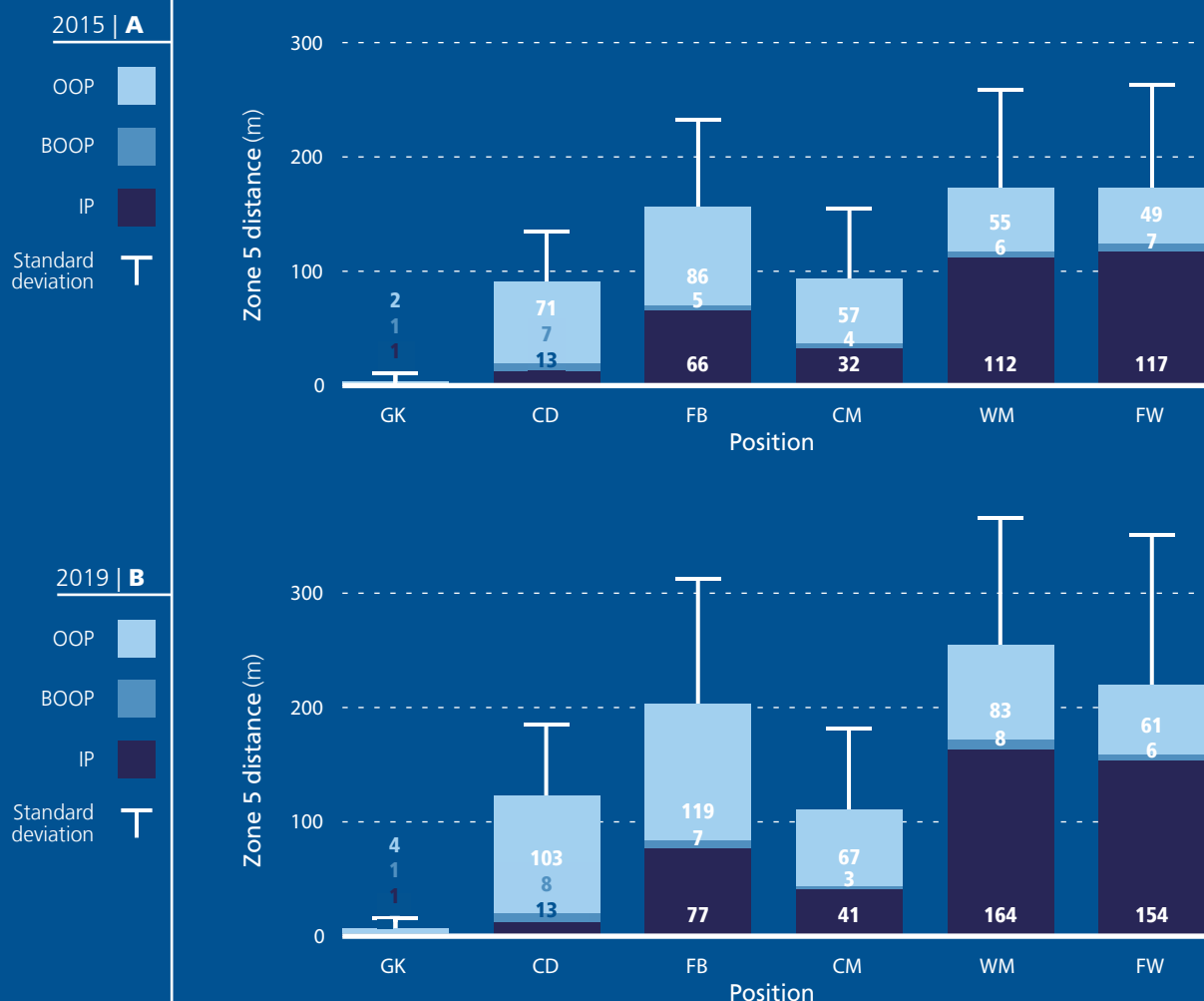


Figure 104. Comparison of the Zone 5 absolute distance covered whilst in possession of the ball, whilst out of possession of the ball, and in ball-out-of-play situations by position during all regular-time matches at Canada 2015 (A) and France 2019 (B). Data is presented as an average and spread (bars = mean; T above bars = standard deviation). Please note that the refiltering of the 2015 data may have modified the data trends and thus caution is needed when comparing between tournaments.

At Canada 2015 and France 2019, Zone 5 distance covered by outfield players whilst in possession was greatest for players who were more attacking, such as wide midfielders (112m and 164m or 65% and 64% of Zone 5 distance) and forwards (117m and 154m or 68% and 70% of Zone 5 distance) but lowest for defensive players, like central defenders (13m and 13m or 14% and 10% of Zone 5 distance). Across both Canada 2015 and France 2019, Zone 5 distance covered by outfield players whilst out of possession was greatest for full-backs (86m and 119m or 56% and 59% of Zone 5 distance) and central defenders (71m and 103m or 70% and 75% of Zone 5 distance) but lowest for forwards (49m and 61m or 28% and 28% of Zone 5 distance). Zone 5 distance covered in ball-out-of-play situations was similar across outfield positions at both Canada 2015 (4-7m) and France 2019 (6-8m), with the sole exception of central midfielders, who only covered 3m in ball-out-of-play situations at France 2019.

Zone 5 distance covered in ball-out-of-play situations actually remained very stable for all positions across France 2019 and Canada 2015. Zone 5 distance covered whilst in possession increased for most outfield positions at France 2019 compared to Canada 2015 (percentage increase: full-backs=16.6%, central midfielders=27.2%, wide midfielders=46.4%, forwards=30.8%), with the sole exception of central defenders, who produced similar Zone 5 distance whilst in possession. Distance covered whilst out of possession also increased for all outfield positions at France 2019 compared to Canada 2015 (percentage increase: central defenders=44.3%, full-backs=39.0%, central midfielders=17.9%, wide midfielders=49.6% and forwards=24.4%).



3.9.2 Summary

- At both Canada 2015 and France 2019, players who had a more attacking role in the team, such as central midfielders, wide midfielders and forwards, covered more overall distance whilst in possession than players who had a more defensive role, like central defenders.
- At both Canada 2015 and France 2019, central midfielders covered the most overall distance whilst out of possession, whereas forwards covered the least such distance amongst outfield players.
- Overall distance covered in ball-out-of-play situations decreased for all positions at France 2019 compared to Canada 2015. In contrast, overall distance covered whilst in possession and whilst out of possession increased for all positions at France 2019 compared to Canada 2015.
- Across both Canada 2015 and France 2019, Zone 3 distance whilst in possession was greatest for central midfielders, wide midfielders and forwards, but lowest for central defenders amongst outfield players.
- Central midfielders covered the most Zone 3 distance whilst out of possession, whereas forwards covered the least such distance amongst outfield players at both Canada 2015 and France 2019.
- Zone 3 distance covered in ball-out-of-play situations actually decreased for all positions at France 2019 compared to Canada 2015, whereas distance covered whilst in possession and whilst out of possession actually increased for most positions at France 2019 compared to Canada 2015.
- Zone 4 distance covered by outfield players whilst in possession was greatest for wide midfielders and forwards but lowest for central defenders across the 2015 and 2019 competitions.
- Distance covered in Zone 4 by outfield players whilst out of possession was greatest for full-backs and central midfielders but lowest for forwards.
- Zone 4 distance covered whilst in possession actually increased for most outfield positions at France 2019 compared to Canada 2015, with the sole exception of central defenders, who produced similar Zone 4 distance whilst in possession. Distance covered whilst out of possession also increased for all positions at France 2019 compared to Canada 2015.
- At Canada 2015 and France 2019, Zone 5 distance covered whilst in possession was greatest for players who were more attacking, such as wide midfielders and forwards.
- Across both Canada 2015 and France 2019, Zone 5 distance whilst out of possession was greatest for full-backs but lowest for forwards amongst outfield players.
- Zone 5 distance whilst in possession and whilst out of possession increased for most positions at France 2019 compared to Canada 2015.



CHAPTER 3 SECTION 10

Positional analysis | Heat maps by position

3.10.1 Contextualising positional demands using heat maps

Previous sections of this report have analysed positional trends for the absolute (m) and relative (m/min) distances covered overall and in various speed zones in all matches at France 2019. However, these distances are usually the summation of all efforts produced by a large sample of players in 15-, 45- and 90-minute periods without considering the location or tactical purpose of the actions. Using heat maps to provide more context can be valuable to practitioners, as they do not necessarily want to determine which positions are the most demanding or cover the most distance, but rather how each individual player/position performs their actions in relation to a specific opponent and team philosophy. Thus, this section will use heat maps of different playing positions across multiple games to quantify the location/ tactical purpose of actions but to also demonstrate the variation in physical demands due to changes in tactical context. Data was obtained from two games for individual players of teams that reached the semi-final stage to enable enough heat maps/games to be analysed per position. Videos of games were also used to help interpret these heat maps. The heat maps in Figures 105-110 specifically detail full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play). The direction of play (arrow) and intensity of activity (colours) are depicted clearly in each heat map.

3.10.2 Heat maps for a forward

Heat maps and additional context can be found in Figure 105 for the same forward in two games. The Game 1 and 2 labels do not denote the chronological order in which the games were played but are simply reference points for the presentation of information.

From the heat map for Game 1 and by using match data and video, it was clear that this forward had a high proportion of activity in the middle and attacking thirds of the pitch when her team was in possession. Although ball possession was the same for both sides (50% v. 50%), the forward's team was much more dominant in the attacking third and as a result produced over 50% more attempts on goal than the opposition. The forward produced frequent activities when the team was in possession, driving through the middle of the pitch to support attacking sequences. Final-third activities are well visualised on the map and include attacking efforts running in behind the defensive line and in particular breaking into the box to create a threat. Specifically, the forward's team scored three goals from attacks coming from wide areas. In each instance, the forward was an option for the player crossing after breaking into the box at high intensity. These tactics exploit space in order to score and create opportunities for team-mates, so they provide added context to practitioners about purposeful attacking running for this forward. From three shots, this forward also scored once and hit the bar with another effort. Out-of-possession activity was also verified by video. This forward pressed fairly high up the pitch (another reason for the advanced heat map activity) but most of the purposeful work was while in possession of the ball. As a result of the above activities and the attacking nature of the game, this forward produced her highest overall distance as well as her greatest distance in Zone 4 and Zone 5 in the tournament.

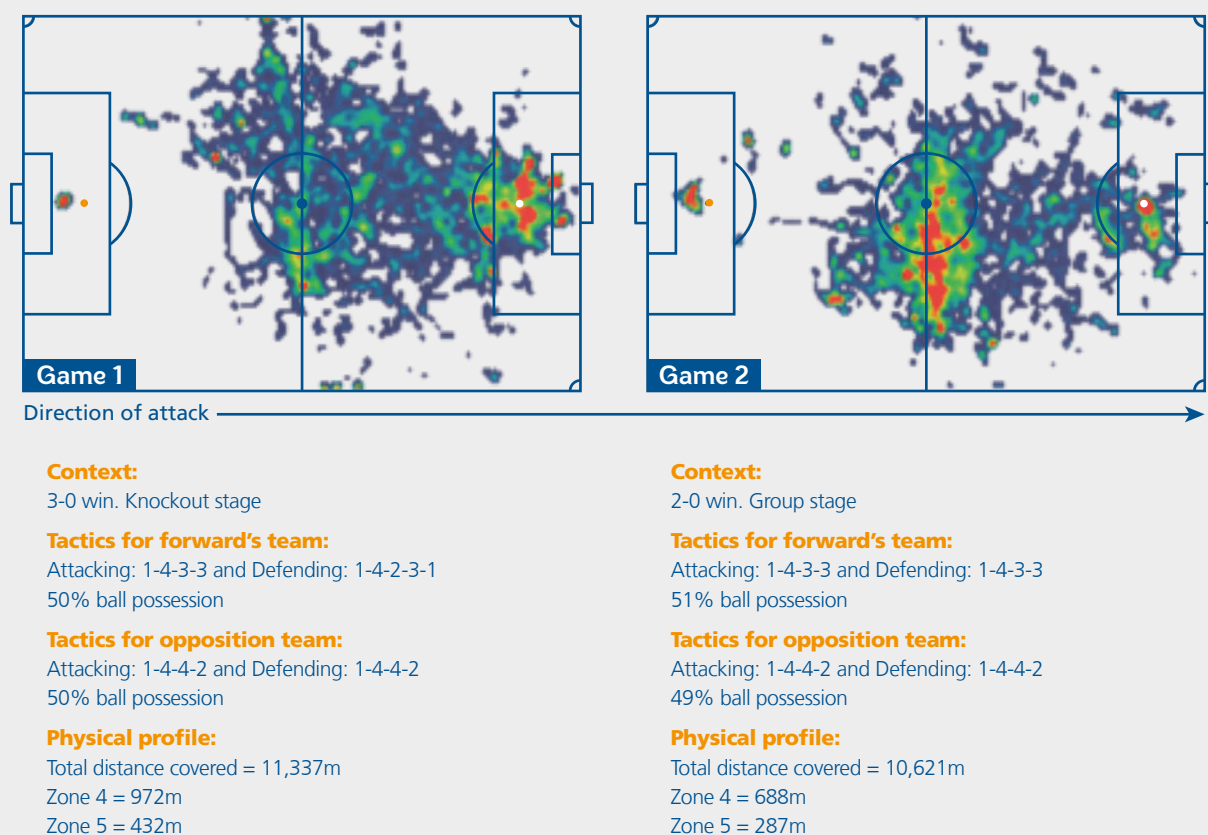


Figure 105. Heat maps for the same forward in two different games at France 2019. Context: Game (1) Dominated in attack against lower-standard opposition, and Game (2) Competitive game against similar-standard opposition using a more defensive approach. Maps are specifically of full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play).

In the heat map for Game 2, there is clearly a much deeper overall position for the forward as the match was more competitive, with both teams having similar possession and a comparable number of shots on goal. The forward's team sat back and absorbed pressure at times in an attempt to hit the opposition on the counter and/or with quick attacks. This tactic worked, as this forward ran in behind the defensive line at high intensity to score on two occasions during brief attacking sequences (verified by video). However, the majority of the forward's activity was spent waiting for breaks on the halfway line or defending from the front while out of possession (clearly visible in the heat map). As a result, the forward would frequently perform runs out of possession to either close down the opponent directly or to delay the opposition's attacks and enable team-mates to support the press. In fact, the forward's team produced 70% more tackles than the opposition. The proportion of distance covered in defensive activities such as closing down/pressing is usually one of the highest in the team for more attacking positions when employing such tactics. The lower distance that this forward covered in total and in Zone 4 and Zone 5 probably reflects the more defensive approach employed for this game. Interestingly, this player covered approximately 40-50% more distance in Zone 4 and Zone 5 in Game 1 than in Game 2. This example demonstrates the dynamic role of an attacking player like a forward and how tactical context has an impact on these physical demands.

3.10.3 Heat maps for a full-back

Heat maps and additional context can be found in Figure 106 for the same full-back in two games. The Game 1 and 2 labels do not denote the chronological order in which the games were played but are simply reference points for the presentation of information.

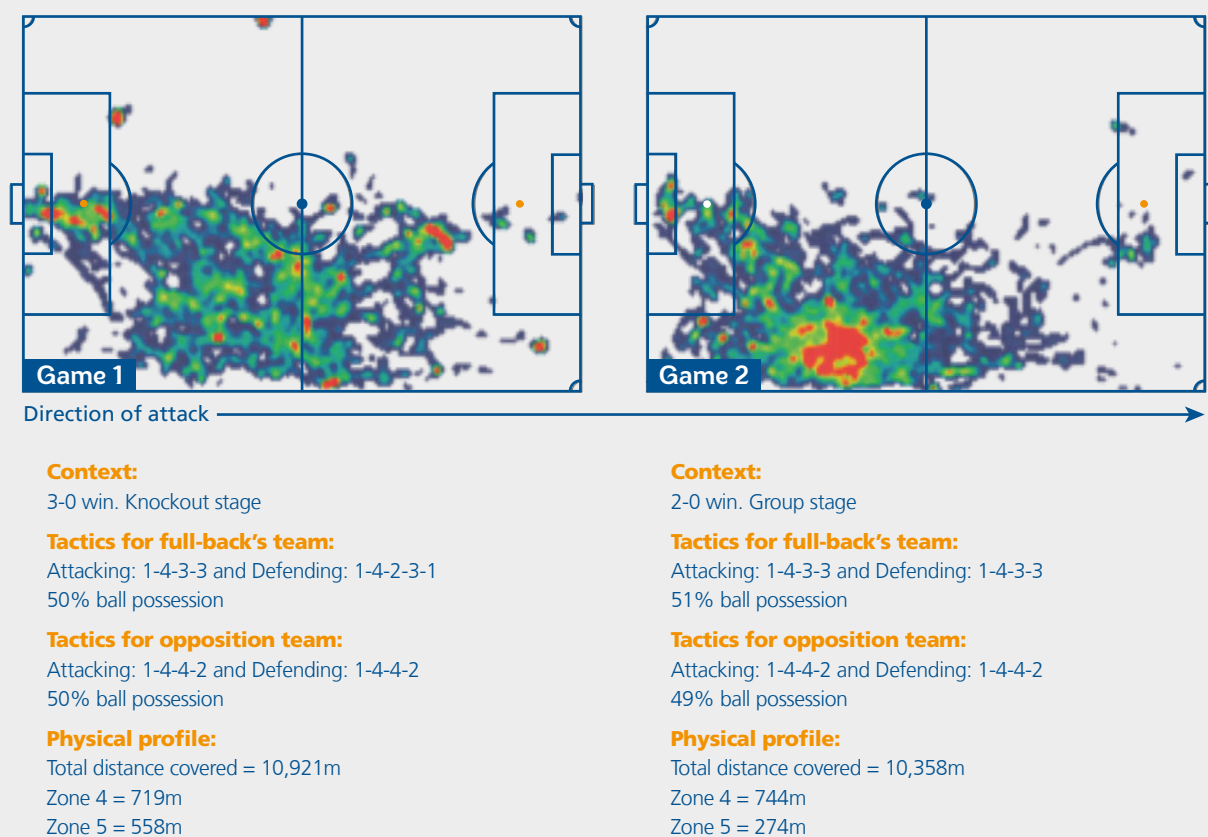


Figure 106. Heat maps for the same full-back in two different games at France 2019. Context: Game (1) Attacking throughout and dominated against lower-standard opposition, and Game (2) Competitive game against more attacking opposition. Maps are specifically of full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play).



From the heat map for Game 1, the full-back was very attacking and covered a significant amount of distance in possession of the ball, particularly in Zone 4 and Zone 5. The heat map clearly shows that the full-back completed more activity higher up the pitch than in the other game. The tactical purpose of these runs included running down the channel, dribbling the ball or pushing up the pitch to support play (sometimes more centrally, as can be seen on the map). Other common in-possession activities included overlapping, driving inside and crossing from wide attacking areas. In fact, the first goal in Game 1 was the result of the full-back running down the channel with the ball before crossing into the box to provide an assist for a central midfielder to score (verified by video). The sequence of passes that resulted in the second goal was initiated by the full-back running with the ball out wide and playing it inside to a forward, who then broke into the box to cross the ball for another forward to score. The final goal was actually scored from a free kick outside the box that was played to the full-back to shoot from long range to score. In contrast, when the team was out of possession, the full-back also had to carry out duties to maintain the team's defensive shape. For example, the full-back conducted the attacking actions described above, but when she was high up the pitch and a turnover in possession occurred, she was required to produce long recovery runs back into the middle and defensive thirds to maintain defensive compactness. Closing down/pressing opposition players was also a common activity in the defensive/middle thirds in addition to covering space and opposition players by moving from wide positions to more narrow central positions (this activity is clear on the heat map). Thus, in Game 1 the full-back had a dual role that required her to be defensive when out of possession but very attacking when in possession. This dual role usually requires a high work rate, and this is probably why this full-back covered the greatest total distance and the most Zone 5 distance in any of her tournament matches.

The heat map for Game 2 indicates a deeper, more concentrated area of activity in the wide areas of the defensive and middle thirds. This is unsurprising given the competitive standard of the opposition, who were astute both tactically and in attack. This resulted in the full-back spending more time carrying out defensive duties like pressing/closing down and covering space/opposition players in wide defensive areas. The deeper position resulted in a more compact shape out of possession but meant less reliance on recovery running from more advanced positions. The heat map illustrates some activity in more advanced positions, and one notable sequence of play was the full-back underlapping a player on the ball after starting an intense run from the middle into the attacking third before receiving the ball to run down the channel to cross the ball into the box (verified by video). This led to a shot on target from a forward. These attacking activities were limited throughout Game 2, however. Thus, this more defensive role probably led to one of the lowest Zone 5 distances covered by the full-back in the tournament. In fact, in Game 1, this full-back covered only 5% more total distance than in Game 2. However, the full-back covered more than double the Zone 5 distance in Game 1 than in Game 2. This clearly demonstrates that the demands on this full-back were impacted substantially if a dual attacking-defensive role was employed as opposed to a more defensive role.

3.10.4 Heat maps for a central defender

Heat maps and additional context can be found in Figure 107 for the same central defender in two games. The Game 1 and 2 labels do not denote the chronological order in which the games were played but are simply reference points for the presentation of information.

From the heat map of Game 1, the central defender's activity was clearly in a higher central area compared to Game 2. The central defender's team dominated possession (64% v. 36%) and had more than twice as many attempts on goal and more corners than the opposition (11 v. 0). The central defender played a pivotal role at corners and this led to a high presence in the box (the heat map shows this clearly). On one occasion, this led to a header on target followed by a high-intensity recovery run to get back into the middle third of the pitch after the ball was cleared (verified by video). As the central defender's team dominated the middle and final thirds for long periods, the central defender was able to push up the pitch with the ball on a few occasions to start off attacking sequences, some of which led to attempts on goal. Out-of-possession activity such as recovery running (e.g. when the ball was played over the top of the defensive line or down the side of the player) and closing down also occurred during quick counter-attacks from the opposition. As the central defender had to combine attacking roles (multiple set pieces and bringing the ball out from the back) with defensive roles (covering, recovery running and closing down players), the total distance covered by this player was her highest out of all tournament games, while the Zone 5 distance was her third highest over the competition.

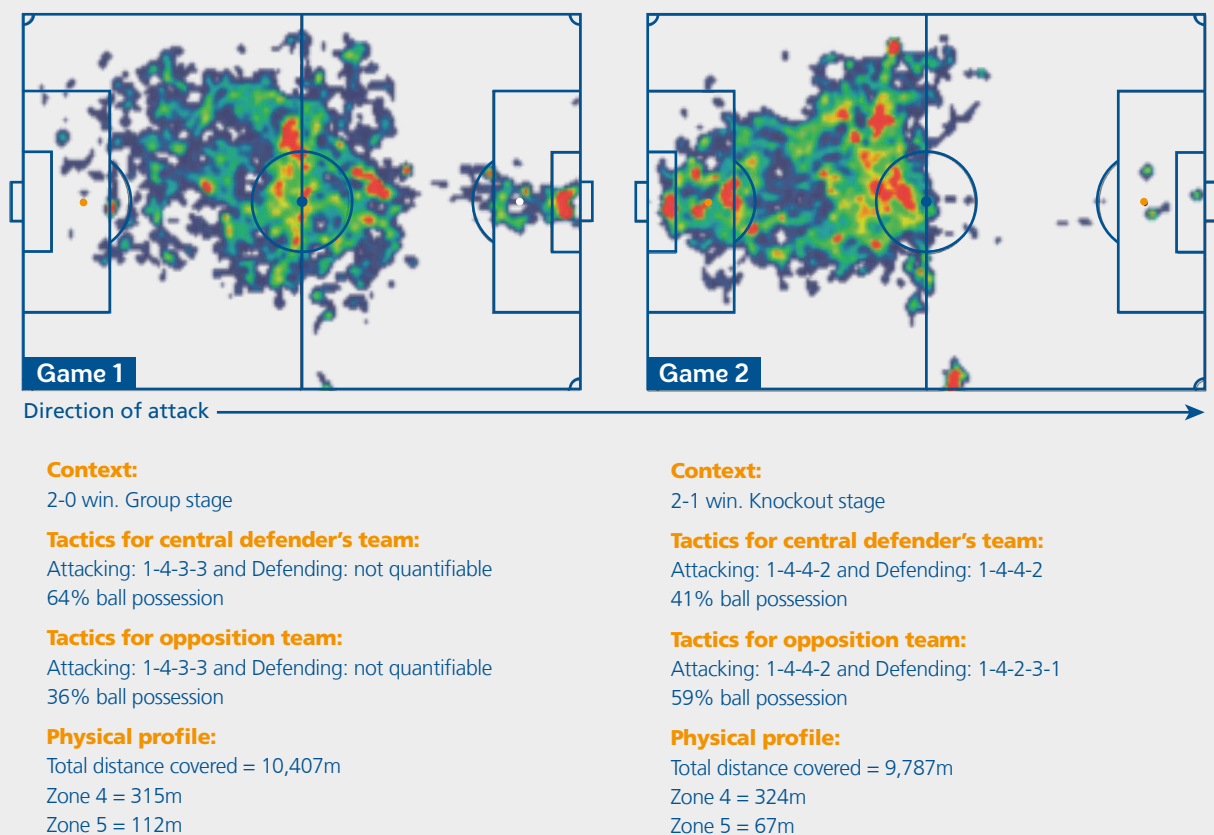


Figure 107. Heat maps for the same central defender in two different games at France 2019. Context: Game (1) Dominating possession against lower-standard opposition, and Game (2) Competitive game against possession-based opposition. Maps are specifically of full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play).

The heat map of Game 2 depicts more activity in deeper central areas such as the middle and defensive thirds. This is not surprising given the competitive nature of the game, with the opposition dominating ball possession (59% v. 41%), but both teams had comparable attempts on goal. Thus, more of the central defender's distance was covered out of possession in deep areas covering space or players while goal side of the ball. Due to the central defender's deeper position, this resulted in less recovery running but more covering by the backline to remain compact to limit space for the opposition (particularly attacking threats down one side of the pitch, hence the slant to one side in the heat map activity). Another common activity that was conducted out of possession was closing down. For instance, the opening goal, which was conceded by the central defender's team, occurred after she pressed the player on the ball outside the box before the ball was played to the opposition forward, who scored (verified by video). In-possession activities were substantially lower in this game, with a few noticeable exceptions of important build-up sequences and a long direct pass from the defensive third over the top of the opposition's defence to assist a forward in scoring the equaliser. This tactical approach resulted in a total distance covered that was similar to her average for the tournament but produced the lowest Zone 5 distance. In fact, her Zone 5 distance was approximately 70% higher in Game 1 than in Game 2 and this clearly shows how a central defender's physical demands are modulated by tactical context.

3.10.5 Heat maps for a wide midfielder

Heat maps and additional context can be found in Figure 108 for the same wide midfielder in two games. The Game 1 and 2 labels do not denote the chronological order in which the games were played but are simply reference points for the presentation of information.

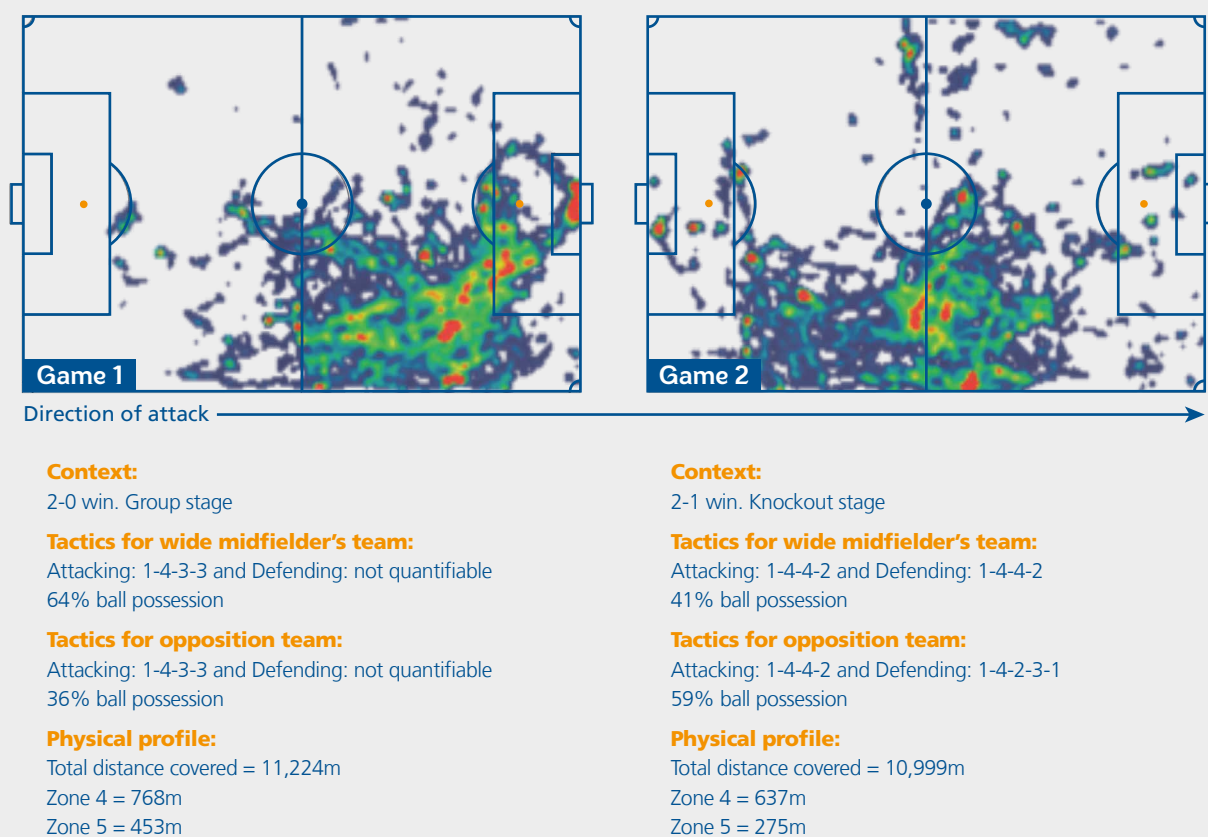


Figure 108. Heat maps for the same wide midfielder in two different games at France 2019. Context: Game (1) Dominated ball possession against lower-standard opposition, and Game (2) Competitive game against possession-based opposition. Maps are specifically of full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play).



The heat map of Game 1 clearly depicts plenty of activity for this wide midfielder in high wide and central areas. The magnitude of the activity in these regions for the wide midfielder is understandable given her team's dominance over the entire game. For instance, the wide midfielder's team made more than twice as many passes as the opposition, with the number of tackles much higher for the opponents, who repeatedly attempted to nullify their plays and win back possession (28 v. 11). In possession, this wide midfielder had plenty of activity in wide attacking areas, either running the channel, dribbling the ball or supporting attacking play. These wide positions are clearly visible on the heat map. However, what is more unique is the mapping intensity that indicates plenty of driving inside from wide to central attacking areas. For instance, hotspots in and around the box are the result of the player supporting attacking sequences or getting directly involved (five shots in total in this game). A specific example was when the wide midfielder moved inside from the far right-hand flank to receive a pass on the edge of the box, before rapidly swivelling to make space for a long-range shot that was saved by the goalkeeper (verified by video). Another notable run occurred when her team quickly transitioned for the second goal and she ran on the outside of the scoring player to offer attacking support. Some out-of-possession activities were completed during opposition attacks (recovery running and closing down in the attacking and middle thirds) but the majority of the physical demands were higher up the pitch. This resulted in her covering the highest Zone 4 and Zone 5 distances of her tournament.

The heat map for Game 2 illustrates a very different visualisation of activity that suggests a much more dual role. This was evident in the style of play and the change in formation to 1-4-4-2. Although the numbers of attempts on goal were similar and the score differential was only one goal, the opposition had much more of the ball throughout the game. This meant that the wide midfielder was generally in a much deeper position as she had to conduct numerous out-of-possession physical actions such as closing down and recovery running. Although in-possession activity was much lower in this game for the wide midfielder, it was crucial to the outcome of the game. For instance, the wide midfielder scored her team's first goal by running at high speed onto a ball played over the top of the defence to score (verified by video). The wide midfielder also dribbled the ball at speed down the channel at the opposition full-back, and on one occasion she crossed the ball into the box and this resulted in the winning goal. Given that the majority of the game's activities for the wide midfielder were defensive (with some crucial attacking activity), this meant that her Zone 4 and Zone 5 distances were approximately 20-40% lower compared to Game 1. Different tactical strategies/opposition resulted in the wide midfielder being employed in various ways, and this had a resultant impact on the physical demands.

3.10.6 Heat maps for a central midfielder

Heat maps and additional context can be found in Figure 109 for the same central midfielder in two games. The Game 1 and 2 labels do not denote the chronological order in which the games were played but are simply reference points for the presentation of information.

The heat map for Game 1 depicts large amounts of activity for the central midfielder in the centre of the middle third with some movement into the attacking and defensive thirds. The central midfielder was playing in the centre of three midfielders in a 1-4-3-3 formation and thus behind three attacking players. Game 1 was a knockout-stage match and was very competitive throughout, with the central midfielder's team having a greater amount of the ball (56% v. 44%), producing double the number of tackles and having slightly more goal attempts (15 v. 11). The opposition did have significantly more corners, however (12 v. 4). The dual role of this central midfielder required her to be defensive when out of possession, but if the opportunity presented itself, to be attack-minded when in possession. The hotspot of activity in the box while the central midfielder was defending numerous opposition corners when out of possession is clearly visible. Multiple high-intensity efforts were performed by the central midfielder while covering space/other players or pressing players once the corner had been cleared in addition to chasing down the second ball. Some recovery running from more advanced positions was evident during fast transitions. In possession, the central midfielder produced efforts by driving through the middle of the pitch with the ball, and this either led to a shot on goal or the player being fouled. Other in-possession activities included supporting the attack. One example involved her breaking into the box to create a threat during a quick transition. The central midfielder was also a key player in

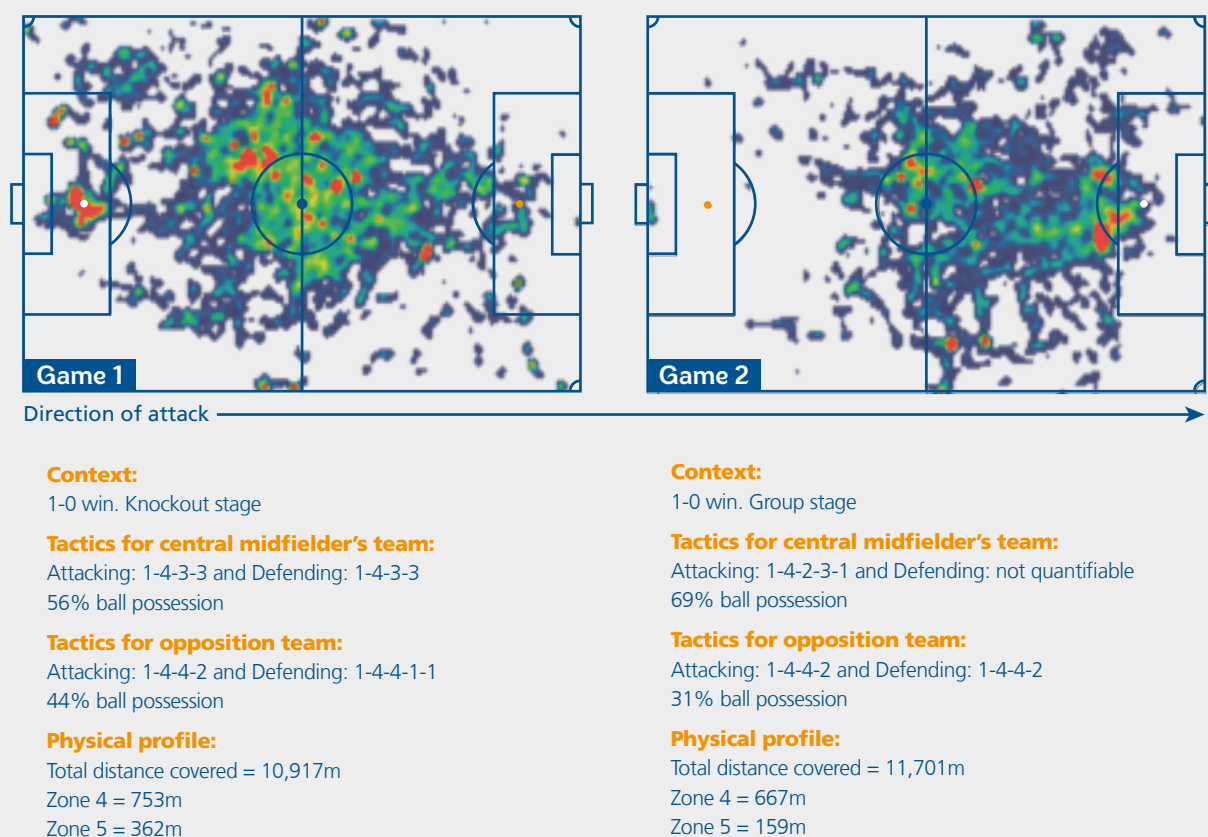


Figure 109. Heat maps for the same central midfielder in two different games at France 2019. Context: Game (1) Competitive game against similar-standard opposition in the knockout stage, and Game (2) Complete dominance over lower-standard opposition during the group stage. Maps are specifically of full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play).



moving between the lines to receive passes from players and starting off attacking sequences. For instance, one of her through-balls allowed a player to run in on goal and score the only goal of the game. When games are competitive and a central midfielder has a dual role, this typically requires a high work rate. When analysing the physical demands for this central midfielder, this was clearly the case as she covered her highest combined Zone 4 and 5 distance of the tournament.

In contrast, the heat map for Game 2 demonstrates more activity in the final third. Due to the lower standard of opposition, the team was set up to employ a more attacking strategy. Due to the additional cover provided by the holding midfielders in this match, the central midfielder worked more in attack in Game 2. The game statistics show the dominance of the central midfielder's team as they had significantly more of the ball (69% v. 31%), more goal attempts (17 v. 6) and more corners (8 v. 1), but they tackled less (5 v. 15). The opposition sat back and absorbed the pressure at times in an attempt to hit the central midfielder's team on the counter and/or with quick attacks. Given the above, this central midfielder produced more of her activity while her team was in possession. As the heat map shows, this central midfielder patrolled the attacking midfield area just outside the box and this can be seen on the mapping pattern and intensity. This is specifically evident in the hotspots that represent the player's position outside the box during corners. Positioning in this specific area allowed her to support and create attacks but to also press during turnovers in possession (verified by video). Recovery running was performed by the central midfielder during counter-attacks but at a moderate speed due to the defensive coverage offered by the holding midfielders. This could be one of the reasons for an elevated Zone 2 and Zone 3 distance and a lower Zone 4-5 distance. Some well-timed runs from deep to enter the box/or reach the outer box area also occurred during this game and her activity can be seen on the map. This player also produced some dribbling efforts and received the ball in intelligent positions between the lines. She produced her highest total distance across the tournament in this game but her lowest Zone 5 distance. Interestingly, the elevated total distance was the direct result of more distance covered in Zone 2 and Zone 3. This example illustrates the diversity of the central midfielder role and the impact that tactical context has on the physical demands of midfielders (e.g. employed more in attack or defensively). This diversity was evident in the large data spread presented in the positional results section for central midfielders. This probably reflects the multiple variations of the central midfielder role (primarily defensive role v. dual role v. primarily attacking role).

3.10.7 Heat maps for a goalkeeper

Heat maps and additional context can be found in Figure 110 for the same goalkeeper in two games. The Game 1 and 2 labels do not denote the chronological order in which the games were played but are simply reference points for the presentation of information.

Heat maps for goalkeepers are less distinctive compared to the equivalent maps for outfield players given the substantially lower distance covered by goalkeepers and as the distribution of activity is largely confined to the penalty area. The physical demands of goalkeepers are also more difficult to quantify because using distance alone fails to capture most of the purposeful energetic activities such as micro-activities (saves, jumping, catching, turning, throwing and kicking).

In Game 1, the goalkeeper's team was dominant in possession (58% v. 42%) and had a greater number of attempts on goal (18 v. 6). Thus, the goalkeeper's team had a high defensive line for long periods, and as such the space behind this line could therefore be exploited by the opposition during counter-attacks. This goalkeeper's heat map illustrates a fairly high position to enable her to guard this area or potentially attack the ball by intercepting it as early as possible after a through-ball, and clearing

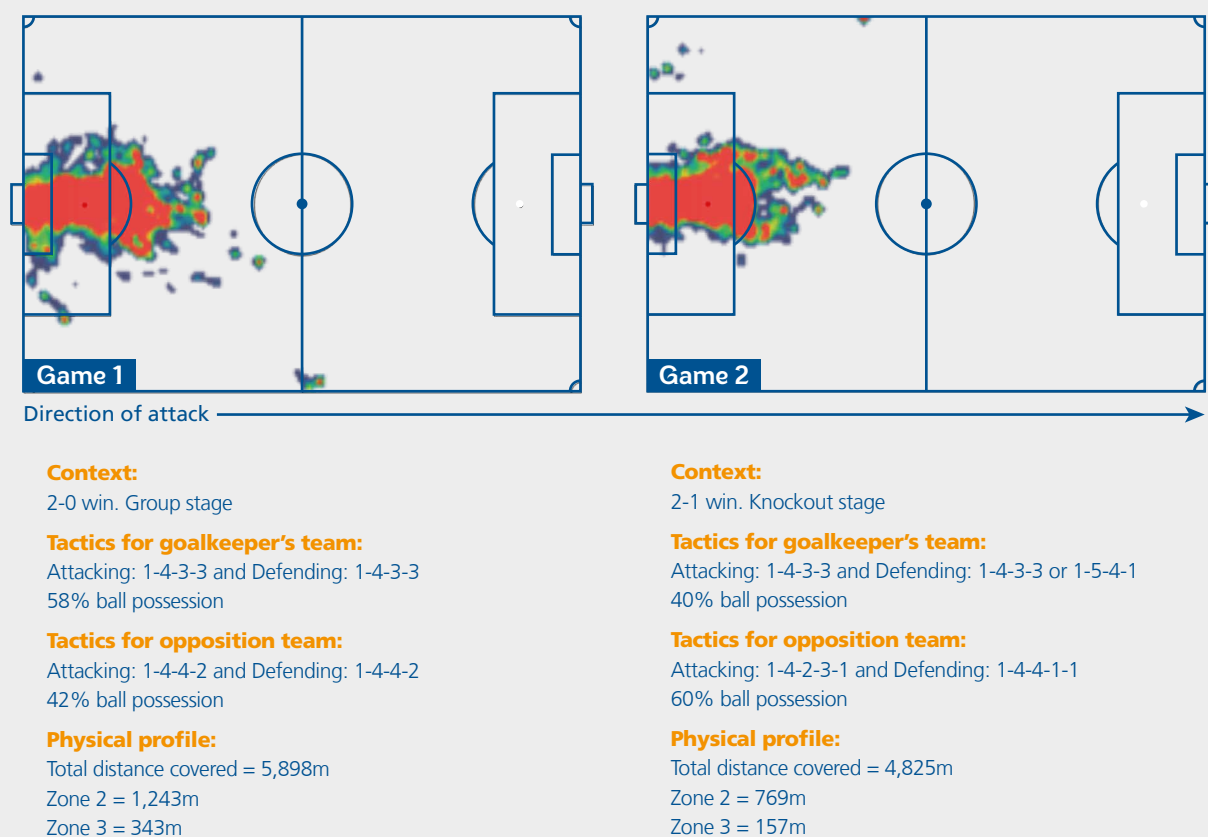


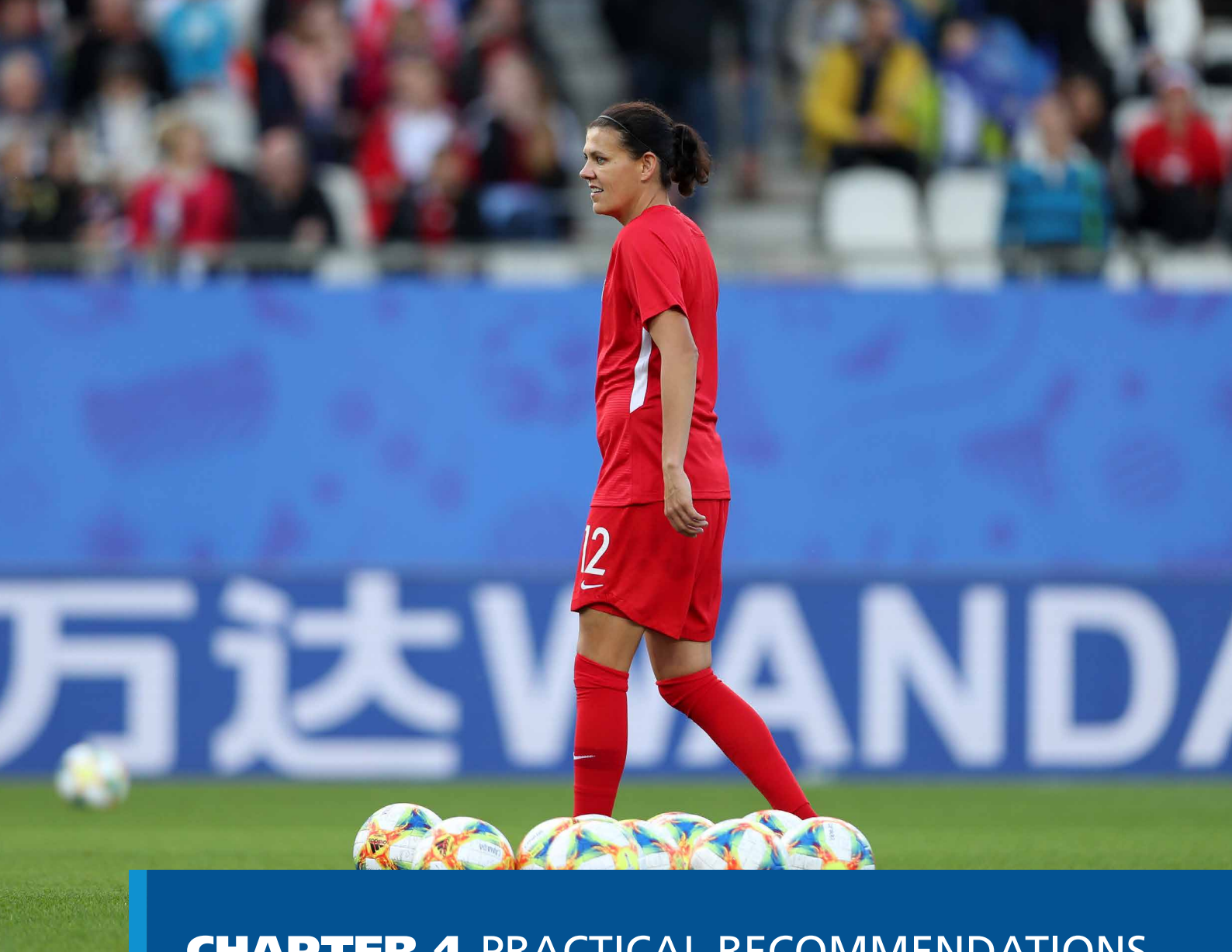
Figure 110. Heat maps for the same goalkeeper in two different games at France 2019. Context: Game (1) Dominated opposition during a less competitive game in a group-stage match, and Game (2) Really competitive game against a team that dominated possession. Maps are specifically of full-game activity (e.g. all positional data for in/out of possession and when the ball is out of play).

many dangerous situations before they start. The goalkeeper also displayed proficient ball control and distribution and even started plays from the back (a total of 36 balls played with the foot). The most distinct visuals from this heat map are the goalkeeper patrolling the spaces outside of her area and adjusting regularly based on her situational awareness. The distances covered in Zone 2 and Zone 3 were the highest for this goalkeeper in the whole tournament. This was probably due to the quick adjustments needed when positioned higher up the pitch. The frequency of micro-activities (saves, jumping, catching, turning, throwing and kicking) was relatively low for this match. For instance, there were four goalkeeper interventions such as catches, dropped catches, deviations and punches, and two saves in the whole game.

In Game 2, the goalkeeper's team had less of the ball (40% v. 60%) and only half the number of goal attempts compared to the opposition. As a result, her team's defensive line was much deeper for long periods, which resulted in a less advanced position when her team was in possession (clearly visible in the heat map). The goalkeeper distributed the ball less often with her feet than in the other game (a total of 21 v. 36 balls played with the foot). Although the distance covered in Zone 2 and Zone 3 was approximately 40-50% lower in Game 2 compared with Game 1, the occurrence of micro-activities (saves, jumping, catching, turning, throwing and kicking) was significantly higher. For instance, there were eight goalkeeper interventions such as catches, dropped catches, deviations and punches, and four saves in the whole game (double the number in the other game). For instance, these common activities for this goalkeeper when out of possession illustrated her ability to reach aerial balls. This goalkeeper also stamped her authority on the game by claiming multiple crosses and passes by collecting them in flight while being challenged by opposition players. In-possession activities also included throwing the ball to distribute it quickly and effectively (twice the number of throws in Game 2 compared to Game 1).

3.10.8 Summary

- Traditionally, the demands of football are quantified by the accumulated distance overall and in various speed zones in 15-, 45- and 90-minute periods without considering the location or tactical purpose of the individual actions.
- Using heat maps to provide more context allows practitioners to visualise how each individual player/position performs their duties in relation to a specific opponent and team philosophy.
- Interestingly, each position reviewed above had a unique physical signature when displayed in a heat map, and this is highly dependent on the location and tactical purpose of the activity.
- The tactical context of the game can have a dramatic influence on not only the overall distance a player covers but particularly the distance covered at higher intensities.
- Using the physical data alongside the location and tactical purpose of the activity can potentially aid applied sports scientists to develop not only position-specific training but also individual-specific training for elite female players.



CHAPTER 4 PRACTICAL RECOMMENDATIONS

4.1 Introduction

The physical analysis of the France 2019 tournament demonstrates that the game demands had increased compared to the Canada 2015 competition, particularly at the higher intensities (zones 4 and 5). Thus, greater importance should be placed on training methods to prepare players for the rigours of the modern women's game. This could require the coach to complement existing generic training practices with conditioning drills related to a player's tactical role (e.g. position-specific) and even elements of the team's playing style/energetic profile (e.g. positional play). Thus, this section will explore how the physical data trends from this report can be incorporated into football conditioning drills.

As football is a combination of physical-, tactical- and technical-performance elements, it is important to include a multitude of these whilst conditioning players. Training that emphasises passing and combination play whilst loading players physically can be advantageous, as players become accustomed to working proficiently with the ball whilst under fatigued conditions (Bradley et al., 2018). Notwithstanding, running-based drills can also be successfully implemented if applicable (e.g. to attain higher physiological responses or to mimic out-of-possession football scenarios).

To add an extra layer of detail to these training recommendations, each national team could examine its own physical performance in matches or tournament averages to prepare game scenarios and/or training drills. By observing some of the match-running performance trends from France 2019, it is clear that full-backs, wide midfielders and forwards covered more combined distance in zones 4-5 (approximately 700-850m) than central defenders and central midfielders (approximately 470-570m). This intense running also increased across positions by approximately 16-32% from Canada 2015 to France 2019, indicating the importance of including high-intensity conditioning modes in each team's training methodology. This information can be combined with football-specific context from each team to create conditioning practices for the collective but also per position and individually (Bradley and Ade, 2018). Conditioning modes detailed below include speed-endurance training and high-intensity aerobic training in the form of team and individual drills.

4.2 Preparation for training

Prior to completing any of these drills, it is important that the players be prepared, hence they should complete an appropriate warm-up session. The main aim of the warm-up is to prepare the body for the activity that the player is about to complete. Therefore, the warm-up should consist of actions that the player will be required to complete throughout a match or training session. Warm-up exercises increase the cardiac output and blood flow to the muscles during the session. The duration of the warm-up should be 15-20 minutes depending on what activity the player will be completing following this period; at times, it may be possible to combine the physical element of the warm-up with a more technical focus. Generally, the warm-up should consist of four phases:

1. Movement preparation (5 minutes)

The first part of the warm-up is designed to loosen up players' bodies, as well as activate the appropriate muscles in preparation for training. Choose 2-3 exercises from each focus group each time you complete any training on the pitch.

General focus:

1. Lumbar rotation stretch, moving knees side to side x 10 (each side)
2. Brettzel stretch x 3 (hold for 5 seconds on each side)
3. Scorpion x 5 (each side)
4. Pigeon/piriformis stretch x 3 (hold for 5 seconds on each side)
5. Kneeling lunge/hip flexor stretch x 3 (3-point clock, in and out = 1 rep)
6. Balancing on each leg for 5-10 seconds x 3; this can be made more challenging by the players lifting their free leg higher, standing on a foam cushion/wobble board and/or closing their eyes

Glut focus:

1. Side plank with clam x 10 (each side)
2. Quadruped (all-fours) hydrant x 10 (each side)
3. Single-leg stance (standing clam) with 45-degree hip extension x 10 (each side)
4. Monster walk x 10 steps forwards/backwards
5. Lateral band walks, 5 yards right/left

Hamstring focus:

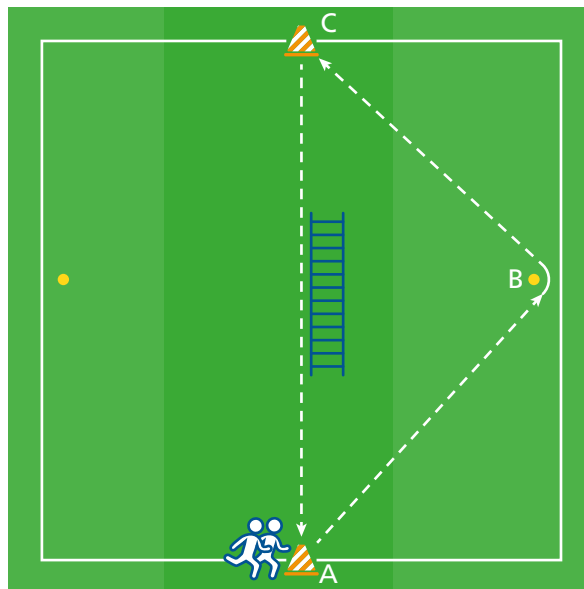
1. Glut bridge walkouts x 5 (4 steps out/back = 1 rep)
2. Single-leg glut bridge with knee hug x 8 (each side)
3. Single-leg glut bridge hold with leg whip x 5 (each side)
4. Single-leg Romanian dead lift x 5 (each side)
5. Posterior and lateral lunges x 5 (each side)
6. Squats (band at knees) x 10

**Core focus:**

1. Dead bug x 20
2. Plank with shoulder taps x 10 (each side)
3. Bear crawl (5 yards forwards/backwards)
4. Bird dog x 10
5. Side plank with top leg raise 2 x 20 seconds on each side

2. Jogging and dynamic movements (4-5 minutes)

The next part of the warm-up should consist of the players completing continuous jogging and functional movements (skipping, sidesteps and backward jogging) involving moving from A to B to C, then back to A, and then repeating the same movements to the left pole.


Session information
 (parts 2-4 of the warm-up)

Duration: 10-15 minutes

Session set-up

Equipment:

2 cones

2 poles

1 ladder


 Place cones, poles and ladders as shown.
 10m x 20m.

Figure A. Set-up for the warm-up (parts 2-3)

3. Stretching (3-5 minutes)

Following the initial phase of the warm-up, the players should complete some stretching. The majority of this should be short, static stretching, followed by dynamic stretching, where the player moves into the stretch. For example, a hamstring stretch should consist of the players holding that stretch and then following it with controlled straight leg kicks. The players should think about how they could stretch other parts of their body dynamically. The players should also be given some time to complete their own stretches, as well as any prehabilitation-type work.

4. High-intensity (3-5 minutes)

The final part of the warm-up should consist of the players completing high-speed activity, such as striding and sprinting through the ladder, and change-of-direction movements specific to football. The main aim of this final part is to prepare the players for the activity that they are about to complete. Figure B shows an example of this, which involves acceleration, deceleration and changes of direction, all of which will be required of players during training and match play. You should aim to vary the movements that the players complete, as well as the starting position and signal.

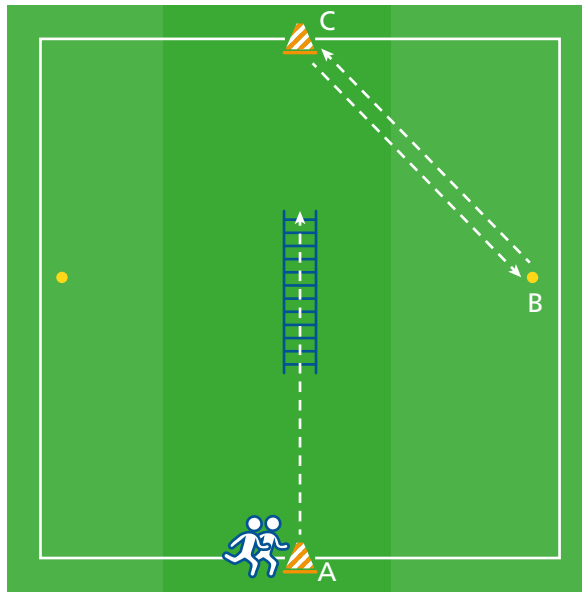


Figure B. Movement for the final phase of the warm-up (part 4)

When possible and appropriate, a ball could be incorporated throughout the warm-up. The FIFA 11+ is also a warm-up developed specifically for football. The FIFA 11+ is an injury-prevention programme that has been specifically designed to reduce football injuries. It was developed by a panel of international experts to build on earlier injury-prevention efforts, including the PEP ("Prevent injury, Enhance Performance") programme and the FIFA 11. The programme takes 20 minutes to complete and is designed to be performed twice a week. No specific equipment is needed. The FIFA 11+ consists of 15 exercises divided into three separate components. You can find information regarding the programme here: <https://www.fifamedicalnetwork.com/lessons/prevention-fifa-11/>.

4.3 Training drills

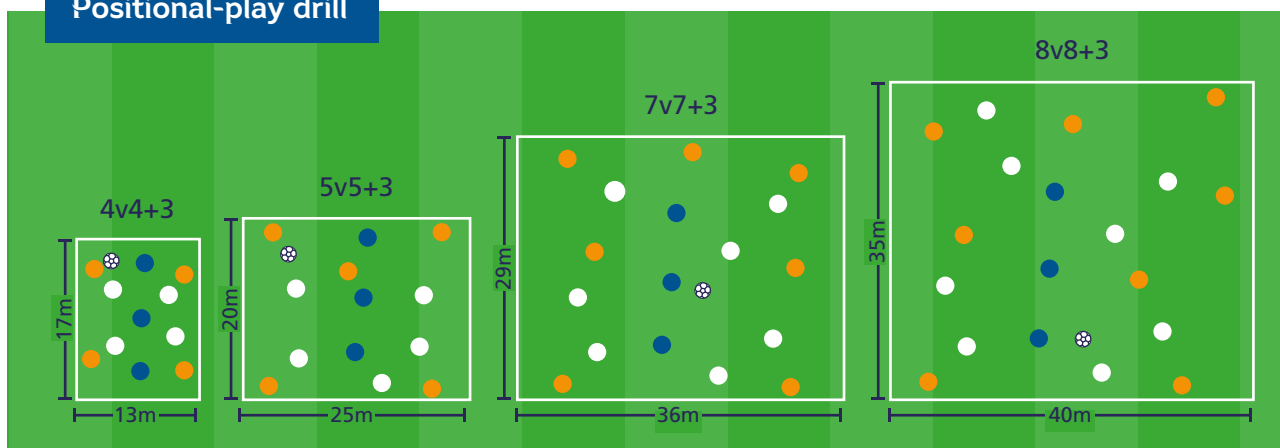
High-intensity, aerobic, positional-play drill

Aerobic high-intensity training aims to improve a player's ability to perform prolonged high-intensity activity and to recover quickly between intense periods (Bangsbo, 2015). This requires a player to perform intervals at around 90% of maximal heart rate for 2-4 minutes using a work-to-rest ratio of approximately 2:1. This has been shown to improve the physical capacity of players (Fransson et al., 2018) and would be advantageous for the modern female player.

Selected simulated situations used by coaches that have a subtler positional stimulus and are more dynamic than the speed-endurance drills in the latter part of this section are small-sided positional drills (Martín-García et al., 2018). In these drills, players have priority areas in which space is tailored to their customary context in competition but without any rules restricting the players' space during the task (Casamichana et al., 2018). Some games adhere to the principle of "positional play", whereby players collectively work at a high tempo to pass the ball to each other in tight spaces and draw in pressing players, so that they can pass to a wide-open player to exploit space. Although these drills are certainly not position-specific, they require selected roles to position themselves intelligently (e.g. full-backs/wide midfielders are wide and can move up and down the line, whilst central players like central midfielders and forwards can move between the lines in highly dense middle areas) and the team works dynamically and collectively in synergy. These positional games do place different physical demands on particular

roles. For example, using “joker” players (also known as “floating” players) encourages ball retention and generates numerical superiority for the team in possession. Thus, “joker” players only experience an attacking role, as they always play for the team in possession; this can be tailored towards distinct players. The physical demands placed on the “joker” players in Figure C are lower than those imposed on others in the game (particularly for 8v8+3 versus 4v4+3 formats; Casamichana et al., 2018). These drills use a work-to-rest ratio of 2:1, whereby players produce 4-6 work periods of 180 seconds with 90 seconds of recovery. This typically elicits an average heart rate of approximately 90% of maximal values during the exercise periods. The rules, player numbers, area and work-to-rest ratio can all be adjusted based on the conditioning aim and the individual needs of the players.

Positional-play drill



Session information for positional-play drill (high-intensity aerobic)

Total duration: approximately 15-25 minutes.
 Work: 180 seconds.
 Rest: 90 seconds.
 Repetitions: 4-6.

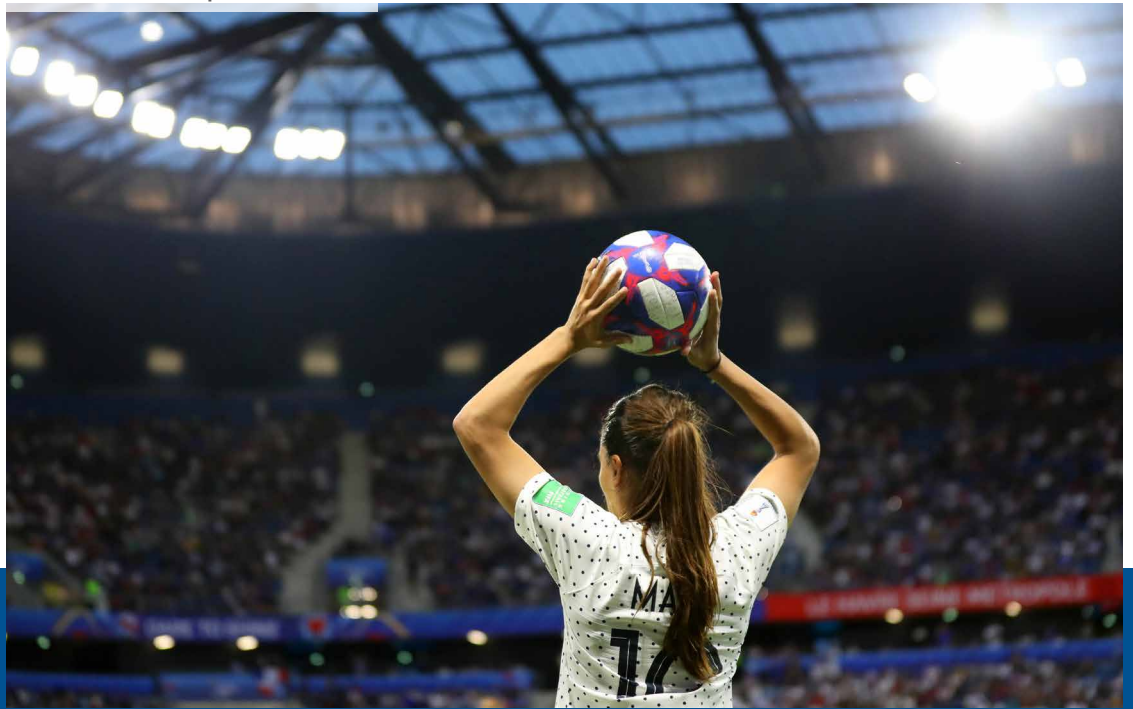
Session set-up

Equipment: 4-8 cones and 4 balls (one ball in use and the extra balls placed outside the box to introduce quickly if a ball goes out of play). Place cones to create the appropriate square (select one drill per training session).

Session information

- These drills use a work-to-rest ratio of 2:1, whereby players produce 4-6 work periods of 180 seconds with 90 seconds of recovery.
- These drills adhere to the principle of “positional play”, whereby players collectively work at a high tempo to pass the ball to each other in tight spaces and draw in pressing players.
- The coach/player should ensure extra balls are present so the players’ activity is high for the full duration of each work period.

Figure C. Game formats of positional-play drills. The orange circles represent team A, the white circles represent team B and the blue circles are the “jokers” (sometimes known as “floating” players). Adapted from Casamichana et al., 2018



Position-specific speed-endurance drill

Drills using intervals enable practitioners to target certain physical qualities. Given such pronounced elevations in high-intensity running from Canada 2015 to France 2019, an effective mode would be speed-endurance training, as it improves football-specific endurance and sprinting abilities (Bangsbo, 2015). This requires a player to perform intense football activity for 20-30 seconds followed by recovery periods of 40-180 seconds, which is repeated 8-10 times depending on the aim of the drill (production training has a work-to-rest ratio of 1:5-1:6 and maintenance training has a work-to-rest ratio of 1:1-1:3; Ade et al., 2014)*. Production training improves a player's ability to perform maximal high-intensity activities for short periods, whilst maintenance training enhances a player's capacity to sustain such high-intensity activities and recover from intense periods (Bangsbo, 2015). Thus, this type of training taxes players aerobically and anaerobically whilst involving the ball, so is ideal to prepare players for the modern demands of the women's game.

These individual drills were designed by blending data from match analysis and the art of coaching to create position-specific speed-endurance drills (Ade et al., 2016, 2018). Match analysis demonstrates that the number of combined Zone 4-5 efforts during games at France 2019 was higher for full-backs, forwards and wide midfielders (44-52) than central defenders and central midfielders (30-37). Contextualised match data provides insight into purposeful efforts in and out of possession and not just "blind" distances and frequencies (Bradley and Ade, 2018). Additional context is provided in the heat map section of the analysis of each position. For example, in possession, forwards generally perform more efforts in the attacking third, whilst driving through the middle, running in behind and breaking into the box. Meanwhile, full-backs and wide midfielders typically produce more efforts down the channels, with full-backs completing a greater number of overlapping runs. They also put in more crosses after these runs than other positions due to efforts finishing in wide attacking areas. Out of possession, positions with a major defensive role in the team like central defenders, full-backs and central midfielders generally produce more intense efforts to cover space and in the form of recovery running, whilst all positions perform frequent efforts to close down the opposition. Thus, these patterns were translated into isolated, position-specific conditioning drills for players. Examples for all positions can be found in Figures D-H, although drill movements can be adapted to the team's tactical requirements for each position. Research using GPS technology revealed that full-backs, wide midfielders and forwards covered greater high-intensity distances per repetition across these drills than central defenders and central midfielders, which is consistent with match trends from France 2019. This type of training generally elicits an average and peak heart-rate response respectively of approximately 80 and >90% of maximal heart rate (Ade et al., 2018).

*Although the ratios quoted are within typical ranges, these may be adapted. For example, work-to-rest ratios of 1:≥5 can also be used to develop speed-endurance production qualities.

Session information for central-defender drill (speed endurance)

Total duration: approximately 15-35 minutes (depending on aim of drill).
 Work: 30 seconds.
 Rest: 40-180 seconds (depending on aim of drill).
 Repetitions: 8-10.

Session set-up

Equipment: 2 mannequins, 4 mini-goals, 2-3 balls.

Session information

- Players perform intense football activity for 30 seconds, followed by a recovery period of 40-180 seconds. The sequence is repeated 8-10 times depending on the aim of the drill (production training has a work-to-rest ratio of 1:5-1:6 and maintenance training has a work-to-rest ratio of 1:1-1:3).
- Players should be working maximally for the full work period (detailed description below).
 1. The central defender performs two headers behind the mannequin with backward and lateral movements.
 2. The central defender reacts to a ball over the top/through-ball from the coach/player.
 3. The central defender sprints onto the ball, takes a touch and clears to a mini-goal of choice.
 4. The central defender closes down the mannequin and intercepts a pass from the coach/player, clearing to another goal.
 5. The central defender runs around the mannequin and defends a cross into the box delivered by the coach/player.
 6. The central defender counter-defends/pushes up the pitch to the edge of the centre circle as if to play offside.

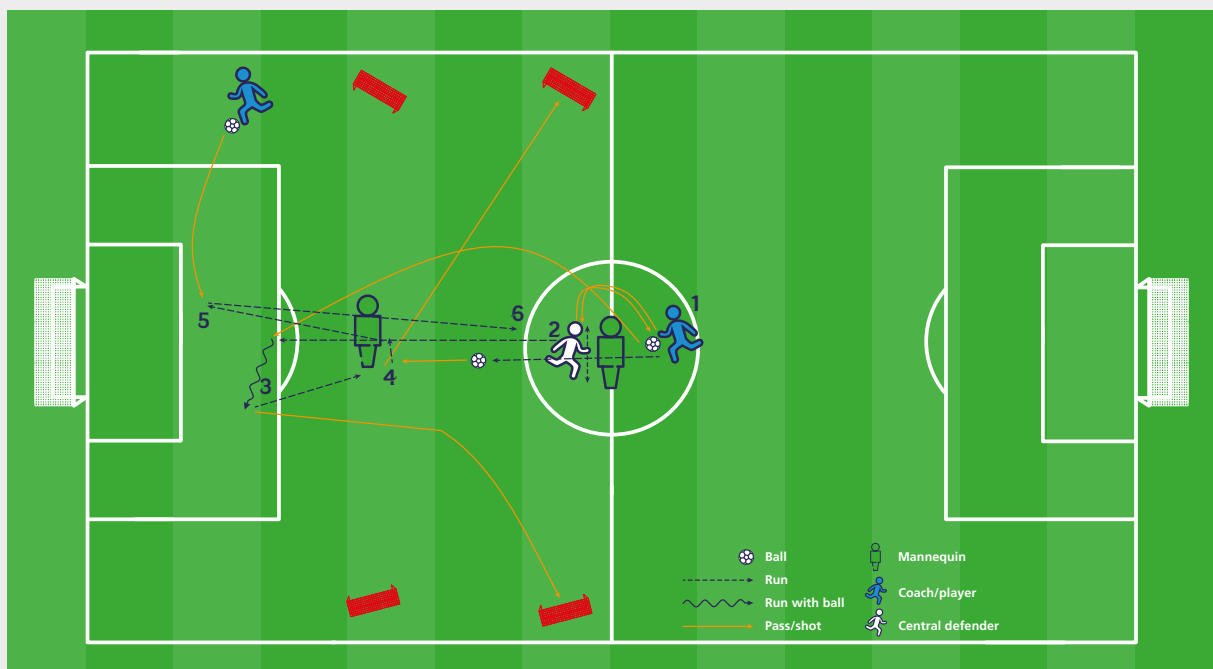


Figure D. Position-specific drill for a central defender. Adapted from Ade et al., 2018

Session information for full-back drill (speed endurance)

Total duration: approximately 15-35 minutes (depending on aim of drill).
 Work: 30 seconds.
 Rest: 40-180 seconds (depending on aim of drill).
 Repetitions: 8-10.

Session set-up

Equipment: 4 mannequins, 1 mini-goal, 2-3 balls, 1 pole (rebound board optional).

Session information

- Players perform intense football activity for 30 seconds, followed by a recovery period of 40-180 seconds. The sequence is repeated 8-10 times depending on the aim of the drill (production training has a work-to-rest ratio of 1:5-1:6 and maintenance training has a work-to-rest ratio of 1:1-1:3).
- Players should be working maximally for the full work period (detailed description below).
 1. The coach/player and full-back play one-twos on either side of the mannequin, moving the full-back side to side.
 2. The coach/player plays the ball down the inside for the full-back to recover.
 3. The full-back sprints to recover the ball, runs with it and passes to the coach/player.
 4. The full-back overlaps the coach/player around the pole and receives the pass in the final third.
 5. The full-back dribbles through the mannequins and delivers a cross into the mini-goal.
 6. The full-back recovers back to the halfway line.

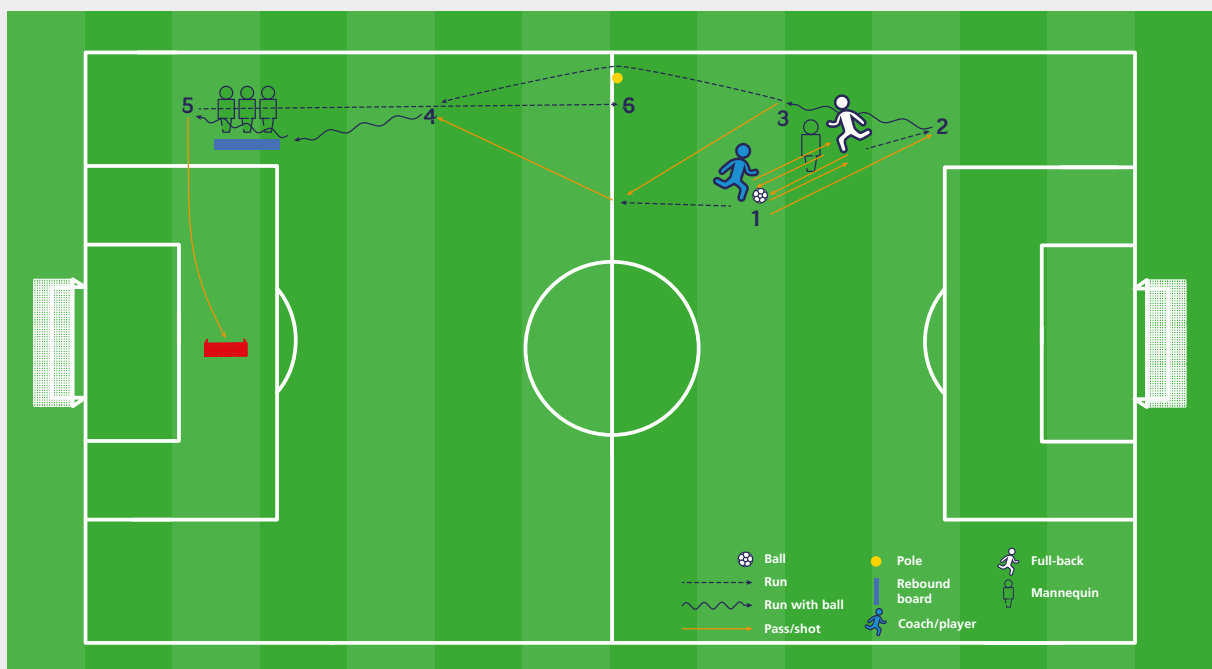


Figure E. Position-specific drill for a full-back. Adapted from Ade et al., 2018

Session information for central-midfielder drill (speed endurance)

Total duration: approximately 15-35 minutes (depending on aim of drill).
 Work: 30 seconds.
 Rest: 40-180 seconds (depending on aim of drill).
 Repetitions: 8-10.

Session set-up

Equipment: 3 rebound boards, 2-3 balls, 8 cones, 2 mini-goals, 2 poles.

Session information

- Players perform intense football activity for 30 seconds, followed by a recovery period of 40-180 seconds. The sequence is repeated 8-10 times depending on the aim of the drill (production training has a work-to-rest ratio of 1:5-1:6 and maintenance training has a work-to-rest ratio of 1:1-1:3).
- Players should be working maximally for the full work period (detailed description below).
 1. The central midfielder plays a one-two off the rebound board and hits a long diagonal pass to the coach/player in the coned area.
 2. The central midfielder sprints to pick up the ball and plays off both the rebound boards as fast as possible.
 3. The central midfielder runs forward and hits the coach/player with a long pass.
 4. The central midfielder runs into the box, performing an arced run.
 5. The central midfielder finishes the cross from the coach/player into the small goal from between the six-yard box and the penalty spot.
 6. The central midfielder recovers back to the halfway line.

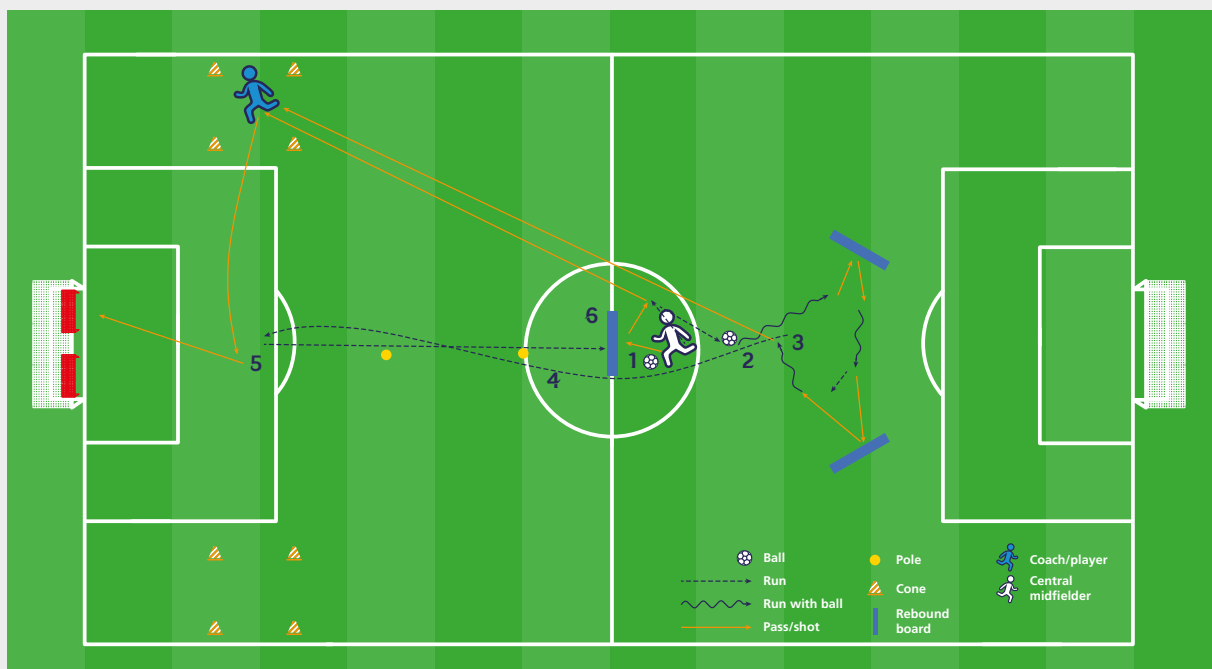


Figure F. Position-specific drill for a central midfielder. Adapted from Ade et al., 2018

Session information for wide-midfielder drill (speed endurance)

Total duration: approximately 15-35 minutes (depending on aim of drill).
 Work: 30 seconds.
 Rest: 40-180 seconds (depending on aim of drill).
 Repetitions: 8-10.

Session set-up

Equipment: 2 mannequins, 2-3 balls, 3 mini-goals, 4 poles.

Session information

- Players perform intense football activity for 30 seconds, followed by a recovery period of 40-180 seconds. The sequence is repeated 8-10 times depending on the aim of the drill (production training has a work-to-rest ratio of 1:5-1:6 and maintenance training has a work-to-rest ratio of 1:1-1:3).
- Players should be working maximally for the full work period (detailed description below).
 1. The wide midfielder sprints deep to play a one-two with the coach/player, then up the pitch to provide an outlet out wide.
 2. The coach/player passes the ball for the wide midfielder to sprint onto and run with the ball.
 3. The wide midfielder checks back, performing a trick, and delivers an inswinging cross into the mini-goal.
 4. The wide midfielder performs a recovery run to the pole on the halfway line.
 5. The wide midfielder drives infield to receive a pass from the coach/player.
 6. The wide midfielder runs infield with the ball and plays a reverse ball out wide to the coach/player.
 7. The wide midfielder sprints into the box around the mannequin to finish a cross around the six-yard box.
 8. The wide midfielder performs a recovery run to the inside pole on the halfway line.

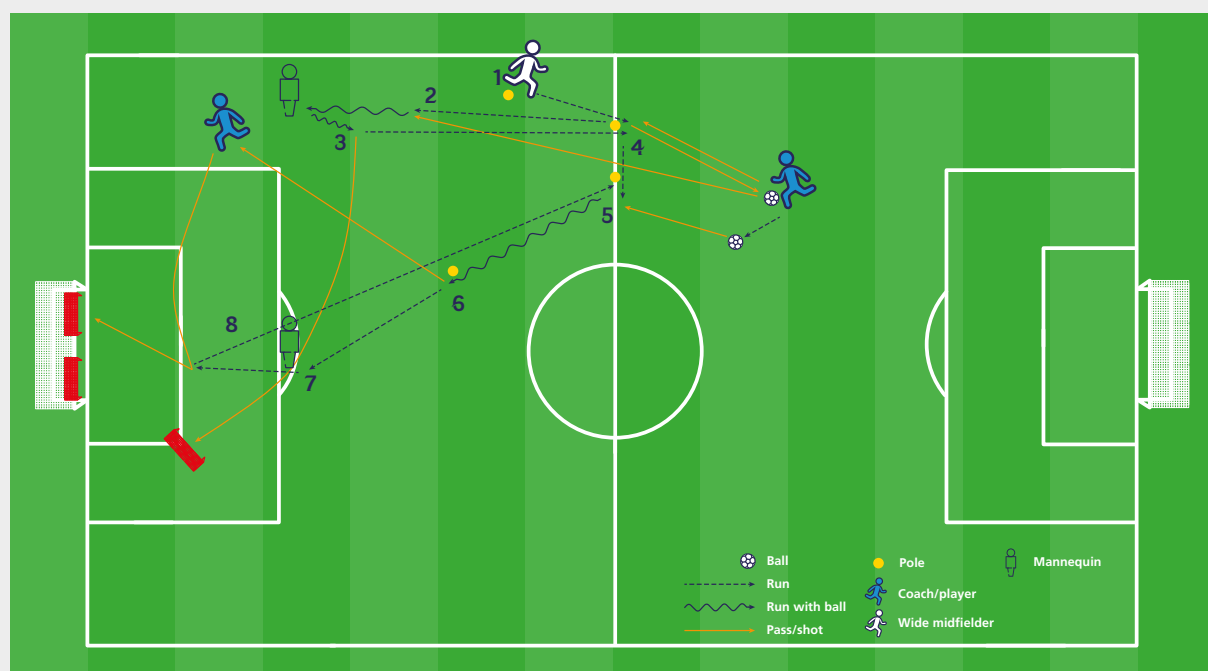


Figure G. Position-specific drill for a wide midfielder. Adapted from Ade et al., 2018

Session information for forward drill (speed endurance)

Total duration: approximately 15-35 minutes (depending on aim of drill).
 Work: 30 seconds.
 Rest: 40-180 seconds (depending on aim of drill).
 Repetitions: 8-10.

Session set-up

Equipment: 4 mannequins, 2-3 balls, 2 mini-goals.

Session information

- Players perform intense football activity for 30 seconds, followed by a recovery period of 40-180 seconds. The sequence is repeated 8-10 times depending on the aim of the drill (production training has a work-to-rest ratio of 1:5-1:6 and maintenance training has a work-to-rest ratio of 1:1-1:3).
- Players should be working maximally for the full work period (detailed description below).
 1. The forward performs two headers behind the mannequin and then passes on either side.
 2. The forward spins away from the mannequin for the coach/player to play a through-ball.
 3. The forward sprints onto the through-ball to beat two mannequins and finish from inside the 18-yard box.
 4. The forward closes down a central defender (mannequin) and then attacks a near-post cross delivered by the coach/player.
 5. The forward closes down a central defender (mannequin) and then attacks a far-post cross delivered by the coach/player.
 6. The forward recovers back to the edge of the centre circle.

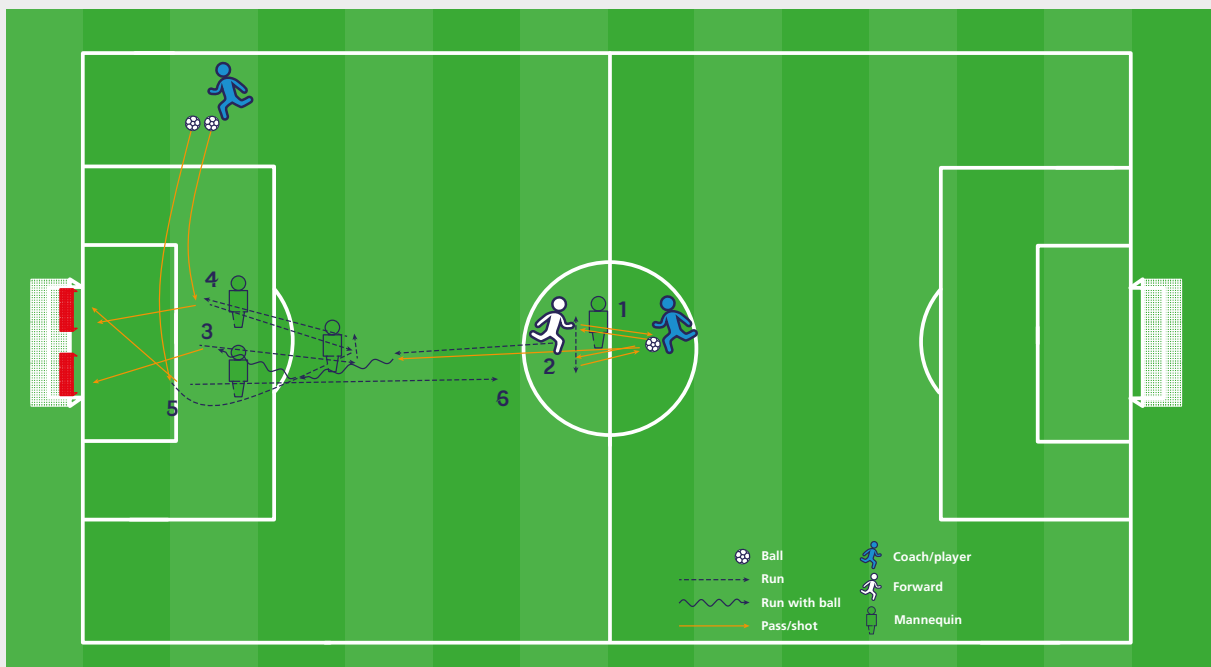


Figure H. Position-specific drill for a forward. Adapted from Ade et al., 2018

4.4 Running-based high-intensity interval training (HIIT)

Despite the growing interest and specificity of technical- and positional-focused conditioning drills, running-based HIIT is a preferred method of training on occasions, especially when there are time constraints, players are training individually or in smaller groups, and/or to ensure a prescribed physical output is achieved, which cannot always be guaranteed in a more technical-focused session. To ensure players are running at the optimal intensity for training adaptations to occur, the 30-15 Intermittent Fitness Test (30-15 IFT) was developed (Buchheit, 2008). The 30-15 IFT was designed to elicit maximal heart rates and oxygen uptake, as well as to optimise anaerobic capacity, acceleration, deceleration and change of direction (COD) abilities, which are all common actions in football match play. The final speed reached at the end of the test, V_{IFT} , can then be used to prescribe the HIIT distances that individual players should achieve to accrue the desired training effect.

30-15 IFT protocol

The 30-15 IFT consists of 30-second shuttle runs interspersed with 15-second passive recovery periods (Buchheit, 2008). The velocity is set at 8km/h for the first 30-second run and the speed is increased by 0.5km/h for every 30-second stage thereafter. Players are required to run back and forth between two lines set 40m apart (Figure I) at a pace dictated by a pre-recorded beep. This pre-recorded beep allows the players to adjust their running speed when they enter a 3m zone placed in the middle and at each end of the pitch. During the 15-second recovery period, players walk forwards towards the closest line,



Figure I. The configuration for the standard 30:15 IFT



which will either be in the middle or at the end of the running area, depending on where their previous run stopped. This line is their starting point for their next run stage. Players are instructed to complete as many stages as possible and the test ends when they can no longer maintain the required running speed or are unable to reach a 3m zone in time with the audio signal for three consecutive beeps. The velocity attained during the last completed stage is noted as the player's V_{IFT} . The audio file and further information regarding the test can be found here: <https://30-15ift.com/>.

Prescribing HIIT for individual players

Once the test has been performed, individual running distances on the pitch for each player (Figure J) can be calculated. The distance that each player should aim to cover is calculated from a set running time and the chosen percentage of V_{IFT} . For example, for a player with a V_{IFT} of 19km/h, and for a 15s-15s HIIT run at 95% of V_{IFT} , the target distance will be as follows: $(19/3.6) \times 0.95 \times 15 = 75\text{m}$ (19 is divided by 3.6 to convert the speed in km/h into m/s, for the sake of convenience). This can be repeated for each player (Buchheit, 2008). On the pitch, it is recommended to have the players start from their own cone and then finish all together on the same line. If runs have to be performed with a COD, which is a key component of football, the time needed for a COD has to be taken into consideration when calculating the target running distance, to ensure a similar cardiorespiratory load in comparison with straight-line runs whilst taking into account the necessary time to decelerate, make the turn and accelerate. Table a) shows a variety of HIIT sessions that could be used, all of which have an impact on developing cardiorespiratory function (Buchheit et al., 2011). The most appropriate form of HIIT should generally be selected based on the weekly training schedule, position-specific match demands, players' individual needs and the phase of the season.



Figure J. Area prepared for a straight-line HIIT exercise (15s-15s run at 95% of V_{IFT})

Table a). Examples of high-intensity intermittent shuttle runs using V_{IFT} as a reference speed to individualise running distance (Buchheit, 2008)

Running time	Running intensity (% V_{IFT})	Recovery duration	Recovery intensity (% V_{IFT})	Running modality	Max series duration	Number of series	Recovery time between series
3'	85-88%	-	-	straight line	-	5 to 6	3'
45"	90%	15"	passive	straight line	7'-8'	2 to 3	3'
30"	90%	15"	passive	straight line	7'-8'	2 to 3	3'
30"	90%	30"	40%	straight line	>12	2	3'
30"	93%	30"	passive	shuttle 40m	10'-12'	2 to 3	3'
15"	100%	15"	passive	straight line	10'	2 to 3	3'
15"	95%	15"	25%	shuttle 40m	15'	2	3'
20"	95%	20"	passive	straight line	7'-8'	2	6'-7' active
20"	90%	20"	45%	shuttle 30m	7'-8'	2	6'-7' active
20"	95%	15"	passive	shuttle 30m	7'-8'	2	6'-7' active
15"	100%	15"	passive	shuttle 40m	7'-8'	2	6'-7' active
15"	95%	15"	25%	straight line	7'	2	6'-7' active
15"	95%	10"	passive	shuttle 40m	7'	2	6'-7' active
10"	90%	10"	passive	shuttle 20m	6'	2	6'-7' active
10"	100-105%	20"	passive	straight line	6'	2	6'-7' active
3"	sprint	17"	passive	20m sprint or 2x10m shuttle	6'	2	6'-7' active

4.5 Summary

This report demonstrates that the physical demands of the modern women's game have increased in recent years. Thus, importance must be placed on the most appropriate training drills to prepare players for these demands. Speed-endurance, high-intensity aerobic and HIIT training methods are appropriate modes to use to develop players' physical capacities. Elite football training requires a blend of science and the art of coaching to design appropriate team and individual drills, although sometimes, with time constraints, running-based drills are necessary to elicit a specific physical load. The approaches presented (general, position-specific and positional play) illustrate that football training that replicates game and positional movement patterns can be used to condition players. It might be advantageous to supplement training with a stimulus related to a player's tactical role in the team and even elements of the club's playing style/energetic profile. It is important to stress that there are many effective ways to accomplish this type of work and this section has only provided a few examples for the interested reader (e.g. many approaches can be used that are specific to the methodological and cultural aspects of each team).

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GLOSSARY

Actual playing time – The amount of time for which the ball is in play during a match.

Ball out of play (BOOP) – Situations either when the ball is off the pitch or when play has been stopped (such as prior to the taking of a set piece).

Bout – A short period of activity of a specified kind (see also “Effort”).

COD – Change of direction.

Coefficient of variance (CV) – The ratio of the standard deviation to the mean.

Compactness – The average area covered by the team shape in or out of possession (m²).

Correlation coefficient (r=) – A numerical measure of some type of correlation, i.e. a statistical relationship between two variables.

Effort – A short period of activity of a specified kind (see also “Bout”).

Football turf – Artificial turf.

Global positioning system (GPS) – A type of technology that tracks location and is used in football to measure movement, distance and speed.

Height, width and depth of the team shape – The distance respectively between a team's own goal line and its closest outfield player to that line, between a team's widest outfield players, and between a team's highest and lowest outfield players.

Hertz (Hz) – A unit of frequency, defined as cycles per one second.

High-speed running (HSR) – A running metric that can be measured from data recorded by GPS technology units, providing an enhanced degree of specificity for conditioning sessions or rehabilitation running.

High-intensity interval training (HIIT) – A form of exercise that involves short bursts of intense anaerobic activity with less intense recovery periods.

In possession of the ball (IP) – The team that has the ball (attacking team) at any given time while the ball is in play or the time spent/distance covered by a team with the ball.

Match duration – The total time for which a game lasts, including stoppages, but excluding half-time and extra time.

Match observation – A unit defining the period (for this report, sometimes half a match and sometimes a full match) for which a team or measure is under observation. With two halves and two teams per match, each game features up to four match observations.

Maximal aerobic speed (MAS) – The lowest running speed at which maximum oxygen uptake occurs.

Mean±SD – A statistic representing the average value and the positive and negative variation.

Metreage – The number of metres covered (in this report, per minute).

National Women's Soccer League (NWSL) – The top division of women's football in the USA.

Out of possession of the ball (OOP) – The team without the ball (defending team) at any given time while the ball is in play or the time spent/distance covered without the ball by a team.

Periodisation – The process of dividing the annual training plan into a series of manageable phases with a view to maintaining performance across a season and achieving peak performance at key moments.

Practitioners – Head coaches, assistant coaches, high-performance coaches and conditioning coaches.

Repeated high-speed activity (RHSA) – A minimum of two high-speed runs or sprints with less than 20 seconds of recovery between efforts.

Repeated sprint activity (RSA) – A minimum of two sprints with less than 20 seconds of recovery between efforts.

Relative distance – The amount of distance covered, adjusted for the match duration.

Standard deviation (SD) – A statistic that measures the variation of a data set relative to its average.

Speed threshold – The upper and lower limits of a speed zone.

Speed zone – A speed range at which a player covers distance or completes an activity, such as an effort.

Women's Super League (WSL) – The top division of women's football in England.

Video assistant referee (VAR) – A match official who monitors games using live footage and reviews key incidents using video-replay technology to ensure that the decision reached by the referee is correct.

Wearable – A GPS/heart-rate system that can be worn.

Work-to-rest ratio – The comparison between the amount of time respectively spent performing an exercise (working) and recovering (resting).

Yo-Yo Intermittent Recovery Test Level 1 – A maximal aerobic fitness test involving running between two markers placed 20 metres apart, at increasing speeds, until exhaustion.

30-15 Intermittent Fitness Test (IFT) – A test to measure physical capabilities and geared towards intermittent sports, which alternates 30 seconds of running at increasing speeds with 15 seconds of walking.

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