Effects of Coach Turnovers on Intensity for Training and Matches in a Norwegian Football Club

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I couldn't have asked for a more interesting research project, and I've learned valuable lessons from this experience. Thank you!

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ABBREVIATIONS

TDC – total distance covered

HSRD – high-speed running distance

SRD – sprint running distance

ACC – accelerations

DEC – decelerations

RHIE – repeat high-intensity efforts

TPL – total player load

PL2D – player load 2D

DC – dismissed coach

NC – new coach

ABSTRACT

Objective: A host of studies have examined the influence of coach turnovers by examining physical responses either side of a change. However, the effects on training have not been widely documented in the literature. The aim of this study was hence to examine physical variables between four weeks before and eight weeks after two coach turnovers in a second division Norwegian football club for both training and matches.

Methods: Individual physical data (n=1174 observations) was derived from the players using GPS-data in combination with the subjects employing wearable instruments from Catapult. The means for variables were divided into four study periods (training 2019, matches 2019, training 2021, and matches 2021) to analyze each variable for each of the four periods.

Results: The training period in 2019 revealed four variables having a significant negative effect, including total distance covered, sprint running distance, total player load, and total player load 2D, with all parameters representing a small effect size. Only repeat high-intensity efforts had a statistically significant negative effect for matches in 2019, with the effect size being small. For the training period in 2021, sprint running distance had a small positive effect size but a statistically significant positive outcome. On the other hand, decelerations in band 3 had a statistically significant and small negative influence after the switch. For the match period in 2021, high-speed running distance revealed a statistically significant negative effect, with the effect size being moderate.

Conclusion: This paper concludes that a coach turnover does influence physical variables in the short term for both training and matches. At least one variable reported an effect with statistical significance for all four study periods. A key finding from this study is that sprint running distance reported a small effect size for both training periods and both match periods, as well as showing statistical significance for both training periods. Furthermore, the results on sprint running distance revealed contrasting effects for both coach turnovers between training and games.

Keywords: football, coach turnover, effect, training, match

STRUCTURE OF THE THESIS

The thesis consists of two parts:

Part 1 presents the theoretical background for undertaking the research project, a methodological chapter of how the study was conducted, and a chapter discussing the methods used in this study as well as the results reported after analysis. A conclusion and practical implications is included at the end of the thesis.

Part 2 presents a research paper, written in accordance with the guidelines outlined by the "International Journal of Performance Analysis in Sport".

The results reported from the analysis are only present in the research paper (part 2) due to the word-limitation of the present master thesis.

PART 1

MASTER THESIS

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1.0 INTRODUCTION

The world of football is in continuous development. A study on the English Premier League showed that high-intensity running distance and actions, sprint distance and number of sprints, and proportion of explosive sprints all increased in the 2012-2013 season compared to the 2006-2007 season (Barnes, Archer, Hogg, Bush, & Bradley, 2014). Higher standards of play mean that players and managers must keep up with current levels and trends if they are to perform at the highest level of top football.

"The demands on a football player during a game can be determined from match analysis and physiological measurements during match play" (Bangsbo, 2014, p. 1). Given the evolution of technology, GPS tracking of player performance have become increasingly popular. Performance staff can use information from training and matches to guide managers by analysing running performances to best optimise team performance. Physical parameters can thus be obtained in order to monitor the taxing and utilization of players.

Football is characterized by intermittent work, where the players perform low-intensity activities for more than 70 % of the game. However, a player at the highest level performs 150-250 brief intense actions during the course of a game, illustrating that the percentage of actions being of high intensity is higher for a top player compared to a lower-league player (Bangsbo, Mohr, & Krustrup, 2006). "It is mainly the high-intensity exercise periods which are important, with the amount of high-speed running having been shown to be a distinguishing factor between top-class players and those at a lower level" (Bangsbo, 2014, p. 1). The physical demands of a professional football player can be described in as little as a simple word: intensity.

A study within professional English football analysed the perceptions of the use of GPS tracking. The coaches working on training data most commonly identified high-intensity actions and variables recognized by the coach as 'work rate/intensity', while players deemed total distance, high-speed running and sprint distances as the information they would most like to see (Nosek, Brownlee, Drust, & Andrew, 2020). As these variables are essential to performance in top football (Bangsbo, 2014), GPS tracking could hence be an effective and useful tool if used correctly. However, lack of a common goal and high volumes of information can be barriers to effective feedback of data (Nosek, Brownlee, Drust, & Andrew, 2020).

As the running demands in football are increasing (Barnes, Archer, Hogg, Bush, & Bradley, 2014), it is the manager's job to coordinate the team to have the best chance of winning. That means imposing your own philosophy and style of play, as well as selecting a formation the team will play. Different formations will have different characteristics and perks, and running characteristics of the different formations could therefore differentiate. As a result, different manager types will produce different strategies both in training and match play to have the best chance of getting a good result.

Dismissing the coach is a drastic and frequent approach (Balduck & Buelens, 2007) that presents an option if performances are not at the level expected by the board of the club (Koning, 2003). This radical course of action could be used as a way of bringing in new ideas and hopefully an improvement in performance both in the short and long run. However, there are no guarantees that changing the manager is for the better, and whether the sacked manager deserved more time is often a question left unanswered.

Given the lack of studies in the literature that examine physical variables derived from training data, this paper aims to explore the effects of coach turnovers on intensity variables for both training and match data. The research questions in this paper is two-fold:

1) Is there a change in intensity after the coach turnover in training for the two periods between four weeks before the turnover and eight weeks after the change?
2) Is there a change in intensity after the coach turnover in matches for the two periods between four weeks before the turnover and eight weeks after the change?

Intensity is defined as individual physical variables examined in this study, and the variables examined are the following: total distance covered, high-speed running distance, sprint running distance, acceleration efforts in band 2-3, acceleration efforts in band 3, deceleration efforts in band 2-3, deceleration efforts in band 3, repeat high-intensity efforts, total player load, and total player load 2D.

1.1 Previous findings on managerial turnover

The effect of coach changes in top football has been subject to great interest in sports science, especially in recent years. Several studies inspected as little as four matches before and after the switch (Balduck, Buelens, & Philippaerts, 2010, Balduck & Buelens, 2007 and Guerrero-Calderón, Owen, Morcillo, & Castillo-Rodríguez, 2021), while other studies explored performances over a season (Argentieri, Canova, & Manera, 2019, Besters, van Ours, & van Tuijl, 2016 and Ronningstad, 2021) or a year (Kim & Kim, 2015 and Kattuman, Loch, & Kurchian, 2019). The studies that have investigated the short-term influence of a coach turnover could therefore focus on the immediate response on performance, while studies that look into the long-term effects could make a clearer picture whether or not the replacement was justified.

"In general, the purpose of a coach turnover is to improve results in the short run" (Balduck & Buelens, 2007, p. 2). In other words, a coach change could for that reason be used as a last resort if the team desperately need sufficient results in a short space of matches. Salomo & Teichmann (2000) identified insufficient performances as the main reason for dismissing the coach. For example, clubs in a bad run of form threatened with relegation could hence switch coaches in a desperate attempt to stay in the league.

On the other hand, Lago-Peñas (2011) argues that the most common reason for firing a coach is the existence of a shock-effect, and claim that a new coach would be better able to motivate the players and thus improve results. The findings from Lago-Peñas (2011) on 10 years from

the Spanish LaLiga show an immediate effect on points gained, but no positive outcome after ten, fifteen or twenty matches.

A host of studies find a positive effect of a coach switch on results, with about equally as many inable to conclude a significant influence either positive or negative. A couple of studies that find positive outcomes report however that the performances of teams who didn't dismiss their coach or manager still performed better than teams that had a turnover (van Ours & van Tuijl, 2014 and González-Gómez, Picazo-Tadeo, & García-Rubio, 2011). Some studies even find a negative outcome on results either in the short term (Audas, Dobson, & Goddard, 2008) or long term (Argentieri, Canova, & Manera, 2019 and Salomo & Teichmann, 2000). Furthermore, long-term effects derived from twenty years evidence on the Korean Premier League found positive effects on performance off-season, but negative effects in-season, showing that a coach change isn't always for the best (Kim & Kim, 2015).

The vast majority of studies focus on team performance, and most commonly examine measures such as points gained and goals scored for and against, while only a few studies dig into running variables as well, as highlighted below. Both Kleinknecht & Würtenberger (2021) and Radzimiński et al. (2022) found a positive effect on team results and total distance covered when examining five matches after a mid-season manager or coach change. In addition, Radzimiński et al. (2022) found a positive influence on high-speed running and the number of high-intensity runs, although positive physical outcomes in this study dissapears after a period of approximately five matches.

Furthermore, Kleinknecht & Würtenberger (2021) only found an improvement in total distance covered if the new coach didn't already have affiliation to the team. They argue that an information loss about the players induced by an external coach would create an incentive for the players to exhibit more effort to impress the new manager, in this study regarded as total distance covered. Contrasting results were found by Augusto et al. (2021) where a mid-season coach replacement led to negative physical responses, such as high-intensity running, sprint running distance, high-intensity actions and decelerations. Although, the duration examined was 17 matches before and after the change so a drop in effort could be expected.

Guerrero-Calderón, Owen, Morcillo, & Castillo-Rodríguez (2021) claims to be "the first study with a detailed analysis of the immediate effect of coach dismissal on the physical performance performed by players after changing the coach in both training and competition". The authors examined a team in each of the top three Spanish leagues, and key findings included an improvement on total distance covered in all speed ranges: >14 km•h−1, 14–18 km•h−1, high-intensity running (18–21 km•h−1), very high-intensity running (21–24 km•h−1), and sprint running distance (>24 km•h−1) on the first division team for training, with equivalent distance index and acceleration events on the second division team.

On one hand, the dismissed coach in the second division team showed higher equivalent distance index, accelerations and decelerations events than the new coach. However, a similar positive influence was found in competition in the second division team. Another key finding

was that a coach change led to negative influences in mathces. The authors conclude that a mid-season coach turnover didn't increase the players' physical performance either in training or in competition (Guerrero-Calderón, Owen, Morcillo, & Castillo-Rodríguez, 2021).

2.0 METHODS

2.1 Literature search

A literature search was conducted on previous studies done on coach turnovers in top football. The search was conducted through the databases of MEDLINE and SPORTDiscus through the database host EBSCOhost. An advanced search using the boolean search mode included relevant search words and contained the following search string: "TI (football OR soccer) AND TI (coach* OR manager*) AND TI (GPS OR parameters* OR variables* OR intensity* OR effect* OR running* OR sprint* OR acceleration* OR endurance* OR performance*)". A total number of 142 studies were produced by the search.

Inclusion criteria to be incorporated in the complete list included that the study had to be written in English, and that the teams and players examined were playing at the top level and at senior level. This means that studies exploring youth football and non-professional football were excluded from the final list of studies in order to examine comparable findings. In addition, other studies were collected from the relevant studies found by the search and the identification process, which resulted in a final list of 32 relevant studies on coach turnover in top football. Both contemporary and older studies were included by not setting a time frame of when the study was published.

2.2 Study design

This longitudinal study followed an inferential design, using quantitative historical data to answer the research questions. To ascertain the influence of coach turnovers, individual physical variables on all players were analyzed during four weeks before and eight weeks after two coach changes within a professional second division club both for training and match data (n=1174 observations). The data was compared between dismissed coach (DC) and new coach (NC) for further analysis.

The first coach change happened in pre-season in 2019, while the other dismissal occurred at the start of the season in 2021. The new coach in 2019 were dismissed in the second period in 2021. The club obtain physical measures derived from GPS use from every training and game, and relevant data material was extracted for use in this study for further analysis. The first coach switch happened before the competitive season started. For this reason, three pre-season games are available in this period of examination. Figure 1 illustrates the aim of this research paper.

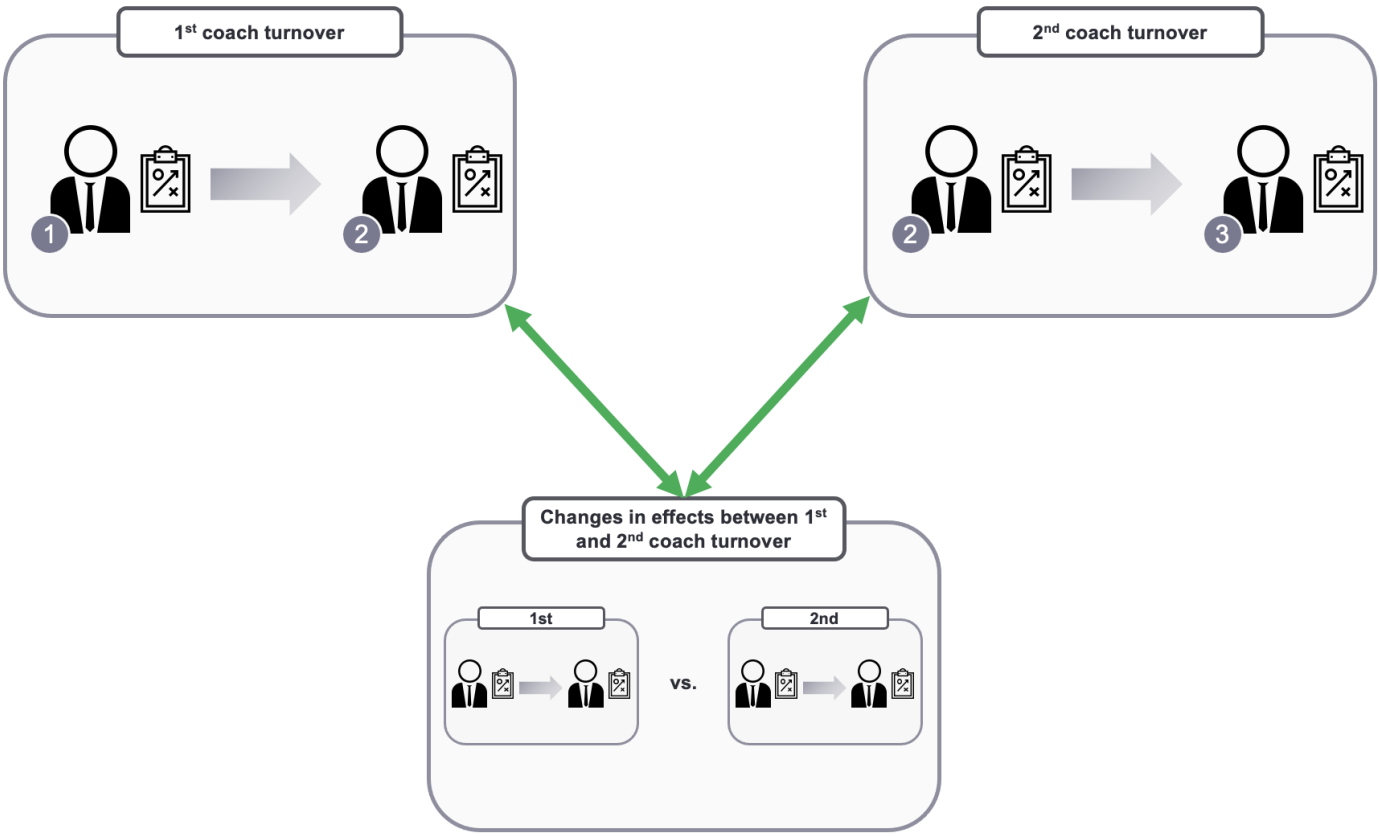

Figure 1: Illustration of the aim of the study

Four matches in total were available in the study period before the first coach change. This included three pre-season matches and a competitive game, whereas eight competitive matches were examined in the study period after the dismissal. Four competitive games were played in the period before the second coach change, with nine competitive games taking part in the period after this switch.

A decision to only include training sessions with a minimum duration time of thirty minutes was implemented for the following reason: the variability of duration times will be minimized and will thus explain less of the effects detected. This criteria also ensures that very short training sessions would not bring down the total values of the variables needlessly. Session observations with zero meters on distance covered were excluded as these instruments weren't used in training. Furthermore, a criteria of a minimum of a thousand meters of total distance was implemented in training as well. This decision was made after a detection of a clear drop in distance at this threshold for both 2019 and 2021, and this would ensure that the data material is more comparable both for duration and distance covered.

After completing an inspection of the histograms regarding the training sessions, the figures showed that the range and pattern of the durations looked similar for both 2019 and 2021. Considering that the training observations include a similar distribution of duration times, and the observations are deemed within a reasonable time frame, the decision to only include

observations within the time frame of thirty minutes minimum could be supported for this study. This decision allows that the observations are comparable as the same criteria applies for both study periods for training.

A review of the histograms regarding the match day observations revealed that there was a significant drop of observations under 90 minutes for both study periods. A decision to only include observations over this threshold thus means that the data material is more comparable. As the starting players were fitted with the devices ten minutes before the start of games, observations with at least 90 minutes translates to around 65 minutes of game time minimum, which again equals more than two thirds of the full 90 minutes of a football match. The cutoff of one and a half hours was hence made to include as many observations as possible whilst maintaining comparable data.

The training the day after a game was excluded due to the possibility of variability in physical data. The training focus the day after a game was that unincluded players in the game train to replicate the intensity and fatigue induced from the game, and the intensity will for this reason be significantly higher than a normal team training session. The weeks that were originally planned to be examined were week numbers 10-13 before the first coach change and weeks 14-21 after this switch for both training and matches. For the second coach turnover, week numbers 21-24 before the switch and weeks 25-32 were formerly designed.

By excluding the training the day after a match, week 23 in the second training period was left with just one observation. For this reason, week 23 was excluded from the analysis and replaced by week 20 in this phase to maintain a four-week period of data before the coach change in the second study period. In similar fashion, week 32 in this period didn't have training observations available. Week 33 is for this reason included to maintain an eight-week period after this coach turnover.

A week with very few training observations would've given a very low data basis to produce the results. Week 23 and week 32 in the 2021 training set were thus replaced by weeks with a sufficient number of observations to secure that enough data material was provided to answer the research questions in this paper. In similar fashion, the second preseason match in 2019 was excluded as this game were only left with one observation after implementing the criteria of minimum 90 minutes. Match data files only took course over seven and six weeks after the coach change, for 2019 and 2021 respectively, instead of the planned eight weeks after the switch.

2.3 Subjects

All outfield players within a professional football club playing in the second division in the two periods were included in the analysis. The first group of players consist from the squad in pre-season and the start of the competitive season in 2019, while the other group are made up of the team at the start of the competitive season in 2021. An overview of which players were represented before and after a coach change was produced. This was done for both training

data periods and both match data periods. Only players that were present both before and after a coach turnover were included in the analysis for the training period or match period. 22 players were reduced to 19 for the training period in 2019, while 32 players were decreased to 27 in 2021 training. 17 players were examined from match data in 2019 with five players excluded, while six players were reduced for match data in 2021, leading to a total of 26 players.

2.4 Instruments

Global positioning satellite systems (Catapult, 10Hz for GPS tracking and 100Hz for IMU tracking, Melbourne, Australia) were utilized to collect data in this study (Catapult Sports, n.d.). The technology used in 2019 was Catapult Optimeye S5, while the instrument used in 2021 is called Catapult Vector S7. These wearable instruments from Catapult are tracking devices equipped on a sports vest that the players wear during training and games. The technology measure physical variables, and is used in football and other team sports. The players were fitted with the devices approximately ten minutes prior to training sessions to prevent possible errors or delays with the activations of the GPS tracking. Similarily, the starting players started wearing the vests around ten minutes before the start of the game. Subtitutes put on the vest right before coming on or when they started warming up.

2.5 Variables

Metabolic and locomotive variables were collected to carry out this study. The metabolic measures that were derived was total player load (2D and 3D), while the locomotive measures included total distance covered (TD), high-speed running distance (HSRD), higher than 19.8 km•h−1, sprint running distance (SRD), higher than 25.2 km•h−1, plus accelerometer-based variables (IMA) such as number of acceleration events (ACC) and deceleration events (DEC), and repeat high-intensity efforts (RHIE). The variables that detect distance covered has been reported on meters. Furthermore, every variable measures the player average of one single observation (one player in one training session or match).

Player load can be defined as total neuromuscular load in its three axes (vertical, anterior-posterior and medial-lateral), and is represented in arbitrary units (Reche-Soto, et al., 2019). A definition for player load by Catapult is “the sum of the accelerations across all axes of the internal tri-axial accelerometer during movement” (Julien, 2022). The definition when examining player load 2D in this study is consequently player load accumulated in the lateral and anterior-posterior planes, excluding vertical (Julien, 2022).

“Inertial Movement Analysis (IMA) is a set of metrics that measures athlete micro movements and direction regardless of unit orientation” (Julien, 2023). The definitions regarding the number of accelerations and decelerations can be explained using the criteria set for detecting acceleration efforts (Gen2) by Catapult Sports. The effort must be registered with a velocity higher than 5 km•h−1, and attempts with a duration less than 0.9 seconds

would not be reported. In addition, a correlation coefficient of the line detected is employed to determine if the effort is a reasonably smooth acceleration, with efforts registering a coefficient under 0.8 being excluded.

Additionally, efforts were excluded if they took place less than one second apart. If a new effort met all aforementioned criteria except that it took place less than a second before the last effort, the attempt would be reported as a single effort continuing from the previous attempt (Julien, 2022). The acceleration and deceleration efforts are divided into band 2-3 and band 3 efforts, with attempts in band 3 being of a greater velocity than attempts in band 2-3. Bands are "zones" set for specific metrics (Souza, 2022). "These bands allow for a more detailed breakdown and analysis of certain metrics such as velocity, acceleration and player load, etc" (Souza, 2022).

Catapult define repeat high-intensity efforts as velocity efforts without adequate recovery, with successive individual efforts that are repeated within a predetermined time frame grouped into RHIE bouts (Julien, 2022). RHIE bouts include the number of B1-B2-B3 accelerations, number of efforts in velocity band 3 and up, and number of IMA accelerations. Player movements can be quantified into low, medium and high intensity movement zones (Julien, 2023). The intensity zones used for IMA accelerations in this study are medium and high. The definition for IMA accelerations used in this study is hence total IMA movements registered in a forward acceleration vector within the medium band and the high band (Julien, 2022).

For a player to perform an effort in band 3 and up, a velocity of 14.5 km/h must be completed. The threshold set by the club to detect RHIE efforts is thus as follows: if a player performs two or more efforts in any of the aforementioned variables within a window of 21 seconds, a RHIE bout is reported.

2.6 Statistical analysis

Microsoft Excel for Mac 2021, version 16.54 was used for analysis in this study. Training and match data were analyzed isolated and was differentiated in four different categories (training 2019, match data 2019, training 2021, and match data 2021). T-tests analyzing two samples with assumed equal variances were used to examine the means of the metabolic and locomotion responses between the coaches (DC and NC) for each of the four study periods. This test was deemed sufficient to analyze the changes in variables between the two selections to answer the research questions.

To determine the meaningfulness of the difference between groups to enhance the interpretation of the findings, effect sizes (ES) using Cohen's d were calculated. This measure can hence be used to discover the significance of such a difference. The magnitude of effect sizes was considered trivial (<0.20), small (0.20 to 0.50), moderate (0.50 to 0.80), or large (>0.80) (Cohen, 1988). Statistical significance was set at an alpha level of 0.05 for both training sessions and match data.

Additionally, the smallest worthwhile change (SWC) was investigated for each variable. The SWC is a number that ascertains whether an actual meaningful change has occurred in the test results. It's been suggested that the SWC for elite athletes can be calculated as 0.2 multiplied by the standard deviation in team sports (Hopkins, 2004). "The calculation is based on Cohen's effect size principle, with 0.2 representing a small, but not trivial, effect size" (Conway, 2017, citing Sullivan & Feinn, 2012). Accordingly, 0.2 was multiplied with the standard deviation for all variables in the four periods to examine if a meaningful effect took place after the coach turnover.

2.7 Ethical considerations

The club was informed about the aim of the study and written consent was obtained from the club, in addition to the approval of the study by the Norwegian Centre for Research Data, and the ethical committee of the faculty at the University of Agder. A formalized cooperation agreement between the faculty at the university and the club was in place to grant permission to use data material belonging to the club. The study was conducted in accordance with the relevant ethical considerations. The data used in this study were thus anonymized. In accordance with research ethics, existing data is used in this study instead of collecting new data material, to avoid unnecessary strain on the field of practice and its participants.

3.0 DISCUSSION

3.1 METHODOLOGICAL DISCUSSION

3.1.1 Literature search

A literature search was completed on previous research done on coach changes in top football. This was done to gain an overview of the relevant literature and to identify potential needs for new knowledge on the topic. MEDLINE and SPORTDiscus were identified as potential databases for search after research articles in sports science. SPORTDiscus includes studies regarding sports, sports psychology, and sports physiology, while MEDLINE cover sports physiology. In addition to sports and sports physiology, sports psychology is connected to the research question in this paper, as the psychology of the players is of interest regarding the coach change. The players could be given a mental boost or a mental downfall after a turnover, and a new coach could provide an incentive for the squad to perform better and run more, as a means to secure your spot in the starting eleven (Kleinknecht & Würtenberger, 2021).

An advanced search employing the boolean search mode contained an ample array of relevant search words in order to find relevant research. Criteria included that the players and teams studied were playing at the top level and at senior level, in order to be able to draw comparisons across the different studies and select a threshold of the quality played. After

recognizing and adding other relevant studies for inspection, the number of 32 related articles on coach turnover in top football were deemed sufficient. Both contemporary and older studies were included in order to make a complete list of the relevant research.

3.1.2 Study design

This longitudinal study followed an inferential design, and considered quantitative historical data to be most appropriate. By using an inferential study design to compare the team either side of a coach turnover, this paper can be an addition to the research made on coach changes by making generalizations about the larger population of subjects (Kuhar, 2010, as cited in ScienceDirect, n.d.), in this case football players playing at the top senior level.

Both training and match data were examined as a way of getting the full perspective on the effects of the turnovers. There is a shortage of research done on the training effects of a coach change, and this study could hence be a supplement to the literature on this field. Paired with the match data as well; a more complete understanding of the performance climate at the time can be obtained. An explanation or discussion about the effects of a turnover can thus be easier to comprehend. An overview of which types of variables reporting significant effect in the period can be inspected and detected, as well as examining if the same type of variables had similar effect both in training and matches for the same period. Lastly, an evaluation of the likeness and differences of the effects between the two turnovers can be investigated both for training and match data.

Given that the first coach switch happened before the competitive season started, three pre-season games are available in this period of examination. However, since these matches happened at the end of the pre-season campaign, the matches were of importance and the team used their preferred line-up to prepare for the league season. These games were thus deemed applicable for comparison between before and after the coach change in this period. The exception is the second preseason match in this period, where shorter observations meant that this match were excluded from analysis. Various explanations for the differences in effect between the study periods can hence be explored, including manager types, playing formations, and playing style. Furthermore, the results produced by this study can be compared up against existing research made on this field, drawing comparisons to other relevant findings.

Balduck & Buelens (2007) argues that a coach turnover generally has the purpose of improving results in the short term. A host of studies have examined as little as four matches (Balduck, Buelens, & Philippaerts, 2010, Balduck & Buelens, 2007 and Guerrero-Calderón, Owen, Morcillo, & Castillo-Rodríguez, 2021), while other authors investigate a longer period of time on the effects of manager turnovers. The focus of this study is to investigate the short-term effects, and a study period of twelve weeks was for this reason determined for each year.

Lago-Peñas (2011) argues that the most common reason for dismissing a coach is the existence of a shock-effect, claiming that a new coach would be more fit to motivate the

squad to improve results. Eight weeks of examination after the dismissal was deemed appropriate to discover if a drop in effort took place after an initial peak, and to examine how long an immediate effect would last. Four weeks of inspection after the turnover could've hence given a more significant positive short-term effect.

The exclusion of certain weeks in the training data set in 2021 means that this study period spans over fourteen weeks as opposed to the planned twelve weeks. The league season had started in this period, meaning that a competitive match took place in week 23 in this period. As these matches were happening at the start of the season, the weeks before the turnover thus looked similar, but a prolonged period of five weeks before the dismissal means that the last four weeks would've given a better representation of the period right before the switch. Comparably, the penultimate week after the change was replaced by the week after, but as these weeks took place during an international break in the summer, this exclusion was not deemed to be a problem. By not excluding weeks, the results could have provided a truer picture of the performance climate at the time, if sufficient observations were available, but comparable weeks assures that a valid number of observations can be explored.

A weakness about this study is that the observations both for training and matches are widely distributed by duration, especially training data. Criteria to include only full training sessions and observations from matches over a certain playing time could not be obtained in order to maintain the anonymity of the players. These criteria would've meant that the observations would span over a more similar duration frame, and the results would for this reason represent more valid results of the effects of a coach change. The reason for this is that shorter observations will bring down the total values of the variables examined.

One other possible confounder is that the inclusion of pre-season matches could also mean that the players exhibited less effort because it wasn't a competitive match, but these matches were included in order to produce a wider range of games to study. Lastly, as the period in 2019 transitioned from pre-season to the competitive season, lighter sessions could occur after the change to manage training load on the players, and the results could've for this reason be negatively affected by this in training. This does not apply for 2021, as the whole period spans over weeks when competitive games were played.

3.1.3 Subjects

Goalkeepers were excluded from analysis as they run significantly less than outfield players; only outfield players are thus included in order to minimize variances in effort. As the team was playing in the second division both in 2019 and 2021, one could argue that the team's quality was more similar between the two years than if the team was playing in the first division in one of the periods. Furthermore, one might argue that the opposition that the team played against between the two seasons were more alike in quality than if the team played against first division teams in one of the years. A strength about this paper is hence that match data and training data are highly comparable as the team played in the same league in both study years. Another strength about the study is that both periods examined were in the start

of the respective seasons. For this reason, the years are highly comparable as the training focus and training volume will look alike between the periods.

Only players that had data files on both side of a coach turnover were included in order to have the same group of players on either side of the switch. One confounding factor that could disrupt the results is that players are represented unequally in analysis. Some players were present in all training sessions and some team members played almost all matches in the periods. On the other hand, some teammates only played a little bit before and after a coach change. This for example means that players that exhibit more effort in training and matches only represented a little before the change, but a lot after the change, could thus affect the results in this way.

Another confounder is that the groups of players are also unequally distributed by positions played. Bloomfield, Polman, & O'Donoghue (2007) evaluated the physical demands of Premier League players classified by three positional categories (defenders, midfielders, and forwards) by examining purposeful movement (PM). The authors found that "position had a significant influence on %PM time spent sprinting, running, shuffling, skipping, and standing still ($p < 0.05$) (Bloomfield, Polman, & O'Donoghue, 2007, p. 63). Furthermore, a key finding showed that "strikers performed most high to very high intensity activities and most contact situations" (Bloomfield, Polman, & O'Donoghue, 2007, p. 63). These actions coincide with variables such as repeat high-intensity efforts and player load, and an overload of strikers in a training week could thus mean higher values for these variables. Different positions will thus provide differences in total values and efforts for various parameters, and this could hence affect the results.

3.1.4 Instruments

The technology used in 2019, Catapult Optimeye S5, has been independently validated in over hundred peer reviewed scientific journals worldwide (Catapult Sports, n.d.). Catapult Vector S7, used in 2021, sets new standards for accuracy, usability, and efficiency (Catapult, n.d.). Wearable technology from Catapult have been independently validated and is trusted by more than 2500 teams worldwide, with the solutions proved at all levels of sport. The technology could be employed to optimize performance, reduce injury risk, and minimize the return to play after injury by monitoring the core metrics in football (Catapult Sports, n.d.).

The reliability and validity of Catapult innovations have been tested and verified in recent studies (Terziotti, Sim, & Polglaze, 2018 and Hoppe, Baumgart, Polglaze, & Freiwald, 2018). In addition, GPS has been shown to be an appropriate tool for acquiring physical data for load monitoring in football (Malone, et al., 2015 and Owen, Djaoui, Newton, Malone, & Mendes, 2017). The players were fitted with the devices approximately ten minutes before training and matches, and this ensures that errors or delays wih the activations of the GPS tracking can be minimized. Subtitutes employed the devices right before they get on, sometimes before warming up, thus ensuring that only relevant data was obtained.

3.1.5 Variables

Both metabolic and locomotive variables were included for analysis in this study to represent the effects of both distance covered on the pitch as well as the neuromuscular load induced by the efforts. By grouping the variables, one can gain an understanding of the results by interpreting the parameters together. By investigating the total distance covered, high-speed running and sprint running, an overview is possible to see how much total distance the players ran, in addition to seeing how much of a proportion this length was covered in higher velocities.

The amounts of accelerations and decelerations in different bands allows an understanding of how many increases and decreases in speed was produced, as well as a comparision of the different intensities of these accelerations and decelerations. Furthermore, these variables can be seen in combination with repeat high intensity efforts for a more complete perception of how many short intense activites were made in the training or match. Finally, player load 2D and 3D stands out from the aforementioned variables as these parameters provide a measure of the total workload performed independent of distance, producing an objective number on the strain induced by the players during the activity (Catapult, 2018).

Akenhead & Nassis (2015) examined the current practices and perceptions of training load and player monitoring in high-level football across 82 teams. Total distance covered, acceleration variables and high speed running were among the top-5 most used variables both in training and matches. In addition, sprint running distance is the third most used variable in match-play, and accelerometer based variables, such as player load, is the seventh most used measure in training. Furthermore, the study made by Nosek, Brownlee, Drust, & Andrew (2020) on perceptions of GPS-tracking within English professional football revealed that the training data coaches most commonly identified high-intensity actions and variables recognized by the coach as ‘work rate/intensity’ as the variables they would most like to see. These terms coincide well with the variable repeat high-intensity efforts. This means that every measured variable collected in this study is justified by relevant contemporary practice and literature.

3.1.6 Statistical analysis

To examine the effects of a coach turnover either side of the switch, only players that had data material both sides of the change was included to investigate the same group of players in the four study periods. Additionally, by assessing the smallest worthwhile change of each variable for each study period, this number can be used to explore how big the effect must be in order for it to be considered meaningful (Conway, 2017). This value can hence be used in combination with the total difference in total values before and after the coach turnover to discover if the difference between the switch for each period met the smallest worthwhile change for each parameter. The analysis chosen was deemed sufficient to answer the research questions in this paper. However, comparing each player either side of the turnover separately would’ve allowed for other analysis such as a paired-samples Wilcoxon-test. This would’ve

provided a mean for each player for each variable, and the weakness that players are unequally represented for the different periods in this study could have hence been avoided by using this method, which would mean each player are weighted equally in analysis.

3.1.7 Ethical considerations

All necessary approvals and agreements were obtained to receive data material from the club and undertake the aim of this study. The data material received was all anonymized, thus protecting the identity of the players as there was no way to identify the players from the data set. No other special considerations had to be taken care off. In similar manner, the identity of the club has been anonymized by not naming the club or revealing other information such as the competition of the different matches that were played in the periods, and dates for coach appointments.

By using existing data, the players undertook training sessions and played matches without being affected by being part of a research study. Valid results can thus be obtained as the players might would've overworked themselves in order to affect the results positively, if they knew the aim of the study. Unnecessary strain on the groups of players were thus avoided as the training sessions and matches were part of the planned training calendar and competitive season, and not done as part of a study.

3.2 DISCUSSION OF RESULTS

The training period in 2019 revealed four variables having a significant negative effect, including total distance covered, sprint running distance, total player load, and total player load 2D, with all parameters representing a small effect size. On the other hand, decelerations in band 3 had a small positive non-significant effect (table 1).

Only repeat high-intensity efforts had a statistically significant negative effect for matches in this year, with the effect size being small. On the contrary, sprint running distance, accelerations in band 2 to band 3, accelerations in band 3, decelerations in band 2 to band 3, and decelerations in band 3 all showed a small positive outcome relative to effect size after the turnover in matches (table 2).

For the training period in 2021, sprint running distance had a small positive effect size but a statistically significant positive outcome. On the other hand, decelerations in band 3 had a statistically significant and small negative influence after the switch (table 3).

Sprint running distance, both acceleration variables, and both deceleration variables all represented a small negative effect size after the coach change. In addition, high-speed running distance revealed a statistically significant negative effect, with the effect size being moderate (table 4).

3.2.1 Training 2019

Sprint distance for this period had a decline of 45 %. Three weeks had a clear drop in sprint meters, with one of these weeks taking place in week 11 before the turnover. This week came after a three-week training camp. Only two sessions were completed, and a lighter training load gave lower completed sprints. Week 18 and week 20 after the coach change had sessions between two games, as this was in the middle of the competitive season. A lower training strain was induced on the players, and an average sprint distance of 11 and 12 meters respectively would hence influence on the results for this variable in particular.

These weeks with few training sessions and a lower prescribed intensity could also explain the reductions for total distance covered, total player load, and total player load 2D. On the other hand, decelerations in band 3 showed an increase of 22 %. There were no clear differences for accelerations in this period, but values for decelerations can differ from accelerations, as decelerations can be the product of a lot of sudden stops of movement and changes of direction.

3.2.2 Matches 2019

Sprint running distance saw an increase of 25 % for matches in this period, which contradicts the -45 % reduction reported in training for this year. The lighter training weeks after the turnover can help explain the reduction in sprint for the training period, but it is still very opposing findings. One explanation for the positive effect in matches could be the coach´s playing style. The dismissed coach in this period had a playing style that focused on defensive structure, solidifying the team´s position, leading to a controlled playing climate. This style often led to few goals both for and against. 4-2-3-1 was the formation most used by the dismissed coach.

The new coach employed a similar approach to playing football. Likewise, the game plan was to remain compact defensively. In addition, the coach wanted to counter-attack as much as possible. This playing style could hence explain the increase in sprint distance for the players. Furthermore, the coach used 4-3-3 as the primary formation. This formation is similarly played as the 4-3-3, with elements such as four at the back, a triangle in midfield, in addition to wingers. One could thus argue that the playing style and playing formation utilized by the new coach could be easily adapted by the team, which then again could influence physical responses positively in combination with the shock-effect of a new coach.

This fast-paced attacking football can thus explain the 32 % increase in accelerations in band 3 as well. Accelerations in band 2-3, decelerations in band 2-3, and decelerations in band 3 also saw a positive effect in this period, highlighting a positive outcome in intensity. Repeat high-intensity efforts saw a reduction that was statistically significant. However, the reduction in means was still only 4,4 per player. This pattern of findings is a parallel to the study made by Guerrero-Calderón, Owen, Morcillo, & Castillo-Rodríguez (2021), who reported

significant higher phyisical responses with the dismissed coach in training, and at the same time a trend of higher physical responses with the new coach in games.

The pattern of an increase in sprint distance can also be detected when only examining the home games this year. Horrillo & Forrest (2007) only found a positive influence in performance after a coach turnover in home games, and they argue that a switch could appease the home crowd, thus creating a home advantage. When examining home game advantage over seven seasons, Balduck, Prinzie and Buelens (2010) also found a positive effect. Evidence from twenty years in the french league and nineteen seasons in the danish league respetively, revealed significant effects in performance only for home games in the short term (Arrondel, Duhautois, & Zimmer, 2020, and Madum, 2016). Sprint distance were reported to have an increase in home games for this paper in 2019, but as this paper examined the short-term effect of a turnover, this influence could've flattened out if the research in this study spanned over a longer time period.

One possible confounder for this period could be that three of four games played before the coach turnover was pre-season matches. The dismissed coach did use his preferred line-ups in preparation for the competitive period. However, if players were not 100 % motivated, a slight reduction in effort could negatively influence the physical responses produced. The intensity in pre-season matches could thus be slightly lower than a competitive game due to a lack of motivation. This could hence mean that lower values before the switch would lead to a higher positive effect from the coach turnover in the analysis.

The positive effects produced after the coach turnover in matches could thus be partly explained by the fact that the switch happened in pre-season. Evidence from thirty years in the Korean leauge found that positive effects on performances from a coach turnover was induced if the swtich happened pre-season, but negative lasting effects occured when the change happened in-season (Kim & Kim, 2015). As the new coach in this period begins before the competetive period starts, he has time to experiement and plan in pre-season, which could explain positive physical responses.

Kim & Kim (2015) also proclaim that whether the new coach is appointed internally or externally affect performance. The new coach appointed in 2019 was appointed internally. This means that the coach already possess knowledge about the players, the qualities they have, and the playing styles the team have equipped, which again could help the team transition from the dismissed coach to the appointed one in a successful manner. Existing knowledge could hence make the coach better equipped in team management which could translate into positive results.

Only eigth games were examined after the coach turnover, and the variables showing a positive effect didn’t seem to show any clear decline towards the end of the study period. Radzimiński et al. (2022) did report significant positive influences for variables such as total distance covered, high-speed running, and number of high-intensity runs. However, the authors concluded that the effects dissapeared after a period of five matches. With this in

mind, it would have been interesting to explore how long the positive outcomes in this period would have lasted.

3.2.3 Training 2021

A huge value of 68 % improvement was reported for sprint distance in this period. Structured training sessions with repeated sprint intervals completed with the new coach will naturally be a reason for this dramatic increase. A 7 % increase in high-speed running could also be a product of these sprint repetitions. Decelerations in band B3 did have a reduction of statistical significance, but the means only fell by less than two in total. The rest of the variables had very similar values between before and after the coach turnover in this study period, ranging from just -1% to 4% in effect. The large training group did hence produce very similar results either side of the turnover for seven of the ten variables examined.

3.2.4 Matches 2021

The enormous increase in sprint distance in training didn't successfully transfer over to games, as the results showed a 14 % decline. Similarly, high-speed running distance fell by 17 %, as well as a fall of 11 % in accelerations in band 3. Accelerations in band 2 to 3, decelerations in band 2-3 and decelerations in band 3 also showed negative results. These variables highlight how the intensity of play after the coach turnover took a hit in matches for this period. One reason for this could be a drastic change in style of play. As mentioned, the dismissed couch favored a counter-attacking style of attacking play. This approach to scoring goals demands runs of high intensity in order to enter scoring opportunities on the break.

On the other hand, the new coach employs a possession-based perspective, where the team has the aim of keeping the ball and play the opposition out of position. This way of playing was a very established way of playing, and a drop in sprint distance was a result of this. Furthermore, a very different formation was primarily used after the coach change. The team were used to playing 4-3-3, but were now changing to a 3-5-2. This change of formation could be harder for the players to get accustomed to. Three center-backs instead of two, wingbacks instead of full-backs and wingers, and two strikers instead of one pose new challenges for the group of players to learn and master.

A primary aim of this play style was to play out from the back. However, this is a challenging way of playing if this has not been of focus prior. A training period in matches to improve this part of the game followed, and a development in this area thus followed after a while. Nevertheless, when employing this tactic in the beginning matches, this way of playing could result in a lot of ball misses and more closed games. This could present a whole other type of match than counter-attacking play in the period before, as matches could become slower in pace and more "locked", which could explain the negative physical responses after the turnover.

Unlike the coach turnover in 2019, this switch happened when the competitive season had already started. Hence, this coach was not granted a pre-season period to get to know the players and experiment with different tactics. Habituating to a whole new team and players could thus take time to perfect, which could help explain the negative physical responses in the opening matches for the new coach. Similar findings can be found from Kim & Kim (2015), who only found negative lasting effects on performance when the coach turnover happened in-season.

These findings can be supported by evidence from over a quarter-century of match-level data in English football, where the authors concluded that, on average, teams that changed their manager within-season under-performed over the following three months (Audas, Dobson, & Goddard, 2002). It would for this reason be interesting to see if the results from this period would have increased in following weeks or months as the team adapted to a new playing style.

In contrast to the switch in 2019, the new coach in 2021 was appointed externally. One could for this reason argue that the coach would possess less about the skills and capabilities of the players, thus making it harder to even know what the best starting eleven would be. An adaptation period for the new coach to get to know the squad, and for the players to absorb the new tactics and playing style could hence be another reason for the negative influence on physical responses for matches in this period. These aspects could be supported by nineteen years' worth of evidence from the Bundesliga, where the authors found a negative effect on managerial succession, but even worse findings if the new manager was appointed externally (Salomo & Teichmann, 2000). Whether the new coach is appointed internally or externally does influence successive performances, also according to (Kim & Kim, 2015).

On the other hand, Lago-Peñas (2011) argues that the most common reason for firing a coach is the existence of a shock-effect, and claim that a new coach would be better equipped to motivate the players and hence improve results. Players could aqquire extra motivation in order to impress the new coach and win their place in the starting XI. This argument can be further supported by the findings made by Kleinknecht & Würtenberger (2021), who reported that only outsider successors induced players to exhibit higher effort after five matches. By using this logic, the negative influcence on physical variables for matches in 2021 can be seen as dissapointing. Nevertheless, negative physical responses after a coach turnover were also reported by Augusto et al. (2021), with variables such as high-speed running, sprinting, high-intensity actions and decelerations.

3.3 STRENGTHS AND LIMITATIONS

Strengths for this study include that both training and match data are available for examination for both coach turnovers. This allows that a full perspective on the performance climate can be explored at the time, and comparisons can be drawn between different periods. Furthermore, the fact that both changes happened at the start of the season mean that the data material is highly comparable. However, a weakness includes that duration times varies by

duration. Another confounder is that pre-season matches could mean that players exhibited less than a 100 % effort, hence influencing results. Lastly, providing a mean for each player would have provided more options more analysis, and a Wilcoxon-test could have given more valid results as each player would be weighted equally in analysis.

4.0 CONCLUSION

Total distance covered, sprint running distance, total player load, and total player load 2D all had a significantly lower value with the new coach compared to the dismissed coach for the training period in 2019. However, two weeks after the turnover with lighter sessions because of a busy competitive schedule could influence the results negatively. On the contrary, decelerations in band 3 had a small positive influence.

Repeat high-intensity efforts was the only variable having a statistically significant negative influence for matches in 2019. Unlike the training period for this coach turnover, the results in matches showed positve outcomes after the switch, with variables such as sprint running distance, accelerations in band 2-3, accelerations in band 3, decelerations in band 2-3, and decelerations in band 3 all increasing. The positive results could be explained by the transition to a more counter attacking playing style, resulting in a more intense style of play.

For the second coach turnover, sprint running distance increased by statistical significance (d=0.36). Repeated sprint intervals in training for this period could explain this drastic increase. On the contrary, decelerations in band 3 had a statistically significant negative outcome after the change.

The matches in 2021 painted a different picture, with sprint running distance, both acceleration variables, and both deceleration variables all reporting a small negative effect size after the turnover. In addition, high-speed running distance decreased with statistical significance. The negative results for matches in this period could be explained by an adaption to a more possession-based playing style, resulting in a slower attacking style of play. Furthermore, the second turnover happened in-season, hence not giving this coach time to experiment with the squad before competition started, thus also possibly negatively influencing the results for this period.

This paper concludes that a coach turnover does influence physical variables in the short term for both training and matches for a second division Norwegian football team. At least one variable reported an effect with statistical significance for all four study periods. A key finding from this study is that sprint running distance reported a small effect size for both training periods and both match periods, as well as showing statistical significance for both training periods. Furthermore, the results on sprint running distance revealed contrasting effects for both coach turnovers between training and games.

5.0 PRACTICAL IMPLICATIONS

Only eigth games were analyzed after the coach change in 2019, and the variables showing a positive influence didn't seem to show any clear reduction in values towards the end of the period. Radzimiński et al. (2022) reported significant positive outcomes for variables such as total distance covered, high-speed running, and number of high-intensity runs in the short-term. But in spite of that, the authors concluded that the effects dissapeared after a period of five matches. With these findings in mind, it would have been interesting to investigate how long the positive results from matches in 2019 for this study would have lasted.

On the other hand, the match period in 2021 showed negative physical responses after the turnover. Audas, Dobson, & Goddard (2002) reported that teams changing their manager in-season under-performed over the next three months. A study analyzing the physical responses of one or more coach turnovers for training and matches over a longer period of time would hence be fascinating in order to discover when a possible drop or peak in effort would occur.

This study could be used to see which variables could have an effect after a coach turnover. Intensity could drop or increase after a change, with sprint running distance having a small effect size for all periods examined in this study. This knowledge could hence be used in order to determine if a newly appointed coach has implented his playing style successfully.

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PART 2

RESEARCH PAPER

Effects of Coach Turnovers on Intensity for Training and Matches in a Norwegian Football Club

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Effects of Coach Turnovers on Intensity for Training and Matches in a Norwegian Football Club

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Effects of Coach Turnovers on Intensity for Training and Matches in a Norwegian Football Club

The aim of this study was to examine physical variables between four weeks before and eight weeks after two coach turnovers in a second division Norwegian football club for both training and matches. Individual physical data (n=1174 observations) was derived from the players using GPS-data in combination with the subjects employing wearable instruments from Catapult. The means for variables were divided into four study periods (training 2019, matches 2019, training 2021, and matches 2021) to analyze each variable for each of the four periods. The training period in 2019 revealed four variables having a significant negative effect, including total distance covered, sprint running distance, total player load, and total player load 2D, with all parameters representing a small effect size. Only repeat high-intensity efforts had a statistically significant negative effect for matches in 2019, with the effect size being small. For the training period in 2021, sprint running distance had a small positive effect size but a statistically significant positive outcome. On the other hand, decelerations in band 3 had a statistically significant and small negative influence after the switch. High-speed running distance revealed a statistically significant negative effect, with the effect size being moderate for matches in 2021.

Keywords: football, coach turnover, effect, training, match

Word count: 7272

Introduction

The world of football is in continuous development. A study on the English Premier League showed that high-intensity running distance and actions, sprint distance and number of sprints, and proportion of explosive sprints all increased in the 2012-2013 season compared to the 2006-2007 season (Barnes et al. 2014). Higher standards of play mean that players and managers must keep up with current levels and trends if they are to perform at the highest level of top football.

"The demands on a football player during a game can be determined from match analysis and physiological measurements during match play" (Bangsbo, 2014, p. 1). Given the evolution of technology, GPS tracking of player performance have become increasingly popular. Performance staff can use information from training and matches to guide managers by analysing running performances to best optimise team performance. Physical parameters can thus be obtained in order to monitor the taxing and utilization of players.

Football is characterized by intermittent work, where the players perform low-intensity activities for more than 70 % of the game. However, a player at the highest level performs 150-250 brief intense actions during the course of a game, illustrating that the percentage of actions being of high intensity is higher for a top player compared to a lower-league player (Bangsbo et al. 2006). "It is mainly the high-intensity exercise periods which are important, with the amount of high-speed running having been shown to be a distinguishing factor between top-class players and those at a lower level" (Bangsbo, 2014, p. 1). The physical demands of a professional football player can be described in as little as a simple word: intensity.

A study within professional English football analysed the perceptions of the use of GPS tracking. The coaches working on training data most commonly identified high-intensity actions and variables recognized by the coach as 'work rate/intensity', while players deemed total distance, high-speed running and sprint distances as the information they would most like to see (Nosek et al. 2020). As these variables are essential to performance in top football (Bangsbo, 2014), GPS tracking could hence be an effective and useful tool if used correctly. However, lack of a common goal and high volumes of information can be barriers to effective feedback of data (Nosek et al. 2020).

As the running demands in football are increasing (Barnes et al. 2014), it is the manager's job to coordinate the team to have the best chance of winning. That means imposing your own philosophy and style of play, as well as selecting a formation the team will play. Different formations will have different characteristics and perks, and running characteristics of the different formations could therefore differentiate. As a result, different manager types will produce different strategies both in training and match play to have the best chance of getting a good result.

Dismissing the coach is a drastic and frequent approach (Balduck & Buelens, 2007) that presents an option if performances are not at the level expected by the board of the club (Koning, 2003). This radical course of action could be used as a way of bringing in new ideas and hopefully an improvement in performance both in the short and long run. However, there are no guarantees that changing the manager is for the better, and whether the sacked manager deserved more time is often a question left unanswered.

Given the lack of studies in the literature that examine physical variables derived from training data, this paper aims to explore the effects of coach turnovers on intensity variables for both training and match data. The research questions in this paper is two-fold:

1) Is there a change in intensity after the coach turnover in training for the two periods between four weeks before the turnover and eight weeks after the change?
2) Is there a change in intensity after the coach turnover in matches for the two periods between four weeks before the turnover and eight weeks after the change?

Intensity is defined as individual physical variables examined in this study, and the variables examined are the following: total distance covered, high-speed running distance, sprint running distance, acceleration efforts in band 2-3, acceleration efforts in band 3, deceleration efforts in band 2-3, deceleration efforts in band 3, repeat high-intensity efforts, total player load, and total player load 2D.

Materials and methods

Literature search

A literature search was conducted on previous studies done on coach turnovers in top football. The search was conducted through the databases of MEDLINE and SPORTDiscus through the database host EBSCOhost. An advanced search using the boolean search mode included relevant search words and contained the following search string: "TI (football OR soccer) AND TI (coach* OR manager*) AND TI (GPS OR parameters* OR variables* OR intensity* OR effect* OR running* OR sprint* OR acceleration* OR endurance* OR performance*)". A total number of 142 studies were produced by the search.

Inclusion criteria to be incorporated in the complete list included that the study had to be written in English, and that the teams and players examined were playing at the top level and at senior level. This means that studies exploring youth football and non-professional football were excluded from the final list of studies in order to examine comparable findings. In addition, other studies were collected from the relevant studies found by the search and the identification process, which resulted in a final list of 32 relevant studies on coach turnover in top football. Both contemporary and older studies were included by not setting a time frame of when the study was published.

Study design

This longitudinal study followed an inferential design, using quantitative historical data to answer the research questions. To ascertain the influence of coach turnovers, individual physical variables on all players were analyzed during four weeks before and eight weeks after two coach changes within a professional second division club both for training and match data (n=1174 observations). The data was compared between dismissed coach (DC) and new coach (NC) for further analysis.

The first coach change happened in pre-season in 2019, while the other dismissal occurred at the start of the season in 2021. The new coach in 2019 were dismissed in the second period in 2021. The club obtain physical measures derived from GPS use from every training and game, and relevant data material was extracted for use in this study for further analysis. The first coach switch happened before the competitive season started. For this reason, three pre-season games are available in this period of examination. Figure 1 illustrates the aim of this research paper.

Four matches in total were available in the study period before the first coach change. This included three pre-season matches and a competitive game, whereas eight competitive matches were examined in the study period after the dismissal. Four competitive games were played in the period before the second coach change, with nine competitive games taking part in the period after this switch.

A decision to only include training sessions with a minimum duration time of thirty minutes was implemented for the following reason: the variability of duration times will be minimized and will thus explain less of the effects detected. This criteria also ensures that very short training sessions would not bring down the total values of the variables needlessly. Session observations with zero meters on distance covered were excluded as these instruments weren't used in training. Furthermore, a criteria of a minimum of a thousand meters of total distance was implemented in training as well. This decision was made after a detection of a clear drop in distance at this threshold for both 2019 and 2021, and this would ensure that the data material is more comparable both for duration and distance covered.

After completing an inspection of the histograms regarding the training sessions, the figures showed that the range and pattern of the durations looked similar for both 2019 and 2021. Considering that the training observations include a similar distribution of duration times, and the observations are deemed within a reasonable time frame, the decision to only include observations within the time frame of thirty minutes minimum could be supported for this study. This decision allows that the observations are comparable as the same criteria applies for both study periods for training.

A review of the histograms regarding the match day observations revealed that there was a significant drop of observations under 90 minutes for both study periods. A decision to only include observations over this threshold thus means that the data material is more comparable. As the starting players were fitted with the devices ten minutes before the start of games, observations with at least 90 minutes translates to around 65 minutes of game time minimum,

which again equals more than two thirds of the full 90 minutes of a football match. The cutoff of one and a half hours was hence made to include as many observations as possible whilst maintaining comparable data.

The training the day after a game was excluded due to the possibility of variability in physical data. The training focus the day after a game was that unincluded players in the game train to replicate the intensity and fatigue induced from the game, and the intensity will for this reason be significantly higher than a normal team training session. The weeks that were originally planned to be examined were week numbers 10-13 before the first coach change and weeks 14-21 after this switch for both training and matches. For the second coach turnover, week numbers 21-24 before the switch and weeks 25-32 were formerly designed.

By excluding the training the day after a match, week 23 in the second training period was left with just one observation. For this reason, week 23 was excluded from the analysis and replaced by week 20 in this phase to maintain a four-week period of data before the coach change in the second study period. In similar fashion, week 32 in this period didn't have training observations available. Week 33 is for this reason included to maintain an eight-week period after this coach turnover.

A week with very few training observations would've given a very low data basis to produce the results. Week 23 and week 32 in the 2021 training set were thus replaced by weeks with a sufficient number of observations to secure that enough data material was provided to answer the research questions in this paper. In similar fashion, the second preseason match in 2019 was excluded as this game were only left with one observation after implementing the criteria of minimum 90 minutes. Match data files only took course over seven and six weeks after the coach change, for 2019 and 2021 respectively, instead of the planned eight weeks after the switch.

Subjects

All outfield players within a professional football club playing in the second division in the two periods were included in the analysis. The first group of players consist from the squad in pre-season and the start of the competitive season in 2019, while the other group are made up of the team at the start of the competitive season in 2021. An overview of which players were represented before and after a coach change was produced. This was done for both training data periods and both match data periods. Only players that were present both before and after a coach turnover were included in the analysis for the training period or match period. 22 players were reduced to 19 for the training period in 2019, while 32 players were decreased to 27 in 2021 training. 17 players were examined from match data in 2019 with five players excluded, while six players were reduced for match data in 2021, leading to a total of 26 players.

Instruments

Global positioning satellite systems (Catapult, 10Hz for GPS tracking and 100Hz for IMU tracking, Melbourne, Australia) were utilized to collect data in this study (Catapult Sports, n.d.). The technology used in 2019 was Catapult Optimeye S5, while the instrument used in 2021 is called Catapult Vector S7. These wearable instruments from Catapult are tracking devices equipped on a sports vest that the players wear during training and games. The technology measure physical variables, and is used in football and other team sports. The players were fitted with the devices approximately ten minutes prior to training sessions to prevent possible errors or delays with the activations of the GPS tracking. Similarily, the starting players started wearing the vests around ten minutes before the start of the game. Subtitutes put on the vest right before coming on or when they started warming up.

Variables

Metabolic and locomotive variables were collected to carry out this study. The metabolic measures that were derived was total player load (2D and 3D), while the locomotive measures included total distance covered (TD), high-speed running distance (HSRD), higher than 19.8 km•h−1, sprint running distance (SRD), higher than 25.2 km•h−1, plus accelerometer-based variables (IMA) such as number of acceleration events (ACC) and deceleration events (DEC), and repeat high-intensity efforts (RHIE). The variables that detect distance covered has been reported on meters. Furthermore, every variable measures the player average of one single observation (one player in one training session or match).

Player load can be defined as total neuromuscular load in its three axes (vertical, anterior-posterior and medial-lateral), and is represented in arbitrary units (Reche-Soto, et al., 2019). A definition for player load by Catapult is “the sum of the accelerations across all axes of the internal tri-axial accelerometer during movement” (Julien, 2022). The definition when examining player load 2D in this study is consequently player load accumulated in the lateral and anterior-posterior planes, excluding vertical (Julien, 2022).

“Inertial Movement Analysis (IMA) is a set of metrics that measures athlete micro movements and direction regardless of unit orientation” (Julien, 2023). The definitions regarding the number of accelerations and decelerations can be explained using the criteria set for detecting acceleration efforts (Gen2) by Catapult Sports. The effort must be registered with a velocity higher than 5 km•h−1, and attempts with a duration less than 0.9 seconds would not be reported. In addition, a correlation coefficient of the line detected is employed to determine if the effort is a reasonably smooth acceleration, with efforts registering a coefficient under 0.8 being excluded.

Additionally, efforts were excluded if they took place less than one second apart. If a new effort met all aforementioned criteria except that it took place less than a second before the last effort, the attempt would be reported as a single effort continuing from the previous attempt (Julien, 2022). The acceleration and deceleration efforts are divided into band 2-3 and band 3 efforts, with attempts in band 3 being of a greater velocity than attempts in band 2-3. Bands are “zones” set for specific metrics (Souza, 2022). “These bands allow for a more

detailed breakdown and analysis of certain metrics such as velocity, acceleration and player load, etc" (Souza, 2022).

Catapult define repeat high-intensity efforts as velocity efforts without adequate recovery, with successive individual efforts that are repeated within a predetermined time frame grouped into RHIE bouts (Julien, 2022). RHIE bouts include the number of B1-B2-B3 accelerations, number of efforts in velocity band 3 and up, and number of IMA accelerations. Player movements can be quantified into low, medium and high intensity movement zones (Julien, 2023). The intensity zones used for IMA accelerations in this study are medium and high. The definition for IMA accelerations used in this study is hence total IMA movements registered in a forward acceleration vector within the medium band and the high band (Julien, 2022).

For a player to perform an effort in band 3 and up, a velocity of 14.5 km/h must be completed. The threshold set by the club to detect RHIE efforts is thus as follows: if a player performs two or more efforts in any of the aforementioned variables within a window of 21 seconds, a RHIE bout is reported.

Statistical analysis

Microsoft Excel for Mac 2021, version 16.54 was used for analysis in this study. Training and match data were analyzed isolated and was differentiated in four different categories (training 2019, match data 2019, training 2021, and match data 2021). T-tests analyzing two samples with assumed equal variances were used to examine the means of the metabolic and locomotion responses between the coaches (DC and NC) for each of the four study periods. This test was deemed sufficient to analyze the changes in variables between the two selections to answer the research questions.

To determine the meaningfulness of the difference between groups to enhance the interpretation of the findings, effect sizes (ES) using Cohen's d were calculated. This measure can hence be used to discover the significance of such a difference. The magnitude of effect sizes was considered trivial (<0.20), small (0.20 to 0.50), moderate (0.50 to 0.80), or large (>0.80) (Cohen, 1988). Statistical significance was set at an alpha level of 0.05 for both training sessions and match data.

Additionally, the smallest worthwhile change (SWC) was investigated for each variable. The SWC is a number that ascertains whether an actual meaningful change has occurred in the test results. It's been suggested that the SWC for elite athletes can be calculated as 0.2 multiplied by the standard deviation in team sports (Hopkins, 2004). "The calculation is based on Cohen's effect size principle, with 0.2 representing a small, but not trivial, effect size" (Conway, 2017, citing Sullivan & Feinn, 2012). Accordingly, 0.2 was multiplied with the standard deviation for all variables in the four periods to examine if a meaningful effect took place after the coach turnover.

Ethical considerations

The club was informed about the aim of the study and written consent was obtained from the club, in addition to the approval of the study by the Norwegian Centre for Research Data, and the ethical committee of the faculty at the University of Agder. A formalized cooperation agreement between the faculty at the university and the club was in place to grant permission to use data material belonging to the club. The study was conducted in accordance with the relevant ethical considerations. The data used in this study were thus anonymized. In accordance with research ethics, existing data is used in this study instead of collecting new data material, to avoid unnecessary strain on the field of practice and its participants.

Results

Training 2019

No significant differences were found for HSRD, ACC B2-3, ACC B3, and RHIE (d=0.06, -0.02, 0.02 and 0.07, respectively). A trivial positive influence regarding effect size was found for DEC B2-3 (d=0.11; p<0.313). A small positive difference relative to effect size was found for DEC B3 (d=0.21; p<0.059), while small negative outcomes was discovered for TDC, SRD, TPL, and PL2D (d=-0.26, -0.45, -0.33, and -0.30, respectively), with the effects being statistically significant.

Matches 2019

TDC, HSRD, TPL and PL2D revealed no significant differences after the turnover (d=0.02, 0.09, -0.04, and -0.04, respectively). A small positive effect relative to effect size was found for SRD, ACC B2-3, ACC B3, DEC B2-3, and DEC B3 (d=0.29, 0.32, 0.43, 0.27, and 0.21, respectively). RHIE showed small negative effects (d=-0.43; p<0.028), with the results being statistically significant.

Training 2021

Variables such as TDC, HSRD, ACC B2-3, ACC B3, and RHIE revealed no significant differences (d=-0.04, 0.09, -0.02, -0.02, and 0.07, respectively). Trivial positive outcomes regarding effect size were found for TPL and PL2D (d=0.13 and 0.11; p<0.393 and p<0.523). Trivial negative effects relative to effect size were discovered for DEC B2-3 (d=-0.13; p<0.105), as well as the results for DEC B3 showing statistical significance in a negative direction (d=-0.18; p<0.036). Lastly, statistical significance was detected for SRD (d=0.36; p<0.001).

Matches 2021

All variables showed a negative effect relative to effect size after the coach turnover in matches for this period. Trivial negative differences regarding effect size were detected for TDC, RHIE, TPL, and PL2D (d=-0.09, -0.11, -0.11, and -0.19, respectively). Small negative

outcomes relative to effect size were shown for SRD, ACC B2-3, ACC B3, DEC B2-3, and DEC B3 (d=-0.29, -0.28, -0.36, -0.34, and -0.28, respectively). A negative statistical significance was revealed for HSRD (d=-0.75; p<0.000).

Discussion

Methodological discussion

Strengths for this study include that both training and match data are available for examination for both coach turnovers. This allows that a full perspective on the performance climate can be explored at the time, and comparisons can be drawn between different periods. Furthermore, the fact that both changes happened at the start of the season mean that the data material is highly comparable. However, a weakness includes that duration times varies by duration. Another confounder is that pre-season matches could mean that players exhibited less than a 100 % effort, hence influencing results. Lastly, providing a mean for each player would have provided more options more analysis, and a Wilcoxon-test could have given more valid results as each player would be weighted equally in analysis.

Discussion of results

Training 2019

Sprint distance for this period had a decline of 45 % (figure 1). Three weeks had a clear drop in sprint meters, with one of these weeks taking place in week 11 before the turnover. This week came after a three-week training camp. Only two sessions were completed, and a lighter training load gave lower completed sprints. Week 18 and week 20 after the coach change had sessions between two games, as this was in the middle of the competitive season. A lower training strain was induced on the players, and an average sprint distance of 11 and 12 meters respectively would hence influence on the results for this variable in particular.

These weeks with few training sessions and a lower prescribed intensity could also explain the reductions for total distance covered, total player load, and total player load 2D. On the other hand, decelerations in band 3 showed an increase of 22 % (figure 2). There were no clear differences for accelerations in this period, but values for decelerations can differ from accelerations, as decelerations can be the product of a lot of sudden stops of movement and changes of direction.

Matches 2019

Sprint running distance saw an increase of 25 % for matches in this period (figure 3), which contradicts the -45 % reduction reported in training for this year. The lighter training weeks after the turnover can help explain the reduction in sprint for the training period, but it is still very opposing findings. One explanation for the positive effect in matches could be the coach´s playing style. The dismissed coach in this period had a playing style that focused on

defensive structure, solidifying the team´s position, leading to a controlled playing climate. This style often led to few goals both for and against. 4-2-3-1 was the formation most used by the dismissed coach.

The new coach employed a similar approach to playing football. Likewise, the game plan was to remain compact defensively. In addition, the coach wanted to counter-attack as much as possible. This playing style could hence explain the increase in sprint distance for the players. Furthermore, the coach used 4-3-3 as the primary formation. This formation is similarly played as the 4-3-3, with elements such as four at the back, a triangle in midfield, in addition to wingers. One could thus argue that the playing style and playing formation utilized by the new coach could be easily adapted by the team, which then again could influence physical responses positively in combination with the shock-effect of a new coach.

This fast-paced attacking football can thus explain the 32 % increase in accelerations in band 3 as well (figure 4). Accelerations in band 2-3, decelerations in band 2-3, and decelerations in band 3 also saw a positive effect in this period, highlighting a positive outcome in intensity. Repeat high-intensity efforts saw a reduction that was statistically significant. However, the reduction in means was still only 4,4 per player. This pattern of findings is a parallel to the study made by Guerrero-Calderón et al. (2021), who reported significant higher phyisical responses with the dismissed coach in training, and at the same time a trend of higher physical responses with the new coach in games.

The pattern of an increase in sprint distance can also be detected when only examining the home games this year. Horrillo & Forrest (2007) only found a positive influence in performance after a coach turnover in home games, and they argue that a switch could appease the home crowd, thus creating a home advantage. When examining home game advantage over seven seasons, Balduck et al. (2010) also found a positive effect. Evidence from twenty years in the french league and nineteen seasons in the danish league respetively, revealed significant effects in performance only for home games in the short term (Arrondel, Duhautois et al. 2016). Sprint distance were reported to have an increase in home games for this paper in 2019, but as this paper examined the short-term effect of a turnover, this influence could've flattened out if the research in this study spanned over a longer time period.

One possible confounder for this period could be that three of four games played before the coach turnover was pre-season matches. The dismissed coach did use his preferred line-ups in preparation for the competitive period. However, if players were not 100 % motivated, a slight reduction in effort could negatively influence the physical responses produced. The intensity in pre-season matches could thus be slightly lower than a competitive game due to a lack of motivation. This could hence mean that lower values before the switch would lead to a higher positive effect from the coach turnover in the analysis.

The positive effects produced after the coach turnover in matches could thus be partly explained by the fact that the switch happened in pre-season. Evidence from thirty years in the Korean leauge found that positive effects on performances from a coach turnover was induced

if the swtich happened pre-season, but negative lasting effects occured when the change happened in-season (Kim & Kim, 2015). As the new coach in this period begins before the competetive period starts, he has time to experiement and plan in pre-season, which could explain positive physical responses.

Kim & Kim (2015) also proclaim that whether the new coach is appointed internally or externally affect performance. The new coach appointed in 2019 was appointed internally. This means that the coach already possess knowledge about the players, the qualities they have, and the playing styles the team have equipped, which again could help the team transition from the dismissed coach to the appointed one in a successful manner. Existing knowledge could hence make the coach better equipped in team management which could translate into positive results.

Only eigth games were examined after the coach turnover, and the variables showing a positive effect didn't seem to show any clear decline towards the end of the study period. Radzimiński et al. (2022) did report significant positive influences for variables such as total distance covered, high-speed running, and number of high-intensity runs. However, the authors concluded that the effects dissapeared after a period of five matches. With this in mind, it would have been interesting to explore how long the positive outcomes in this period would have lasted.

Training 2021

A huge value of 68 % improvement was reported for sprint distance in this period (figure 6). Structured training sessions with repeated sprint intervals completed with the new coach will naturally be a reason for this dramatic increase. A 7 % increase in high-speed running could also be a product of these sprint repetitions (figure 5). Decelerations in band B3 did have a reduction of statistical significance, but the means only fell by less than two in total. The rest of the variables had very similar values between before and after the coach turnover in this study period, ranging from just -1% to 4% in effect. The large training group did hence produce very similar results either side of the turnover for seven of the ten variables examined.

Matches 2021

The enormous increase in sprint distance in training didn't successfully transfer over to games, as the results showed a 14 % decline (figure 8). Similarly, high-speed running distance fell by 17 % (figure 7), as well as a fall of 11 % in accelerations in band 3. Accelerations in band 2 to 3, decelerations in band 2-3 and decelerations in band 3 also showed negative results. These variables highlight how the intensity of play after the coach turnover took a hit in matches for this period. One reason for this could be a drastic change in style of play. As mentioned, the dismissed couch favored a counter-attacking style of attacking play. This approach to scoring goals demands runs of high intensity in order to enter scoring opportunities on the break.

On the other hand, the new coach employs a possession-based perspective, where the team has the aim of keeping the ball and play the opposition out of position. This way of playing was a very established way of playing, and a drop in sprint distance was a result of this. Furthermore, a very different formation was primarily used after the coach change. The team were used to playing 4-3-3, but were now changing to a 3-5-2. This change of formation could be harder for the players to get accustomed to. Three center-backs instead of two, wingbacks instead of full-backs and wingers, and two strikers instead of one pose new challenges for the group of players to learn and master.

A primary aim of this play style was to play out from the back. However, this is a challenging way of playing if this has not been of focus prior. A training period in matches to improve this part of the game followed, and a development in this area thus followed after a while. Nevertheless, when employing this tactic in the beginning matches, this way of playing could result in a lot of ball misses and more closed games. This could present a whole other type of match than counter-attacking play in the period before, as matches could become slower in pace and more "locked", which could explain the negative physical responses after the turnover.

Unlike the coach turnover in 2019, this switch happened when the competitive season had already started. Hence, this coach was not granted a pre-season period to get to know the players and experiment with different tactics. Habituating to a whole new team and players could thus take time to perfect, which could help explain the negative physical responses in the opening matches for the new coach. Similar findings can be found from Kim & Kim (2015), who only found negative lasting effects on performance when the coach turnover happened in-season.

These findings can be supported by evidence from over a quarter-century of match-level data in English football, where the authors concluded that, on average, teams that changed their manager within-season under-performed over the following three months (Audas et al. 2002). It would for this reason be interesting to see if the results from this period would have increased in following weeks or months as the team adapted to a new playing style.

In contrast to the switch in 2019, the new coach in 2021 was appointed externally. One could for this reason argue that the coach would possess less about the skills and capabilities of the players, thus making it harder to even know what the best starting eleven would be. An adaptation period for the new coach to get to know the squad, and for the players to absorb the new tactics and playing style could hence be another reason for the negative influence on physical responses for matches in this period. These aspects could be supported by nineteen years' worth of evidence from the Bundesliga, where the authors found a negative effect on managerial succession, but even worse findings if the new manager was appointed externally (Salomo & Teichmann, 2000). Whether the new coach is appointed internally or externally does influence successive performances, also according to (Kim & Kim, 2015).

On the other hand, Lago-Peñas (2011) argues that the most common reason for firing a coach is the existence of a shock-effect, and claim that a new coach would be better equipped to motivate the players and hence improve results. Players could aqquire extra motivation in order to impress the new coach and win their place in the starting XI. This argument can be further supported by the findings made by Kleinknecht & Würtenberger (2021), who reported that only outsider successors induced players to exhibit higher effort after five matches. By using this logic, the negative influcence on physical variables for matches in 2021 can be seen as dissapointing. Nevertheless, negative physical responses after a coach turnover were also reported by Augusto et al. (2021), with variables such as high-speed running, sprinting, high-intensity actions and decelerations.

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Declaration of interest

The author report there are no competing interests to declare.

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Table 1. Comparative analysis (t-test) between DC and NC for physical responses for training 2019

Data expressed as means ± SD

	DC (n=)	NC (n=)	*p*	*D*	*SWC*
TDC (m)	4851.4±1609.1	4452.0±1489.2	0.015	-0.26*	307.5
HSRD (m)	153.7±109.5	161.5±149.9	0.594	0.06	33.7
SRD (m)	64.6±80.4	35.2±46.8	0.000	-0.45*	12.3
ACC B2-3	34.0±26.5	33.4±23.1	0.823	-0.02	5.5
ACC B3	5.3±5.4	5.4±5.6	0.875	0.02	1.2
DEC B2-3	30.0±24.0	32.4±22.5	0.313	0.11	5.6
DEC B3	6.8±6.5	8.3±7.8	0.059	0.21	1.7
RHIE	22.5±8.9	23.0±7.5	0.495	0.07	2.0
TPL	526.2±165.1	474.3±146.3	0.001	-0.33*	41.6
PL2D	315.8±100.7	286.4±97.5	0.005	-0.30*	25.2

**p-value* of t-test: $p \leq 0.05$, *d*: Cohen's d (effect size), *SWD*: smallest worthwhile change.
DC: dismissed coach, NC: new coach
TDC: total distance covered, HSRD: high-speed running distance, SRD: sprint running distance, ACC: accelerations, DEC: decelerations, RHIE: repeat high-intensity efforts, TPL: total player load, PL2D: player load 2D

Table 2. Comparative analysis (t-test) between DC and NC for physical responses for matches 2019

Data expressed as means ± SD

	DC (n=)	NC (n=)	*p*	*d*	*SWD*
TDC (m)	10044.8±2113.7	10090.4±2192.8	0.910	0.02	434.4
HSRD (m)	475.3±208.9	494.8±236.6	0.691	0.09	45.7
SRD (m)	95.1±73.3	118.5±86.1	0.193	0.29	16.6
ACC B2-3	65.9±32.7	76.2±31.6	0.138	0.32	6.5
ACC B3	8.3±5.5	11.0±6.8	0.053	0.43	1.3
DEC B2-3	79.4±38.6	89.1±34.0	0.207	0.27	7.2
DEC B3	24.1±13.4	27.0±14.2	0.323	0.21	2.8
RHIE	46.6±10.9	42.2±9.8	0.028	-0.43*	2.0
TPL	1019.4±123.6	1012.7±216.2	0.869	-0.04	38.4
PL2D	603.5±119.8	597.9±133.8	0.829	-0.04	25.8

**p-value* of t-test: $p \leq 0.05$, *d*: Cohen's d (effect size), *SWD*: smallest worthwhile change

DC: dismissed coach, NC: new coach

TDC: total distance covered, HSRD: high-speed running distance, SRD: sprint running distance, ACC: accelerations, DEC: decelerations, RHIE: repeat high-intensity efforts, TPL: total player load, PL2D: player load 2D

Table 3. Comparative analysis (t-test) between DC and NC for physical responses for training 2021

Data expressed as means ± SD

	DC (n=)	NC (n=)	*p*	*d*	*SWD*
TDC (m)	5253.1±1451.9	5190.8±1696.7	0.419	-0.04	326.8
HSRD (m)	152.5±94.3	162.4±118.7	0.463	0.09	22.5
SRD (m)	31.3±42.1	52.6±73.8	0.001	0.36*	13.5
ACC B2-3	61.4±28.6	60.9±30.4	0.626	-0.02	6.0
ACC B3	15.7±9.2	15.5±8.7	0.616	-0.02	1.8
DEC B2-3	57.0±27.3	53.5±28.1	0.105	-0.13	5.6
DEC B3	16.5±9.4	14.8±9.6	0.036	-0.18*	1.9
RHIE	24.7±8.3	25.2±7.4	0.769	0.07	1.5
TPL	552.0±143.8	572.6±174.2	0.393	0.13	33.3
PL2D	330.3±82.5	340.0±99.2	0.523	0.11	19.0

**p-value* of t-test: $p \leq 0.05$, *d*: Cohen's d (effect size), *SWD*: smallest worthwhile change

DC: dismissed coach, NC: new coach

TDC: total distance covered, HSRD: high-speed running: distance, SRD: sprint running distance, ACC: accelerations, DEC: decelerations, RHIE: repeat high-intensity efforts, TPL: total player load, PL2D: player load 2D

Table 4. Comparative analysis (t-test) between DC and NC for physical responses for matches 2021

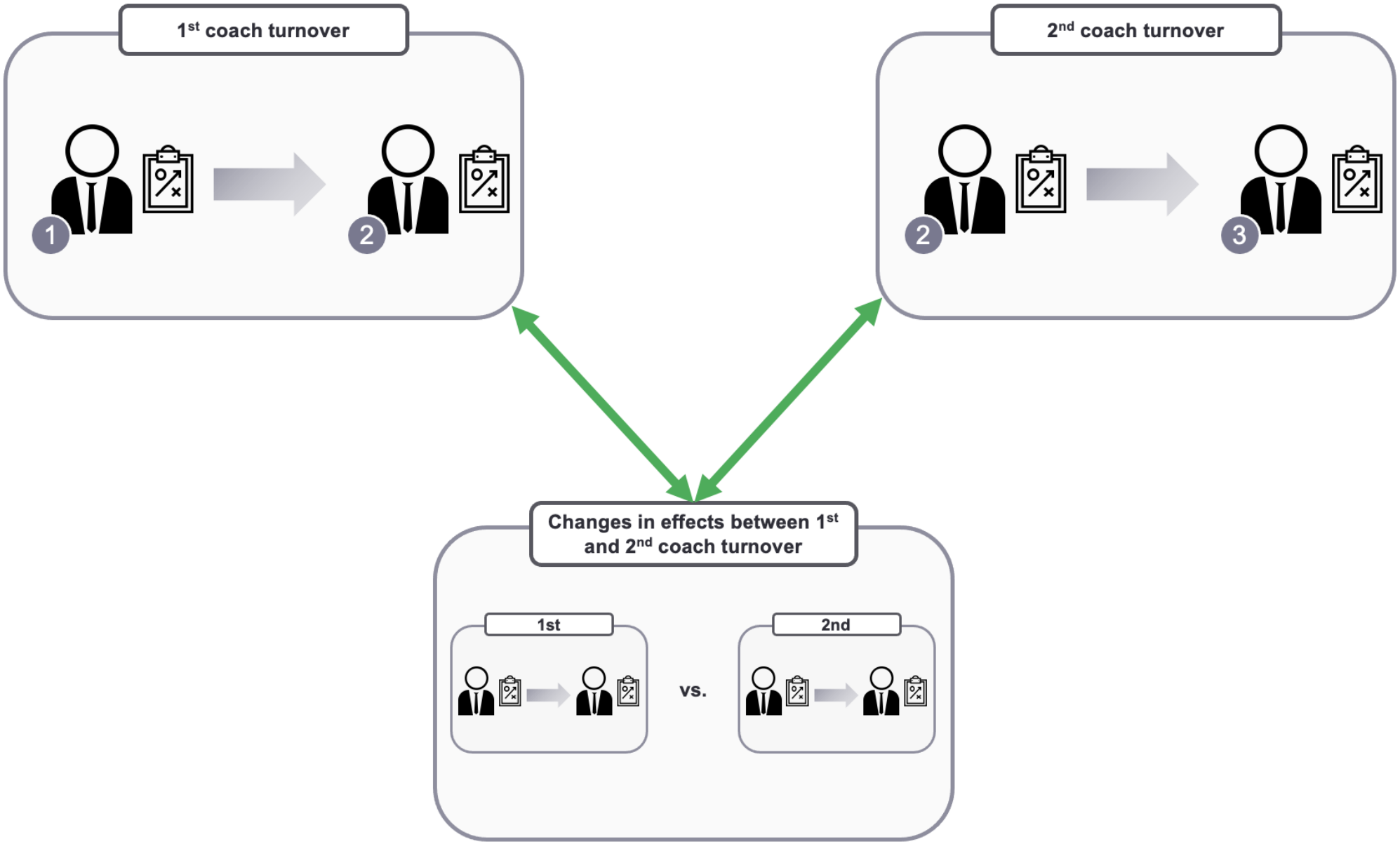
Data expressed as means ± SD

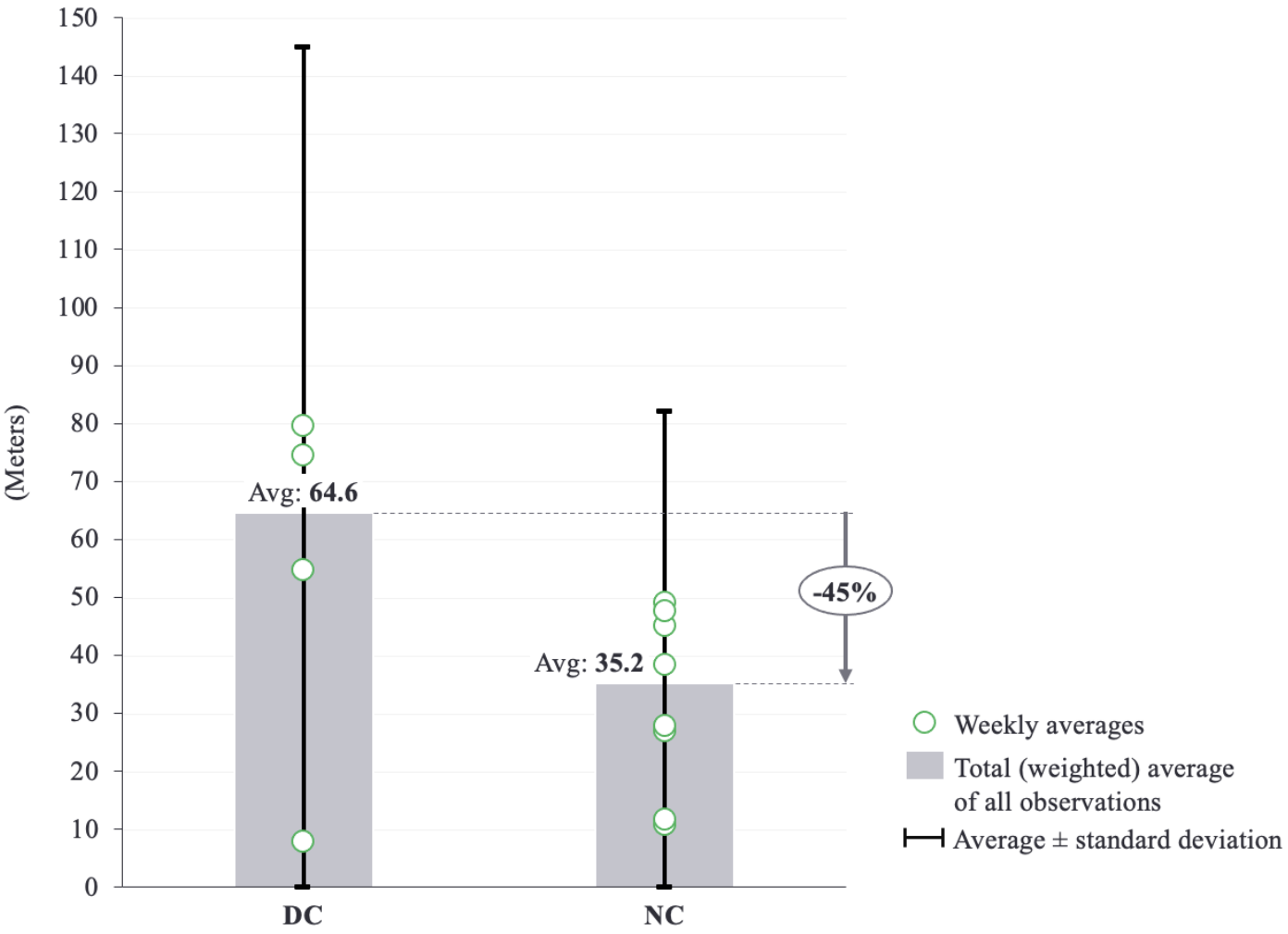
	DC (n=)	NC (n=)	*p*	*d*	*SWD*
TDC (m)	10394.6±1456.0	10260.6±1385.9	0.632	-0.09	280.7
HSRD (m)	606.3±142.3	503.5±130.7	0.000	-0.75*	28.4
SRD (m)	139.9±62.0	119.8±75.6	0.161	-0.29	14.4
ACC B2-3	108.9±21.5	103.2±19.2	0.151	-0.28	4.0
ACC B3	27.4±8.4	24.5±7.5	0.064	-0.36	1.6
DEC B2-3	111.8±22.8	103.9±23.0	0.087	-0.34	4.6
DEC B3	36.6±11.4	33.4±11.3	0.159	-0.28	2.3
RHIE	44.4±10.0	43.3±9.5	0.575	-0.11	1.9
TPL	1050.6±187.6	1031.4±169.6	0.583	-0.11	35.0
PL2D	619.6±113.0	600.1±92.8	0.327	-0.19	19.9

**p-value* of t-test: $p \leq 0.05$, *d*: Cohen's d (effect size), *SWD*: smallest worthwhile change

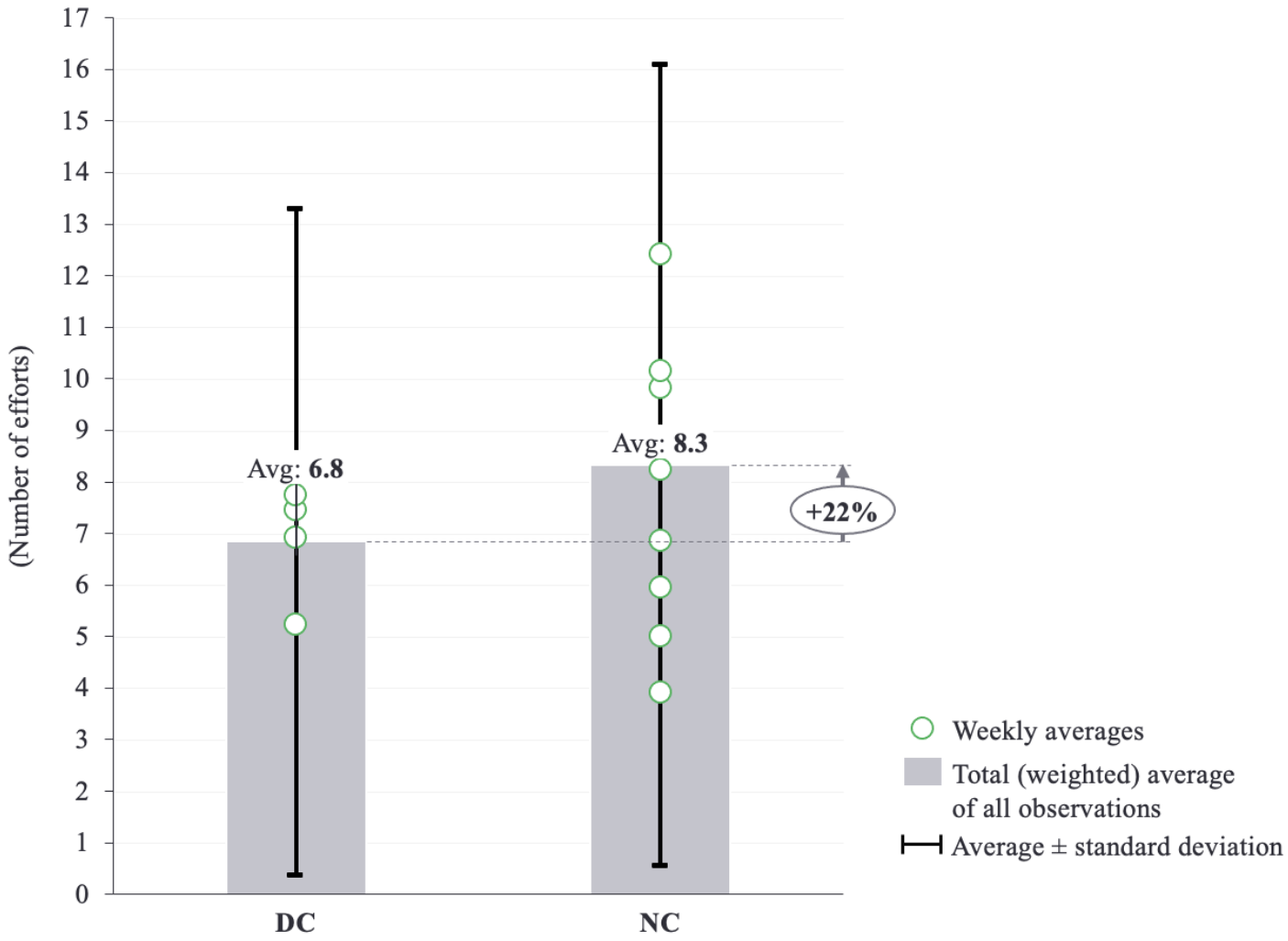
DC: dismissed coach, NC: new coach

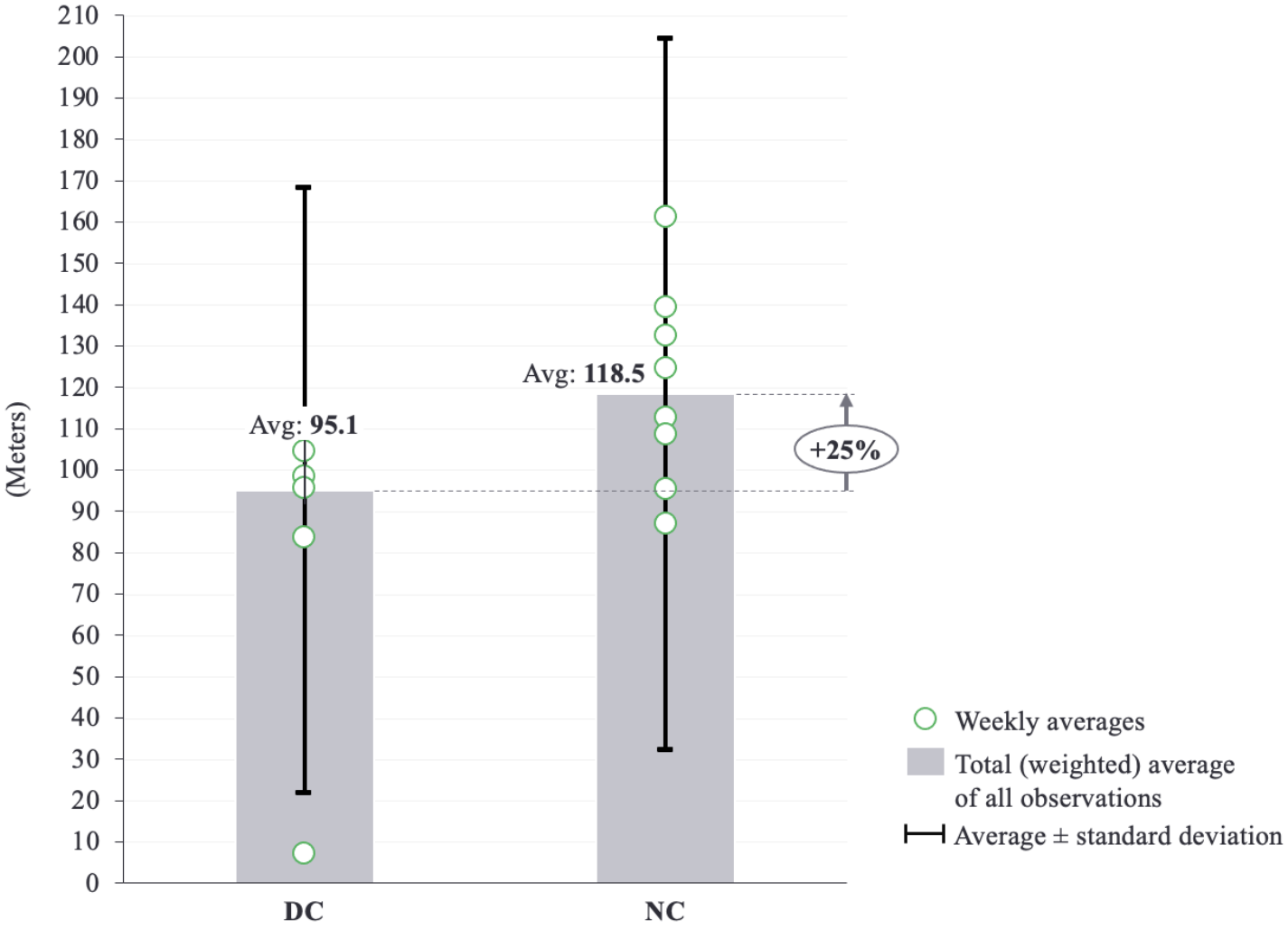
TDC: total distance covered, HSRD: high-speed running distance, SRD: sprint running distance, ACC: accelerations, DEC: decelerations, RHIE: repeat high-intensity efforts, TPL: total player load, PL2D: player load 2D

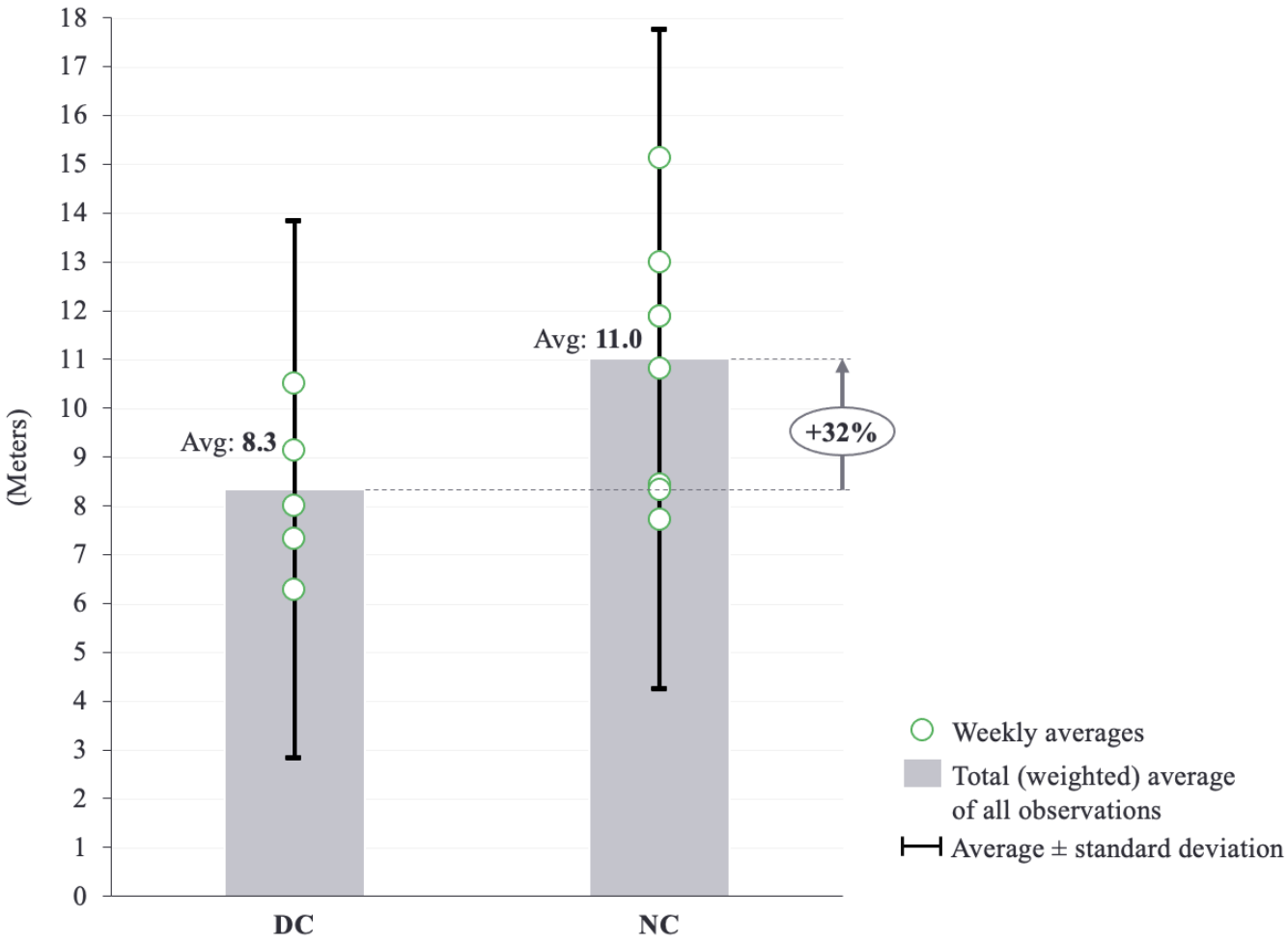

1st coach turnover
1
2
2nd coach turnover
2
3
Changes in effects between 1st and 2nd coach turnover
1st
vs.
2nd



Lower bound set to zero as standard deviation exceeds the average value


17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
(Number of efforts)
Avg: 6.8
Avg: 8.3
+22%
DC
NC
Weekly averages
Total (weighted) average of all observations
Average ± standard deviation


(Meters)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Avg: 95.1
Avg: 118.5
+25%
DC
NC
Weekly averages
Total (weighted) average of all observations
Average ± standard deviation


18
17
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7
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5
4
3
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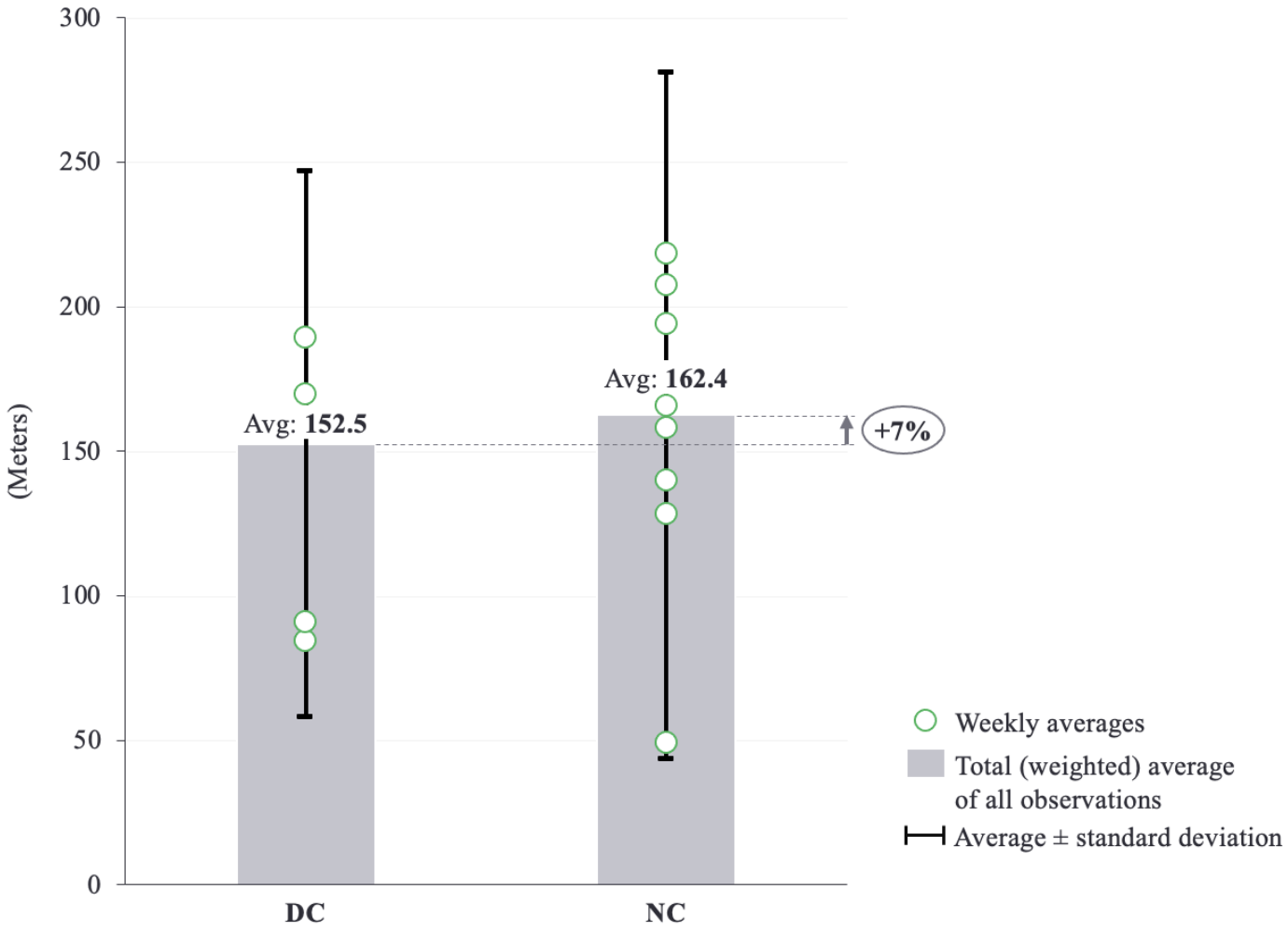
0
(Meters)
Avg: 8.3
Avg: 11.0
+32%
DC
NC
Weekly averages
Total (weighted) average of all observations
Average ± standard deviation


300
250
200
150
100
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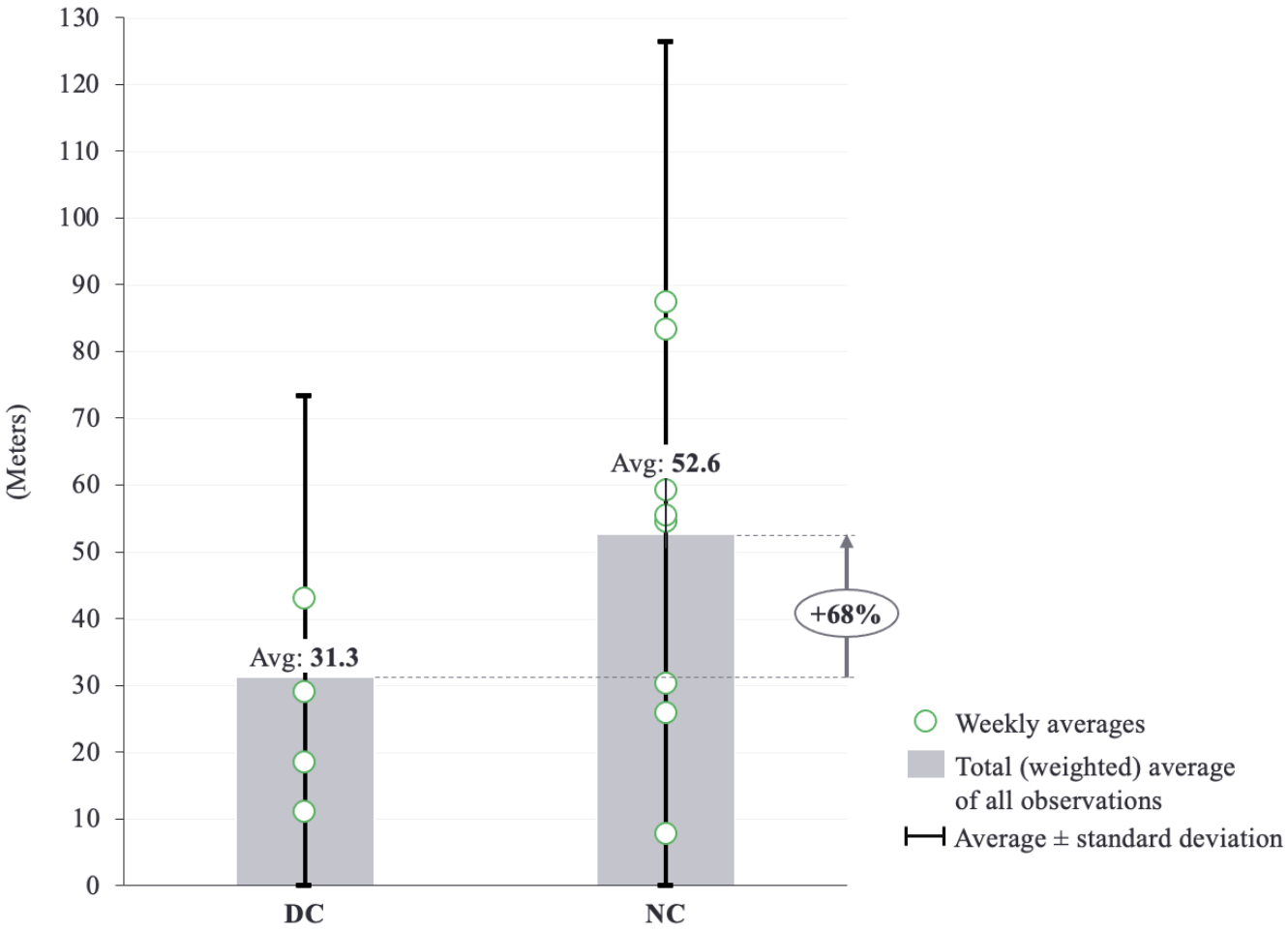
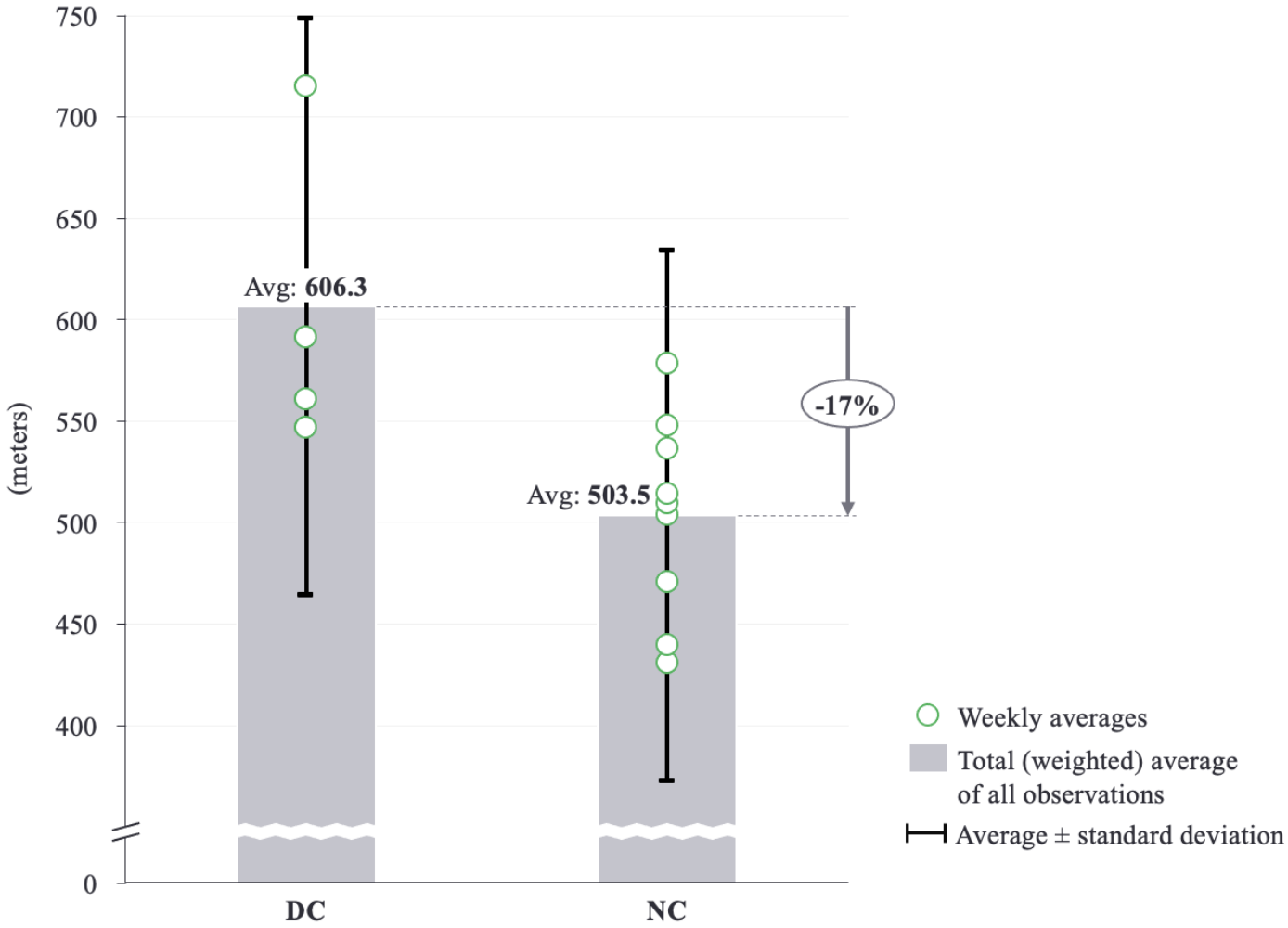
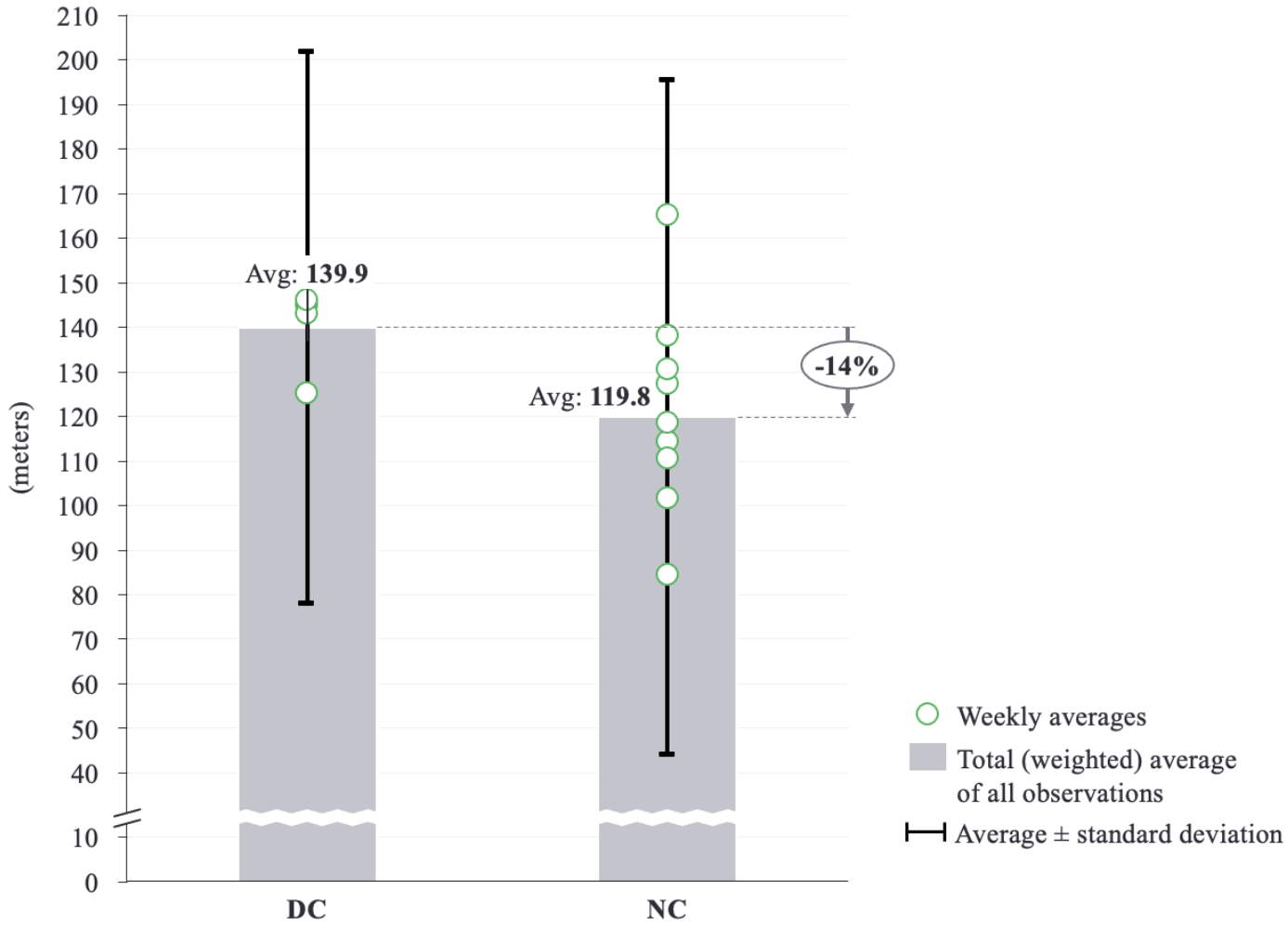
(Meters)
Avg: 152.5
Avg: 162.4
+7%
DC
NC
Weekly averages
Total (weighted) average of all observations
Average ± standard deviation



Lower bound set to zero as standard deviation exceeds the average value


750
700
650
600
550
500
450
400
0
(meters)
Avg: 606.3
Avg: 503.5
-17%
DC
NC
Weekly averages
Total (weighted) average of all observations
Average ± standard deviation


210
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100
90
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50
40
10
0
(meters)
Avg: 139.9
Avg: 119.8
-14%
DC
NC
Weekly averages
Total (weighted) average of all observations
Average ± standard deviation

Figure captions

Figure 1. Illustration of the aim of the study
Figure 2. Sprint running distance for training 2019
Figure 3. Deceleration B2-3 efforts for training 2019
Figure 4. Sprint running distance for matches 2019
Figure 5. Acceleration B3 efforts for matches 2019
Figure 6. High-speed running distance for training 2021
Figure 7. Sprint running distance for training 2021
Figure 8. High-speed running distance for matches 2021
Figure 9. Sprint running distance for matches 2021