

Article

Running more than before? The evolution of running load demands in the English Premier League

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1 **Running More than Before?**

2 **The Evolution of Running Load Demands in English Premier**
3 **League Football**

4

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26 **ABSTRACT**

27 **Purpose:** The purpose of this study was to assess the running load trends (total distance (TD), high
28 intensity distance (HID; $>5.5\text{ms}^{-1}$) and sprint distance (SprD; $>7\text{ms}^{-1}$)) in the English Premier League
29 (EPL) between the 2014/15 and 2018/19 seasons using a semi-automated optical tracking system.

30 **Methods:** 1634 games across 5 seasons (2014/15-2018/19) were analysed for team and positional TD,
31 HID and SprD. All matches were tracked using TRACAB® Gen-4 HD motion cameras. Data was analysed
32 to identify significant team and positional differences for each metric.

33 **Results:** Small to moderate increases were seen in team running load for TD ($p=0.02$; $ES: 0.21$), HID
34 ($p<0.001$; $ES: 0.88$) and SprD ($p<0.001$; $ES: 0.67$) between 2014/15 and 2018/19. Positional analysis
35 showed significant increases in TD for all except for defensive-midfielders, attacking-midfielders and
36 wide-midfielders ($p<0.001-0.009$; $ES: 0.14-0.36$); HID for all positions excluding goalkeepers
37 ($p<0.001-0.007$; $ES: 0.2-0.54$) and SprD for all positions except for goalkeepers, central-midfielders
38 and attacking-midfielders, ($p<0.001-0.020$; $ES: 0.19-0.39$). Trivial to small differences were seen in
39 season-to-season comparisons for TD ($p<0.001-0.023$; $ES: -0.16-0.52$), HID ($p<0.001 - 0.033$; $ES: 0.10-$
40 0.38) and SprD ($p<0.001-0.025$; $ES: 0.13-0.27$) for both team and positional differences.

41 **Conclusion:** Small to moderate increases in team TD, HID and SprD occurred in the EPL between
42 2014/15 and 2018/19, with trivial to small changes in season-to-season variations. Actual changes in
43 running load over time appear to be dependent on playing position. Running load trends should be
44 updated regularly and practitioners need to be aware that there may be variations within their team,
45 and program accordingly.

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55 **Introduction**

56 Player load monitoring is a common term used within elite football and is a consistent means of
57 assessing the running load players perform in both training and competition (1). Running loads during
58 competitive matches have been proposed to have become more intense, placing greater physical
59 stress upon the modern-day footballer (2). However, the literature underpinning this extrapolation is
60 dated, with almost 10 years since the last study in the English Premier League (EPL) (3) and may not
61 fully represent the running load profiles of players since 2013.

62 Running load outputs in competition are commonly obtained through either optical, or more recently
63 global positioning systems. High intensity distance (HID) in the EPL increased in games between 2006-
64 2013 (HID; +30%; $>5.5\text{ms}^{-1}$ and sprinting distance (SprD; +35%; $>7\text{ms}^{-1}$; (3)). Positionally, full backs
65 were shown to have the highest increases (HID: 35% and SprD 62%) and attackers the lowest (HID:
66 24% and SprD 36%; (4)). Therefore, consideration must be given to the evolving positional and
67 individual differences displayed in running load in relation to positional demands, to effectively
68 physically prepare players for their positional requirements (4,5). Additionally, inter-individual
69 differences related to team playing strategies and their associated positional requirements will affect
70 the running load requirements for the player over time (5).

71 Findings from previous studies have led to the assumption that the intensity of the game will continue
72 to evolve, with predicted increases of 40% in HID by 2030 (6). Further work has highlighted the
73 potential requirement for players to possess the capacity to perform greater acceleration and
74 deceleration movements more efficiently (2). There is a lack of recent evidence surrounding running
75 load (volume and intensity) demands on players within the EPL and predictions based on the work of
76 Barnes et al., (3) must be interpreted with caution due to the age of the study and improvements in
77 optical tracking technologies (7). For these reasons, it is important to update the current information
78 available to see if there are changes in running load trends.

79 The aim of the present study is to provide an update on team and positional running loads of
80 footballers in the EPL, seeing how these have evolved over the course of 5 seasons from 2014/15 to
81 2018/19. This will build upon the existing literature (3) and provide more insight into how the running
82 loads of EPL football have evolved.

83 **Methods**

84 ***Participants***

85 Running load data of 1397 players from 1872 games over a 5-season period (2014/15 to 2018/19)
86 were collated in the present study. Natural variation occurred in the 1397 players analysed between

87 the number of seasons played (table 2) and number of positions players played in throughout the
88 season (table 3). Due to change of optical tracking provider (from TRACAB® to Second Spectrum®) in
89 the 2019/2020 season and changes in stoppages (additional water breaks) and increased substitutions
90 due to the impact of COVID-19, data from the 2019/2020 season was excluded from the analysis.
91 Players were split by position, determined by OPTA statistics (www.optasports.com), for more
92 detailed analysis: goalkeeper (GK), centre back (CB), full back (FB), defensive midfielder (DM), centre
93 midfielder (CM), attacking midfielder (AM), wide midfielder (WM), centre forward (CF). 27 games in
94 the 5-year period did not have tracking data due to technical faults. Games where the match finished
95 with less than 22 players on the pitch (238 games; due to a sending off or injury) were removed from
96 this data set. This left 1634 games for analysis.

97 Table 1 displays the season-by-season number of games selected for analysis, number which finished
98 11v11, game duration, players utilised (in matches which finished 11v11). Ethical approval for the use
99 of match data was obtained from the host university, in accordance with the Helsinki Declaration.

100

101

****insert table 1 here****

102 Table 2 shows the number of players and the corresponding number of seasons they appeared in
103 the analysis.

104

****insert table 2 here****

105 Table 3 shows the number of players and the number of different positions they played in.

106

****insert table 3 here****

107

108 **Data Collection**

109 Positional tracking data for 1634 games over 5 EPL seasons was recorded by TRACAB® Gen-4 (TRACAB;
110 ChyronHego, New York, USA). The data for TRACAB® has been shown to be valid and reliable (8,9).
111 TRACAB® Gen-4 utilises 6 semi-automated HD cameras sampling at 25Hz, installed at a height of 36m
112 in the EPL stadiums. The dwell time (minimum effort duration) was set at 0.5s for HID running and 1s
113 to detect SprD efforts as per manufacturer's guidelines. Tracking data were measured throughout the
114 full game, including any stoppages, and added time. After the games, TRACAB® delivered a physical
115 summary file (Excel, .csv format) to the EPL portal. Activities analysed were total distance (TD) covered
116 by the players, absolute HID, (speed >5.5m/s) which combines high-speed running (5.5m/s – 7m/s)
117 and sprint (speed >7m/s) distances, and absolute SprD. These running load measurements were

118 chosen as they are frequently reported in the literature and are often monitored closely by
119 professional football clubs when analysing optical tracking data (1,10). All player data was
120 anonymised prior to analysis to ensure confidentiality.

121 ***Statistical Analysis***

122 Data was analysed for season-to-season changes in team and positional (GK, CB, FB, DM, CM, AM,
123 WM, CF) running load (i.e., 2014/15 compared to 2015/16; 2015/16 compared to 2016/17 etc.). The
124 data was processed and analysed using R software (<https://www.r-project.org/>), Rstatix and
125 Tidyverse.

126 A one-way ANOVA (used to determine whether there is a statistically significant difference between
127 the means of >3 groups) and Tukey's range test were used to analyse statistical significance. Statistical
128 significance was set at $p < 0.05$. The p-value was adjusted for multiple pairwise comparisons. The effect
129 size (ES) was calculated using Cohen's d to determine the relationship between the seasons evaluated.
130 The magnitudes were reported as trivial (<0.2), small (0.2–0.6), moderate (0.6–1.2) and large (1.2–2.0)
131 (11). A confidence interval of 95% (11) was used to show the difference in mean outputs between
132 successive seasons (i.e. 2014/15 to 2015/16; 2015/16 to 2016/17 etc.) and when comparing seasons
133 2014/15 to 2018/19.

134

135 **Results**

136 Team and positional running load characteristics (TD, HID and SprD) for each season are reported in
137 Table 4. Small to moderate increases in total team TD, HID and SprD were found when comparing
138 season 2014/15 to 2018/19.

139

140 ****insert table 4 here****

141

142 **Team Total Running Load**

143 Team total running load for TD, HID and SprD for each season are displayed in table 5. The main
144 findings here showed trivial to small changes (majority increases) from season-to-season for team
145 total TD, HID and SprD.

146

147

insert table 5 here

148

149 **Positional Running Load**

150 Table 6 details the positional breakdown for TD, HID and SprD running load covered season to season
151 (metres).

152

153

insert table 6 here

154

155 On a positional level, season-to-season changes showed trivial to small changes in running load
156 outputs for all positions apart from WMs who saw no significant change between seasons (table 6).
157 The majority of season-to-season running load changes were increases. However, while CB's exhibited
158 small increases in two of the seasons, there were also two seasons during the observation period
159 where they showed trivial decreases in TD. The combination of these trivial to small increases, cause
160 a small to moderate increase in running load over the five seasons. Small increases in TD were seen
161 for GK, CM and CF when comparing 2014/15 to 2018/19 (table 4), whilst trivial increases occurred for
162 CB and FB. A small decrease in TD was seen for AMs, whilst no differences were apparent for DM or
163 WM. GKs displayed no difference in HID and SprD between 2014/15 and 2018/19 seasons (table 4).
164 All other positions had significant small increases in HID (ES=0.25-0.54) and trivial (DMs) to small (CB,
165 FB, CM, AM, CF) increases in SprD between 2014/15 and 2018/19 seasons, with the largest increases
166 seen in CBs (HID (ES=0.54) and SprD (ES=0.38)) and CFs (SprD (ES=0.39)) (table 4).

167

168 **Discussion**

169 The aim of the present study was to update team and positional running load demands in the EPL and
170 look at the evolution across five seasons from 2014/15 to 2018/19. The most recent work identifying
171 running load demands in EPL football was completed by Barnes et al., (3), which may no longer be
172 representative of current positional game demands. Team totals increased for TD (small), HID
173 (moderate) and SprD (moderate) between the 2014/15 and 2018/19 seasons. On a season-to-season
174 basis, trivial to small changes were observed in some, but not all, of the five seasons analysed when
175 comparing to the previous season.

176 *Team Running Load*

177 Significant changes in TD, HID and SprD on a team level were observed between 2014/15 and 2018/19.
178 Previous literature reports increases in running load, 2006/07 to 2012/13 highlighting a 30% and 35%
179 increase in HID and SprD respectively (3). Recently, work by Nassis et al., (6), predicted an increase of
180 ~40% in HID by 2030, however the present body of work potentially highlights this may be
181 overestimated, highlighting increases of 12% and 15% for HID and SprD, respectively. Comparisons of
182 these data sets must consider the tracking technologies utilised to quantify the running loads.
183 Previous work (3) utilising Prozone technology had a sample frequency of 10Hz, whereas the
184 technology used in this study (TRACAB) samples at 25Hz, a factor which has been shown to increase
185 the accuracy of reported measurements (12). Research has indicated differences of ~50% in SprD
186 values when different tracking systems are utilised (7,13), potentially, explaining the over estimations
187 of earlier running load data sets. For this reason, regular updates of running load trends may be
188 required as technology advances and optical tracking providers change.

189 Interestingly, although mean season-to-season increases were noted for metrics of TD, HID and SprD
190 these were not consistently significant, again coherent with the findings of Barnes et al., (3). It is also
191 important to note no season saw a significant increase in all 3 variables in the same season, although,
192 over a longitudinal period all three displayed a significant increase. There could be important
193 implications to our findings, where practitioners should not ignore these incremental increases, as
194 rises in running loads should prompt the need to review training prescription and recovery methods
195 to ensure players are best prepared for game demands. These incremental increases may also allow
196 players to cope better with changes in match running load, allowing them to become more
197 accustomed and prepare for such increases. This could also be important for players coming from
198 academies, with trivial to small rises seen season-to-season; the compounding of these changes may
199 see players need to increase their average running load ~15% every 5 seasons. However, the running
200 load trends for academy players is not reported in the research literature (to our knowledge) and
201 should be addressed in future research. Additionally, the increase in the number of games through
202 additions of international tournaments may require players to produce higher running loads per game
203 as well as maintain it for more games, and more frequently, across the season. This could potentially
204 present an increased injury risk for a player, with higher demands required across a season.
205 Consequently, this places an increasing emphasis on appropriate training prescription to meet the
206 increased volume, frequency and density of running load alongside implementation of recovery
207 strategies around dense fixture periods.

208 It is possible that tactical changes to positions (e.g., more pressing / increase in number of CM in a
209 formation – 442 vs 532) over the years may have caused players to run differently (more or less)
210 season-to-season, but this is purely speculation. Increases in high velocity running load metrics, such

211 as HID and SprD, may be explained by evolving formational and tactical trends (14). Research suggests
212 football is moving towards a higher pressing (15) and more transitional game (16), with counterattacks
213 becoming a prominent way to score (17). These transitions have been shown to increase running load
214 demands (18) and could lead to increased speed of ball play. This potentially influences the managers
215 to select players who can perform at higher speeds, evolving the physical profiles of teams in the EPL,
216 consequently contributing to an increased running load profile of teams in the EPL. These outcomes
217 will be determined by a team's style of play, with trends being shown to differ among teams (19) and
218 leagues (20). In turn, a team's style of play is likely to influence the running load requirements for
219 individual positions within a team. Future work should consider the contribution of formational and
220 tactical influence on the longitudinal analysis of running loads.

221 *Positional Running Loads*

222 Most significant positional running load changes between 2014/15 and 2018/19 showed increases
223 across five seasons (table 4); however, AMs showed a small decrease in TD, highlighting the need for
224 practitioners to observe changes at a more granular level when making decisions around training and
225 recovery. Season-to-season running load showed most of the significant changes in positions were
226 increases, however, trivial decreases were seen in 2 seasons for CBs. This highlights how positional
227 running load can fluctuate season-to-season again emphasising the importance of practitioners
228 evaluating the running load demands in their teams and players regularly. Small and trivial increases
229 were seen in 2016/17 (ES=0.23) and 2017/18 (ES=0.18) for team TD. Positionally, 2016/17 showed
230 increases in TD by GK, CB, FB and CM and in 2017/18 increases in TD for CB, DM, CM and CF. Reasons
231 for this increase and more specifically in these seasons are unclear, but the increasing trend in
232 transitional football (16) may offer a partial explanation. Logically, evolving formational and tactical
233 demands could contribute to greater distances being covered (18,21) with faster transitions meaning
234 teams will have to move more in relation to the ball and opposition. The variations in the running load
235 outputs in each season highlight the importance for practitioners to understand the need to delve
236 deeper into match data, contextualising the running demands for individual players (22).
237 Contextualising data will allow staff to design training sessions to suit their teams and individual
238 players needs around their playing style (e.g., high press / counterattacking) and individual roles within
239 the team's training and playing methodology. The variability between players and even positions,
240 highlights the need to be aware of potential fluctuations in running load requirements through time,
241 suggesting that averages over longer periods cannot be the sole information used. Rolling averages,
242 maximum and minimum running loads may provide a richer source of information in the preparation
243 for the fluctuating demands of footballers. Over a season, increases in certain running load metrics on
244 a game-by-game basis, may mean players could be under prepared to compete at certain times in the

245 season. Practitioners may benefit by exposing players to higher running loads during training so
246 players are better prepared to cope with higher match running loads. Opposition teams may cause a
247 certain position to increase HID in matches through tactical reasons (e.g. transitions; 18). Should this
248 occur for a period of time, players may become overexposed to HID and could increase risk to
249 posterior thigh injury (23). This would require practitioners to adapt training demands for certain
250 individuals.

251 Interestingly, the TD reduced for CBs (2018/19 season) when there was a significant increase in HID
252 and SprD between 2016/17 and 2017/18 season. The reduced TD in the 2018/19 season may have
253 been due to a tactical response to reduce the opportunity for teams to counter by suppressing spaces
254 between the teams. Although not significant, this same pattern was seen for the CFs TD, HID and SprD
255 in the same seasons, suggesting that these may be linked to tactical responses. Previous research has
256 shown teams movements are linked with one responding to another (i.e., one goes forward, other
257 goes back; 24). Unfortunately, due to the data set used, we cannot see whether this trend was the
258 same for the 2015/16 season due to not having TRACAB® data for the 2013/14 season.

259 No significant changes in running load were observed season-to-season for WMs. Similarly, DMs
260 showed an increase in TD in one season (2017/18) and AMs in HID in one season (2016/17). This
261 suggests there may be no significant tactical changes in the roles of a WM, or any changes in tactical
262 requirements did not have a significant impact upon WM running load. Minimal changes are seen in
263 the DM and AM roles in the EPL between seasons. Whilst speculative and requires further
264 investigation, tactical changes over the years may be one explanation to why running loads have
265 changed. Alternatively, the athletic profiles of players in these positions may not have changed too
266 much over this period. Whereas increases seen in the HID and SprD between seasons for other
267 positions (and overall team values) may be due to the athletic profiles of some of the players chosen
268 to play. It is plausible that faster players might acquire greater absolute HID and SprD values due to
269 their ability to get to those speeds easier. This will be individual dependant, due to the different player
270 profiles within a team (25). Managers may believe having faster players in key positions allows them
271 to perform tactical requirements (e.g. increased speed of transitional football) which may increase
272 success in games. This may produce a “Darwinian effect” with those who possess these traits being
273 more likely to be picked for EPL teams.

274 **Conclusion**

275 The present study updates previous work observing longitudinal physical running load outputs in the
276 EPL (3,4,28). This paper adds to the work of Barnes et al., (3), by analysing season-to-season
277 comparisons. Running load demands between 2014/15 and 2018/19 have increased, but it is

278 imperative that practitioners in elite football understand that player running load profiles are changing
279 from season-to-season. Due to the inter-positional differences, it is key that staff consider the
280 contextual influence upon distances to inform the training prescription at their club, focused within
281 their respective game model. This increase in game running loads suggest practitioners are required
282 to prepare players for these greater demands, but we suggest this should be achieved by considering
283 ecological dynamics and incorporating contextual information such as position-specific conditioning
284 i.e., training that relates to key game moments, due to the positional running load differences seen.
285 The variability in the averages suggest that a long-term average alone may not be enough to build a
286 full understanding. Running load is likely to be affected by environmental and situational factors
287 around the player within the same game and from one game to another.

288 Running loads show differences between positions from season-to-season. Findings in the present
289 study detail that small to moderate increases in TD, HID and SprD were found for team totals in the
290 EPL between 2014 and 2019. Positional analysis highlights significant increases in HID for all positions
291 except GK, with SprD and TD significantly increasing for all positions except for CM/AM/GK and
292 WM/DM respectively. Trivial to small differences were found in team and positional TD, HID and SprD,
293 which when combined sees a bigger increase in running load over the time period analysed. This is an
294 important consideration for sports scientists responsible for the physical preparation of players for
295 competition and recovery strategies between games. As we did not find consistent increases for all
296 the seasons and all positions, this highlights the need for practitioners to understand the individual
297 player demands when assessing and preparing them for training and competition. Although, it is
298 important for practitioners to contextualise this information to establish why some teams, positions
299 and players run more than others and how this may affect match outcome. It is also suggested that
300 these trends need to be updated regularly to monitor running load patterns and see how the physical
301 demands are increasing for players in an ever-increasing fixture schedule.

302 **Future Research**

303 Running load is only one aspect of the game and an interaction between a myriad of factors is required
304 to create the optimal chance of winning a football match. Future studies should consider the effect of
305 running outputs on match outcome in the EPL. Previously, running has been suggested to be an
306 important aspect of a team's chance of winning (26,27). This may mislead practitioners and
307 underestimate the complexity of the game. Contextualisation of the running, how it relates to tactical
308 and formational change and an understanding of how different types of running influences match
309 outcome is needed. Emphasising the importance for researchers and practitioners to search for the
310 process, and how these impact upon team success. It is important to note that running more may not

311 be the desired outcome, but rather to be in the right place at the right time (28). Importantly, given
312 that football is not a 'brainless task' (29) the effects of increased running load may increase mental
313 fatigue for a player, which may affect the players decision making (30).

314 The incorporation of tactical elements within the physical data has started to be explored (22).
315 Additional tactical information in the future may provide an understanding as to whether players are
316 able to run more efficiently, affecting the movement of the team and increasing the chances of
317 successful outcomes (e.g. pass / goal). The speed of which certain movements are performed may
318 affect the chances of success and may determine the times in which a player should run faster or
319 more. Should this be a possibility, a better understanding from the player may preserve their running
320 load; allowing the player to "keep more in the tank" through pacing strategies (31) for the pertinent
321 moments in the game or for the next fixture.

322 Although this research is an update on previous findings, it is important practitioners begin to look at
323 if there are optimal moments in a game to run, which may increase potential for team success.

324 **Limitations**

325 Running load involves extensive (e.g. HID and SprD) and intensive (e.g. acceleration and deceleration)
326 measures (32). This paper focuses primarily on the extensive load of football. HID includes SprD within
327 that which may contribute to some of the findings. These metrics were chosen due to their use with
328 practitioners in football (1). It is also important to understand that a key part of the running load in
329 football is the intensive load (acceleration and decelerations). Current optical tracking technologies
330 are not capable of accurately determining acceleration and deceleration efforts (33), hence why they
331 were not analysed in this study. However, research has suggested that intensive outputs may play a
332 significant role in match play (2,34). Future research needs to look at this over multiple teams and
333 seasons to see if this is a contributing factor towards team success.

334

335 **Disclosure of Interest**

336 The authors report no conflict of interest

337

338 **Additional**

339 This paper was published with the permission of The Premier League but not implying the views of
340 The Premier League.

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