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Published in:
Science and Medicine in Football

DOI:
10.1080/24733938.2020.1789201

Routledge
Taylor & Francis Group

Science and Medicine in Football

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rsmf20

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SCIENCE AND MEDICINE IN FOOTBALL
2021, VOL. 5, NO. 1, 1–5
https://doi.org/10.1080/24733938.2020.1789201

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External load differences between elite youth and professional football players: ready for take-off?

Kobe C. Houtmeyers[a], Arne Jaspers[a], Michel S. Brink[b], Jos Vanrenterghem[a], Matthew C. Varley[c,d] and Werner F. Helsen[a]

[a]Faculty of Movement and Rehabilitation Sciences, KU Leuven, Leuven, Belgium; [b]Center for Human Movement Sciences, University of Groningen, University Medical Center, Groningen, Netherlands; [c]Sport and Exercise Science, School of Allied Health, Human Services & Sport, La Trobe University, Melbourne, Australia; [d]La Trobe Sport and Exercise Medicine Research Centre, La Trobe University, Melbourne, Australia

ABSTRACT This study examines differences in weekly load between the first (FT) and the under 19 team (U19) within a professional football setting. Data were collected in 11 FT and 9 U19 players (2016-2017 season). FT data was divided into weeks with (FT-M1) or without (FT-M0) a mid-week match. Indicators were total distance (TD) and TD at 12-15, 15-20, 20-25 and >25 km· h^{-1} and were analysed as external load (m), intensity (m· min^{-1}) and load monotony (a.u.). TD-based load was higher for U19 compared to FT-M0 (very likely moderate) and FT-M1 (likely large). Differences at higher velocities were substantially less (trivial to possibly small), with TD >25 km· h^{-1} being lower than FT-M0 (very likely moderate) and FT-M1 (likely small). All intensity indicators were lower for U19 (likely small to almost certainly large). Load monotony was higher compared to FT-M1 (possibly small to almost certainly very large). Compared to FT-M0, monotony was higher for TD (possibly very large) and TD >25 km· h^{-1} (possibly moderate) but lower for TD 12-15 (possibly small) and 15-20 km· h^{-1} (likely moderate). So, despite higher weekly external loads at low velocity for elite youth players, external intensity and load variation increases when these players may transition to professional football.

ARTICLE HISTORY
Accepted 21 June 2020

KEYWORDS
Load monitoring; intensity; monotony; player development; match congestion

Introduction

In professional football, youth academies aim to prepare players towards first team appearances (Relvas et al. 2010). In addition to tactical, technical and mental training, the development of physical fitness is essential to prepare the players for training and match demands at the professional level. For first teams, previous research in the English Premier League has reported increased running distances at high velocity in competitive matches from 2006 to 2013 (Bush et al. 2015), and periods of match congestion are known to impose additional demands on the player. (Carling et al. 2015) Therefore, when elite youth players transition to the first team, a sudden increase in training and match demands may be present, which should be avoided through ensuring a progressive increase in training and match load. (Brink et al. 2010b)

Previous research has described weekly loads in particular age groups. (Malone et al. 2015) In addition, research has focused on the differences in weekly load between youth categories. (Coutinho et al. 2015). However, little is known about differences in weekly load between elite youth and first team players. Therefore, the present study aims to examine differences in weekly load between the first team (FT) and the under 19 team (U19) within a professional football club. By including both congested (FT-M1) and non-congested weeks (FT-M0), this study aims to compare the weekly load of U19 players against different weekly scenarios and corresponding demands at the professional level. The examination and possible detection of differences in load may provide insight in what is needed to optimise the physical development during the transition to the first team.

Methods

Participants

Data were collected from 11 FT players (25.1 ± 2.8 years, 182.4 ± 5.4 cm, 79.7 ± 7.0 kg, 10.0 ± 1.3% body fat) and 9 U19 players (17.6 ± 0.6 years, 178.8 ± 6.3 cm, 69.8 ± 6.0 kg, 9.4 ± 2.2% body fat). Both teams were part of the same professional football club that competed in the highest league in the Netherlands. The study was conducted according to the requirements of the Declaration of Helsinki and was approved by the KU Leuven ethics committee (s57732).

Design

In-season training and match data were collected during the 2016–2017 season. U19 players had a regular one-match per week schedule. FT players competed in 3 official competitions across the season, including the national league, cup and the Europa League. Therefore, FT often played a mid-week match. To compare the weekly load of U19 against both congested and non-congested weeks, FT data were divided into 2 types of playing weeks (i.e., 1 match/week [FT-M0] and 2 matches/week [FT-M1]). Data were only considered for players who played all

CONTACT Kobe C. Houtmeyers kobe.houtmeyers@kuleuven.be Department of Movement Sciences, Katholieke Universiteit Leuven, Leuven, Belgium
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Table 1. Mean (±SD) weekly indicators and mean differences (±90% CL) between teams.

Indicator		Under 19 (U19)	First team (FT-M0)	First team (FT-M1)	Difference U19 vs M0	Difference U19 vs M1
No. of weeks (n)*		33	22	33		
No. of sessions (n)**		6.3 (±0.9)	5.0 (±0.0)	5.0 (±0.0)		
Duration (min)		496 (±60)	397 (±32)	365 (±13)	**99 (±21)**	**132 (±18)**
TD	LOAD (m)	35,265 (±3863)	31,084 (±2808)	30,580 (±2366)	**4180 (±1508)**	**4684 (±1320)**
	INT (m· min^{-1})	71.3 (±5.0)	78.4 (±5.3)	84.0 (±6.7)	**−7.1 (±2.4)**	**−12.7 (±2.4)**
	MON (a.u.)	1.55 (±0.22)	1.30 (±0.06)	1.10 (±0.05)	**0.25 (±0.08)**	**0.45 (±0.08)**
TD 12–15 km· h^{-1}	LOAD (m)	3743 (±775)	3473 (±839)	3529 (±746)	**269 (±377)**	**213 (±312)**
	INT (m· min^{-1})	7.6 (±1.3)	8.7 (±1.8)	9.7 (±2.0)	**−1.2 (±0.6)**	**−2.1 (±0.7)**
	MON (a.u.)	1.04 (±0.12)	1.10 (±0.15)	0.86 (±0.07)	**−0.06 (±0.07)**	**0.18 (±0.05)**
TD 15–20 km· h^{-1}	LOAD (m)	2967 (±625)	2881 (±708)	2942 (±773)	**86 (±313)**	**25 (±289)**
	INT (m· min^{-1})	6.0 (±1.1)	7.2 (±1.5)	8.0 (±2.1)	**−1.2 (±0.6)**	**−2.1 (±0.7)**
	MON (a.u.)	0.96 (±0.12)	1.07 (±0.14)	0.85 (±0.08)	**−0.11 (±0.06)**	**0.10 (±0.05)**
TD 20–25 km· h^{-1}	LOAD (m)	1036 (±271)	961 (261)	983 (316)	**75 (±122)**	**52 (±121)**
	INT (m· min^{-1})	2.1 (±0.5)	2.4 (±0.7)	2.7 (±0.9)	**−0.3 (±0.3)**	**−0.6 (±0.3)**
	MON (a.u.)	0.90 (±0.21)	0.93 (±0.09)	0.77 (±0.07)	**−0.03 (±0.08)**	**0.12 (±0.08)**
TD >25 km· h^{-1}	LOAD (m)	214 (±111)	333 (±128)	294 (±154)	**−118 (±56)**	**−79 (±62)**
	INT (m· min^{-1})	0.4 (±0.2)	0.9 (±0.4)	0.8 (±0.4)	**−0.4 (±0.2)**	**−0.4 (±0.1)**
	MON (a.u.)	0.83 (±0.44)	0.64 (±0.11)	0.68 (±0.10)	**0.19 (±0.16)**	**0.16 (±0.16)**

TD, total distance; INT, intensity; MON, monotony.
[a]The total number of individual player weeks (e.g., player 1: 3 weeks + player 2: 2 weeks + …).
[b]Training + match.

weekly matches in full and took part in all team training sessions during that week. No individual sessions were included because these sessions were only present in the context of on-field rehabilitation sessions. These sessions, along with recovery and gym sessions, were excluded from the analyses.

Methodology

External load was measured using 10 Hz GPS technology, OptimEye S5 for FT and OptimEye X4 for U19 (Catapult Sports, Melbourne, Australia), and processed using the same software version (Sprint^{TM}, version 5.1.7) and settings. To minimise the potential error by using different GPS devices, a consistent data processing method was applied similar to the methodology applied in earlier research and advised in guidelines for using GPS devices in sports (i.e., visual inspection of spikes, >8 satellites, horizontal dilution of precision <1.5) (Malone et al. 2017; Jaspers et al. 2018). Indicators were expressed as external load, external intensity and external load monotony values per week. (Gaudino et al. 2015) External load indicators were total distance (TD) and the distance covered at 12–15, 15–20, 20–25, >25 km· h^{-1}. To calculate external intensity, the distance values (m) were divided by the duration (min) (Gaudino et al. 2015). Finally, weekly external load monotony was used to provide an indication of the within-week load variation. It was calculated as the weekly mean external load divided by the weekly standard deviation (Foster 1998).

Statistical analysis

Raw data are presented as means (±SD) and between-group differences as means (±90% compatibility limits (CL)). The Shapiro–Wilk Test of Normality indicated that assumptions of normality were violated (SPSS version 26, IBM Corp., Armonk, USA). Prior to analysis, all data were therefore log-transformed to reduce skewness or heteroscedasticity. Between-group differences were examined using general linear models and standardised using Cohen's d principle with 90% CL. Probabilities were used to make a qualitative probabilistic mechanistic inference about the true effect using the following scale: >25 – 75%, possibly; >75-95%, likely; >95-99%, very likely; >99%, almost certainly. The magnitude of the effect was determined from its observed standardised value (Δ means/pooled between-participant SD) using the following scale: >0.2 (small), >0.6 (moderate), >1.2 (large) and >2.0 (very large). All analyses were performed in a customised Excel spreadsheet (Hopkins 2006).

Results

Table 1 shows the mean (±SD) for weekly indicators of U19, FT-M0 and FT-M1, as well as the mean differences (±90% compatibility limits) between the teams. In Figure 1, the standardised differences (±90% CL) in weekly external load, intensity and load monotony are presented for U19 vs. FT-M0 and U19 vs. FT-M1.

External load

U19 performed 1 field session more per week than FT-M0 and FT-M1, resulting in a higher duration (large and very large magnitude) and TD (moderate and large). However, the additional time was mainly spent in the lower velocity zones (< 12 km· h^{-1}), with differences in TD at 12–15, 15–20 and 20–25 km· h^{-1} ranging from trivial to small. In fact, their TD at >25 km· h^{-1} was lower compared to FT-M0 (moderate) and FT-M1 (small).

External intensity

In terms of intensity, all indicators were lower for U19 (FT-M0: small to large, FT-M1: moderate to large).

External load monotony

External load monotony indicators were higher for U19 compared to FT-M1 (small to very large). External load monotony

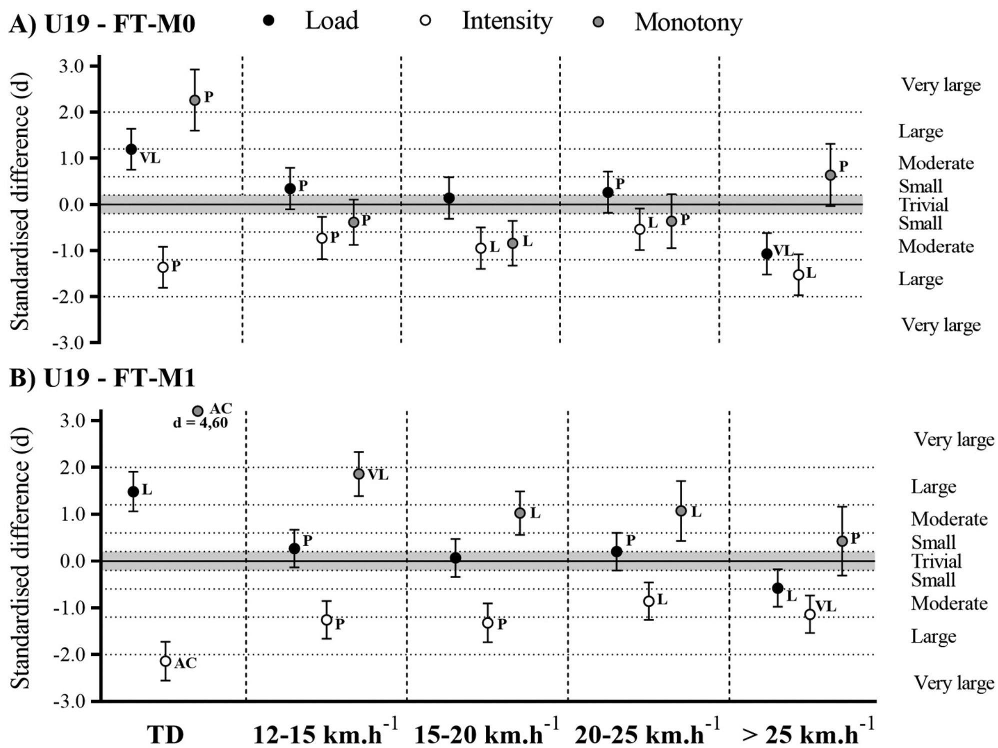

Figure 1. Standardised differences in weekly external load, intensity and load monotony between U19 and FT-M0 (A) and FT-M1 (B). Positive differences indicate higher U19 values. P, possibly; L, likely; VL, very likely; AC, almost certain; TD, total distance.

was also higher compared to FT-M0 for TD and TD at >25 km· h^{-1} (moderate to very large), while it was lower for TD at 12–15 and 15–20 km· h^{-1} (small to moderate).

Discussion

To our knowledge, this is the first study examining differences in weekly load between U19 and FT players within a professional football setting. For external load, results were inconsistent across velocity zones. U19 players covered more distance in total but this difference was mainly the result of a higher low-velocity distance (<12 km· h^{-1}). This was partly explained by a higher number of weekly sessions (U19: 6.3 vs FT: 5.0). Previous research has indeed demonstrated the importance of training volume to build a basic physical foundation in elite youth football players. (Brink et al. 2010a). However, for running velocities above 25 km· h^{-1}, the total distance was in fact less than in FT players. This discrepancy in results between low and high-velocity distances was also found for external match loads. So, although U19 covered overall more distance on a weekly basis, they did not reach similar external sprint loads as FT players, both during training and matches.

In terms of external intensity, U19 players covered considerably less distance per minute in both low and high-velocity zones. When compared to FT-M1, this gap in external intensity may have resulted from a relatively lower exposure to match time, while in comparison with FT-M0, as illustrated in Figure 2, this difference resulted from a generally lower external training intensity (MD-5, MD-4 and MD-2), as the external match intensity was found to be higher in U19 players. Therefore, the current data shows that FT players are more used to shorter training sessions at higher external intensity. Although U19 players need longer session durations for development, introducing them to shorter training sessions at higher intensity might also be required to prepare them for this type of training when they transition to the FT.

Finally, external load monotony was analysed to assess the within-week load variation. External load monotony was expected to be higher in U19 as their training focus should be more based on long-term development goals than on preparation or recovery from the week's match. Indeed, TD-based external load monotony was higher for U19 players compared to FT players, confirming a need for more pronounced differentiation in FT players between the high-intensity matches and low intensity/low volume preparation or recovery sessions. These results clearly indicate that, especially during congested weeks, FT players are exposed to a higher within-week load variation, leading to different demands in terms of load and recovery than for the U19. Therefore, attention must be paid to external load monotony during the transition phase.

Taken together, the results show that weekly external intensity and within-week load variation are lower in U19. However, these results should be interpreted with caution as this study is not without its limitations. First, data were gathered within a single professional football club. We do believe that our observations are representative of a typical professional football club setting, with training methodology and corresponding loads in U19 and FT players typically being dictated by a club's organisation and culture. Further

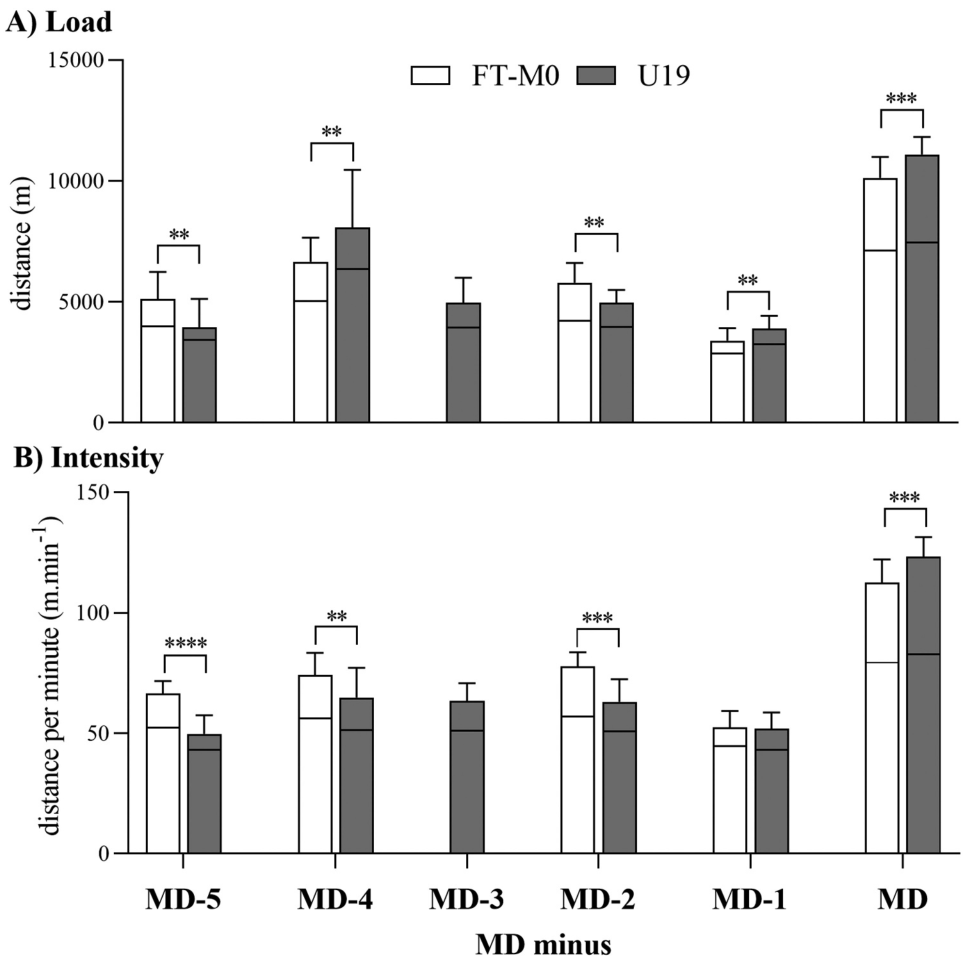

Figure 2. Daily mean (SD) external load (A) and intensity (B) in relation to days prior to a match. Low (<12 km· h^{-1}, lower bar) and high (>12 km· h^{-1}1, upper bar) velocity distances are stacked. MD, match day. *small, **moderate, ***large, **** very large difference in daily external load and intensity between FT-M0 and U19.

research is needed though to confirm such generalisation. Second, the analysis was conducted on a weekly level without considering the composition of individual drills. Also, because of the small sample size, positional differences could not be taken into account. Therefore, future research is needed to examine this topic more into detail. Also, further research quantifying the external loads of youth players following their transition into the FT is required as they are likely subject to additional training for development purposes.

Practical implications

This study provides a first insight into the differences in weekly load between elite youth and first team players within a professional football setting. Specifically, to optimise the physical development of elite youth players, our findings highlighted the importance of paying attention to external intensity and variation in addition to external load. Therefore, a gradual increase in external intensity and variation during the transition is advised. In this respect, introducing high-intensity mid-week training sessions or even simulate congested week schedules may better prepare elite youth players towards the demands of professional football. However, following the rationale of the training process model (Impellizzeri et al. 2019), it is at the same time important to monitor the internal load response and training outcome to assess the youth players' ability to cope with such increased external intensity and variation.

Conclusions

The main finding of this study is that the weekly external intensity and within-week load variation appears to be lower in elite youth compared to first team footballers. Therefore, to optimise the physical development and ultimately improve U19 players' chances of a successful transition towards the first team, a gradual progression in weekly external intensity and variation should be targeted.

Acknowlegments

The authors would like to thank the players and both physical and medical staff for their participation. This study was part of 2 research projects both supported by a research grant from the Agency for Innovation by Science and Technology-IWT, Belgium (IWT 130841 [A. Jaspers] and IWT HBC.2017.0569 [K. Houtmeyers]).

Disclosure statement

The research grants contained a collaboration between the University of Leuven and TopSportsLab NV.

Funding

This work part of two research projects both supported by a research grant from the Agency for Innovation by Science and Technology-IWT, Belgium (IWT 130841 [A. Jaspers] and IWT HBC.2017.0569 [K. Houtmeyers]).

ORCID

Kobe C. Houtmeyers http://orcid.org/0000-0003-0060-3090
Arne Jaspers http://orcid.org/0000-0001-6809-0792
Michel S. Brink http://orcid.org/0000-0002-0730-1979
Jos Vanrenterghem http://orcid.org/0000-0002-1682-8430
Matthew C. Varley http://orcid.org/0000-0003-3033-571X
Werner F. Helsen http://orcid.org/0000-0001-7066-8127

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