European Journal of Human Movement

OPEN ACCESS

*Original Research*

# Contextual Factors Associated with the 30-15 Intermittent Fitness Test in a Youth Football Academy

**Gonzalo Fernández-Jávega and Iván Peña-González**

Sports Research Centre (Department of Sport Sciences), Miguel Hernández University of Elche.

* Correspondence: (IPG) ipena@umh.es. ORCID ID nº: 0000-0001-6810-0911

Received: 29/01/2024; Accepted: 09/04/2024; Published: 30/06/2024

**Abstract:** The aim of this study was to examine the effect of various contextual factors on the 30-15 Intermittent Fitness Test (30-15 IFT) in young male football players.30-15 IFT was evaluated in U-14 and U-16 football teams (n=229). The sample was categorized by relative age, biological maturation, playing position and competitive level (CL). The results revealed a trend in the overall sample towards an overrepresentation of players born in the early months of the year. Significant differences were found when comparing vIFT (maximal intermittent running velocity) values across age categories (U13: 17.73 ± 1.24; U14: 18.14 ± 1.56; U15: 18.99 ± 1.31; U16: 18.81 ± 1.55; F = 9.93; p < .001) and between maturity groups, in favor of the more mature players (PrePHV: 17.77 ± 1.38; MidPHV: 18.53 ± 1.37; PostPHV: 18.83 ± 1.48). There were some minor differences in the vIFT between players from different field positions (F = 2.96; p = .014; $\eta p^2$ = 0.078). As well as players who compete at higher levels of competition reached higher results for the vIFT (CL: F = 9.01; p < .001; $\eta p^2$ = 0.238 and CL2: F = 15.44; p < .001; $\eta p^2$ = 0.184). This study showed the complexity of factors influencing the 30-15 IFT of young football players and suggest that maturity may play a more influential role than RA in physical performance which could influence the selection process at early ages.

**Keywords:** Talent Identification, Peak height velocity, Maturity status, Running Performance

## 1. Introduction

As for top-level adults (Bradley et al., 2013, 2009), the demands for young football players during football matches involve sequences of high intensity efforts (e.g., sprints, high speed running or changes of direction (COD)) interspersed with periods of low intensity activity (Buchheit, Saint, Football, Simpson, & Mendez-Villanueva, 2012; Palucci Vieira, Carling, Barbieri, Aquino, & Santiago, 2019). Attending to the intermittent nature of the game, to perform at high level, young soccer players need high aerobic endurance levels and the ability to repeat high-speed actions, which are crucial in the important periods of the match (Faude, Koch, & Meyer, 2012; Mohr, Krustrup, & Bangsbo, 2003). As young players are better able to repeat high intensity efforts compared with adults this capacity may be playing a major role in players match activity (Ratel, Duché, & Williams, 2006).

Therefore, objective physiological measures (e.g., maximal oxygen uptake [$VO_{2max}$]), are highly important to established thresholds for individual players running capacities (Altmann et al., 2023). To this day researchers have been looking for the most soccer-specific test, as some of the most used ones have limitations in its application for team-sports training prescription. To note, the "Léger-Boucher" or "University of Montreal track test" (UM-TT) (Leger & Boucher, 1980), with the inconvenient of not assessing inter-effort recovery ability. Alternatively to these continuous tests there is the Yo-Yo Intermittent Recovery Test (Yo-Yo IR) (Bangsbo, Iaia, & Krustrup, 2008), although Yo-Yo IR is one of the most used tests in soccer, final velocity achieved at the end of the test is not accurate for individualizing high-intensity-interval-training (HIIT) as it is speed-dependent (Dupont et al., 2010). Attending to these issues Buchheit (2008) realized the need of a new field test, which could assess this maximal cardiorespiratory capacity taking into account the intermittent efforts of team-sports as well as the COD and with higher maximal running speeds than previous protocols.

The 30-15 IFT developed by Buchheit (2008) is an intermittent, incremental shuttle-run test, which evaluates aerobic and anaerobic capacity, inter-effort recovery ability, anaerobic speed reserve and COD ability. The 30-15 has been validated and proof its reliability in football, basketball, handball, ice hockey and professional teams (Buchheit, 2015; Thomas et al., 2016). In addition to de specificity of the test, the 30-15 IFT's main asset is that it allows HIIT training prescription based on its maximal intermittent running velocity (vIFT), which appears to overcome the limitations of the previous testing protocols (Buchheit & Rabbani, 2014). Indeed, recent literature have tested the accuracy of 30-15 vIFT for individualizing interval training in young soccer players, showing minor inter-player differences than when using maximal running speeds determined by UM-TT or Yo-Yo IR (Buchheit, 2008; Buchheit & Rabbani, 2014).

Young football players are categorized by chronological age and grouped into 1-or 2-years cohorts accordingly (Cobley, Baker, Wattie, & McKenna, 2009). The term relative age (RA) refers to the player´s age regarding the cohort age and it has been observed that young football players with higher RA are more likely to be selected for elite teams or football development programs (Helsen, Van Winckel, & Williams, 2005). This phenomenon is referred to as the relative age effect (RAE), and it has been noted across various national and international teams, competitions, competitive level (CL), and age categories. This observation indicates that it constitutes a genuine bias in talent identification and selection processes (Yagüe, de la Rubia, Sánchez-Molina, Maroto-Izquierdo, & Molinero, 2018). Recent investigations have dissembled this statement, showing that simply being born a few months earlier or later during the selection year does not imply a higher sports performance, when the effect of maturation is controlled (Deprez et al., 2013; Peña-González et al., 2018). Considering this, it could be hypothesised that the maturity status might have a greater influence on young players' physical performance, as it refers to the structural and functional changes in the body (Deprez et al., 2013; Radnor et al., 2021). Maturation refers to the developmental process by which individuals transition into their adult state, while the concept of maturity status pertains to a distinct point within the progression of an individual's maturation. Players with an advanced maturity status (i.e. who have past their peak height velocity [PHV]) are generally taller and heavier than their less mature peers (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004). Additionally, they also tend to exhibit superior physical capacities (Buchheit & Mendez-Villanueva, 2014; Buchheit et al., 2014; Peña-González et al., 2018). These physical characteristics related to the player´s growth and development, may influence the selection process of young football players (Peña-González, Fernández-Fernández, Moya-Ramón, & Cervelló, 2018). Furthermore, specific anthropometric and physiological attributes may be needed for each playing position, hence advanced-maturity players regularly have an advantage to be selected for specific outfield positions as they use to be larger in body size, faster and stronger (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007). It is known that midfielders cover greater distances compared with attackers or central defenders, whereas forward-players, wingers and strikers, perform the most high-intensity runs (Sporis, Jukic, Ostojic, & Milanovic, 2009).

The main aim of youth football academies is to identify and select players at early ages who have the potential to perform at top level (Williams, Ford, & Drust, 2020). The assessment of running performance is therefore needed to successfully accomplish the selection process and long-term development programs (Vaeyens et al., 2006; Williams et al., 2020). To conduct this selection process in the fairest manner, is needed to understand how contextual factors are affecting the assessment protocols so as to interpret its results from a more comprehensive spectrum. The present study aimed to analyze how contextual factors associated with young football players affect the actual most used soccer-specific running assessment test, the 30-15 IFT. We hypothesize that players born in the early months of the year would be overrepresented in the sample. Furthermore, contextual factors as age-categories, biological maturation, field position and CL would have a significant impact on vIFT.

## 2. Materials and Methods

### *Participants*

Two hundred and twenty-nine young male football players from a Spanish football academy participated in the study (age: 13.97 ± 1.17 years; body weight: 54.71 ± 11.47 kg; body height: 164.48 ± 8.96 cm; PHV: 0.15 ± 1.24 years; vIFT: 18.46 ± 1.45).

For this sample, statistical software (G*Power; version 3.1.9.6, Franz Faul. Universität Düsseldorf) was employed to determine the necessary sample size based on the specified variables and groups. An Effect Size "f" = 0.25, an alpha error probability (p) ≤ 0.05, study power ≥ 0.80, for six, four and three groups. For these study variables, the statistical software estimates a total sample size of between 159 and 216 participants, considering the various possibilities outlined. Despite this, the sample was increased due to access to a larger sample of players.

The participants were from U13 to U16 teams and from the first national CL to the lowest one. To participate in the study, players had to have an active licence with the hosting federation, experience in playing football for at least three years and being free from injuries or illness at the time of the assessment and/or in the previous weeks. To be evaluated, the players should not have trained or engaged in moderate or vigorous physical activity in the last 48 hours. Players were classified for the further analyses by:

*Age categories.* Players were classified into two age-category classifications. First, they were divided into U13-14 age category or U15-16 age category (because they are the competitive age categories in Spain). In addition, players were classified into four age categories according to their birth (U13, U14, U15 and U16).

*Competitive levels*. Players were also classified into 2 CL classifications. They were divided into the 8 recognised CLs (1: first and maximum CL for U15-16 players; 2: second CLCL for U15-16 players; 3: third CL for U15-16 players; 4: fourth CL for U15-16 players; 5: first CL for U13-14 players; 6: second CL for U13-14 players; 7: third CL for U13-14 players; 8: fourth CL for U13-14 players). Moreover, they were also classified into 4 CLs with similar samples (CL2) (1:CL 1 and 2; 2: CL 3 and 4; 3: CL 5 and 6; 4: CL 7 and 8).

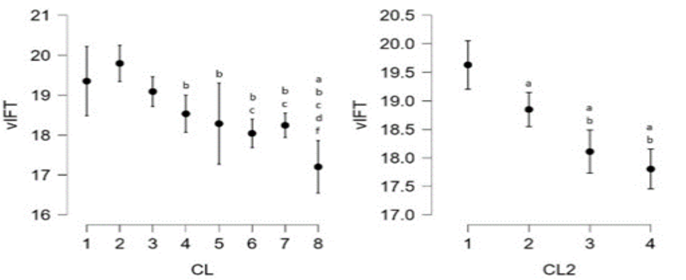
*Field positions*. Players were divided into 6 field position, according to the previous literature (Peña-González, Javaloyes, Sarabia, & Moya-Ramón, 2021; Sweeney, Cumming, MacNamara, & Horan, 2022; Towlson et al., 2021). The playing positions were goalkeeper, central defender, full back, midfielder, winger and forward.

*Relative age*. Players were divided into four birth quartiles regarding their month of birth, in accordance with the previous literature (Peña-González et al., 2021; Salinero, Pérez, Burillo, & Lesma, 2013) (Q1: players born in January to March; Q2: players born in April to June; Q3: players born in July to September; Q4: players born in October to December).

*Maturity status*. The peak height velocity (PHV) (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002) was estimated as player's maturity status since it is the most commonly used indicator of the somatic maturation in the sports field (Kozieł & Malina, 2018). The PHV takes into account the player's body weight, height, sitting height, leg-length and decimal age to estimate the years from/to the PHV, which is a theoretical and individual benchmark that represents a point of maximum growth during the adolescence (Kozieł & Malina, 2018; Pitlovic et al., 2013) .Players in this study were classified, according to the years from/to their PHV, into three maturity groups named as PrePHV (players before their PHV [< -0.5 years to their PHV]), MidPHV (players circa their PHV [from -0.5 years to their PHV to 0.5 years from their PHV]) and PostPHV (players after their PHV [> 0.5 years from their PHV]).

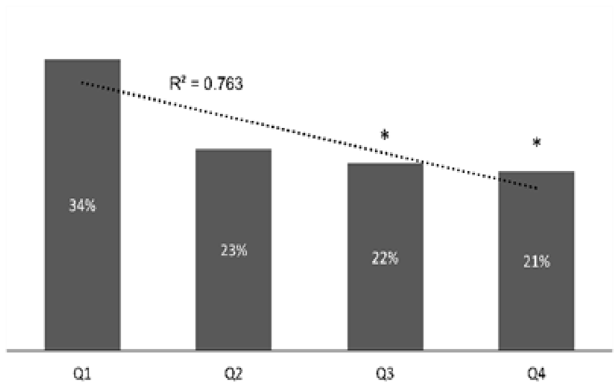
An Ethical Committee of the hosting institution approved this research (DCD.IPG.01.21). Each participant and their parents/guardians were informed about the study's aims and protocols, and they signed an informed consent according to the Declaration of Helsinki (2013).

**Figure 1.** vIFT performance according to player's CL (ANOVA).




*CL1: CL 1; CL2: CL 2; CL3-4: CLs 3 and 4; CL 5-6: CLs 5 and 6; CL 7-8: CLs 7 and 8. a: statistically different (p < 0.05) from CL1 b: statistically different (p < 0.05) from CL2 c: statistically different (p < 0.05) from CL3 d: statistically different (p < 0.05) from CL4 f: statistically different (p < 0.05) from CL5.*

**Figure 2.** Birth quartile distribution in percentage (with a trend line) (chi-square)




*Q1: Birth quartile 1; Q2: Birth quartile 2; Q3: Birth quartile 3; Q4: Birth quartile 4*

### *Testing Procedure*

All the player's assessments were performed in one testing session. First, players' body height and sitting height was measured with a fixed stadiometer (± 0.1 cm; SECA LTD, Hamburg, Germany) and players' body mass was measured using a digital scale (± 0.1 kg; Tanita BC-601, Tokio, Japan). Then, players carried out a standardized warm-up which consisted of low-intensity running, dynamic stretching and high-intensity actions, including submaximal sprints and COD. The 30-15 IFT was performed following the protocol described by Buchheit, (2008). The velocity of the last competed stage was registered as the players' vIFT. All players were familiarized with the 30-15 IFT as they perform this test two or three times at season. The reliability of this test has been demonstrated with football players (Thomas et al., 2016). The test was performed in a synthetic grass pitch and players wear their usual sport clothes and football boots. Players were encouraged during the test to achieve their maximal effort.

### *Statistical Analysis*

Descriptive data was presented as mean ± standard deviation (M ± SD). A chi-square test was used to assess the RAE, comparing the observed vs the expected birth distribution (assuming the expected birth distribution is a 25% of birth per quartile) (Salinero et al., 2013). The one-way analysis of variance (ANOVA) with post-hoc (Bonferroni) test was used to compare the players' vIFT according to their age category, level of competition, field position, relative age and maturity status. The effect size for each ANOVA was calculated as the "partial eta squared" ($\eta p^2$) and it was interpreted as $\eta p^2 = 0.010$ small effect size, $\eta p^2 = 0.060$ medium effect size, $\eta p^2 = 0.140$ large effect size. All calculations were performed using JASP software (JASP Team, Version 0.17.3) and the level of significance was set at $p < .05$.

## 3. Results

The vIFT was higher for the U15-16 category (18.92 ± 1.41) than the U13-14 category (17.92 ± 1.40) (t = 5.18; $p < .001$). In addition, there were significant differences when comparing across four age categories (U13: 17.73 ± 1.24; U14: 18.14 ± 1.56; U15: 18.99 ± 1.31; U16: 18.81 ± 1.55; F = 9.93; $p < .001$), with significant differences in the pairwise comparison between U13 and U15 (t

**Table 1.** Descriptive data (M ± SD) and mean comparisons (ANOVA) of the vIFT across field positions.

| | vIFT | F | *p* | ηp² |
|---|---|---|---|---|
| Goalkeepers | 17.50 ± 1.51 | 2.96 | <.014 | 0.078 |
| Central defenders | 18.74 ± 1.37 | | | |
| Full backs | 18.79± 1.39[a] | | | |
| Midfielders | 18.52 ± 1.37 | | | |
| Wingers | 18.85± 1.56[a] | | | |
| Forwards | 18.00 ± 1.37 | | | |

[a] *statistically different (p < .05) from goalkeepers.*

**Table 2.** Descriptive data (M ± SD) and mean comparisons (ANOVA) of the vIFT across birth quartiles (Q) based on categories.

| | Q1 | Q2 | Q3 | Q4 | F | p | ηp² |
|---|---|---|---|---|---|---|---|
| U13 | 18.07 ± 0.95 | 17.57 ± 1.67 | 17.71 ± 1.38 | 17.33 ± 1.23 | 1.12 | .347 | 0.055 |
| U14 | 18.56 ± 1.58 | 17.89 ± 1.14 | 17.96 ± 1.84 | 18.21 ± 1.69 | 0.55 | .652 | 0.033 |
| U15 | 19.32 ± 1.09 | 19.18 ± 1.40 | 18.83 ± 1.20 | 18.79 ± 1.18 | 0.60 | .616 | 0.033 |
| U16 | 18.66 ± 1.51 | 19.78 ± 0.94 | 19.28 ± 1.30 | 18.92 ± 1.46 | 1.42 | .253 | 0.106 |

*vIFT: final velocity at the 30-15 intermittent fitness test; Q: birth quartile*.

= 4.93; $p < .001$), U13 and U16 (t = 3.83; $p < .001$) and U14 and U15 (t = 3.20; $p = .009$).

Players who compete at higher levels of competition reached higher results for the vIFT (CL: F = 9.01; $p < .001$; $\eta p^2 = 0.238$ and CL2: F = 15.44; $p < .001$; $\eta p^2 = 0.184$). Pairwise comparison is presented in the Figure 1.

Descriptive statistic comparing vIFT values between different playing position are summarized in Table 1. There were some minor differences in the vIFT between players from different field positions (F = 2.96; $p = .014$; $\eta p^2 = 0.078$) , being statistically different between goalkeepers and full backs (t = 2.94; $p = .042$) and goalkeepers and wingers (t = 2.93; $p = .044$).

Figure 2 shows birth quartile distribution of the analysed players. There was an overrepresentation of players who has born in the first quartile of the year, indicating the presence of the RAE in the sample of this study.

Descriptive data and mean comparisons of the vIFT across birth quartile on each age categories are presented in Table 2. There was no difference in the vIFT for players from different birth quartiles for any age category. The ANOVA for the vIFT according to the young players' maturity status revealed significant differences (F = 11.73; $p < .001$; $\eta p^2 = 0.099$) favourable to more mature players (PrePHV: 17.77 ± 1.38; MidPHV: 18.53 ± 1.37; PostPHV: 18.83 ± 1.48) with statistical differences for the three groups in the pairwise comparison.

## 4. Discussion

In the present study, we analyzed how different contextual factors associated with young football players impact on the 30-15 IFT in order help football coaches to contextualize the results obtained from this running assessment test and upgrade the talent selection processes. The results revealed a trend in the overall sample towards an overrepresentation of players born in the early months of the year. The main contributions of the present research show significant differences were found when comparing vIFT across age categories and between maturity groups, in favor of the more mature players. There were some minor differences in the vIFT between players from different field positions. As well as players who compete at higher levels of competition reached higher results for the vIFT.

Previous literature shows that nowadays the bias towards early-born players in the talent discovery and selection process is unquestionable. As hypothesized, n the analyzed sample there was an overrepresentation of players who has born in first quartile of the year. These results are in consistent with previous research analyzing RAE in football academies (Helsen et al., 2005; Mujika et al., 2009; Peña-González et al., 2018). The bibliography reports contradictory hypothesis for the causes of RAE and suggest that physical performance differences may have a substantial influence in RAE in football (Bliss & Brickley, 2011). Whereas, the results of the present study showed no influence of RA in players' vIFT, so the hypothesis of an advantage of early-born players due to a better physical performance not seemed to be definite for explaining RAE. The late investigations which analyze the possible influence of RA in other physical performance qualities (jumps, sprints, COD, etc.) are in accordance with the results of this research and did not find a firm impact of RA in physical performance (Radnor et al., 2021).

Age- and/or maturation-differences in physical performance have been widely analyzed in youth soccer players, in deep, previous literature have shown that physical performance in youth players may be influence by many factors mediated by growth. In prior investigations which compare running performance in different category-age groups, the older and/or the more mature players shown greater capacity than their younger and/or less mature teammates in field test (Radnor et al., 2021). Mendez-Villanueva et al.(2011) found positive effects of age and maturation on running speed qualities (acceleration, maximum running speed, and repeated-sprint ability) in a sample of well-trained young football players. Whereas, despite the ability to repeat high intensity runs during the games seems a crucial ability to perform at high level, the bibliography analyzing the effect of growth-related variables in intermittent running test is not abundant. The results of the present study showed a superior vIFT with increasing category-age, as well as significant differences favorable to the more mature players. These findings corroborate the assertions that players with advanced maturity, as a result of elevated androgen and creatine phosphate levels, along with the development of muscle fiber types and architectural changes in muscle tendon units associated with the maturation process, might exhibit enhanced performance in physical tasks. This improvement is attributed to the potential impact of these adaptations on factors influencing aerobic qualities, including quicker phosphocreatine resynthesis, heightened oxidative capacity, and improved acid-base regulation (Lloyd & Oliver, 2012; Ratel et al., 2006). This superior capacity of more mature and/or older players to perform and recover from high intensity running bouts may have a similar outcome on match running performances, as theoretically, older and/or more mature players may have a better match running performance. In regard to this results, Buchheit et al. (2010) reported that older players generally cover greater distances at high-intensities during international club games in highly trained young football players. Therefore, in line with the most recent publications, the results of this study underpin the statement of maturity having a greater association than RA with physical performance in young football players (Peña-González et al., 2022).

Moreover, another factor that may be influencing running performance in young football players is their playing position on the pitch. The results obtained in this study reveal some minor differences in the vIFT between players from different positions. In deep, full backs and wingers showed the major vIFT values, unlike goalkeepers who got the poorest results. On a conjectural basis, it could be hypothesized that players position may be constraining player's game efforts, which could be influencing bidirectionally the results of the test: (1) players may be obtaining different vIFT values because they are tactically constrained and gradually, they adapt to these running efforts or (2) players have been selected to occupy these positions partially due to their running capacities. When comparing our results with those obtained by Buchheit et al. (2010) some controversies arise, contrary to our study, in Buchheit's, full backs obtained worse results than wingers in the Vam-eval test, whereas, in match running performances both obtained similar results for high-intensity runs. These results may reinforce the statements which positioned 30-15 IFT as a better option for evaluating football players running performance as it may replicate more closely the efforts of the game.

Physical performance field tests are commonly used as an objective and reliable way to evaluate young football players current level of performance and future capacity to success (Reilly, Williams, Nevill, & Franks, 2000; Williams, Ford, & Drust, 2020). Players competing in higher categories tend to show superior performances in physical tests. This may be exemplified by Toselli et al. (2022) in which study elite young football players were capable of higher accelerations as well as a tendency to present better sprint and COD performances than non-elite player. Even though the wide bibliography about 30-15 IFT and its commonly use in professional teams, no references are available relating this test with the CL of young football players. As it could be expected, in this sample, players who competed at higher levels obtained higher vIFT in the analysed sample. These results are comparable to Peña-González et al. (2021) and Rebelo et al. (2013), which, utilizing a different intermittent running tests, obtained the same positive correlation between superior performances in intermittent running test and CL. On this basis, performances of elite players during matches may demand higher work rates (Bangsbo, Mohr, & Krustrup, 2006; Mohr et al., 2003). Some conjectures emerge based on this statement, as it may suggest a possible bias in the selection of players. Higher competitive levels demand higher physical capacities, is therefore that players with higher physical performance at younger ages may have a better chance of being selected. This approach will assume that the best current young players will also be the best player in the future, which would distance the selection process from finding the players with the highest potential. As well, on this basis, an early enrolment or selection for higher competitive level youth football academies may also be conditioning young players physical development as players may be exposed to systematic training during their development process. In any case, this factor may have a clear practical application since, as mentioned, to perform at high level, football games demand a great capacity to repeat high intensity runs, hence field tests which may be able to analyze this capacity among young footballers seems to be greatly valuable to profile players, identify determinants of performance and develop an effective training plan (Reilly, Bangsbo, & Franks, 2000; Reilly, Williams, et al., 2000; Williams et al., 2020).

## 5. Practical Applications.

a) Particular attention should be given to the maturational status of players. On the basis of the results obtained, we can state that, later matures are more likely to perform under adverse situations, making it difficult for teams to identify characteristics in these players that suggest they have the capacity to perform at an elite level. Players with delayed maturational states can not only perform as well as their peers with more advanced maturational states, but they can also reach higher performance as they have more time to apply appropriate training stimuli for conditional improvement.

b) Physical coaches should consider age category, playing position and competitive level in the running performance evaluation of young players so as to interpret the results from a broader spectrum.

c) The importance of playing position when assessing and designing training programs may be emphasized. This factor may be influencing largely players running performance and the control of this variable may have a substantial impact for the long-term player development, among others, to prevent early specialization.

In the practical field, these findings not only offer valuable insights for coaches, but also suggest key areas for future research and more effective coaching strategies. Among the future lines of research that arise from the results obtained in this study, the authors consider it of particular relevance to investigate not only how the maturation status is a contextual factor that affects the physical performance of young players but also how it can influence the adaptive processes to training. Understanding the role that maturation status plays in players' adaptation to the training they undergo would allow us, in the future, to individualize the training process to a greater extent, tailoring it to the maturation characteristics of the players and maximizing their development in the medium and long term.

## 6. Conclusions

To conclude, this study supports a better understanding of contextual factors as the influence of relative age, biological maturation, playing position or level of competition in 30-15 IFT young football players performance. It was identified a trend towards an overrepresentation of players born in the early months of the year. The results of this study underscore the complexity of factors influencing the vIFT of young football players and suggest that maturity may play a more influential role than RA in physical performance. These findings support the idea that a deeper and more contextualized understanding of the factors influencing performance is essential to optimize training and talent identification in youth football.

**Supplementary Materials:** The following are available online at http://eurjhm.com/index.php/eurjhm, Figure S1: title, Table S1: title, Video S1: title.

**Funding:** This project was funded by the research project development grant from the Spanish Association of Sports Sciences (AECD) and the Association of Physical Trainers (APF).

**Acknowledgments:** In this section you can acknowledge any support given which is not covered by the author contribution or funding sections. This may include administrative and technical support, or donations in kind (e.g., materials used for experiments).

**Conflicts of Interest:** The authors report there are no competing interests to declare.

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