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# Influence of Two Different Competition Models on Physical Performance in Under-13 Basketball Players: Analysis Considering Maturity Timing

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**Abstract:** The rules of team sport have been influenced by professional competitions without considering all the factors that differentiate children and adolescents from adults. The aim of this study was to analyse the performance of kinematic variables in two different types of tournaments and the influence of somatic maturation on performance in young basketball players. Thirty-seven under-13 male basketball players (age = 12.91 ± 0.57 years) were selected by four southeast Spanish teams to participate in two different tournaments. On the first day, the tournament was played according to the rules of the Spanish Basketball Federation (FEB) for under-14 players, and on the second day, the tournament was played according to modified rules (Modified Tournament). In this tournament, the height of the basket was lowered to 2.90 m; the three-point line was a rectangle that was 4 m from the basket.The following kinematic variables were analysed: Acceleration (n), Deceleration (n), Maximum Acceleration Speed (km/h), Maximum Deceleration Speed (km/h), Acceleration Meters Covered (m), Deceleration Meters Covered (m), Number of Sprints (n), Sprint Meters Covered (m), Maximum Sprint Speed, and Player Load (n). The results showed no significant differences in player performance between the tournaments. However, significant differences in performance ($p < 0.05$) were found in players at different stages of maturation. Early maturity players showed the best performance in the kinematic variables in both tournaments; because of this, there should be a modification of the rules and organisation of competitions by bio-banding. It can be concluded that there were no significant differences in the kinematic variables between the two tournaments. However, when comparing maturation timing, there tends to be a group effect.

**Keywords:** maturation; growth; development; team sports; competition



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## 1. Introduction

Team sports have as their main characteristics the relationship of the subject with other teammates, the environment, and tasks [1–3]. For many years, these sports have been governed by the rules and regulations of professional sports without considering all the factors that differentiate children and adolescents from adults [4–6]. A review of

989 children demonstrated that they prefer using scaling equipment and adult playing area equipment because they feel more engaged in the tasks and have a greater self-efficacy to execute skills. Thus, modifying the rules and scaling equipment provokes a great variability in the technical–tactical actions of young players and improvement in the self-efficacy perception [1,7]. However, in recent years, federations, clubs, coaches, and researchers have begun to consider this matter, and the first modifications have appeared in the competitions of training categories. Although, many of these modifications do not have a scientific verification, and it is unknown if these changes are useful [8].

In team sports, different proposals for rule modifications have been made to create a better sport adapted to the characteristics of young players. Thus, small modifications to the rules make it possible to increase both the participation of an athlete (number of technical–tactical actions carried out during the competition) and the variability in the number of technical–tactical actions, as well as their levels of enjoyment and self-efficacy. These results have been observed in soccer [6] and basketball [9], in technical–tactical and psychological variables, but not in physical performance variables. Proposed rule modifications have been seen from four main perspectives: (a) studies modifying target size [10,11], (b) studies that modify the number of players [12,13], (c) studies that modify the size of the ball [14,15], and (d) studies that modify aspects related to scoring [9]. All these studies suggest what a child must obtain to be successful. This evidence reflects the importance of basketball federations changing the rules on the beginners' player stages in order to approach the game in a way which more accurately reflects the evolution of young players.

The study of physical performance variables, such as kinematic variables, allows for the detection of the risk of future injuries that may cause early withdrawal from the sport [16,17]. Despite attempts to modify the rules of competitions according to the characteristics of the players, maturity age is not considered. This fact is decisive for a more suitable practise environment [18]. Thus, studies in soccer have shown that knowledge of the maturational state of each player is key to the control of loads during training and competition. The adaptation of a competition will also allow for a better physical and technical–tactical performance to be showed. Indeed, the number of early injuries decreases [19,20]. Thus, muscle–tendon development and the different levels of stiffness related to the performance of young basketball players during the maturation process may characterize the level of specific sports performance, implying the need for adjustments in the level of play that consider the maturation process [21].

Currently, chronological age is the only factor used by federations to create competition levels for young players. This method does not consider the maturational evolution of children and adolescents because each person has different anthropometric conditions and growth rates [3,22]. However, in some countries, biological age (bio-banding) competitions exist. Players are grouped according to their maturational state. These types of competitions allow for a balanced physical game that provokes a variability in physical, motor, and more technical–tactical actions in late-maturity players. In the case of early maturity players, these adaptations permit them to find a challenge in the level of difficulty of the situations that occur during the game. Several studies have reported that "late-maturity" players have more difficulties in national team call-ups, participation in talent detection programmes, and the possibility of training with more experienced coaches than "early maturity players" [23,24]. This is not only a unique cause but also influences frustration and lack of interest, which provoke early dropout from sports [25,26].

The main hypothesis of the present study is that making a modification to basketball rules modifies the physical performance of young basketball players. The secondary hypothesis is that making a modification to basketball rules changes cinematic performance by maturity age.

The aims of this study were (a) to analyse the kinematic variables performance in two different competition models in under-13 basketball players (b), and to observe the influence of biological age on kinematic performance in under-13 basketball players.

## 2. Materials and Methods

### 2.1. Participants

In total, 41 under-13 male basketball players (age = 12.91 ± 0.57 years) were selected by four southeast Spanish teams to participate in two different tournaments on two different days. All players committed themselves to the research group and participated in the pre-tournament data collection and performed all the proposed activities during the formal tournament and the Modified Tournament; 4 players did not comply with the abovementioned criteria. Therefore, 37 players were included in the present study ($n$ = 37). The 34-participant sample size of this study is the usual size for this type of study. Written informed consent was obtained from all participants and their parents before this investigation. The study was approved by the Institutional Research Ethics Committee of the University of Murcia (No. 2828/2020).

### 2.2. Procedures and Materials

The study consisted of two different competitions over a weekend. Each team played 3 matches per tournament. On the first day, the tournament was played according to the rules of the Spanish Basketball Federation (FEB) for under-14 players. These rules are the same as the FIBA rules, except that in the first three quarters, there can be no changes. All players registered on the scoresheet; during the game, they must play a minimum of 1 quarter between the first 3 quarters and a maximum of 2 quarters in a row. No changes were allowed, except for injuries or exclusions for 5 fouls. On the second day, we hosted a tournament with modified rules. In this tournament, the height of the basket was lowered to 2.90 m, and the 3-point line used in Spanish mini-basket competitions was used, that being a rectangle 4 m from the basket (Figure 1). All shots made behind this line were valued at 3 points, and all the shots made from the 6.75 m line were valued 4 points. Before the tournament, somatic maturation data were collected.

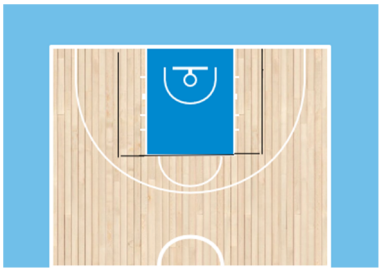

**Figure 1.** Modified tournament half-court.

Somatic maturation: Height was recorded using a commercially portable stadiometer (Tanita BF-522W, Tokyo, Japan, nearest 0.1 cm). Body mass was estimated using the scales (Tanita BF-522W, Tokyo, Japan, nearest 0.1 kg). All measurements were taken following the guidelines outlined by the International Society for the Advancement of Kinanthropometry (ISAK) by the same researcher, who holds an ISAK Level 1 accreditation. Players' height, weight, birth date, and mid-parent height were used to predict the adult height of each player [27]. The heights of the biological parents of each player were self-reported and adjusted for over-estimation using the previously established equations [28,29]. The current height of each player was expressed as a percentage of their predicted adult height (% PAH), which was then used as an index of somatic maturation [30]. Players were grouped into two maturity timing bands based on z-scores: Average, On-Time to Late (z-score between +0.5 and <−0.5), and Early (z-score > +0.5) [31].

In each tournament, the following kinematic data were collected and normalised by minute: Acceleration (n), Deceleration (n), Maximum Acceleration Speed (km/h), Maximum Deceleration Speed (km/h), Acceleration Meters Covered (m), Deceleration Meters Covered (m), Number of Sprints (n), Sprint Meters Covered (m), Maximum Sprint Speed, and Player Load (n). Measures were gathered using a real-time motion tracking

system that includes a local positioning system (LPS) device based on UWB technology and an inertial measurement unit (IMU; WIMU PROTM, RealTrack Systems, Almeria, Spain) in an indoor basketball court. For data extraction, the software was SPRO (RealTrack Systems, Almeria, Spain). This instrument was validated in a previous basketball study [17].

### 2.3. Statically Analysis

Data are presented as mean ± SD. The normality of data distribution and homoscedasticity were confirmed using the Shapiro–Wilk statistic and Levene's test for equality of variances; thus, parametric analyses were used. The related samples *t*-test was used to analyse within-group changes. A 2 × 2 mixed-model analysis of variance (ANOVA) was performed on the absolute values of all the parameters to determine the main effects between maturity timing groups and competition models. Effect sizes were evaluated using an omega squared ($\omega^2$), with <0.06, 0.06–0.14, and >0.14 indicating a small, medium, and large effect, respectively. The sample sizes were evaluated using a power of 0.80, alpha = 0.05, and a medium effect size (f = 0.25). All statistical analyses were performed using JASP software (version 0.13, University of Amsterdam, Netherlands) and G Power 3.1.9.7.

## 3. Results

### 3.1. Offence Positional Phases

Table 1 shows the mean values and standard deviations of the kinematic variables during the offence positional phases.

**Table 1.** Mean values and standard deviation of kinematics variables, according to maturity timing and tournament, during offence positional phases.

| Kinematic Variables | Early Group (n = 25) | | On-Time to Late Group (n = 12) | | Total (n = 37) | |
|---|---|---|---|---|---|---|
| | FEB | Modified | FEB | Modified | FEB | Modified |
| Acceleration | 1.56 ± 0.42 | 1.45 ± 0.46 | 2.09 ± 0.41 | 2.56 ± 1.08 | 1.73 ± 0.48 | 1.81 ± 0.88 |
| Deacceleration | 1.45 ± 0.39 | 1.39 ± 0.51 | 1.93 ± 0.49 | 2.02 ± 0.57 | 1.60 ± 0.48 | 1.59 ± 0.6 |
| Maximum Acceleration Speed | 11.11 ± 4.77 | 11.20 ± 4.37 | 10.47 ± 4.46 | 8.81 ± 1.95 | 10.90 ± 4.62 | 10.42 ± 3.9 |
| Maximum Deceleration Speed | −8.24 ± 2.88 | −8.62 ± 2.88 | −8.92 ± 3.47 | −7.97 ± 2.89 | −8.46 ± 3.05 | −8.41 ± 2.86 |
| Acceleration Meters Covered | 4.37 ± 1.27 | 4.02 ± 1.29 | 6.06 ± 1.33 | 5.77 ± 1.58 | 4.92 ± 1.50 | 4.59 ± 1.6 |
| Deceleration Meters Covered | 3.87 ± 1.04 | 3.55 ± 1.17 | 5.99 ± 1.69 | 5.39 ± 1.16 | 4.56 ± 1.61 | 4.15 ± 1.45 |
| Number of Sprints | 0.22 ± 0.08 | 0.21 ± 0.12 | 0.38 ± 0.14 | 0.40 ± 0.20 | 0.27 ± 0.13 | 0.27 ± 0.17 |
| Sprint Meters Covered | 2.30 ± 1.03 | 1.78 ± 0.89 | 3.95 ± 1.46 | 2.94 ± 1.40 | 2.84 ± 1.40 | 2.15 ± 1.2 |
| Maximum Sprint Speed | 25.49 ± 6.32 | 25.77 ± 5.93 | 27.45 ± 5.72 | 22.43 ± 2.57 | 26.13 ± 6.12 | 24.68 ± 5.29 |
| Player Load | 0.48 ± 0.12 | 0.47 ± 0.12 | 0.56 ± 0.14 | 0.68 ± 0.26 | 0.51 ± 0.13 | 0.54 ± 0.2 |

FEB = FEB Tournament; Modified = Modified Tournament.

A higher number of Accelerations and Player Load was recorded in the Modified Tournament in the offence positional phases. Although, significant differences were only observed in Sprint Meters Covered (Z = −3.78, $p$ = 0.001) and Deceleration Meters Covered (Z = −2.39, $p$ = 0.017). In the first case, differences were observed in the Early Group ($p$ = 0.001), and there were tendencies to significance in the Late Group ($p$ = 0.071). In the case of Deceleration Meters Covered, differences were observed in the Early Group ($p$ = 0.017) but not in the Late Group ($p$ = 0.308).

The two-factor analysis of variance (2 × 2) showed maturation level (Early Group vs. On-Time to Late Group) and tournament (FEB Tournament vs. Modified Tournament) as important factors, with repeated measures in the last factor. The interaction effect of the tournament factor due to maturation level is significant in the variables Accelerations (F1.35 = 5.58, $p$ = 0.024, η2 = 0.137) and Maximum Sprint Speed (F1.35 = 5.22, $p$ = 0.029, η2 = 0.130), and there are tendencies to significance in the variable Player Load (F1.35 = 4.02, $p$ = 0.053, η2 = 0.103).

Thus, increased values in the Accelerations and Player Load variables (Figures 2 and 3) were observed in the Modified Tournament. Significant differences were observed in the On-Time to Late Group ($p = 0.026$ and $p = 0.034$).

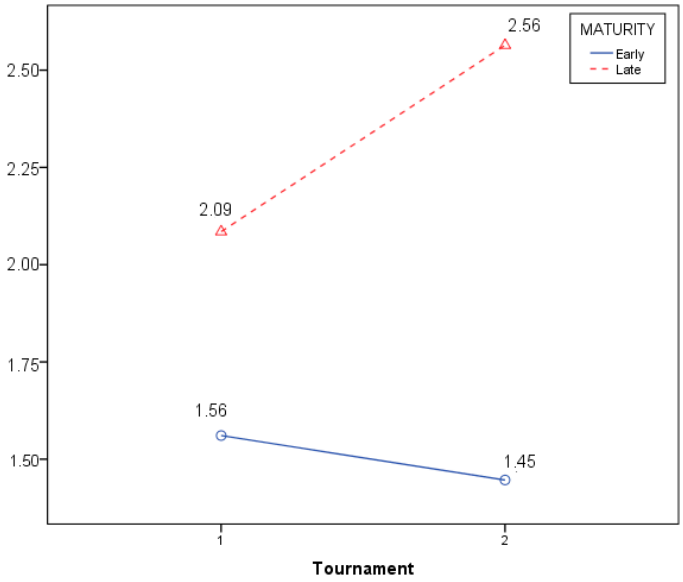


**Figure 2.** Accelerations evolution variable during offence positional phases according to maturity group. 1 = FEB Tournament; 2 = Modified Tournament.

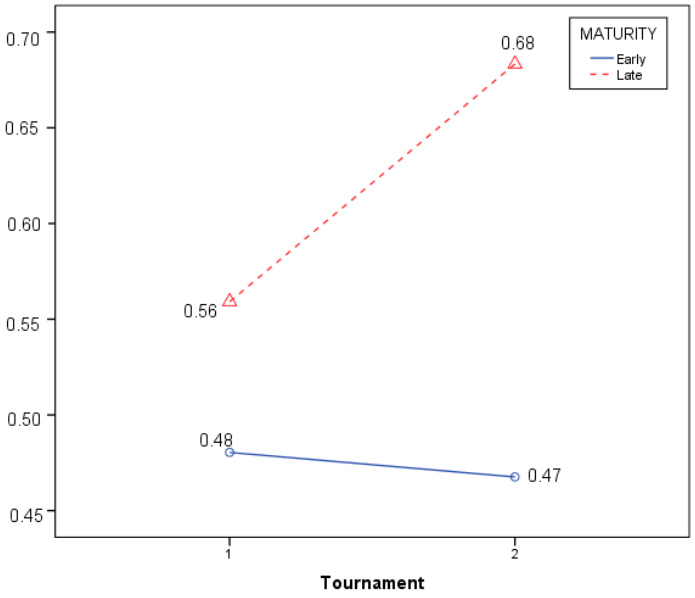


**Figure 3.** Player Load evolution variable, during offence positional phases, according to maturity group. 1 = FEB Tournament; 2 = Modified Tournament.

On the other hand, considering the Maximum Sprint Speed variable (Figure 4), there was a decrease in the Modified Tournament in the On-Time to Late Group and a slight increase in the Early Group. Although, significant differences were observed in the On-Time to Late Group ($p = 0.012$).

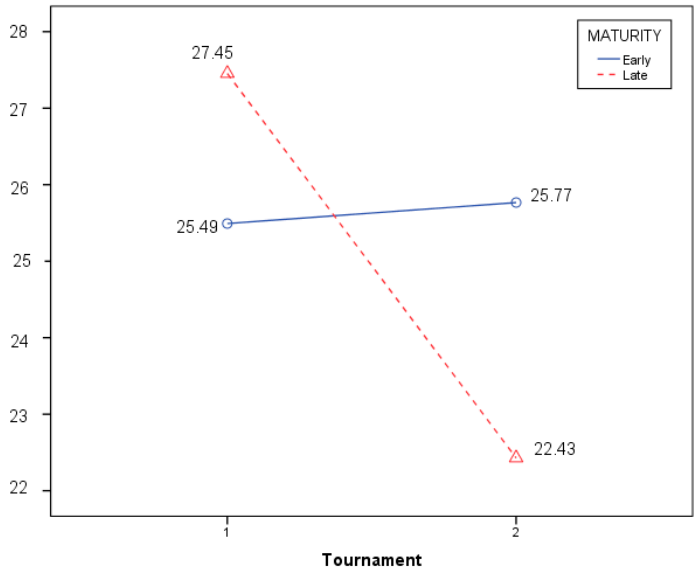


**Figure 4.** Maximum Sprint Speed evolution variable, offence positional phases, according to maturity group. 1 = FEB Tournament; 2 = Modified Tournament.

### *3.2. Fast-Break Phases*

Table 2 shows the mean values and standard deviations of the kinematic variables during the fast-break phases.

**Table 2.** Mean values and standard deviation of kinematics variables, according to maturity timing and tournament, during fast-break phases.

| Kinematic Variables | Early Group (n = 25) | | On-Time to Late Group (n = 12) | | Total (n = 37) | |
|---|---|---|---|---|---|---|
| | FEB | Modified | FEB | Modified | FEB | Modified |
| Acceleration | 1.17 ± 0.34 | 1.01 ± 0.37 | 1.45 ± 0.5 | 1.52 ± 0.68 | 1.26 ± 0.42 | 1.18 ± 0.54 |
| Deacceleration | 1.01 ± 0.28 | 0.93 ± 0.35 | 1.19 ± 0.29 | 1.42 ± 0.72 | 1.07 ± 0.29 | 1.09 ± 0.54 |
| Maximum Acceleration Speed | 9.83 ± 3.68 | 10.89 ± 4.41 | 8.89 ± 4.85 | 8.76 ± 3.11 | 9.52 ± 4.05 | 10.20 ± 4.12 |
| Maximum Deceleration Speed | −7.00 ± 2.00 | −7.56 ± 5.85 | −7.27 ± 3.5 | −7.23 ± 5.65 | −7.09 ± 2.53 | −7.45 ± 5.71 |
| Acceleration Meters Covered | 4.71 ± 1.43 | 4.27 ± 1.64 | 5.97 ± 1.51 | 6.10 ± 2.98 | 5.12 ± 1.56 | 4.86 ± 2.29 |
| Deceleration Meters Covered | 3.38 ± 1.09 | 3.19 ± 1.20 | 4.42 ± 1.48 | 4.85 ± 2.84 | 3.71 ± 1.31 | 3.73 ± 2.01 |
| Number of Sprints | 0.39 ± 0.15 | 0.35 ± 0.17 | 0.52 ± 0.18 | 0.57 ± 0.34 | 0.43 ± 0.17 | 0.42 ± 0.25 |
| Sprint Meters Covered | 3.99 ± 1.88 | 3.54 ± 1.82 | 5.27 ± 2.48 | 6.01 ± 4.31 | 4.41 ± 2.14 | 4.34 ± 3.04 |
| Maximum Sprint Speed | 25.29 ± 5.55 | 27.90 ± 5.88 | 26.38 ± 5.73 | 24.09 ± 4.01 | 25.65 ± 5.55 | 26.67 ± 5.59 |
| Player Load | 0.44 ± 0.12 | 0.45 ± 0.16 | 0.48 ± 0.11 | 0.56 ± 0.23 | 0.45 ± 0.12 | 0.48 ± 0.19 |

FEB = FEB Tournament; Modified = Modified Tournament.

There were higher Maximum Acceleration Speed, Maximum Sprint Speed, Deceleration Meters Covered, and Player Load values in the Modified Tournament. Although, significant differences were observed for the Accelerations variable ($Z = -2.25$, $p = 0.025$). In terms of Acceleration, significant differences were only observed in the Early Group ($p = 0.003$), not in the On-Time to Late Group ($p = 0.999$).

After the application of the two-factor analysis of variance (2 × 2), maturation level (Early Group vs. On-Time to Late Group) and tournament (FEB Tournament vs. Modified Tournament) were the highlighted factors. The repeated measures for the last factor indicate that the interaction effect of the tournament factor by maturation level is not significant in any variable.

## 4. Discussion

According to the hypothesis, changes in the kinematic variables were identified. Certain raising tendencies and differences can be seen in the Modified Tournament in the

following variables: Acceleration and Maximum Sprint Speed (offence positional phases), Deacceleration, Maximum Acceleration Speed, Maximum Deceleration Speed, Deceleration Meters Covered, Maximum Sprint Speed, and Player Load (fast-break phases). These results contradict several studies that showed that a better performance is obtained in small-sided games compared to analytical or formal tasks [13]. However, we showed that a Modified Competition increases players' participation and, consequently, increases physical performance. Several studies on semi-professional male and professional women basketball players have demonstrated a significant increase in kinematic performance (i.e., acceleration, deceleration, jumps, speed, impact) in modified and manipulated activities [21,27].

However, no significant results were observed in the present study. Nevertheless, an increase in players' performance in the Modified Tournament was observed (Accelerations and Player Load) in the offence positional phases. In the fast-break phases, an increase in performance was obtained for the factors of Maximum Acceleration Speed, Maximum Sprint Speed, Decelerations Meters Covered, and Player Load.

Players who undergo an early development are more likely to call-up selection teams and participate in talent arrest programmes [26,32]. Adjusting competitions to biological age would help to make them fairer and allow athletes to develop a greater variability in actions and a greater perception of self-efficacy [3,24], which would result in greater development of their physical abilities as well as more exponential evolution at a technical or tactical level [3]. In addition, an adapted competition promotes coordination and functional movement variability (i.e., number of jumps, hand–eye coordination, bilateral coordination, and balance coordination); so, children's acquisition of skills could be hindered and potentially regressed when inappropriately sized equipment is used [1,7].

Thus, in this study, we observed an increase in kinematic actions in Early Group players in the Modified Tournament (Figures 2 and 3), while On-Time to Late-Maturity players did not present an increase. These changes may be due to a decrease in the height of the basket and the inclusion of the 3-point line at 4 m, meaning that players had to exert less effort to achieve a better performance. Thus, the On-Time to Late Group players participated more actively in the Modified Tournament.

On the other hand, Figure 4 shows that the Maximum Sprint Speed by the Early Maturity players decreased, which may be influenced by the fact that the proposed modified rules imply the application of less effort to achieve a better performance. In both cases, the modifications of the rules allowed On-Time to Late-Maturity players to apply less effort in their actions to achieve an adequate performance.

Several authors have pointed out that this sport must be adapted to player development [7,8]. The increase in efficiency, mainly in finishing actions (i.e., shooting, passing, fouls, etc.), will generate higher levels of perceived efficiency, self-efficacy, enjoyment, and satisfaction [14,16], which will result in an improvement in the teaching–learning process [1,33]. Indeed, there is scientific evidence supporting adapted sports and the prevention of injury. Several studies have indicated that adaptations could reduce the issue of early injury in young players because of a lower external load response. Specifically, this lower external load was observed in total distances, total m/min, number of accelerations at high speed, and average speed [4,7,34].

Thus, these modified rules will facilitate efficiency in the game, allowing for greater equality, which is key to making competition a formative tool [13]. An adequate competition structure would create an ideal environment for a great teaching–learning process [26]. Thus, competitions with modified rules promote children's participation, self-efficacy perception increases, and there is an increase in players' variability in their actions. This study demonstrates that variables related to physical performance in basketball are equalised between children with different levels of maturation when a small rule modification is produced. These data show that rule modifications may be interesting and appropriate for achieving a better sporting learning environment. The lower basket height and three-line point closest to the basket should be in the same direction and the bio-banding structural

level. The maturity differences among young players provoke the disadvantage of late-maturity players in terms of physical performance during the competition. Modifying the rules could make the game simpler, and late-maturity players can balance their physical differences to increase the possibility of success.

### 4.1. Practical Applications

A modified competition would permit late-maturity players to show better physical performance. The basketball federations need to revise the official rules for basketball competitions involving young players. In addition, clubs and federations should create bio-banding competitions with the aim of creating a competitive sports model appropriate for the development of children and adolescents.

### 4.2. Further Research

It is necessary to analyse the technical–tactical performance and psychological variables of these players. In addition, it is important to create experimental studies with different basketball levels and a consideration of maturity timing.

### 4.3. Limitations

The main limitation of this study was the short rest time between the FEB Tournament and Modified Tournament, so this could have had an influence on the results. Also, the impossibility for the players to practise previously with the modification of the height of the basket and the three- and four-point lines. In future studies, it is important to allow rest between the tournaments and to provide the players with the possibility of practicing with the new rules. Therefore, it was not possible to use a cross-sectional design in this study.

## 5. Conclusions

This study showed (a) no significant differences in kinematic variables between the two tournaments, although some tendencies to change were observed; (b) Early Group players showed higher kinematic values in the FEB Tournament. While players considered to be in the On-Time to Late Maturity Group had higher kinematic values in the Modified Tournament, (c) both groups of players had higher values in the FEB Tournament, but the difference between the groups was reduced in the Modified Tournament. (d) There were significant differences in the On-Time to Late Maturity Group in terms of Accelerations, Maximum Sprint Speed, and Player Load in the Modified Tournament on the offence positional phase, showing the need to apply less effort to obtain a better sporting performance; (e) however, there were no differences when comparing the Modified Tournament and maturity timing on fast-break phases. The authors of this study believe that sporting federations need to review and modify the rules of basketball competitions involving young people according to the development of the players' maturity.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study. The study was approved by the Institutional Research Ethics Committee of the University of Murcia (No. 2828/2020).

**Data Availability Statement:** Data are contained within the article.

**Conflicts of Interest:** The authors declare no conflict of interest.

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