

Young soccer players aggrupation for conditioning trainings according to players' maturation and physical performance: A practical example

Agrupación de jóvenes jugadores de fútbol para los entrenamientos de acondicionamiento de acuerdo a su maduración y rendimiento físico: Un ejemplo práctico

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Abstract. Under the current structure of soccer, young players are organized according to their chronological age, which may create physical differences between them within a same age-group. These differences influence the player talent identification and selection process and the strength and conditioning development as they give an advantage to those players who are more advanced in their maturation. The present study provides an example carried out by a Spanish soccer academy which reorganized their players according to their maturity status and their physical condition with the aim of comparing conditioning levels and development in a more homogeneous context. The measurements, the player data analysis that was performed and the examples of players who were assigned to other teams according to this grouping model are shown. Final strength and conditioning training recommendations are provided from the scientific literature regarding the specific adaptations throughout the maturation process.

Key words: Soccer, testing, physical performance, maturation.

Resumen. Bajo la estructura actual del fútbol, los jóvenes jugadores son organizados de acuerdo con su edad cronológica, lo que puede crear diferencias físicas y madurativas entre ellos dentro de un mismo grupo de edad. Esas diferencias influyen en el proceso de identificación y selección de talentos y en el desarrollo de la fuerza y el acondicionamiento físico dado que los jugadores que están más avanzados en su proceso madurativo suelen tener una ventaja física. Este estudio proporciona un ejemplo llevado a cabo en un club de fútbol español el cual reorganizó a sus jugadores en función de su estado madurativo y su condición física con el objetivo de comparar su nivel de acondicionamiento y su desarrollo en un contexto madurativo más homogéneo. En el trabajo se muestran las medidas, los análisis realizados a los jugadores y ejemplos de jugadores que fueron asignados a otros equipos de acuerdo con este modelo de agrupación. Finalmente se muestran recomendaciones para el entrenamiento de fuerza y el acondicionamiento de acuerdo con la literatura científica relacionada con adaptaciones específicas a lo largo del proceso madurativo.

Palabras clave: Fútbol, evaluaciones, rendimiento físico, maduración.

Introduction

Relative age effect (RAE)

Sports competitions at early ages are traditionally organised in groups according to the participants' age. These groups are generally made up by subjects who were born in the same year with the aim of creating a fairer participation in which young athletes train, learn and compete in theoretically equal conditions (Cobley et al., 2009). Soccer is an example of a sport in which clubs and academies group their young players in age-related groups or teams, assuming that they are in equal conditions to participate in the same training and

development programs. However, this classical grouping system at early ages may result in between-players differences in the development process in a same age-group (Musch & Grondin, 2001) The relative age effect (RAE) is one of the most reported effect derived from the age-related grouping. Relative age (RA) has been defined as the difference in chronological age between players from the same age-group (Dixon et al., 2011; Gutiérrez Díaz del Campo, 2015). The most common «cut-off» date to create age-related groups is the 1st of January. Using this «cut-off» date, players who were born in the same year but in different months can differ in their RA in up to almost one year (i.e., between two players born in January and December, respectively) (Yagüe et al., 2018). In addition, other issues as between-player differences in biological maturation can be derived from the classical age-based grouping model.

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The RAE has been defined as the consequences of the differences in RA between players of the same selection year that results in an overrepresentation of early-born players (those who were born in the first months of the year) (Yagüe et al., 2018). This fact entails a bias in sport participation through athlete selection process, and it has been widely reported in many sports, mainly in soccer. RAE in soccer has been shown to exist from early ages to adulthood, and from amateur to professional soccer around the world (González-Villora et al., 2015; Götze & Hoppe, 2021; Kirkendall, 2014; Mujika et al., 2009). This bias in soccer participation reveals that early-born players are more likely to be eligible to participate in better teams and to be enrolled in talent development programs at early ages (Vincent & Glamser, 2006). In contrast, it has been shown that late-born players are less likely to promote to better teams and they are more likely to drop-out of sport (Delorme et al., 2010).

Nonetheless, the causes of the RAE are still being discussed by authors, and there is a lack of consensus about the reasons for a higher early-born player selection in soccer (Wattie et al., 2015). While traditional literature suggests anthropometrical and physical performance advantages at early ages from those players who were born in the first months of the year which make them eligible to a greater extent than their late-born peers (Bliss & Birckley, 2012), other studies did not find physical advantages in early born players (Carling et al., 2009). More recently, authors have linked RA advantages to a higher development of the player's maturity status. Under this perspective, a player's physical advantages are due to an advanced maturity and not to the fact of being born some months earlier (Deprez et al., 2013). Other theories focus the main issue on the responsible of the talent identification and selection process (i.e., coaches or scouts) instead of on the players' differences. In this way, traditional theories such as the «Self-fulfilling prophecy» (Merton, 1948) may partially explain the RAE showing that coaches expect more from early-born players than from late-born ones even when there are no physical performance differences between them (Hancock et al., 2013; Peña-González et al., 2018).

Biological maturation

From the birthdate, people experience non-linear changes in their body dimensions and composition called 'growth' (Hermanussen et al., 1988). The growth process is linked to maturation, which refers to structural

and functional changes in the body (i.e., the ossification of cartilage). Maturation is the process that leads to adulthood or the adult state (Malina et al., 2015). Specifically, the term «maturity status» refers to the biological maturation state of an individual at the time of observation (Malina et al., 2004). The maturation process usually progresses alongside chronological age (*average-matures*) but there are inter-individual differences in the maturation progress, showing children ahead of maturation in comparison to their chronological age (*early-matures*) or children with a delayed maturation process regarding their chronological age (*late-matures*) (Lloyd et al., 2014). Thus, it is common to find young players with the same age but different maturity status and this may imply differences in players' anthropometrics and physical performance in the same team (Peña-González et al., 2019). For this reason, it is important to assess the maturity status of young soccer players regularly in a club or academy, considering that the maturation timing is individual and that the maturation progress may vary between participants (Malina et al., 2004). The regular assessment of the players' maturity status may help coaches and conditioning trainers to optimize the training processes, increasing the players' adaptations and reducing injuries throughout their development process (Lloyd et al., 2015).

Traditional methods to assess the maturity, primary from the medical field, were associated with the ossification process (i.e., skeletal age or dental age), but these kinds of methods were expensive and require qualified radiographers or medical personal (Mirwald et al., 2002). Another method to assess the maturity status was the sexual age (i.e., the Tanner method) (Brooks-Gunn & Warren, 1988). However, this method, which consists in the observation of secondary sexual characteristics, may be considered intrusive (Brooks-Gunn & Warren, 1988). Considering the limitations of these methods, which are considered the gold standard for the assessment of maturation, the somatic maturity evaluation (i.e., predicted adult height or the maturity offset) is the most commonly used method in the sports field (KozieB & Malina, 2018). The maturity offset is also called the years from/to the peak height velocity (PHV). PHV refers to the adolescence point of maximum growth velocity in height, which is connected to an accurate landmark of the adolescent maturation (Mirwald et al., 2002; Sherar et al., 2005). This point is set, on average, at 12 years in girls and 14 in boys and provides an estimation of between-participant

differences related to their maturity status. The estimation of the years from/to the PHV is mainly accurate for boys between 12 and 16 years who are on average in their maturation process (Malina & KozieB, 2014).

The aims of the present study were: (a) to examine these possible negative effects resulting from the soccer player grouping based on the age of the participants, (b) to analyse the possible implications in player conditioning and sport development and (c) to show an alternative way to group young soccer players according to the maturity status, the physical performance and the coaches' efficacy expectations of these players.

Talent identification and selection process

The main aim of youth soccer clubs and academies is to identify and select players at early ages who have the potential to succeed in the future, provide them specialized training stimulus within a development program (Gil et al., 2014). This talent identification and selection process is complex due to the fact that soccer is multifactorial and several factors (technical, tactical, physical, physiological or psychological) may influence future success (Reilly et al., 2000). The main attributes that have been studied and applied by clubs and academies in their talent identification and selection processes are the players' anthropometrics and physical performance (Carling et al., 2009). As mentioned in the previous section, these physical characteristics are related to the maturity status in young soccer players, which is different between the individuals belonging a team. For this reason, we can find players in a team who have an advanced maturity status in comparison to their peers, and usually they have anthropometrical and physical performance advantages that could bias the talent identification, selection and development processes (Beunen & Malina, 2008).

The physical advantages of early-mature players have been reported in young soccer players (Peña-González et al., 2019), and the causes of the higher physical development are linked to a higher strength-related development of early-matures (Radnor et al., 2018). Specifically, the strength development linked to the maturation process is due to the increase of muscle mass, changes in fiber-type composition and the improvement of neuromuscular factors (i.e., the recruitment of motor units), among others (Radnor et al., 2018). For this reason, the maturity status is influencing the young players' physical performance in a match since the main physical actions that determine a high performance in

soccer (such as jumping, sprinting or changing direction) (Stølen et al., 2005) are related to the strength development (Asadi et al., 2018). However, these advantages in physical performance from those players with advanced maturation are only «temporal», as late-mature players will reach the same maturity status in the future. In addition, in a grouping system based on chronological age these temporal advantages may be mistaken by coaches and conditioning trainers as «physical talent», and players with advanced maturation are more likely to be selected for talent development programs than the late-mature players who are usually excluded from them (Unnithan et al., 2012). In this way, the age-based grouping system in soccer may mean a disadvantage for late-mature players in the talent identification and selection process.

Strength and conditioning development

From a talent identification and selection process point of view, it would be reasonable to group young soccer players in clubs and academies according to their maturity status rather than to their chronological age (Cumming et al., 2017). However, the structure of soccer federations (regional, national and international) does not allow this kind of grouping to compete. So far, only a few references have reported de benefits of grouping young soccer players according their maturity status (Bio-banding) (Abbott et al., 2019; Bradley et al., 2019; Cumming et al., 2018; Romann et al., 2020). Cumming et al., (2018) and Bradeley et al., (2019) observed that young soccer players feel physically more comfortable in a tournament with players with the same maturity status, while Abbot et al., (2019) and Bradley et al., (2020) have recently observed the physical, technical and tactical differences in competition when players were grouped by chronological age and by their maturity status. Although up until now it is not allowed by official competitions to group players by their maturity status instead of their chronological age to compete, the player grouping by maturity-related features may be a good strategy in a soccer club or academy with training purposes.

Previous research has shown how young people with different maturity status not only have different physical performance but they also adapt to the same training stimulus differently (Lloyd et al., 2016; Meylan et al., 2014; Moran, Sandercock, Ramírez-Campillo, Todd, et al., 2017; Radnor et al., 2017). Meylan et al., (2014) showed greater changes in strength-related adaptation after an 8-week resistance training program (i.e., 1RM

test) for those individuals who were around or passed their PHV. Similarly, Moran et al., (2017) showed that more mature hockey players benefit to a greater extent than less mature players from a 6-week plyometric training program. In Lloyd et al., (2016) and Radnor et al., (2017) pre-PHV school-aged boys showed more positive adaptations from a 6-week plyometric training while post-PHV ones had more positive adaptations after a 6-week traditional resistance training program. Specifically, with young soccer players, Asadi et al., (2018) showed greater gains in jump and sprint performance for players with advanced maturity status after a 6-week plyometric training period. However, Peña-González et al., (2019) did not find player improvements in sprint and change of direction ability in a similar program to the one by Asadi et al., (2018), while they found that an 8-week of low-dose (20-min) combined (plyometric and resistance) training performed prior to their normal training is beneficial to improve the maximal and explosive strength (1RM and peak power output) in young soccer players, showing greater benefits in the players who have not reached their PHV (Asadi et al., 2018; Peña-González et al., 2019).

These differences in young player adaptations to a training stimulus according to their maturity status should be considered in long-term player development programs. One of the most cited concepts about the strength development in youth is the «window of opportunity» (Ford et al., 2011). This program reveals the importance of strength training just after the PHV to obtain greater gains in strength, as at this point of maturation there is an increase of androgen concentrations, a fibre-type differentiation, an increase of creatine phosphate levels and an increase of the architectural development of muscles and tendons (Lloyd & Oliver, 2012; Meylan et al., 2014; Moran, Sandercock, Ramírez-Campillo, Todd, et al., 2017). New long-term athlete development models also highlight the importance of strength training prior to the PHV to benefit from the neural plasticity associated to young individuals through neuromuscular adaptations (i.e., intra- or intermuscular coordination) (Lloyd & Oliver, 2012). The need to individualize the conditioning stimulus to the players' maturity status for the correct strength development of young soccer players may support the idea of grouping these young players in maturity-related groups. This grouping may facilitate the coach and conditioning trainer's task and may allow players to develop their physical performance in a fair and equitable system.

Both, the talent identification and selection process and the long-term development process may be improved with the young soccer player grouping by maturity-related characteristics. This may allow coaches and scouts to compare players in an academy in a more homogeneous physical context, detecting (without any bias) the young players' physical advantages or disadvantages (Till et al., 2018) and train with more homogeneous player groups.

A practical example

The present study provides a practical example carried out within a Spanish youth male soccer academy to decide which players (U13 to U15; age: 14.4 ± 0.4 years; weight: 59.4 ± 12.9 kg; height: 168.6 ± 10.3 cm; PHV: 0.3 ± 1.0 years; 30-m sprint: 5.0 ± 0.2 s; T-test: 10.0 ± 0.3 s; Dribbling: 13.9 ± 0.6 s; Yo-YoIR1: 533.3 ± 158.3 m) should promote to the next age-group, stay in their current group or drop to the previous age-group, according to their physical and maturity-related characteristics.

Maturity assessment

The Maturity Offset proposed by Mirwald et al., (2002) was used to estimate the players' maturity status. Although this formula has been recently improved (Malina et al., 2020), the estimation of the years from/to the PHV is one of the most commonly used indicators of maturity status in young soccer players (Malina et al., 2020). In addition, it is a simple non-invasive and non-expensive way to estimate the players' maturity status by coaches and trainers based on the players' anthropometrical variables. This point of accelerated growth occurs around the age of 12 in girls and 14 in boys, and the estimation of the years from/to the PHV provides the coach or conditioning trainer with a global view of the inter-individual maturity-related differences within a group or team, allowing the maturity comparison between players with the same chronological age. The birthdate of the player, the calculation of the decimal age (chronological age), as well as anthropometrical measurements such as weight, height, sitting height and the estimation of leg length are necessary to evaluate the years from/to the PHV. For this example, all players were assessed of these measures the same day and in the same conditions, previously to the physical performance assessment. The chronological age was calculated as Measurement Date – Birthdate / 365.25. Body height and sitting height were measured

with a fixed stadiometer (± 0.1 cm, SECA LTD., Germany), and the leg length was the result of body height minus sitting height. Body mass was measured with a digital scale (± 0.1 kg, Oregon scientific® GA101/GR101).

*Maturity offset for boys (in years) (Mirwald et al., 2002) = $-9.236 + (0.0002708 * (Leg\ length * Sitting\ height)) + (0.001663 * (Chronological\ age * Leg\ length)) + (0.007216 * (Chronological\ age * Sitting\ height)) + (0.02292 * (Weight / Height * 100))$*

If a player has an average maturation timing, his years from/to the PHV should be: around -1.0 in U13, 0.0 in U14, and +1.0 in U15. For this reason, players are advised to *stay* in their current group if they are between -2.0 and 0.0 years to their PHV in U13, between -1.0 and 1.0 in U14 and between 0.0 and 2.0 in U15. If a player of any of these categories is below the lower limit, he will be advised to *drop* to the team below in the conditioning trainings. On the contrary, if a player of any of these categories is over the upper limit, he will be advised to *promote* to the next age-group. Since during a year the maturity status of the players changes and the velocity of these maturity changes is different for each player (KozieB & Malina, 2018), a periodical evaluation of the maturity status of the players is important to reorganize the conditioning groups.

Physical performance assessment

For the evaluation of the physical performance, five field tests with easy procedures were carried out. With the data obtained in these tests, a relative player profile was created to compare the physical performance between players. It is especially relevant to involve conditioning trainers in this process as the physical condition battery can be adapted to other specific contexts. The tests selected for the physical performance assessment may be adapted to the players' competitive level, their playing experience or even the coach or conditioning trainer's preferences. For the present example, the physical performance battery included: (1) the countermovement jump test (CMJ) (Bosco et al., 1983), (2) a 30-m linear sprint test, (3) the agility T-test (Semenick, 1990), (4) a dribbling test using the same structure as in the T-test but driving the ball and (5) the Yo-Yo IR1 test (Bangsbo et al., 2008). For the evaluation of the CMJ the use of a contact platform to calculate the height of the jump in centimeters is preferable, but classical evaluation without specific material is allowed. In the same way, the use of photocells

to calculate the time in the 30-m sprint, the T-test and the T-test with ball is suggested, but the evaluation with a manual chronometer is allowed if it is applied in the same way with all participants.

To create the relative player profile for the comparison among players in a group, the data was normalized by Z-Scores (Z-score = [Player Score – Mean Score] / Standard Deviation) (Till et al., 2018). The standardization of the data with the Z-scores allows for the comparison between the different tests with different units of measurements. For the physical performance data processing, ± 0.5 Z-score was set as the limit to be included in the «average» or to be classified as «better performer» or «worse performer» in each physical performance test. If a player classifies as «better performer» in at least three of the five physical tests, the player will obtain «+1 point» and he will be advised to *promote* to the next group. On the contrary, if a player classifies as «worse performer» in at least three of the five physical tests, the player will obtain «-1 point» and be advised to *drop* to the group below. If the player is between the ± 0.5 Z-score or he does not get the «+1» or «-1» point in the physical performance tests, he will obtain a «0 point», and the player will be advised to *stay* in his current group.

Once the maturity status and the physical performance of a player has been evaluated, the coach or conditioning trainer have to take the decision of keeping, promoting or dropping the player based on the recommendations obtained in the data processing of each section. For the present example, the technical staff of the three teams which were evaluated decided that both recommendations regarding the maturity status and the physical performance were necessary to decide to *promote* or *drop* a player; thus, if the maturity status advised to promote but the physical performance didn't (or vice versa) the player *stayed* in his current age-group. Table 1 shows the players' descriptive data within a team. An example of players who *promoted* to the next age-group and who *dropped* to the team below are provided.

Table 1.
Descriptive data of players within the U14 team.

	Age (yr)	Weight (kg)	Height (cm)	PHV	CMJ (cm)	30_m (s)	T-test (s)	Dribbling (s)	Yo-YoIR1 (m)
Player_1	14.7	57.1	166.5	0.59	28.0	5.00	10.49	14.05	640
Player_2	14.3	74.0	185.0	1.88	31.0	4.65	9.52	12.76	680
Player_3	14.9	54.3	164.1	-0.21	29.4	5.15	10.29	13.87	760
Player_4	14.6	59.0	168.7	0.32	33.2	4.83	9.59	14.40	560
Player_5	14.4	52.7	163.0	-0.10	37.5	4.66	9.52	12.90	760
Player_6	14.9	44.4	159.0	0.11	34.6	5.10	10.07	13.44	400
Player_7	15.0	90.4	183.5	2.11	27.0	5.17	10.27	13.48	320
Player_8	14.1	37.4	147.0	-1.16	33.0	5.15	10.18	13.56	400
Player_9	14.4	68.4	174.4	0.48	28.9	4.84	9.87	13.16	640
Player_10	14.2	53.9	173.0	-1.36	26.2	5.19	10.27	14.41	320
Player_11	14.3	63.0	177.6	0.82	29.6	5.05	9.99	14.13	600
Player_12	14.4	66.2	169.0	1.07	27.8	4.98	10.03	14.09	400
Player_13	14.4	63.5	173.4	0.84	27.3	4.96	9.58	14.24	600
Player_14	14.7	45.9	154.0	-0.80	29.6	5.11	10.20	14.64	320
Player_15	13.4	61.4	170.5	0.10	29.2	5.10	10.28	14.77	600

PHV: Peak height velocity; CMJ: Countermovement jump; 30-m: 30-meter sprint test

Example 1

Player_2 passed his PHV 1.88 years ago. As previously mentioned, average-mature boys should be between -1.0 and 1.0 years from/to their PHV. For this reason, it is suggested that this player, according to his maturity status, promotes to the next age-group.

Regarding his physical performance, Figure 1 shows *Player_2*'s normalized differences from the team average (Z-scores). Since the *Player_2* reached more than 0.5 Z-scores in four of the five physical performance tests, he was advised, from the physical performance section, to promote to the next age-group.

As *Player_2* was advised to promote from the maturity and the physical performance sections, the final recommendation for this player was to *promote*, to carry out the conditioning trainings in the following team.

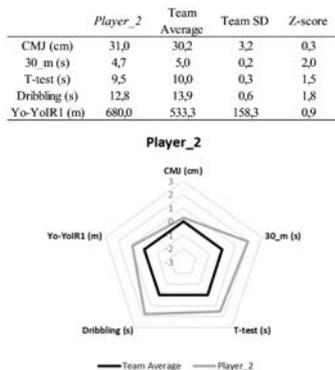


Figure 1. Z-Scores for *Player_2* in each physical performance test in comparison to the team average.

Example 2

Player_10 will pass his PHV in 1.36 years. As the average-mature boys are between -1.0 and 1.0 years from/to their PHV, *Player_10* is advised to *drop* to the age-team below in this section.

The normalized differences of the *Player_10* with the team average can be seen in Figure 2. This player reached -0.5 Z-scores in all the five physical performance tests; thus, it was suggested that he *drop* to the

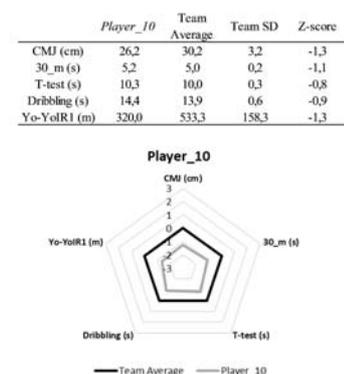


Figure 2. Z-Scores for *Player_10* in each physical performance test in comparison to the team average.

age-group below in this section.

As *Player_10* was advised to downgrade from the maturity and physical performance sections, the final recommendation for this player was to *drop* and to carry out the conditioning trainings in the team below.

Practical recommendations

The present study shows a re-grouping of young soccer players (U13 to U15) regarding their maturity status and physical performance trying to make players train in a more homogeneous context, favouring a fairer player comparison by coaches and technical staff and allowing more adjustable strength and conditioning stimulus according to the players' biological characteristics.

Throughout the strength and conditioning process, coaches and conditioning trainers try to enhance the specific physical performance of players regarding the main soccer demands as jumping, sprinting and rapid changes of direction. High-intensity actions related to a high level of performance in soccer are related to maximal and explosive strength (i.e., jumping ability). In this regard, previous literature has shown strength and velocity adaptations to different strength training stimulus according to young soccer players' maturity status (Asadi et al., 2018; Peña-González et al., 2019). Strength training progression according to specific adaptations regarding the players' maturation process is needed for the correct development of players' soccer-specific performance adaptations.

Plyometric training has been shown to be effective in all maturity groups (pre-, mid- and post-PHV) (Asadi et al., 2018). Although controversial results have been shown regarding the maturity group with greater improvements after a plyometric training program, pre-PHV players seem to benefit to a greater extent from this kind of training stimulus (Lloyd et al., 2016). The application of a correct plyometric training program in pre-PHV players (the U13 group in this study) may enhance the natural development of neuromuscular features in this population. The main neuromuscular enhancements that are expected from these players by a combination of plyometric training and an average biological development are a higher motor recruitment, a higher type II fibre recruitment, a higher stretch-reflex activation, an increase in neural drive, and better inter-muscular coordination (as less agonist-antagonist co-contraction), among others (Radnor et al., 2018). The main characteristics of training in this period are

the bodyweight loads in exercises with stretch-shortening cycle phase, a progression in plyometric training volume, the combination of exercises with vertical and horizontal force-vectors, the combination of unilateral and bilateral exercises and a very high (if not maximal) movement velocity. Typical exercises under this strength training methodology may include: different kinds of skipping, drop landings, vertical/horizontal sided jumps, single leg forward/lateral hop and stick, multiple sided rebounds (one or two legs, horizontal or vertical, forward/backwards or lateral, etc.) among others.

Furthermore, traditional strength training (or resistance training) are traditionally linked to structural adaptations. This kind of training impacts muscle and tendon architecture by increasing the cross sectional area, the fascicle length, the pennation angle or the stiffness, among others (Radnor et al., 2018). Some effects of resistance training in young athletes are unclear and the main limitation for this strength training method in youth is the importance of hormonal anabolic production which is dependent on the maturation process (Moran, et al., 2017). In this regard, combined plyometric and resistance trainings have been shown to be more effective to improve jumping and sprinting abilities in players during and after the PHV (Moran et al., 2017). These increased adaptations to a combined training stimulus rather than the plyometric-only one for post-PHV are also related to the natural adaptative process throughout the maturation process (Lloyd et al., 2016). The main characteristics of training in this period are the weightlifting exercises (for sports modalities it would be interesting to maintain high velocities of movement), a progression in external loads (weights and volumes), the combination of exercises in vertical and horizontal force-vectors and the combination of unilateral and bilateral exercises. Typical exercises under this strength training methodology may include: back squat, (barbell) forward or lateral lunges, deadlift, hip-trust, among others.

Differences between mid- and post-PHV players strength training may be the specific target of post-PHV. Whereas the focus in the pre- and mid-PHV soccer player training should be placed on long-term adaptations and development, post-PHV may be focused on specific short-term needs since players will be in higher stages of the academy's development model, which may imply short-term performance.

Finally, low-dose strength training stimulus, as a circuit, two times per week and performed before the field training seems to be an effective (and a time-

efficient) stimulus when players started the strength training (Peña-González et al., 2019), while an increase, not only in the training orientation, but also in the strength training volume is necessary for post-PHV when they are getting used to strength training stimulus (Moran et al., 2017).

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