Bio-banding in soccer: Benefits on performance, psychological development and its influence on talent identification

Bio-banding en fútbol: Beneficios sobre el rendimiento, desarrollo psicológico y su influencia en la identificación del talento

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Abstract

The purpose of this study was to analyze the existing evidence on the use of Bio-banding (BB) and its possible benefits at the physical and technical-tactical level, psychological development, and talent identification (TI). A search was performed following the guidelines for rapid reviews and the PRISMA guide in Scopus and PudMed. The following keywords were entered: ('Bio-banding') AND ('soccer'). We included n = 10 articles and identified the following variables for analysis: a) Technical-tactical and physical aspects with BB, b) Experiences and psychological aspects through BB, and c) BB in TI. The studies on BB reflect that, during the use of this strategy, great variability of technical-tactical and physical aspects was presented, which favored all maturation groups. Likewise, it is evident that it is a tool that contributes to the psychological development of the players, where it is necessary to expand research on its functionality in the TI process.

Key words: Adolescent development, talent identification, sports, children.

Resumen

El propósito de este estudio fue analizar la evidencia existente sobre el uso del Bio-banding (BB) y sus posibles beneficios a nivel físico y técnico-táctico, desarrollo psicológico y en la Identificación de talentos (ITD). Una búsqueda fue realizada siguiendo las pautas para revisiones rápidas y la guía PRISMA en Scopus, y PudMed. Se ingresaron las siguientes palabras claves: ('Bio-banding') AND ('soccer'). Se incluyeron n = 10 artículos y se identificaron las siguientes variables de análisis: a) Aspectos técnicos-tácticos y físicos con BB b) Experiencias y aspectos psicológicos a través del BB y, c) BB en la ITD. Los estudios sobre BB reflejan que, durante la utilización con esta estrategia, se presentó una gran variabilidad de los aspectos técnico-tácticos y físicos, que favorecieron a todos los grupos de maduración. Asimismo, es evidente que es una herramienta que contribuye al desarrollo psicológico de los jugadores, en donde es necesario ampliar la investigación sobre su funcionalidad en el proceso de ITD.

Palabras clave: Desarrollo adolescente, Identificación de talentos, deporte, niños.

Introduction

Biological maturation is a natural process that occurs in all tissues, organs, and body systems. Generally speaking, it refers to a progression to an adult status and can be defined in terms of status, timing and tempo (Malina et al., 2015). The first term refers to the maturity status observed at the time of a physical evaluation, known as prepubertal, pubertal and postpubertal. On the other hand, timing is the age at which events such as menarche, peak height velocity (PHV) and the development of sexual characteristics occur, while tempo is the speed at which biological maturation proceeds. Historically, since the 1950s, the influence of maturation and growth in young athletes has been a relevant aspect of the prediction and sports talent identification (TI) (Krogman, 1959; Meylan et al., 2010; Verdugo, 2015).

It is well known that biological maturation in young people of the same chronological age (CA) varies greatly in both athletic and non-athletic populations (Meylan et al., 2010). In soccer, for example, significant differences have been found between early and late maturing players in variables such as muscle power, speed, body mass, height, body fat, flexibility, lower limb strength, and cardiorespiratory capacity (Gouvea et al., 2016). As a result, it is usually the early-maturing players who have greater opportunities to access specialized training and high-performance processes, while the late-maturing players are often excluded from these development opportunities (Albaladejo-Saura et al., 2022; Cobley, 2017). In relation to the latter, recent research found that late-maturing players accounted for less than 5% of the U15 and U17 cohorts in an English soccer academy (Johnson et al., 2017).

Often, grouping in soccer competitions is done according to players' CA and rarely considers inter-individual differences in players' growth and maturation, which can lead to inequitable competitions (Bradley et al., 2019; Cumming et al., 2018). In this sport, it is usually the early-maturing players who dominate due to their superior skills, and, many times, their promotion in the training and selection process is more effective (Malina et al., 2019). However, although they may experience greater success at these stages, it is argued that, simultaneously, they present fewer challenges at the physical and technical-tactical level, which is a limiting factor in competition when facing opponents of equal physical condition but more advanced in maturity (Cumming et al., 2017).

Recently, a strategy called Bio-Banding (BB) has been proposed and applied, which seeks to reduce the variation in physical characteristics between athletes and teams, generating competitive equity and variety in learning during training (Cumming et al., 2017). BB is an extension of the concept of "maturity matching" (Malina & Beunen, 1996). and consists of a competitive grouping based on attributes associated with maturation and growth rather than CA (Malina et al., 2019). One of its main objectives is to support late-maturing athletes, giving them the opportunity to compete much more since, due to the greater physical maturity of their peers, they are limited in their participation (Abbott et al., 2019). It also seeks to reduce biases in the selection of early-maturing players, who may not be competent when only physical aspects are controlled (Cumming et al., 2017). On the other hand, from a psychological perspective, it has been mentioned that BB can have a beneficial influence on important social skills such as communication and leadership (Cumming et al., 2018).

In the last 5 years, the study on the influence of maturation on sport performance and the effectiveness of the BB strategy has intensified (Stănilă et al., 2020). The different studies, for the most part, have addressed the experiences and influence of BB on variables such as physical and technical-tactical performance in both training and competition, as well as its possible influence on TI in soccer. Based on the relevance that BB has taken, our purpose was to analyze the existing evidence on the use of BB and its possible benefits at a physical and technical-tactical level, psychological development and TI.

Materials and methods

Study design

This is a rapid review (Tricco et al., 2015). The protocol has not been registered, but we follow the indications of the PRISMA statement (Urrútia & Bonfill, 2010).

Study selection criteria

The PICOT question model was used to define the inclusion and exclusion criteria for the studies (Table 1).

Table 1. PICOT question model for inclusion/exclusion criterio

Item	Inclusion criteria
Participants	Children and youth soccer players between the ages of 8 and 18, male and female.
Intervention	BB utilization.
Comparation	Experiences with BB vs. EC.
Outcomes	Technical-tactical and physical variables, general perceptions, and applicability in TI.
Type of study	Descriptive, observational, experimental, case-controls, in English
Item	**Exclusion criteria**
Participants	-
Intervention	-
Comparation	-
Outcomes	-
Type of study	Editorials, commentaries, summaries, opinions, and reviews.

Search strategy and databases

Searches were conducted in two databases (Scopus and PubMed) using the following simple equation: ("Bio-banding") AND ("Soccer") including articles from January 1, 2015, to June 31, 2022. References were included in the Mendeley software to remove duplicates.

Once the duplicates were removed, they were reviewed by title and abstract and then evaluated in full text, excluding those that did not meet the inclusion or exclusion criteria. Finally, a qualitative analysis was performed using QDA Miner Lite (v. 2.0.8) of the studies admitted to the review to determine the categories analyzed.

Data extraction and collection

Once the studies were obtained, the essential information was extracted in a table, which included the following items: authors and year of publication, characteristics of the participants (number of subjects, category and gender) and key findings.

Results

The initial search yielded a total of 202 articles. After applying the inclusion and exclusion criteria, n = 10 articles were selected (see Figure 1).

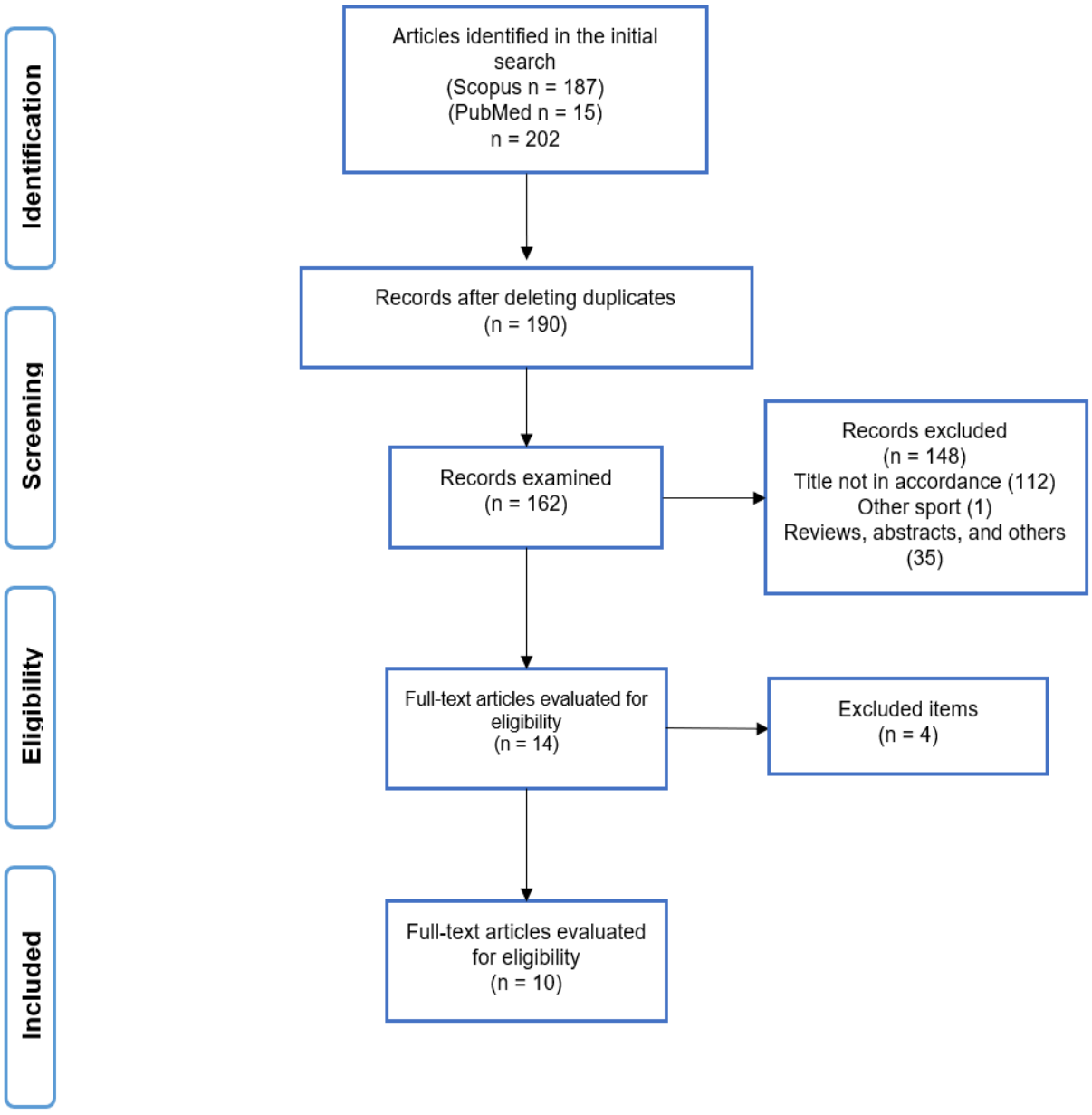

Figure 1. Flow diagram - PRISMA

Table 2 shows that 50% of the studies on BB in soccer have sought to observe the effects of this strategy on technical, tactical and physical variables, comparing them with the grouping by CA. The results show that BB seems to result in a more technically and tactically challenging game for the players. On the other hand, it could be observed that the tendency of the studies is to select male players for the interventions. The results highlight that the BB strategy presents greater challenges for early maturing players from a technical and tactical point of view, while late maturing players perceive lesser challenges.

From a psychological perspective, the studies showed that all maturity groups perceived better leadership opportunities during the game, due to the fact that they had to play with new teammates and other opportunities for competitive development. Regarding the use of BB in TI, it appears that less mature players have the opportunity to demonstrate key skills and psychological characteristics considered desirable during these processes.

Table 2. Studies on Bio-bandig in soccer

Variable	Author, year	Sample	Gender	Category	Key findings
Technical-tactical and physical aspects	Abbott et al. (2019)	25	M	U11-U13	The results showed that competition with BB changed the technical demands placed on the athletes compared to chronological competition without reducing the physical demand.
	Romann et al. (2020)	33	M/F	U13	The BB allowed for a greater amount of dueling, dropped passes, and set pieces, resulting in a quicker change of game situations from team to team. While the physical demand was reduced, the BB seems to result in a more technically and tactically challenging game.
	MacMaster et al. (2021)	319	M	U14-U15	BB reduced within-group variance for anthropometric and physical performance values compared to the CA group (BB: 3.0–17.3% CV; CE: 5.1–16.7% CV) and (CA: 4.8–24.9% CV; BB: 3.8–26.5% CV), respectively.
	Towlson, Abt et al. (2021)	32	M	U12	BB (mainly in early-maturing players) and altered field size may influence tactical and passing behaviors in youth soccer players. Also, early maturing players exhibited more effective collective behaviors than late-maturing players.
	Lüdin et al. (2021)	81	M	U13-U14	The data showed mainly significant interactions between competition format and BB for the following key performance indicators: a) high accelerations; b) conquered balls; and c) attacking balls.
Experiences and psychological aspects of BB	Cumming et al. (2018)	66	-	U12-U15	Early maturing players described the BB as more challenging physically, technically, and tactically. On the other hand, early maturing players perceived it as less challenging but appreciated having more opportunities to use, develop, and demonstrate their technical, physical, and psychological skills.
	Bradley et al. (2019)	115	M	U10-U15	Early maturing players perceived greater physical and technical challenges, while late-maturing players perceived fewer.
	Hill et al. (2020)	NR	NR	U14-U15	Providing psychology sessions customized for the players' maturational age allows the cognitive processes of the early and late maturity states to function within the zone of proximal development (ZPD).
	Reeves et al. (2018)	Pla = 66 Staff = 6 Par = 80		U10-U15	The results suggested that there are six key issues associated with preseason training with BB: (1) interpretation of biobands; (2) perceived disadvantages; (3) perceived advantages; (4) changes in training planning and practice; (5) educating stakeholders; and (6) logistical issues.
BB in TI	Towlson, MacMaster et al. (2021)	n = 72	M	U12-U15	Maturity-matched biological bands had a limited effect on physical variables in all players while improving a number of psychological variables considered key to talent identification in pre-PHP players.

M: male, F: female, CV: coefficient variation, NR: no report, Pla: players; Par: parents; PHV: peak height velocity; TI: talent identification.

Discussion

The objective of this study was to analyze the existing evidence on the use of BB in soccer. A total of n = 10 studies were included and categorized into the following variables: a) Technical-tactical and physical aspects; b) experiences and psychological aspects through the BB; and c) the BB in TI.

Technical-tactical and physical aspects

Abbot et al. (2019) evaluated running performance during the match and technical aspects. In terms of physical performance, players who matured early and on time covered longer total distances during the BB format, although this was not significant (p> .05). On the other hand, late maturing players reduced their total distance during this format (CA = 9083.8 ± 248.9 vs BB = 8971.9 ± 329.5). In terms of explosive running distances, early maturing players improved substantially during BB. Another variable evaluated by the authors was the rating of perceived exertion (RPE), observing a significant increase only in early maturing players during the BB format (p< .05). This may be because these players must strive to better develop their technical-tactical and physical skills to keep up with physically equal opponents, which is not the case when competing in their usual CA format. Regarding the technical performance evaluated, significant differences were found between both formats (p< .05). On the one hand, there was a higher frequency of short passes in early maturing players and a decrease in long passes by early maturing and late maturing players during the BB competition. Dribbling significantly decreased in early maturing players (EC = 7.7 ± 2.1 vs. BB = 6.0 ± 2.2; p< .05) and increased in early maturing players (EC = 3.0 ± 2.3 vs. BB = 4.6 ± 2.5; p< .01). In addition, there were more tackles made by late-maturing players during BB competition compared to that with CA (CA = 4.4 ± 2.7 vs. BB = 7.5 ± 3.4; p< .01).

Romann et al. (2020) found that physically, the BB format reduced the distances covered by jogging, running, and high-speed running compared to the CA format. Regarding technical-tactical aspects, the results highlight a significant increase in the number of duels (p = .024) and set pieces (p = .025) during the BB format. In addition, there was a reduction in the average time of possession of the ball per action (p = .021). As for the number of total passes, there were no significant differences (p = .796), where the rate of successful passes was lower, and the rate of failed passes was higher.

The study by MacMaster et al. (2021) demonstrated that BB is an effective strategy for creating discrete, homogenized groups of players, with each independent group characterized by clear anthropometric differences. Their results show that BB reduced the variance within the group of players for anthropometric variables (CA: 5.1-16.7% CV; BB: 3.0-17.3% CV), with the exception of early maturing players. Likewise, BB reduced the variance for fitness characteristics compared to grouping by CA. Towlson et al. (2021) presented the following most important findings: a) Early maturing players exhibited more effective collective behaviors than late maturing players; b) BB seems to have a greater influence on early maturing players, so they became more integral in team dynamics when mixed with late maturing players; c) BB appears to have a limited effect on performance and team-play behaviors for late maturing players, and d) smaller playing areas tended to increase the tactical and technical performance behaviors of late maturing players.

This variability in technical-tactical actions during different competition formats could provide additional short- and long-term opportunities in the acquisition of specific soccer skills. BB format allows players to express themselves or interact more with the ball (Bradley et al., 2019) and poses greater technical-tactical challenges for early maturing players. Similarly, early maturing players can use, demonstrate and develop certain technical attributes and exert their influence on the game (Abbott et al., 2019), furthermore, the finding that BB alters the frequency of technical actions demonstrates a potential method for manipulating technical performance during youth soccer competitions. It should be noted that the authors do not recommend BB competency as a replacement for regular competency, but as an assistant that contributes to development. Likewise, BB can be applied to modify the competition environment to benefit the development of players by offering them new stimuli for the acquisition of technical-tactical skills and physical challenges adjusted to their level of maturity.

Experiences and psychological aspects through the BB

Recently, Hill et al. (2020) addressed the different psychological aspects related to BB and its similarity to the zones of proximal development (ZPD) proposed by Vygotsky in the 1930s, who points out that children are more likely to increase their understanding and acquire new skills by interacting with other children within these developmental areas, where they can incorporate new learning. This aspect has been the subject of great debate in the educational field, where it has been asked whether mixing children of different ages has positive, negative, or insurmountable effects and where it has been suggested that this type of grouping usually brings benefits, although in different ways for different types of maturity (Balyi, 2004; Hill et al., 2020). One argument within the context of BB is that early maturing players, by virtue of competing with and against larger CA and physically matched opponents, would be more likely to mature within their ZPD. Similarly, late maturing players would have the opportunity to strengthen their learning and understanding of the game when mentoring and assisting their younger peers in CA. These authors were able to explain that sessions with BB within a soccer club may not only have benefits in terms of reducing large maturational differences but also allow for better learning opportunities for players.

This review included two studies (Bradley et al., 2019; Cumming et al., 2018) that have investigated experiences in competition with BB, where players were interviewed and where across the board participants mentioned that this format was more fun than their usual competition due to the fact that for them it was a "new and different experience". In both studies, for example, players expressed that this competition allowed them to express themselves or relate more to the ball, which was a motivating factor. On the other hand, early maturing players expressed that the BB encouraged them to adapt their game, emphasizing technique, tactics, and teamwork over the physical realm because they were facing similarly maturing peers. For their part, early maturing players, like those who matured early, found the greater physical and technical challenges presented to them when playing with and against older and/or more experienced teammates to be more valuable.

It is important to mention that, in addition to conditional skills, advanced maturation has been shown to have a broader influence on child development. For example, children who mature early have higher self-esteem and a better physical self-concept (Hill et al., 2020). Thus, it has been suggested that BB may allow late-maturing players to feel stigmatized as less capable (Reeves et al., 2018), and it is often these differences in the psychosocial developmental aspect that have been an argument against BB (Cumming et al., 2017). In this sense, education about the nature and purpose of BB can mitigate this consequence. It is important to educate both players and parents and coaches to be aware that the BB format is just one strategy of many and one teaching that can be used to present players with new learning experiences, challenges, and opportunities without being limited to just that of a CA format (Abbott et al., 2019).

On the other hand, the studies reflected that all maturity groups perceived better leadership opportunities during the game due to the fact that they had to play with new partners. It should be noted that the effect was greater in players with chronologically higher late maturation who could perceive higher expectations to assume leadership positions when playing with younger players. On the other hand, during the competition with BB, the players perceived the different challenges as learning opportunities; for example, (a) assimilate new skills; (b) better perceive their strengths and weaknesses; (c) engage in creative problem solving; (d) assume new roles and responsibilities; and (e) form new friendships (Cumming et al., 2018).

BB in TI

Individual differences in the biological maturation of players are known to affect the TI process directly and indirectly (Cumming et al., 2017). For example, recent research has shown that advanced biological maturation is associated with more positive coach evaluations of match performance in the U10, U14, and U15 age groups (Hill et al., 2021). That is, coaches felt that early maturing players performed better than their other peers (Hill et al., 2021). The fact that late maturing players are overlooked in TI processes implies a strong psychological impact on the player, even if that player is as talented as his or her more advanced peers. In this context, BB addresses important needs, such as strategy in the talent identification process, where late maturation by competing with players of similar skills can confront, demonstrate, and ensure that their skills are qualified and possibly better utilized. For example, Towlson, MacMaster et al. (2021) were able to conclude that mismatched biobands (i.e., pre-PHV vs. post-PHV) provided a challenging game environment that gave less mature players the opportunity to demonstrate key skills and psychological characteristics considered desirable during the IT process, which could possibly be hidden during a CA competition. While this may be true, it needs to be addressed in better detail, and special attention should be paid to the impact of BB on talent assessments (Towlson & Cumming, 2022).

Conclusion

Studies on BB in soccer reflect that, during the use of this strategy, there is a great variability of physical and technical-tactical aspects that favor all maturity groups. It is also evident that it is a tool that can contribute positively to the psychological development of the players since it has a direct influence on social skills such as leadership, teamwork, and communication.

Their goal of supporting late maturing players, giving them the opportunity to compete much more, and reducing the bias in the selection of early maturing players, seems logical when only physical aspects are considered.

It is necessary to expand the research on its functionality in IT processes since only one study was found in relation to this specific topic. Likewise, it is important to realize and observe its importance and behavior in the female population as well as in other sports, both collective and individual. Also, more research is needed to evaluate the long-term effectiveness of BB, identify and understand the potential mechanisms behind any benefits, establish best practices, and, of course, identify barriers or limitations to its use.

A possible limitation of this review study was the non-inclusion of methodological quality assessments of the studies. However, the evidence included is the most up-to-date and from the most influential authors on the subject.

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