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Comparison of physical fitness level among different competition categories in women's basketball: A systematic review

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Abstract

Acquiring good levels of physical fitness in women's basketball is crucial for success in this complex sport. Thus, the objective of the research is to compare the level of physical fitness in women's basketball between different competitive categories through a systematic review. For this purpose, four databases were consulted (Google Scholar, PubMed, Scielo and LILACS) in Portuguese, Spanish and/or English, in which 32 primary scientific articles were found on physical fitness in women's basketball in the competitive categories and 51 manuscripts complementary secondary about the theme. Physical fitness indicators are divided into anthropometric, metabolic and neuromuscular. Each indicator has a series of variables whose sum will allow us to understand the athlete's actual physical fitness status. The physical training of female players follows the same guidelines as male athletes, but three aspects deserve attention when prescribing programs: menstrual cycle, eating disorders and bone mineral loss. In addition, cardiovascular and neuromuscular characteristics distinguish genders and interfere with physical fitness gains. In general results, professional basketball players presented better averages in the group of indicators (63.1%), followed by formative (21.0%), college (10.5%) and semi-professional (5.26%) players. Finally, it was evident that as female players progress in chronological age, they mature biologically and acquire training support, advancing between the competitive categories. In this way, your physical fitness comes to denote improvement. However, there is a large individual biological variability that impacts the average numbers between the indicators.

Introduction

The distinguishing characteristic of basketball is that it belongs to the class of team sports involving territorial invasion. This means that in a game, the acyclic activities of repetitive multidirectional runs in various planes of movement, changes of direction, decelerations and vertical jumps are present in the cooperation, opposition and completion tasks carried out by the players. These motor actions are performed with and without control of the ball (Narazaki et al., 2009; Aschendorf et al., 2019; Stojanović et al., 2019; Vretaros, 2021). In addition, it is highlighted that these tasks are linked to maximum strength, muscular power, speed, motor coordination and agility (Figueiredo et al., 2015; Townsend et al., 2019).

Achieving optimal performance in competitive basketball is a complex task. The sum of technical skills, tactical knowledge, mental qualities, physiological profile and body structure can determine the ideal performance for a team (Mancha-Triguero et al., 2019; Zarić et al., 2020). Regarding physical preparation, with the changes in rules adopted by the International Basketball Federation (FIBA) in 2000, the game became faster. This fact made basketball players concerned with developing better physical fitness, to tolerate the fast pace and high physiological demands imposed in matches (Drinkwater et al., 2008; Ziv & Lidor, 2009; Delextrat et al., 2012).

Physical conditioning is one of the critical elements in a basketball player's athletic preparation program. In this sense, one of its main goals is to expand functional possibilities in physical fitness (Jukić et al., 2005; Ziv & Lidor, 2009). Physical fitness is a conglomerate of psychobiological attributes that allow the individual to carry out their activities with adequate physical effort. It

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can be interpreted with a focus on health and also on athletic performance (Matsudo, 1995; Venâncio et al., 2022). Among the biological indicators of physical fitness most related to physical sports performance are: anthropometric, metabolic and neuromuscular (Matsudo, 1995; Drinkwater et al., 2008; Fontoura et al., 2013; Zarić et al., 2018).

It is worth mentioning that not always the player who has the favorable sum of anthropometric, metabolic and neuromuscular characteristics can be successful in the sport. Much of success in basketball is linked to solving situational problems through technical skills, as well as individual and group tactical intelligence (Drinkwater et al., 2008; Maricone et al., 2016). In this way, a convenient level of physical fitness, through the stimulation of coordinative and conditioning biomotor capabilities, will serve as support for athletes to continually improve tactical-technical requirements under the effect of fatigue in training sessions (Ziv & Lidor, 2009; Bompa & Haff, 2012; Arede et al., 2021). In fact, the harmful effects of fatigue can be reduced and physical fitness increased if the stimulating load is well dosed. Fatigue is a component that limits performance and can lead to injuries (Delextrat et al., 2012; Power et al., 2022). Therefore, keeping the acute load low and the chronic load high leads to high levels of physical fitness (Vretaros, 2021).

Furthermore, in order for the physical fitness of basketball players to evolve during the season's training program, periodization is a viable resource. A periodization model alternates high loads with recovery phases, seeking to produce positive adaptations and avoiding non-functional overreaching (Lukonaitienė et al., 2020; Vretaros, 2022a). Periodization training contents need to be interconnected in a logical and structured way (Jukić et al., 2005). Two principles help training loads to guarantee the aforementioned objectives: biological individuality and specificity (Reina et al., 2020).

In scientific publications, it is noted that physical preparation programs must take into account the gender of the athletes to be trained. Female athletes demonstrate biological differences that should be considered when prescribing sports physical training. Some of the distinctions between sexes are physical size, body composition, hormonal levels, menstrual cycle, bone density, nutritional intake, cardiovascular and neuromuscular attributes (Wilmore & Costill, 2001; Zatsiorsky & Kraemer, 2008; Kenney et al., 2013; Fleck & Kraemer, 2017; Portes et al., 2020).

The first women's basketball match appeared in 1893, with adaptations to the original men's basketball rules. Since then, women's basketball has spread throughout the world (Reina et al., 2020; Power et al., 2022). In the United States, the high-level league WNBA (Women's National Basketball Association) was created in 1997 (Moreira et al., 2014). In Europe, women's basketball is very active and popular in different countries (Lleshi & Kurti, 2024). Here in Brazil, women's basketball has grown considerably. Therefore, systematized intensive training and competitions have become an increasingly common scenario (Leonardi et al., 2018).

A sports program that involves talent selection and athlete improvement follows a line of constructive procedures in the long term. The approach to achieve this aim is to classify athletes into competitive categories from foundation to high qualification. Therefore, athletes' career planning progresses between these categories (Bojikian et al., 2011; Karpowicz et al., 2015; Calleja-González et al., 2016; Carvalho et al., 2019). In this circumstance, knowing the level of physical fitness between the different competitive categories is necessary, so that professionals committed to these populations of athletes can obtain concrete practical parameters in the design and conduct of the training process based on more reliable bases (Portes et al ., 2020; Williams et al., 2022).

Therefore, the aim of this systematic review is to compare the level of physical fitness in women's basketball between different competitive categories. With this intention, the study was divided into the following topics: 1)- physical fitness in basketball, 2)- physiology of physical training in female athletes, 3)- results, 4)- discussion and 5)- conclusion.

Method

The present study is a systematic review work. This research methodology consists of a critical analysis of specialized literature regarding a specific topic. With the delimited theme, the starting point for the main objective is created, which will be treated based on a certain area of knowledge centered on previous publications (Cristante & Kfuri, 2011; Mancha-Triguero et al., 2019).

The systematic review seeks answers to a certain question, seeking to update and improve the existing field of knowledge. The quality of this process is supported by the organizational systematization of research during academic writing. With pre-planned stages, rigorous selection of studies and data extraction, a quantitatively detailed investigation is constructed. The central premise is not just the isolated explanation of the fact, but checking its possible interrelations, counterpoints and gaps to obtain a solution to the objective with data that supports it (Silva & Paiva, 2022; Mancha-Triguero et al., 2019).

A transparent and reproducible methodology facilitates the quality of the systematic review (De Sousa et al., 2017; Mancha-Triguero et al., 2019). To achieve this purpose, the PICO structural approach (population, problem, intervention, comparison and outcome) served as the initial line of reasoning (De Sousa et al., 2017; Roever et al., 2021). In this case, the sample population consists of female basketball players. The guiding problem is related to the level of physical fitness between competitive categories. The intervention concerns the type of physical fitness indicator analyzed (anthropometric, metabolic or neuromuscular). The confrontation between the formative, college, semi-professional and professional categories represents the topic of comparison. In the outcome, the stratified average numerical data from the research underwent specific statistical treatment.

In addition, this manuscript was built based on the seven-step investigative methodology for systematic reviews proposed by De Sousa et al. (2017): 1)- identification of the main theme and the problem question, 2)- legitimize the inclusion and exclusion criteria, 3)- analyze the quality of pre-selected texts. 4)- establishment of the data that will be extracted from the research, 5)- present the evaluation of the results found, 6)- interpretative debate of the results with reference to the available theoretical-scientific bases and, 7)- synthesis of the knowledge found and final conclusion.

Through a literary search in four electronic databases (Google Scholar, PubMed, Scielo and LILACS) in Portuguese, English and/or Spanish, scientific articles were chosen that circumscribed the topic of physical fitness in women's basketball between different competitive categories. In the Boolean search for words, the operators "AND" and "OR" were used together in the following keywords: "basquetebol AND/OR aptidão física", "basketball AND/OR fitness", "baloncesto AND/OR aptitud física", "basquetebol feminino AND/OR aptidão física", "female basketball AND/OR fitness", "baloncesto femenino AND/OR aptitud física", "basquetebol feminino AND/OR antropometria", "baloncesto femenino AND/OR antropometría", "female basketball AND/OR anthropometry", "basquetebol feminino AND/OR capacidade anaeróbica", "baloncesto femenino AND/OR capacidad anaeróbica", "female basketball AND/OR anaerobic capacity", "basquetebol feminino AND/OR capacidade aeróbica", "baloncesto femenino AND/OR capacidad aeróbica", "female basketball AND/OR aerobic capacity", "basquetebol feminino AND/OR testes neuromusculares", "baloncesto femenino AND/OR pruebas neuromusculares", "female basketball AND/OR neuromuscular tests", "basquetebol feminino AND/OR testes metabólicos", "baloncesto femenino AND/OR pruebas metabólicas", "female basketball AND/OR metabolic tests", "basquetebol feminino AND/OR composição corporal", "baloncesto femenino AND/OR composición corporal", "female basketball AND/OR body composition", "basquetebol feminino AND/OR testes de aptidão física", "baloncesto femenino AND/OR pruebas de aptitud fisica", "female basketball AND/OR physical fitness tests".

Inclusion and exclusion criteria were used for the manuscripts found with the purpose of election based on academic rigor. The inclusion criteria chose: 1)- research discussing physical fitness in women's basketball in various competitive categories, 2)- studies on anthropometric, metabolic and/or neuromuscular tests in female basketball players, 3)- investigations into the organic physiology of female athletes , 4)- physical fitness data in women's and men's basketball, 5)- training loads in women's basketball and 6)- physical fitness assessment process in team sports. In the exclusion criteria, incomplete texts, duplicate articles, investigations where the competitive category was not identified, manuscripts on physical fitness in individual sports and anthropometric, metabolic and neuromuscular tests in individual sports were disregarded.

The final writing of the investigation involved 32 primary scientific articles and 37 complementary research published between 1997 and 2024, 03 textbooks on exercise physiology, 07 textbooks on the theory of sports training, 02 textbooks on assessment of physical fitness, 02 textbooks on statistics, 04 studies in the field of scientific research methodology and an institutional website.

Statistical Treatment

The exploratory analysis of the nominal data set of the chosen researches was carried out using the measure of central tendency (arithmetic mean) and its dispersion values (standard deviation) (Ogliari & Andrade, 2005). The numerical values of each physical fitness variable for the different competitive basketball categories were compared through the mathematical calculation of the percentile delta [Δ% = (Major Value - Minor Value) / Minor Value x 100] (Vretaros, 2022b). Added to this, the effect size (ES) between means was calculated, using the Cohen's d calculation (Cohen's d= [Mean 2 – Mean 1] ⁄ Grouped Standard Deviation) (McGuigan, 2017; Garcia-Gil et al., 2018). Its magnitude rating scale for assessment is <0.20 trivial, 0.20-0.60 small, 0.60-1.20 moderate, 1.20-2.00 large, 2.00-4.00 very large, and >4.00 extremely large (McGuigan, 2017). The significance level adopted is 5% ($p<0.05$) and the "t" distribution for independent samples is calculated as recommended by Kirkwood & Sterne (2003).

Physical Fitness in Basketball

A definition of physical fitness encompasses a series of psychobiological attributes that will allow athletes to carry out their activities with physiological effort in an appropriate manner (Matsudo, 1995; Venâncio et al., 2022).

The functional capacity of athletes is highly linked to their level of physical fitness. Therefore, this physical fitness must be specific to the sporting modality, so that it induces the harmonious development of anthropometric, metabolic and neuromuscular indicators (Matsudo, 1995; Figueiredo et al., 2015; Mancha-Triguero et al., 2021).

The main characteristics of physical fitness in basketball have evolved over the years. Much of the information pertinent to physical fitness in basketball has been used to understand the complex dynamics of performance, especially in the selection and detection of talent (Sánchez, 2007; Bojikian et al., 2011; Calleja-González et al., 2016; Knihs et al. al., 2016; Garcia-Gil et al., 2018).

The physical fitness of basketball players must be monitored regularly during the season, so that the actual state of preparation of the athletes is in hand and, therefore, a suitable training program can be created (Jukić et al., 2005; Knihs et al., 2016). Laboratory and field test protocols allow measuring and predicting the physical fitness behavior of basketball players (Apostolidis et al., 2004; Drinkwater et al., 2008; Zarić et al., 2018). The intention of these tests that evaluate the physical fitness of athletes is to verify the progress of the physical training program (Knihs et al., 2016; Mancha-Triguero et al., 2019). However, although both are necessary for an appropriate assessment of physical fitness, there is a clear difference in the use of laboratory and field tests. While laboratory tests have high validity and reproducibility, field tests meet the requirements of ecological validity (Apostolidis et al., 2004). These tests are classified into general and specific. General tests serve to measure global physical fitness, without relation to the sport. In specific tests, the physical fitness assessed is directly related to the operational elements necessary for sports performance (Mancha-Triguero et al., 2019).

Such tests that assess physical fitness in basketball are related to six determining factors, namely: individual behavior of the athlete in the game, tactical role performed, minutes played, group behavior of the team, tactical-technical skills and risk of injuries (Drinkwater et al., 2008).

Collecting data on athletes' physical fitness indicators is a very common practice in the field of physical preparation. These indicators, when observed from a biological perspective, are divided into anthropometric, metabolic and neuromuscular. Only by bringing together these three indicators can one deduce the true condition of the player's and/or team's physical fitness (Matsudo, 1995; Figueiredo et al., 2015; Knihs et al., 2016; Mancha- Triguero et al., 2019).

In anthropometric indicators, we are dealing with measurements of the human body that are related to dimensions of the physical structure and that are conceived in parts or as a whole. For example: height, body mass, fat percentage, bone diameters, muscle circumferences, etc. (Matsudo, 1995; Fontoura et al., 2013). Genetics has a strong contribution to the development of anthropometric characteristics of athletes (Lleshi & Kurti, 2024).

Experts report that basketball is a sport in which the high height and weight of players can denote a competitive advantage and determine the tactical role on the court. A commonly accepted natural tendency is to place players with high height and body mass close to the basket so that they can carry out an easier attack and, at the same time, defend their basket in a defensive dynamic. Another real advantage of having taller and heavier players playing close to the basket is gaining privileged space during physical collisions in games (Ackland et al., 1997; Garcia-Gil et al., 2018).

In this scenario, another anthropometric variable arises: wingspan. The wingspan of basketball players helps to improve the total range of rebounds, ball disputes, scoring and dunks (Knihs et al., 2016). Consequently, players with smaller stature tend to play on the perimeter of the court, as they have less body mass and are able to move with greater ease. Thus, the five tactical roles in basketball are divided into point guards, shooting guards, small forwards, power forwards and centers. Point guards, shooting guards and small forwards as players with smaller physical size and power forwards and centers as athletes with larger body dimensions (Drinkwater et al., 2008; Pizzigalli et al., 2017; Zarić et al., 2018).

The body fat percentile is another important anthropometric variable that helps in the interpretation of height and body mass (Wilmore & Costill, 2001; Kenney et al., 2013). Thus, among the tactical functions, Delextrat & Cohen (2009) mention that players who play as centers have a higher percentage of body fat than other positions. The same authors argue that this fact may be opportune for these players due to the constant physical contact.

In relation to metabolic indicators, they focus on bioenergetic production processes, that is, the anaerobic (alactic and lactic) and aerobic pathways (Matsudo, 1995). In the view of Fontoura et al (2013), these indicators are added to the cardiometabolic process, which reflects the combination of the organic functional capacity of the cardiovascular, respiratory systems and muscular activity. Some of the metabolic indicators measured in basketball players would be maximum oxygen consumption (VO2max), maximum heart rate (HRmax), resting heart rate (HRrest), blood pressure, among other variables (Apostolidis et al., 2004; Halder et al., 2016; Venâncio et al., 2022). Basketball requires three physiological bioenergetic pathways (alactic anaerobic, lactic anaerobic and aerobic) during the countless motor actions required in training and competitions. Of the systems mentioned, the primary metabolic substrate in basketball is alactic anaerobic, which is evident in explosive intermittent tasks (Narazaki et al., 2009; Gonzalez et al., 2012; Mancha-Triguero et al., 2017; Pizzigalli et al. , 2017). Aerobic processes contribute to the resynthesis of creatine phosphate and reduction of blood lactate during short-term active and passive breaks (Mancha-Triguero et al., 2017). Therefore, measuring metabolic indicators such as VO2max (indicates aerobic fitness), HRmax (highlights the intensity of effort), HRrest (cardiac recovery capacity) are fundamental (Narazaki et al., 2009; Emrah & Kayalarli, 2013; Halder et al., 2016).

Neuromuscular indicators are associated with muscular strength and the biomotor capabilities that depend on it for their evolution: explosive power, maximum strength, acceleration, agility and flexibility (Matsudo, 1995; Fontoura et al., 2013). The muscular strength and power of the upper and lower limbs must be in suitable conditions so that the movements can be performed with due body awareness and mastery (Knihs et al., 2016; Pizzigalli et al., 2017; Vretaros, 2021). Moving with changes in speed, over short distances, causes acceleration to be recruited by players (Conte et al., 2015; Zarić et al., 2018; Stojanović et al., 2019). The motor efficiency of these movements in fast motor actions such as counterattacks or defensive tactics describes agility (Knihs et al., 2016). Thus, in basketball, the tests that evaluate the most listed neuromuscular indicators are the countermovement jump (CMJ), squat jump (SJ), one maximum repetition (1RM) of the bench press exercise, 1RM in the squat exercise, t-test, acceleration in 5 meters (A5), acceleration in 10 -meters (A10), acceleration in 20-meters (A20), etc. (Kilinç, 2008; Erculj et al., 2010; Nunes et al., 2014; Fort-Vanmeerhaeghe et al. 2016; Zarić et al., 2018).

Specific motor skills performed by players during matches have a positive correlation with physical fitness (Jukić et al., 2005; Fort-Vanmeerhaeghe et al., 2016).It has been shown that assists during games are correlated with vertical leap, agility, acceleration, anaerobic power and aerobic power. Ball tackling is correlated with agility, acceleration, aerobic power and anaerobic power (Fort-Vanmeerhaeghe et al., 2016). Diverse passes and ball control are rooted in the explosive power of the upper limbs (Jukić et al., 2005). Dribbling, speed, high-intensity lateral movements and agility have a significant relationship with average anaerobic power (Apostolidis et al., 2004). In addition, low percentiles of body fat contribute to faster actions in tasks such as dribbling and agility with dribbling (Ziv & Lidor, 2009). Athletes' somatotype correlates with the ability to perform repeated accelerations, just as lean body mass helps maintain effort intensity (Miguel-Ortega et al., 2023). Finally, maximum handgrip strength, resting heart rate and blood lactate levels play an important role in players' effectiveness (Zarić et al., 2021). However, it is necessary to remember that the correlations between basketball-specific motor skills and physical fitness are subject to the athletes' age, gender, training history and competitive category (Mancha-Triguero et al., 2019).

The organizational structure of basketball is concerned with the process of body development in the long term, involving a sequential hierarchy that begins in the formative competitive categories (under-10 to under-23), advancing to college and semi-professional athletes and, concluding with the universe of professional players (Calleja-González et al., 2016; Fort-Vanmeerhaeghe et al., 2016; Lukonaitienė et al., 2020; CBB, 2022). This continuous progressive system serves both genders, being supported by the concepts of chronological age and maturational age (Carvalho et al., 2019).

The training content for the formative categories is made up of multilateral preparation activities that serve as a foundation for the following categories. When entering the subsequent categories (college, semi-professional and professional), players are trained for maximized specific development (Jukić et al., 2005). That said, it is to be expected that from the moment athletes progress in category, their physical fitness indicators will show a natural development (Fleck & Kraemer, 2017). This situation is due to the intrinsic association between body growth and the training material acquired (Erculj et al., 2010; Leonardi et al., 2018). Furthermore, there is interference from the biological variability of basketball players (Drinkwater et al., 2008).

The physical fitness levels of basketball players are dependent on the period of the season analyzed, the team's playing style and the tests that are administered for their evaluation. From this perspective, the results of physical fitness tests must be understood individually, based on the unique characteristics of each athlete and can also be grouped by tactical function (Delextrat & Cohen, 2009; Ziv & Lidor, 2009; Calleja-González et al ., 2016).

Basketball players with high levels of physical fitness are able to sustain high-intensity workloads with greater competence and exhibit a high rhythm in tactical-technical actions during games (Sánchez, 2007; Stojanović et al., 2019). Consequently, the athlete's full performance in the game system becomes more participatory. In other words, the conditional competitive profile is reached (Cedenilla et al., 2014). Currently, a well-constructed physical conditioning program takes into account individualizing the training loads imposed on athletes, to obtain a satisfactory level of physical fitness (Drinkwater et al., 2008; Delextrat & Cohen, 2009).

The objective of the physical training program in team sports is not to exceed the organic limits of the athletes' physical fitness. The main guideline is to keep players at low risk of injury and with a sustainable competitive readiness to tolerate games every three to five days during the season (Walker & Hawkins, 2017; Vretaros, 2022a).

Physiology of Physical Training in Female Athletes

Looking at the process of body growth, there are no substantial differences between male and female pre-pubertal children in the anthropometric indicators of height, body mass, proportionality between limbs, bone width, and fat percentage until puberty. With the entry into puberty, a series of hormonal action events occur that distinguish genders and affect biological maturation (Wilmore & Costill, 2001; Kenney et al., 2013).

Table 1

Physical fitness indicators and some variables analyzed in each category (Adapted from Matsudo, 1995; Ackland et al., 1997; Apostolidis et al., 2004; Drinkwater et al., 2008; Bojikian et al., 2011; Fontoura et al., 2013; Calleja-González et al., 2016; Halder et al., 2016; Knihs et al., 2016; Pizzigalli et al., 2017; Zarić et al., 2018).

Physical Fitness Indicators	Variables Analyzed
Anthropometrics	Height, total height, wingspan, body mass, bone weight, muscle weight, body fat percentage, body mass index, palmar diameter, somatotype, palmar length, etc.
Metabolic	VO_2max, HRmax, maximum heart rate percentile, HRrest, blood pressure, blood lactate, Wingate test, etc.
Neuromuscular	1RM in the squat exercise, 1RM in the bench press exercise, CMJ, SJ, ABK, medicine ball throw, horizontal jump, Sargent jump test, A5, A10, A20, A25, 25-centimeters drop jump, 30-centimeters drop jump, agility t-test, sit and reach flexibility test, maximum isometric handgrip strength, etc.

VO_2max= Maximum oxygen consumption, HRmax=Maximum heart rate, HRrest=Resting heart rate. 1RM=One repetition maximum, CMJ=Countermovement jump, SJ=Squat jump, ABK=Abalakov jump, A5=Acceleration in 5-meters, A10=Acceleration in 10-meters, A20=Acceleration in 20-meters, A25=Acceleration in 25-meters.

Male athletes have a longer growth spurt and body development when compared to female athletes (Farinatti, 1995; Wilmore & Costill, 2001). For example, male athletes reach their peak height speed at fourteen years of age and continue in this process until approximately eighteen years of age. On the other hand, female athletes establish their developmental peak at twelve years of age and reach a plateau at fifteen years of age (Drinkwater et al., 2008). Final height is genetically inherited. The height growth rate of boys is 10.3 centimeters/year and, for girls, it remains at 9.0 centimeters/year. Growth hormone has a significant contribution to this process (Bojikian et al., 2011).

Children undergoing body development are categorized according to their biological age (early, intermediate or late) (Farinatti, 1995; Bojikian et al., 2011; Gryko et al., 2022). In girls, the age at menarche (first menstruation) can help with this panorama. Early menarche in relation to the population average of a given region would indicate an early biological age and, intermediate or late menarche, would follow this same conception (Leonardi et al., 2018). In Weineck's argument (2005), children at an intermediate stage of bodily development coincide in chronological age with biological age. In late subjects, biological age is delayed and, in early subjects, biological age is accelerated in relation to chronological age. It is noteworthy that this growth is not orchestrated in a regular manner between the various organic systems and body segments (Farinatti, 1995).

Formative categories are established based on chronological age. However, it is clear that in the same classification range there may be players with wide biological ages (late or early). The margin of this variation is approximately three years. A typical example would be in the under-15 category, where athletes with biological ages ranging from 12 to 18 years old will be found (Bojikian et al., 2011).

A notable finding in the differences between sexes in the body growth phase during the transition to adolescence is the increase in the adipose tissue percentile for female athletes and a gain in muscularity in male athletes (Drinkwater et al., 2008; Carvalho et al., 2019). The gain in adiposity in female athletes at the end of puberty ranges from around 25% to 30% (Carvalho et al., 2019). However, with continuous training this value can be changed to lower numbers (Wilmore & Costill, 2001).

In terms of muscular strength, the difference between sexes in children is related to the gradual maturation of the central nervous system, anatomical dimensions and biological maturity. While newborns have muscle mass corresponding to 25% of their weight, when they enter adolescence this number increases to 40% of their total weight (Farinatti, 1995). Girls in the developmental stage tend not to exhibit a linear pattern of strength gains as they age. Evidence reports that girls aged 12 and 13 who do not undertake some training approach sometimes have lower strength levels than those aged 9 and 10 (Fleck & Kraemer, 2017). In adulthood, female muscle strength is lower than that of males (Wilmore & Costill, 2001). This differentiation is located in the absolute and relative strength of the upper body. This circumstance occurs due to the smaller cross-sectional area of muscle fibers in female athletes. In addition, in male athletes the amount of muscle mass in the upper limbs is more significant (42.9%) when compared to female athletes (39.7%). In the lower limbs, the ability to generate relative strength of female athletes is very close to that of male athletes (Wilmore & Costill, 2001; Zatsiorsky & Kraemer, 2008; Kenney et al., 2013; Rice et al., 2016; Fleck & Kraemer, 2017). In female athletes trained with maximum strength, the morphological issue of the fibers shows unfavorable variations. For example, the cross-sectional area of fibers, the size of these fibers, the number of fibers and the proportionality between type I and II fibers tend to be lower in women. This finding emerges in certain muscle groups (Zatsiorsky & Kraemer, 2008; Fleck & Kraemer, 2017). In muscular power, the premise is the same. Female athletes produce less explosive force per muscle unit volume. Adaptations in neural discharge, activation of motor units and stiffness in the musculotendinous unit are some causes of this differentiation. This fact can be seen in the vertical jump height test and in Olympic lifting exercises (Zatsiorsky & Kraemer, 2008; Fleck & Kraemer, 2017; Arede et al., 2021). In addition to the above, testosterone helps to obtain strength and power in male athletes, as they have an endogenous resting proportion of this hormone equivalent to 10-40 times higher compared to female athletes (Powers & Howley, 2014; Fleck & Kraemer , 2017). When we overcome sexual differences between genders in strength and power training, it seems that the volume of loads in female athletes during the preparatory period would be another element that would disturb work capacity (Mikolajec et al., 2003).

In the cardiovascular context, female athletes have a smaller heart size and lower blood plasma volume. Under conditions of similar effort, the heart rate of female athletes tends to be higher. However, cardiac output is similar to that of men, due to the maintenance of a higher heart rate and a lower stroke volume. The VO2max, which reflects the cardiorespiratory endurance for the release and subsequent use of oxygen, has discrepancies between sexes. Female athletes have lower values than male athletes, the origin of this distinction being the higher body fat content and lower amount of hemoglobin. The decreased concentration of hemoglobin interferes with the release of oxygen to the muscles active during exercise (Wilmore & Costill, 2001; Kenney et al., 2013). For illustration purposes, the average value of VO2max in adult male basketball players is around 50.0-60.0-ml/kg/min and, in female players, it is between 44.0-54.0-ml/kg/min (Calleja-González et al., 2016).

Systematized and rigorous physical training can minimize some of these differences between genders, within genetically pre-established limits. However, three singularities mark the prescription of physical training in female athletes: the menstrual cycle, eating disorders and bone mineral loss. The sum of this set of aspects is called the female athlete triad (Wilmore & Costill, 2001; Zatsiorsky & Kraemer, 2008; Kenney et al., 2013; Powers & Howley, 2014).

The menstrual cycle, which lasts an average of twenty-eight days, has a certain degree of contribution to the performance of female basketball players. Certain phases of the menstrual cycle can accentuate gains in performance and other phases can be detrimental. However, there is no consensus among experts in the field in which phase the peak of physical fitness predominates. There is the effect of great individual variation in these physiological responses (Wilmore & Costill, 2001; Vretaros, 2022a). The cyclical menstrual dynamics can also result in dysfunctions, such as oligomenorrhea (irregular or scanty menstruation), amenorrhea (total absence of menstruation) and dysmenorrhea (painful menstruation). For example, amenorrhea can lead players to greater mineral loss in total bone density. The most common causes are associated with a previous history of dysfunction, high acute stress, high training loads, decreased fat content or body mass, unbalanced nutrition and hormonal variations (Wilmore & Costill, 2001; Kenney et al., 2013; Powers & Howley, 2014). A study with Turkish female team sports athletes (basketball, football, hockey and handball) showed that 8.3% of players had menstrual changes after starting sports. Among these sports, basketball players were the most affected (41.4%). It is claimed that athletes who train more than 14-16 hours a week are more prone to menstrual dysfunction. However, the menstrual problems found in the study are related to the type of modality and not necessarily the frequency of training. According to researchers, the psychological component has a strong link with these disorders (Karacan et al., 2013).

Likewise, we should be concerned about the age of menarche in formative basketball players. Menarche is delayed by five months for each year that the female child undergoes an intensive training program (Wilmore & Costill, 2001). In practice, it is usually identified that athletes with early menarche have a taller height, providing a competitive advantage (Gryko et al., 2022). Even so, in an investigation with basketball players from the under-13 and under-15 categories, their state of maturation and performance were examined based on age at menarche. It was proven that late menarche plus older chronological age resulted in better results in height, body mass and countermovement jumping (Leonardi et al., 2018).

Eating disorders affect female athletes due to excessive concern with aesthetics imposed by sociocultural standards and the media. This attitude impacts the menstrual cycle, causing dysfunctions and can result in the appearance of more serious pathological conditions such as anorexia or bulimia nervosa. These irregularities in nutritional intake require complex clinical treatment. Female athletes need to be aware of consuming a caloric intake of nutrients according to the demands of their activities. The central idea is that the coach identifies the problem as early as possible to refer the player to a specialized professional (Zatsiorsky & Kraemer, 2008; Wilmore & Costill, 2001; Kenney et al., 2013).

The decrease in bone mineral density is the result of the two aspects mentioned above: amenorrhea and eating disorders. It is worth noting that nutritional disorders precede amenorrhea and loss of bone density (Wilmore & Costill, 2001; Kenney et al., 2013). Prolonged amenorrhea leads to a reduction in blood levels of the hormone estrogen. From this, combined with poor intake of calcium and/or vitamin D leads to bone mineral loss (Powers & Howley, 2014). The regions of the body in female athletes that are affected by loss in bone density are the locomotor system in general, the spine and the hip (Karacan et al., 2013).

Female athletes in team sports have a strong predisposition to poor knee alignment. This joint segment in female players has a deficit in neuromuscular control, encouraging medial valgus misalignment, especially in the dominant leg. This manifestation is evident around ten to twenty times higher in adolescent women when compared to males. In this circumstance, during neuromuscular training, it will be necessary to incorporate corrective exercises to improve the biomechanics of movement and reduce the risk of injuries to the anterior cruciate ligament (Gamble, 2008).

Typically, female basketball players' physical training follows the same guidelines as male players. Female athletes can be subjected to the same training systems, means and methods to optimize their physical fitness. Loads compatible with biological age, physical structure, psychological maturity and competitive category are recommended. However, despite the prescribed physical training being identical between sexes, the magnitude of morphological, physiological and mechanical adaptations may differ in some intervening variables (Zatsiorsky & Kraemer, 2008; Kenney et al., 2013; Rice et al., 2016; Fleck & Kraemer, 2017).

When organizing a physical conditioning program aimed at female athletes, the structuring of the content of the tasks and loads applied must be governed by a periodization model (Vretaros, 2022a). Each period of the season requires particular physical training goals. In the pre-season, where the aim is to create a foundation in physical condition, some objectives can be encouraged: substantially increased volume in workloads, stimulation of different biomotor capabilities to increase the level of physical fitness and prepare athletes for the competition period. During the competitive period, considered the longest, athletes must seek to improve their biomotor capabilities alternating with moments of stabilization. When entering the transition period, we have the following points to be observed: maintenance of body weight avoiding fat gain, stabilization of minimum standards of muscular strength and cardiorespiratory endurance, prevention of injuries with multicomponent exercises, action in areas of physical weakness to correction and ensure training with technical skills (Powers & Howley, 2014; Vretaros, 2021; Vretaros, 2022a).

When distributing loads, a definition between the amount of general and specific training will be necessary. The age of maturation of female basketball players and their competitive category should be taken into account. The current individualized state of physical fitness will influence the athletes' behavior in the games. Therefore, the creation of functional indicators that associate physical condition with tactical-technical requirements is essential (Komotska & Sushko, 2022).

Results

A pronounced profile of basketball is the use of technical and tactical motor skills to compose the game itself (Knihs et al., 2016; Gómez-Carmona et al., 2021). However, what will guide the legitimized performance of these different skills is the physical fitness of the athletes (Weineck, 2005; Bompa & Haff, 2012). Based on this observation, interpreting the conduct of physical fitness in female basketball players across the different competitive categories becomes an indispensable responsibility.

In the systematic review, 32 primary studies were carefully selected covering physical fitness in women's basketball across different competitive categories (table 02). Therefore, in this topic we will describe in detail the sample size of the research, competitive categories involved, anthropometric indicators, metabolic indicators and neuromuscular indicators. In the subsequent topic (discussion), a more detailed analysis will be made of the results found in accordance with the opinion of the scientific literature on the subject.

In these thirty-two investigations related to physical fitness in women's basketball, the total sample size was 691 (100%) female basketball players. Of this total, 343 (49.6%) were formative players, 40 (5.78%) belonged to college basketball, 16 (2.31%) were semi-professional basketball players and 292 (42.2%) participated in the professional category Fernández-Río et al., 2000; Kilinç, 2008; Nunes et al., 2008; Delextrat & Cohen, 2009; Narazaki et al., 2009; Erculj et al., 2010; Delextrat et al., 2012; Emrah & Kayalarli, 2013; Nunes et al., 2014; Fort-Vanmeerhaeghe et al., 2016; Halder et al., 2016; Rice et al., 2016; Doma et al., 2018; Garcia-Gil et al., 2018; Leonardi et al., 2018; Park et al., 2018; Zarić et al., 2018; Aschendorf et al., 2019; Meszler & Váczi, 2019; Stojanović et al., 2019; Bouteraa et al., 2020; Lukonaitienė et al., 2020; Mancha-Triguero et al., 2020; Arede et al., 2021; Cherni et al., 2021; Javanmardi et al., 2021; Zarić et al., 2021; Komotska & Sushko, 2022; Kooroshfar & Rahimi, 2022; Ibáñez et al., 2023; Miguel-Ortega et al., 2023; Papaevangelou et al., 2023).

Due to the large number of components that represent the three physical fitness indicators, it was decided to filter some relevant variables for analysis in the research. As a result, the players' height (H), body mass (BM) and body fat percentage (BF) values were observed in the anthropometric indicators. In metabolic indicators, attention was paid to VO2max, HRmax and HRrest. Regarding neuromuscular indicators, data collection was carried out based on the values of 1RM in the bench press exercise, one maximum repetition in the squat exercise, eight maximum repetitions in the squat exercise, 1RM in the leg press exercise, CMJ, SJ, Sargent jump test (ST), medicine ball throw (MBT), A5, A10, A20 and t-test.

In anthropometric indicators, of the three metrics mentioned, only 14 (43.7%) studies analyzed the variables together. In the remaining 16 (50.0%) studies, only H and BM values were presented. There was one investigation (3.44%) in which no anthropometric variables were mentioned (Komotska & Sushko, 2022).

Regarding metabolic indicators, 11 (34.3%) investigations contain VO2max. The HRmax was observed in 06 (18.7%) studies and the HRrest was observed in 03 (9.37%) studies. In other investigations, there was no data on the metabolic indicators mentioned.

Neuromuscular indicators of maximum strength (1RM in the bench press exercise, 1RM in the squat exercise, eight maximum repetitions (8RM) in the squat exercise and 1RM in the leg press exercise) were analyzed in five (17.2%) studies. Tests that assess the explosive power of the lower limbs (CMJ, SJ, ABK and ST) are exposed in 26 (81.2%) of the studies. Thirteen (40.6%) investigations examined acceleration tests (A5, A10, and A20). The upper limb explosive power test (MBT) was investigated in five (15.6%) studies. The test that assesses agility (t-test) was published in seven (21.8%) studies.

In a comparison between the three indicators of physical fitness, it is noted that anthropometric indicators are the most studied in research, in 31 (96.8%) of the investigations. Next, there are neuromuscular indicators, with data present in 27 (84.3%) studies. Finally, metabolic indicators are reported in 12 (37.5%) of the studies analyzed.

Regarding anthropometric indicators, the average H of formative, college, semi-professional and professional basketball players was 171.4±8.3-centimeters, 168.9±6.6-centimeters, 166.5±8.5-centimeters and 176.1±3.1-centimeters, respectively. In the BM variable, the average found was values of 62.3±7.8-kilograms, 58.6±7.0-kilograms, 62.0±9.3-kilograms and 71.2±3.9-kilograms in the formative, college, semi-professional and professional categories. The BF presented an average of 17.8±2.4%, 15.5±4.3% and 20.7±3.2% in formative, college and professional players, respectively. In the semi-professional category, no data was found on the body fat percentage variable.

The metabolic indicator of VO2max demonstrated an average value of 41.1±5.6--ml/kg/min, 40.1±10.1-ml/kg/min, 44.1±2.5-ml/kg/min and 46.2±7.9-ml/kg /min in the formative, college, semi-professional and professional categories, respectively. The HRmax had an average expressed in the formative categories of 192.8±0.5-beats per minute, college players of 191.5±0.8 beats per minute and professional players of 185.9±9.5-beats per minute. In the semi-professional category, no data regarding maximum heart rate was presented. The average HRrest showed values of 82.9±7.2-beats per minute for formative players, 75.4±6.4-beats per minute in the college category and 70.3±11.8-beats per minute for professional basketball players. In semi-professional athletes we do not have data regarding resting heart rate.

In terms of neuromuscular indicators, 1RM in the bench press exercise had an average of 37.6±3.6-kilograms, 31.4±3.4-kilograms and 61.6±4.4-kilograms for the formative, college and professional categories, respectively. The semi-professional category did not present numerical data on 1RM in the bench press exercise. In the variable 1RM in the squat exercise, the average in the college category was 41.7±1.3-kilograms and in the professional category it was 98.5±16.6-kilograms. For 8RM in the squat exercise, an average of 74.9±6.1-kilograms was found in the professional category. The other categories did not analyze the 8RM test in the squat exercise. Players in the semi-professional category did not report the value of 1RM in the squat exercise. In formative basketball players, 1RM in the leg press exercise was measured, whose average value is 162.3±19.3-kilograms. The CMJ demonstrated an average of 29.7±6.4-centimeters, 52.7±5.3-centimeters and 38.7±6.9-centimeters in the formative, college and professional categories, respectively. The squat jump was measured only in the formative and professional categories, with average values of 23.1±1.5-centimeters and 33.2±4.3-centimeters, respectively. The ABK averaged 30.7±3.3-centimeters and 34.8±0.9-centimeters in the formative and professional categories, respectively. No nominal data for the ABK was found in the college and semi-professional categories. The ST was measured in the professional and semi-professional categories, in which the average values found were 39.4±6.0-centimeters and 32.7±2.3-centimeters, respectively. The college and formative players did not present data regarding the ST. The MBT test was investigated in the formative and professional categories, with average values of 6.32±2.2-meters and 7.31±0.3-meters, respectively. A5 averaged 1.05±0.1-seconds and 1.18±0.1-seconds for the formative and professional categories, respectively. In the college and semi-professional categories there was no data on A5. Regarding A10, the average values are 1.92±0.1-seconds and 2.06±0.1-seconds for the formative and professional categories. Basketball players in the college and semi-professional categories did not evaluate A10. In variable A20, the average values for the formative, college, semi-professional and professional categories were 3.49±0.2 seconds, 3.30±0.1 seconds, 3.97±0.2 seconds and 3.43±0. 1 seconds respectively. The t-test was measured in the formative, semi-professional and professional categories with an average of 10.96±0.1-seconds, 7.40±0.3-seconds and 10.66±0.6-seconds, respectively. The college category did not present data regarding the t-test.

Discussion

It is noted that of the thirty-two research studies under analysis, a large percentage (49.6%) of the sample of female basketball players belong to the formative category. In second place, we have the professional category (42.2%), college (5.78%) and semi-professionals (2.31%). From this point of view, it is necessary to note that formative players are a special population that is in the process of bodily and cognitive growth and development (Farinatti, 1995; Bojikian et al., 2011). This specific group is subject to categorization based on chronological age, in a wide spectrum of age groups (under-10 to under-23), as the biological maturational process evolves (Calleja-González et al., 2016; Fort-Vanmeerhaeghe et al., 2016; Lukonaitienė et al., 2020; CBB, 2022). Perhaps this finding illustrates why it is the predominant population in investigations.

The anthropometric H indicator presented a higher average in the professional category (175.8±3.4-cm) when compared to semi-professional basketball players (166.5±8.5-cm, Δ=5.58%, [ES=1.43, large, t=-9.501, $p<0.0001$]), college (168.9±6.6-cm, Δ=4.08%, [ES=1.31, large, t=-10.449, $p<0.0001$]) and formative (171.4±8.3-cm, Δ=2.56%, [ES=0.69, moderate, t=-8.473, $p<0.0001$]). As expected, professional players who are biologically mature tend to demonstrate higher height values than other categories. The discrepancy that stands out in height is found in the formative category, with values higher than the group of college players (Δ=1.48%) and semi-professional players (Δ=2.94%). This detail can be partially explained by the fact that the formative category covers ages close to athletes who play in college and semi-professional categories (under-19 to under-23). Also, formative basketball players with an early stage of body development manifest tall height (Leonardi et al., 2018; Bojikian et al., 2011).

BM followed the same trend observed in H, with professional players having higher average values (70.2±4.4-kg), compared to semi-professional athletes (62.0±9.3-kg, Δ=13.2%, [ES=1.12, moderate, t=-6.710, $p<0.0001$]), college (58.6±7.0-kg, Δ=19.7%, [ES=1.98, large, t=-9.903, $p<0.0001$]) and formative (62.3±7.8- kg, Δ=12.6%, [ES=1.24, large, t=-15.351, $p<0.0001$]). Along with this, again, the formative category shows superiority in relation to semi-professional (Δ=0.48%) and college (Δ=5.93%) players. In this case, if we interpret the height and body mass values together, it is possible to observe a proportionality in the average results. That is, players with greater height have greater body mass. According to Wilmore & Costill (2001) the sum of height and body mass designates physical size (body size). These authors argue that the physical size of athletes varies depending on the sport, tactical position in the team and performance needs.

Table 2
Summary of research on physical fitness in women's basketball.

Study	Sample Size (category)	Anthropometric Indicators	Metabolic Indicators	Neuromuscular Indicators
Fernandez-Rio et al. (2000)	n=10 female basketball players (professional)	H=173.8±7.3 cm BM=70.2±9.8 kg BF=14.3±2.9 %	VO2max=32.3±3.4 ml/kg/min HRmax=191.3±4.8 bpm	---
Kilinç (2008)	n=24 female basketball players (college)	H=173.0±0.0 cm BM=59.2±4.4 kg BF=11.2±1.4 %	---	1RM BP=31.4±3.4 kg 1RM SQ=41.7±1.3 kg CMJ=52.7±5.3 cm A20=3.30±0.1 s
Nunes et al. (2008)	n=12 female basketball players (professional)	H=182.6±9.6 cm BM=77.6±12.7 kg BF=22.0±5.0 %	VO2max=46.9±3.3 ml/kg/min	1RM BP=57.2±7.2 kg 8RM SQ=68.8±5.9 kg CMJ=48.4±7.0 cm
Delextrat & Cohen (2009)	n=30 female basketball players (professional)	H=174.5±5.4 cm BM=68.2±9.0 kg BF=21.3±4.4 %	---	CMJ=42.5±5.9 cm MBT=6.93±0.6 m A20=3.50±0.2 s T-Test=10.4±0.5 s
Narazaki et al. (2009)	n=06 female basketball players (college)	H=174.2±9.0 cm BM=66.9±5.8 kg BF=19.8±4.5 %	VO2max=50.3±5.9 ml/kg/min HRmax=190.7±13.2 bpm	---
Erculj et al. (2010)	n=65 basketball players female (formative – under-15)	*Division A* H=175.3±7.9 cm BM=63.9±7.6 kg *Division B* H=173.2±7.9 cm BM=62.1±6.9 kg *Division C* H=168.8±7.2 cm BM=60.2±7.1 kg	---	*Division A* CMJ=26.3±5.1 cm MBT=4.66±2.6 m A20=3.60±0.2 s *Division B* CMJ=27.5±3.4 cm MBT=4.57±4.5 m A20=3.53±0.1 s *Division C* CMJ=26.6±3.7 cm MBT=4.27±3.9 m A20=3.67±0.1 s

Table 2 - Continued
Summary of research on physical fitness in women's basketball.

Delextrat et al. (2012)	n=09 female basketball players (professional)	H=173.0±7.9 cm BM=65.1±10.9 kg BF=21.1±3.8 %	---	---
Emrah & Kayalarli (2013)	n=11 female basketball players (formative – under-12)	H=147.2±7.2 cm BM=39.6±6.2 kg	VO2max=37.1±2.4 ml/kg/min HRrest=82.9±7.2 bpm	CMJ=47.8±5.6 cm
Nunes et al. (2014)	n=19 female basketball players (professional)	H=181.1±7.2 cm BM=75.6±12.6 kg	VO2max= 57.0±12.0 ml/kg/min	1RM BP=66.0±5.4 kg 8RM SQ=81.0±7.6 kg SJ=39.4±3.9 cm
Fort-Vanmeerhaeghe et al. (2016)	n=23 female basketball players (formative - under-16 and under-18)	*Under-16* H=180.0±0.0 cm BM=72.3±14.3 kg BF=15.6±3.3 %	*Under-16* VO2max=45.9±2.6 ml/kg/min	*Under-16* 1RM BP= 34.0±3.3 kg 1RM LP=143.0±12.9 kg SJ=21.0±0.3 cm CMJ=24.0±0.5 cm ABK=28.0±0.6 cm MBT=6.97±0.4 m T-Test=11.0±0.6 s
		Under-18 H=182.0±0.0 cm BM=70.1±8.1 kg BF=14.7±2.3 %	*Under-18* VO2max= 46.5±1.8 ml/kg/min	*Under-18* 1RM BP=41.2±34.0 kg 1RM LP=181.7±15.0 kg SJ=24.0±0.2 cm CMJ=27.0±0.3 cm ABK=31.0±0.3 cm MBT=7.28±0.9 m T-Test=10.8±0.5 s
Halder et al. (2016)	n=10 female basketball players (college)	H=159.5±3.3 cm BM=49.7±3.5 kg	V02max=30.0±3.1 ml/kg/min HRrest=75.4±6.4 bpm HRmax=192.3±7.3 bpm	---
Rice et al. (2016)	n=08 female basketball players (professional)	H=173.0±9.6 cm BM=72.8±7.9 kg	---	1RM SQ=98.5±16.6 kg CMJ=45.0±0.7 cm

Table 2 - Continued
Summary of research on physical fitness in women's basketball.

Doma et al. (2018)	n=10 female basketball players (professional)	H=180.0±0.7 cm BM=76.7±8.3 kg	---	CMJ=50.0±0.8 cm
Garcia-Gil et al. (2018)	n=41 female basketball players (professional)	H=177.6±8.3 cm BM=72.1±9.7 kg	---	ABK=35.5±5.0 cm A20=3.09±0.1 s T-Test: 10.0±0.4 s
Leonardi et al. (2018)	n=47 female basketball players (formative - under-13 and under-15)	*Under-13* H=162.0±5.8 cm BM=56.7±9.6 kg *Under-15* H=166.2±6.4 cm BM=59.7±7.6 kg	---	*Under-13* CMJ=24.1±2.7 cm *Under-15* CMJ=27.4±3.6 cm
Park et al. (2018)	n=24 female basketball players (professional)	*Starters* H=174.9±6.4 cm BM=67.3±6.6 kg BF=17.2±3.0% Non-Starters H=175.5±7.3 cm BM=69.2±8.8 kg BF=20.7±4.7 %	*Starters* VO2max=49.2±2.8 ml/kg/min HRmax=171.0±6.0 bpm *Non-Starters* VO2max=45.6±8.0 ml/kg/min HRmax=184.9±6.2 bpm	*Starters* ST=46.0±4.3 cm *Non-Starters* ST=40.9±5.8 cm
Zarić et al. (2018)	n=30 female basketball players (formative - under-16)	H=174.3±7.4 cm BM=67.0±10.3 kg	VO2max=39.8±5.3 ml/kg/min	CMJ=24.4±3.3 cm ABK=28.9±4.1 cm A5=1.20±0.0 s A10=2.04±0.1 s A20=3.53±0.1 s
Aschendorf et al. (2019)	n=24 female basketball players (formative – under-16)	H=170.0±5.2 cm BM=60.9±6.0 kg BF=18.1±4.8 %	---	CMJ=27.0±3.6 cm ABK=30.5±3.6 cm SJ=25.2±3.6 cm MBT=10.2±0.5 m

Table 2 - Continued
Summary of research on physical fitness in women's basketball.

Meszler & Váczi (2019)	n=18 female basketball players (formative – under-17)	H=176.4±8.6 cm BM=63.5±8.6 kg	---	CMJ=31.9±3.4 cm T-Test=11.1±0.4 s
Stojanović et al. (2019)	n=10 female basketball players (professional)	H=175.4±5.9 cm BM=69.2±6.3 kg BF=19.7±5.2 %	---	CMJ=29.2±4.3 cm ABK=35.1±5.0 cm SJ=27.2±4.3 cm A5=1.18±0.1 s A10=2.01±0.1 s A20=3.49±0.2 s
Bouteraa et al. (2020)	n=26 female basketball players (formative – under-17)	H=168.0±0.0 cm BM=56.0±7.6 kg	---	SJ=22.5±3.5 cm CMJ=28.8±3.3 cm A5=0.91±0.0 s A10=1.72±0.0 s A20=3.27±0.1 s
Lukonaitienė et al. (2020)	n=28 female basketball players (formative - under-18 and under-20)	*Under-18* H=180.4±7.5 cm BM=72.7±9.3 kg BF=18.5±2.5 % *Under-20* H=178.6±6.4 cm BM=68.0±5.9 kg BF=22.0±3.3 %	*Under-18* HRmax=193.4±8.5 bpm *Under-20* HRmax=192.3±5.7 bpm	*Under-18* A10=1.91±0.0 s A20=3.31±0.3 s CMJ=39.0±4.8-cm *Under-20* A10=1.90±0.0 s A20=3.21±0.3 s CMJ=42.6±6.2 cm
Mancha-Triguero et al. (2020)	n=10 female basketball players (formative – under-18)	H=168.7±8.2 cm BM=57.3±5.7 kg	---	ABK=37.3±4.4 cm
Arede et al. (2021)	n=16 female basketball players (formative – under-19)	H=169.8±5.3 cm BM=62.3±3.9 kg	---	CMJ=25.1±2.5 cm A10=2.02±0.0 s
Cherni et al. (2021)	n=27 female basketball players (professional)	E=172.0±3.6 cm MC=66.2±9.7 kg BF=25.0±3.9 %	---	SJ=33.5±4.5 cm CMJ=34.7±4.5 cm A10=2.11±0.1 s A20=3.62±0.1 s T-Test=11.6±0.5 s

Table 2 - Continued
Summary of research on physical fitness in women's basketball.

Javanmardi et al. (2021)	n=16 female basketball players (semi professional)	H=166.5±8.5 cm BM=62.0±9.3 kg	VO2max=44.1±2.5 ml/kg/min	ST= 32.7±2.3 cm A20= 3.97±0.2 s T-Test=7.40±0.3 s
Zarić et al. (2021)	n=30 female basketball players (formative – under-16)	H=174.3±7.4 cm BM=67.0±10.3 kg	---	CMJ=24.4±3.3 cm ABK=28.9±4.1 cm
Komotska & Sushko (2022)	n=15 female basketball players (formative – under-16)	---	---	CMJ=39.0±2.0 cm A20=3.83±0.1 s
Kooroshfard & Rahimi (2022)	n=42 female basketball players (professional)	H=172.3±6.2 cm BM=63.5±4.6 kg	---	ST=31.4±1.5 cm
Ibáñez et al. (2023)	n=12 female basketball players (professional)	H=178.2±9.2 cm BM=72.3±11.6 kg	---	T-Test=12.4±0.13 s
Miguel-Ortega et al. (2023)	n=12 female basketball players (professional)	H=178.8±6.8 cm BM=75.7±11.4 kg BF=20.0±2.9 %	---	SJ=32.7±5.2 cm CMJ=32.5±4.3 cm ABK=33.5±3.9 cm MBT=7.69±0.9 m A20=3.45±0.1 s
Papaevangelou et al. (2023)	n=26 female basketball players (professional)	H=175.4±5.7 cm BM=71.6±13.7 kg BF=26.4±4.4 %	VO2max=45.9±6.4 ml/kg/min HRrest=70.3±11.8 bpm HRmax=196.6±5.2 bpm	---

H=Body height, BM=Body mass, BF=Body fat percentile, VO_2max=Maximum oxygen consumption, 1RM BP=One repetition maximum in bench press exercise, 1RM SQ=One repetition maximum in the squat exercise, 8RM SQ=Eight maximum repetitions in the squat exercise, 1RM LP=A maximum reduction in the leg press exercise, CMJ=Countermovement jump, ABK=Abalakov jump, A5=Acceleration in 5 meters, A10=Acceleration in 10 meters, A20=Acceleration in 20 meters, SJ=Squat jump, ST=Sargent jump test, HRmax=Maximum heart rate, kg=Kilograms, cm=Centimeters, bpm=Beats per minute, s=Seconds, m=Meters, ml/kg/min=Milliliters kilograms per minute, MBT=Medicine ball throw test, HRrest=Resting heart rate, T-Test=T-test of agility.

The average BF of basketball players varied according to the competitive category. The lowest value obtained is found in the group of college players (15.5±4.3%), followed by formative athletes (17.8±2.4%, [ES=0.66, moderate, t=5.180, p<0.0001]) and professionals (20.1±3.2 %, [ES=1.21, large, t=8.147, p<0.0001]). The semi-professional category did not have the BF data reported by the studies. The difference in the percentile delta between the lowest value achieved by the group of college athletes in relation to the others is 14.8% and 29.6% for the formative and professional categories, respectively. Regarding this issue, it is first necessary to highlight that the authors used different instruments to determine BF: electronic bioimpedance (Park et al., 2018; Lukonaitienė et al., 2020), skinfolds (Kilinç, 2008; Narazaki et al., 2009; Fort-Vanmeerhaeghe et al., 2016; Garcia-Gil et al., 2018; Cherni et al., 2021) and there were three episodes where measurement tools were not discriminated (Delextrat et al., 2012; Aschendorf et al., 2019; Stojanović et al., 2019). Regardless of this, BF can pose a serious problem in female players, as they naturally have a larger fat reserve than men. Even so, there must be strict control over the body composition of female basketball players, by estimating the appropriate fat percentile range on an individual basis. The information contained in the fat percentile values is more relevant than the isolated analysis of height and/or body mass. In addition, it should be noted that excess body weight can impair performance in activities involving acceleration, balance, resistance, agility and vertical jumping (Wilmore & Costill, 2001; Kenney et al., 2013; Vretaros, 2022b). In relation to this, Garcia-Gil et al (2018) noted that the best ranked professional women's basketball teams in competitions had a low percentage of fat.

The VO_2max variable denoted a higher value in professional players (46.2±7.9-ml/kg/min) when compared to semi-professional athletes (44.1±2.5-ml/kg/min, [ES=0.35, small, t=- 1.059, p=0.2905]), college (40.1±10.1-ml/kg/min [ES=0.67, moderate, t=-4.417, p<0.0001]) and formative (41.1±5.6 ml/kg/min, [ES =0.74, moderate, t=-9.481, p<0.0001]). The differences between professional basketball players compared to the others were Δ=4.76% for the group of semi-professional athletes, Δ=15.2% for college players and Δ=12.4% for formative basketball players. Perhaps, selective attention should be given to formative athletes, who reached a higher VO_2max than college athletes (Δ=2.43%). In this aspect, it is worth mentioning that the protocols that evaluated VO2max were carried out through incremental tests on the cycle ergometer (Halder et al., 2016), treadmill (Narazaki et al., 2009; Apostolidis et al., 2004) platform ascent and descent (Atay & Kayalarli, 2013), continuous field test (Javanmardi et al., 2021) and intermittent running test (Venâncio et al., 2022). Therefore, there may be more or less pronounced variations in the final results, depending on the type of protocol adopted to measure VO2max. Adding to this, an influence of early specialization in the group of formative basketball players is speculated, accelerating the peak of performance in this variable (Karpowicz et al., 2015; Carvalho et al., 2019; Komotska & Sushko, 2022).

At HRmax, only formative, college and professional basketball players had their values presented in the analyzed literature. In professional players, the value achieved was 185.9±9.5-bpm. In the group of college athletes this number reached 191.5±0.8 bpm (ES=0.83, moderate, t=3.722, p=0.002) and, in the formative basketball players, it was found 192.8±0.5 bpm (ES=1.02, moderate, t=13.432, p <0.0001). There is a greater cardiac demand in this variable in the group of training athletes when compared to the college (Δ=0.67%) and professional (Δ=3.71%) categories. This fact is linked to the perception and subsequent cardiometabolic response to the implemented workload (Wilmore & Costill, 2001; Schelling & Torres-Ronda, 2016). In addition, the HRmax, which is estimated using predictive equations based on age, tends to decrease with age (Wilmore & Costill, 2001). Therefore, it would be acceptable for formative basketball players to have higher heart rate values compared to college and professional athletes, given a standard training load.

With regard to HRrest, the data is restricted to professional, college and formative players. Lower values were found in professional basketball players (70.3±11.8-bpm) compared to college athletes (75.4±6.4-bpm, Δ=7.25% [ES=0.53, small, t=2.678, p=0.0078]) and female players formative (82.9±7.2-bpm, Δ=17.9 [ES=1.28, large, t=16.496, p<0.0001]). This metabolic indicator of physical fitness is associated with the athlete's recovery capacity. The faster the HRrest value returns to baseline values after physical effort, the more efficient its restorative capacity will be considered from a cardiovascular point of view (Emrah & Kayalarli, 2013; Halder et al., 2016). The lower HRrest is the result of aerobic work on vagal activity, causing the physiological effect of bradycardia (Kenney et al., 2013; Halder et al., 2016). Thus, it can be speculated that professional players would apparently have better metabolic physical fitness compared to college and formative athletes.

The neuromuscular indicator test of 1RM in bench press exercise was higher in professional basketball players (61.6±4.4-kg) compared to the group of college players (31.4±3.4-kg, Δ=96.1%, [ES=7.68, extremely large , t=-41.716, p<0.0001]) and formative (37.6±3.6-kg, Δ=63.8%, [ES=5.97, extremely large, t=-75.585, p<0.0001]). For semi-professional players, no data was presented regarding this variable. The 1RM bench press test measures maximum upper limb strength. The particularity is due to the formative basketball players who exhibited a higher average strength of the upper limbs (Δ=19.7%), when compared to the college athletes. From this perspective, it is possible to speculate that these results are in line with the fact that formative athletes belonging to categories above under-17 are very close in age to college players. In addition, there could be some effect of early specialization on the results, as previously mentioned in the maximum oxygen consumption variable (Karpowicz et al., 2015 Carvalho et al., 2019; Komotska & Sushko, 2022).

The 1RM test in the squat exercise was evaluated in two categories (college and professional). Additional details are provided by professional athletes, in which two tests were used for this purpose: 1RM and 8RM in the squat exercise, considered a submaximal test. In the group of formative basketball players, the 1RM test was used in the leg press exercise. In numerical terms, the test value of one repetition in the squat exercise found in professional players was higher (98.5±16.6-kg) in relation to college players (41.7±1.3-kg, Δ=136.2%, [ES=4.82, extremely large, t=-21.604, p<0.0001]). The test of 8RM in the squat exercise presented a value of 74.9±6.1-kg in the professional category. In formative players, the final value of a 1RM the leg press exercise is 162.3±19.3-kg. These two tests measure maximum lower limb strength. However, it is not possible to compare the results in two completely different exercises (squats and leg press). While the squat is performed freely with a bar and a load on the back, the leg press is a guided device in which the execution technique is different and, with less recruitment of the muscles in the lumbar region (Fort-Vanmeerhaeghe et al., 2016; Fleck & Kraemer, 2017). Also, when examining the results, the scientific literature corroborates the concept that highly qualified athletes have higher levels of maximum strength than those with lower levels (Zatsiorsky & Kraemer, 2008; Fleck & Kraemer, 2017; Vretaros, 2021). In addition to this, there is a strong influence of maturational development on the production of maximum strength among competitive categories (Mancha-Triguero et al., 2021).

CMJ was measured in three categories, namely: professional, college and formative. In the group of semi-professional athletes, this variable was not measured. The value of this neuromuscular indicator demonstrated superiority in college players (52.7±5.3-cm), when compared to professional athletes (38.7±6.9-cm, Δ=36.1%, [ES=2.27, very large, t=-12.337, p <0.0001]) and formative (29.7±6.4-cm, Δ=43.6%, [ES=3.91, very large, t=-21.864, p<0.0001]). This higher value found in college players may be due to two factors: measuring instrument used and trainability. Different resources for measuring CMJ were detected in the research, which would lead to disparate results: optical system (Erculj et al., 2010; Garcia-Gil et al., 2018; Aschendorf et al., 2019; Stojanović et al., 2019 ; Bouteraa et al., 2020; Lukonaitienė et al., 2020; Arede et al., 2021), electronic jumping mat (Fort Vanmeerhaeghe et al., 2016; Leonardi et al., 2018), force platform (Rice et al., 2016, Zarić et al., 2021) and metric marker (Doma et al., 2018; Komotska & Sushko, 2022; Kooroshfar & Rahimi, 2022). Also, the principle of trainability may have an impact on professional players, compared to college athletes. Trainability advocates that the more trained the athlete is, the smaller their biological adaptation window is to acquire higher levels in the variables that constitute physical fitness (Rice et al., 2016; Vretaros, 2021).

The SJ presented its results in the professional and formative categories. Semi-professional and college basketball players were not evaluated in this variable. A higher value was found in the squat jump in professional players (33.2±4.3-cm) when compared to formative athletes (23.1±1.5-cm, Δ=43.7%, [ES=3.13, very large, t=-40.694, p <0.0001]). These results are in line with the premise that athletes in higher categories have higher levels of explosive power in their lower limbs (Vretaros, 2021; Vretaros, 2022b; Williams et al., 2022).

The ABK was measured in two categories (professional and formative). In professional players, the average of this neuromuscular indicator was higher (34.8±0.9-cm) compared to formative athletes (30.7±3.3-cm, Δ=13.3%, [ES=1.69, large, t=-20.587, p<0.0001]). This test that assesses the explosive power of the lower limbs is little investigated in basketball research. There should be greater concern in analyzing the ABK, as it balances the arms, a typical and common situation faced by players during training and matches (Ziv & Lidor, 2009). These numerical results reinforce the thesis that the higher the athlete's qualification, the higher level of explosive power (Vretaros, 2021; Vretaros, 2022b; Williams et al., 2022).

The ST test was used in three studies, involving professional (n=02) and semi-professional (n=01) basketball players. The average value found in professional players was higher (39.4±6.0-cm) than in semi-professional athletes (32.7±2.3-cm, Δ=20.4%, [ES=1.47, large, t=-4.443, p<0.0001]). An addendum to this variable is that in the study with professional basketball players, starting players showed higher results (46.0±4.3-cm) than non-starters (40.9±5.8-cm) (Park et al., 2018). Thus, this is another variable in the neuromuscular indicators that corroborates the idea that higher category athletes exhibit higher values in the test that assesses the explosive power of the lower limbs, compared to those in a lower category (Vretaros, 2021; Vretaros, 2022b; Williams et al., 2022).

The MBT test was used in three studies, involving professional and formative basketball players. The average found was 6.32±2.2-m for formative athletes and 7.31±0.3-m (ES=0.63, moderate, t=-7.629, p<0.0001) for professional players. The difference between the two competitive categories is Δ=15.6%, in favor of professional basketball players. This assessment allows us to understand the explosive power of the upper limbs, which is vitally important for the athletic improvement of female basketball players (Aschendorf et al., 2019; Vretaros, 2021). The numerical superiority in this variable once again reinforces the previous statement, in which higher categories show a tendency to higher levels of explosive power, whether of upper or lower limbs (Vretaros, 2021; Vretaros, 2022b; Williams et al., 2022).

Formative and professional players had their A5 values measured. A better performance in this variable was demonstrated in the group of formative basketball players (1.05±0.1-s) when compared to professional athletes (1.18±0.1-s, Δ=-12.3%, [ES=1.30, large, t=16.327, p< 0.0001])). The A10 included professional and training players. Therefore, formative basketball players showed superiority in this neuromuscular indicator (1.92±0.1-s) in relation to professional athletes (2.06±0.1 s, Δ=-7.29%, [ES=1.40, large, t=17.582, p<0.0001]). The four competitive categories were measured in A20. The results in this test indicate better performance in college players (3.30±0.1-s) in relation to that observed in formative basketball players (3.49±0.2-s, Δ=5.75%, [ES=1.20, moderate, t=5.918, p<0.0001]), semi-professionals (3.97±0.2-s, Δ=20.3%, [ES=4.23, extremely large, t=16.728, p<0.0001]) and professionals (3.43±0.1-s, Δ=3.93%, [ES= 1.30, large, t=7.711, p<0.0001]). The three distances used (5-m, 10-m and 20-m) are the most appropriate for evaluating acceleration, given that in basketball the number of accelerations occurs over short distances, but with a significantly high repetitive quantity, due to the reduced size of the court (Delextrat et al., 2012; Vretaros, 2023). According to Jukić et al. (2005) acceleration in basketball can be stimulated in a short and quick way, as well as in the format of speed resistance. The disparity in results found in accelerative speed, sometimes favoring formative (5-m and 10-m) or college (20-m) players, may be subordinated to the principle of trainability (Rice et al., 2016; Vretaros, 2021).

The t-test was only evaluated in the professional, semi-professional and formative categories. There were better mean values in semi-professional basketball players (7.40±0.3-s) when compared to professional athletes (10.66±0.6-s, Δ=44.0%, [ES=6.87, extremely large, t=21.561, p<0.0001]) and formative (10.96±0.1-s, Δ=48.1%, [ES=15.9, extremely large, t=120.416, p<0.0001]). This test is regularly used to assess agility, replicating specific situations of multidirectional movement over short distances in the shortest time (Stojanović et al., 2019; Mancha-Triguero et al., 2020; Javanmardi et al., 2021). The agility of basketball players is strongly dependent on the levels of maximum strength, explosive power, acceleration and balance. In this line of reasoning, there will be interference from other biomotor capabilities in agility gains, which would elucidate the results between the different competitive categories (Meszler & Váczi, 2019; Vretaros, 2021). A singularity that deserves to be highlighted is the fact that the t-test presents a strong correlation with the basketball players' individual performance index. In other words, the higher the level of agility in multidirectional tasks, the higher the player's performance index may be (Garcia-Gil et al., 2018).

In general, it was observed that in the nineteen physical fitness indicators analyzed (H, BM, BF, VO2max, HRmax, HRrest, 1RM in the bench press exercise, 1RM in the squat, 8RM in the squat exercise, 1RM in the leg press exercise, CMJ, SJ, ABK, ST test, MBT, A5, A10, A20 and t-test), 63.1% of investigations with results favorable to professional players, 21.0% formative, 10.5% college and 5.26% semi-professional.

When dividing by specific indicators of physical fitness, another scenario becomes evident. In the three anthropometric indicators, 66.6% of the data showed better results in professional basketball players and 33.3% in the college category. In relation to the three metabolic indicators, the dynamics of the results favor players in the professional competitive category by 100%. Finally, in the thirteen neuromuscular indicators it was recorded as follows: 53.8% professional, 23.0% formative, 15.3% college and 7.69% semi-professional.

The measuring instruments for some indicators (BF, VO2max and CMJ) were different in the studies. It is suggested that there are measurement interferences in the interpretation of the average results of physical fitness indicators. In future investigations, researchers could standardize the instruments in physical fitness tests, so that a sustainable comparison can be made with a smaller margin of error.

In view of what has been exposed so far, it seems that the discrepancies that occur in physical fitness between different categories in a long-term training program are governed by the interaction of four main factors: chronological age, biological age, training basis in the modality, genetics and measuring equipment. Such factors denote linear evolutionary behavior in physical fitness indicators as they approach the age of maturation and stability after the body growth spurt. However, this fact does not prevent the existence of individual variability in the average results of athletes (Farinatti, 1995; Bojikian et al., 2011; Carvalho et al., 2019).

As a rule, there is a willingness on the part of coaches to seek early specialization, accelerating steps so that physical fitness reaches its peak before the natural maturation curve. In the short term, early specialization increases performance in some physical fitness variables. However, in the long term, this athlete's potential for biomotor growth in the sport is exhausted (Karpowicz et al., 2015; Carvalho et al., 2019; Komotska & Sushko, 2022). It is assumed that this phenomenon is evidenced in the average results where the formative category was superior to the college players (body mass, maximum oxygen consumption and maximum repetition in the bench press exercise).

From this perspective, it can be speculated that as basketball players become more mature, transitioning from the formative category to the college environment and then to the semi-professional and professional universe, their physical fitness indicators would tend to show significant improvements. This statement can be confirmed in the study that analyzed the long-term training program of the Spanish Basketball Federation (Calleja-González et al., 2016), with Brazilian female basketball players (Carvalho et al., 2019) and with Polish players (Gryko et al., 2022).

According to Power et al (2022), the training loads organically imposed on female basketball players vary depending on the competitive category in which they are inserted. Complementing this information, it is essential to reinforce that physical fitness behavior, mainly metabolic and neuromuscular indicators, present fluctuations during the season influenced by workload, volume of games, period of the season, biological responsiveness and the heterochronicity of physical form (Vretaros, 2022a). In this way, all these aggregated factors can somehow influence when measuring physical fitness in female basketball players.

Another aspect to be highlighted is that the average physical fitness indicators used in training basketball players involved several subdivisions (under-12, under-13, under-15, under-16, under-17, under-18, under-19 and sub-20). This warning alone implies that we work with a general average of eight different subdivisions in a grouped manner, and therefore there may be divergences if the average of each particular subgroup is calculated.

An obvious limitation of this research is the fact that some physical fitness variables were omitted because we did not find data in the literature. For example, it was observed that there were some gaps in variables in the professional (1RM LP), semi-professional (BF, HRmax, HRrest, 1RM BP, 1RM SQ, 8RM SQ, 1RM LP, CMJ, SJ, ABK, MBT, A5, A10), college (8RM SQ, 1RM LP, SJ, ABK, ST, MBT, A5, A10, T-Test), and formative (1RM SQ, 8RM SQ, ST) categories. Furthermore, the sample size of the semi-professional (n=16) and college (n=40) categories showed substantially lower values when compared to the population of professional (n=292) and formative (n=343) basketball players. In addition to this, the numerical values were analyzed with the extraction of the group average of the physical fitness indicators, thus lacking results in the different tactical functions performed by the basketball players. Therefore, additional research on this topic with this specific population of athletes is imperative, to fill the gaps left.

Table 3

Summary of average values grouped in physical fitness indicators between competitive categories in women's basketball.

Professional Women's Basketball Players	Semi-Professional Women's Basketball Players	College Women's Basketball Players	Formative Women's Basketball Players
Anthropometric	*Anthropometric*	*Anthropometric*	*Anthropometric*
H=176.1±3.1 cm	H=166.5±8.5 cm	H=168.9±6.6 cm	H=171.4±8.3 cm
BM=71.2±3.9 kg	BM=62.0±9.3 kg	BM=58.6±7.0 kg	BM=62.3±7.8 kg
BF=20.7±3.2 %	BF= ---	BF=15.5±4.3 %	BF=17.8±2.4 %
Metabolic	*Metabolic*	*Metabolic*	*Metabolic*
VO2max= 46.2±7.9 ml/kg/min	VO2max= 44.1±2.5-ml/kg/min	VO2max=40.1±10.1 ml/kg/min	VO2max=41.1±5.6 ml/kg/min
HRmax=185.9±9.5-bpm	HRmax= ---	HRmax=191.5±0.8 bpm	HRmax=192.8±0.5 bpm
HRrest=70.3±11.8-bpm	HRrest= ---	HRrest=75.4±6.4 bpm	HRrest=82.9±7.2 bpm
Neuromuscular	*Neuromuscular*	*Neuromuscular*	*Neuromuscular*
1RM BP=61.6±4.4 kg	1RM BP= ---	1RM BP= 31.4±3.4 kg	1RM BP=37.6±3.6 kg
1RM SQ=98.5±16.6 kg	1RM SQ= ---	1RM SQ= 41.7±1.3 kg	1RM SQ= ---
8RM SQ=74.9±6.1 kg	8RM SQ= ---	8RM SQ= ---	8RM SQ= ---
1RM LP=---	1RM LP= ---	1RM LP= ---	1RM LP=162.3±19.3 kg
CMJ=38.7±6.9 cm	CMJ= ---	CMJ= 52.7±5.3 cm	CMJ=29.7±6.4 cm
SJ=33.2±4.3 cm	SJ= ---	SJ= ---	SJ= 23.1±1.5 cm
ABK=34.8±0.9 cm	ABK= ---	ABK= ---	ABK= 30.7±3.3 cm
ST=39.4±6.0 cm	ST=32.7±2.3 cm	ST= ---	ST= ---
MBT=7.31±0.3 m	MBT= ---	MBT= ---	MBT= 6.32±2.2 m
A5=1.18±0.1 s	A5= ---	A5= ---	A5=1.05±0.1 s
A10=2.06±0.1 s	A10= ---	A10= ---	A10=1.92±0.1 s
A20=3.43±0.1 s	A20= 3.97±0.2 s	A20= 3.30±0.1 s	A20=3.49±0.2 s
T-Test: 10.66±0.6 s	T-Test= 7.40±0.3 s	T-Test= ---	T-Test=10.96±0.1 s

cm=centimeters, kg=kilograms, %=percentile, ml/kg/min=milliliters kilograms per minute, bpm=beats per minute, s=seconds, H=height, BM=body mass, BF=body fat percentile, VO2max=maximum oxygen consumption, HRmax=maximum heart rate, HRrest=resting heart rate, 1RM BP=one repetition maximum in bench press exercise, 1RM SQ=one repetition maximum in the squat exercise, 8RM=eight maximum repetitions in the squat exercise, 1RM LP=one repetition maximum in the leg press exercise, CMJ=countermovement jump, SJ=squat jump, ABK=Abalakov jump, ST: Sargent jump test, MBT=medicine ball throw, A5=acceleration in 5 meters, A10=acceleration in 10 meters, A20=acceleration in 20 meters, t-test=agility t-test.

Conclusion

Physical fitness in women's basketball is of paramount importance so that athletic performance is optimized, both in terms of the biomotor capabilities that are stimulated, as well as the technical-tactical skills required. The countless variables that constitute anthropometric, metabolic and neuromuscular indicators represent physical fitness. The sum of each indicator has a direct contribution to achieving sporting success in this modality.

There is a peculiar physiological profile in physical training aimed at developing the physical fitness of female basketball players in relation to male players. In this issue, three aspects stand out: the menstrual cycle, eating disorders and bone mineral loss. Furthermore, cardiovascular and neuromuscular characteristics distinguish the genders.

In the research analyzed, it can be seen that professional basketball players were those who demonstrated the best results in the set of indicators (63.1%), followed by formative (21.0%), college (10.5%) and semi-professional (5.26%) players. When specifying the indicators, 66.6% of the anthropometric data examined favored the professional category and 33.3% of college players. In metabolic indicators, there was a predominance of 100.0% favorability in the category of professional basketball players. In terms of neuromuscular indicators, the division was distributed as follows: 53.8% professional, 23.0% formative, 15.3% college and 7.69% semi-professional.

Finally, it was recognized that as female players progress in chronological age, biologically mature and acquire training, advancing through the competitive categories, their physical fitness begins to show improvement. However, individual biological variability impacts the average numbers between indicators.

Authors' Contribution

Study Design: AV, Data Collection: AV; Statistical Analysis: AV; Manuscript Preparation: AV; Funds Collection: AV.

Ethical Approval

The study conducted was not experimental in nature.

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Conflict of Interest

The author hereby declares that there was no conflict of interest in conducting this research.

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