

PARTICULARITIES OF PHYSICAL TRAINING FOR JUNIOR TENNIS PLAYERS: A LITERATURE REVIEW

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ABSTRACT. The modern high-performance tennis is characterised by intense dynamism. The players are required to think and act rapidly in order to apply their technical and tactical arsenal effectively in a multitude of competitive scenarios. Due to the increasing duration of matches, the large number of tournaments within a competitive season, and the diversity of playing conditions, athletes have to make exceptional physical and psychological efforts. This paper aims to present the primary aspects of physical training specific to tennis across the different stages of the junior period. Various studies highlight that well-structured physical training programs can significantly improve the speed and accuracy of technical execution by optimising the strength and endurance of relevant muscle groups. In tennis, better performance is closely correlated with implementing effective periodised training programs, adjusted to the age-specific characteristics of junior athletes. We focused on isometric power, muscle mass development, and force-generation capacity. Resistance training, when integrated into a structured, progressive program that targets both limb strength and core stability, is mandatory to increase stroke speed and overall sports performance. Therefore, we encourage coaches to integrate these physical training methods and perfect technical skills. The ultimate goal is to train complete athletes capable of performing effectively under high-stress conditions.

Keywords: tennis; physical training; strength; performance; juniors

INTRODUCTION

Although the training factors are closely interdependent, each is developed in a specific manner. Physical training represents the foundation upon which all other training components are built. The stronger the physical base, the greater the potential for developing technical, tactical, and psychological qualities.

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Sometimes, coaches fail to consider the strong correlation between physical and technical training. When the physical training foundation is inadequate, fatigue sets in quickly, and athletes struggle to make progress in other areas of their training. It is worth mentioning that physical training is the foundation of technical evolution, while technique is the most important element in acquiring and applying tactical skills in sport. As an athlete's physical condition improves, so do their technical and tactical capabilities, thus enhancing self-confidence and other psychological factors. In conclusion, physical training is the cornerstone on which all training components develop, ultimately enabling athletes to excel in sport (Bompa, 2021).

Generally, it is considered that for maximum physiological adaptation specific to athletic performance, an athlete should train for 8 to 12 years. Throughout all these years of practice, exercises are repeated systematically to promote adaptations that lead to better performance. When creating a training plan, a coach can choose from a wide range of exercises, selecting those that best fit the athlete's needs and the specific demands of the sport. Both general and specific exercises are included in the annual training program. However, their contribution to the overall plan varies according to the training cycle and the athlete's age (Gabbet & Kelly, 2008).

THE ROLE OF PHYSICAL TRAINING

Starting from a high level of the body's morphofunctional indices and the possibility to perform motor actions with high speed and power, while maintaining coordinated movements over extended periods, athletes can perfect the technical and tactical components depending on the requirements of performance sport. It is generally considered that the development of physical characteristics with age has a positive influence on the technical-tactical repertoire. However, recent research has shown that specific strength training can improve performance regardless of age (Bagis, 2020).

Studies have highlighted that including specific physical training can enhance both the speed and accuracy of technique by developing strength and muscular resistance in relevant areas (Kara et al., 2015). Coaches are encouraged to integrate these training methods alongside technical practice to train complete athletes who are able to perform effectively even under high stress (Myers et al., 2016).

Better tennis performance requires well-structured training plans that include working on isometric strength, muscle mass, and strength-generating capacity, all of them supported by proper monitoring and recovery (Fig. 1).

When incorporated into a periodised program and focused on limb strength and torso stability, resistance training routines plays a key role in improving serve speed and overall athletic performance (Ma et al., 2024).



Fig. 1. Physical training practice to develop isometric strength

A good technical repertoire in junior players is closely linked to their physical preparation. The research conducted by Filipčić et al. shows that junior players frequently take part in short rally exchanges, which highlights the importance of the efficiency of groundstrokes for those who wish to compete at high levels (Filipčić et al., 2021).

According to Fett et al., the requirements of modern tennis have made this sport increasingly competitive, thus forcing young athletes to perfect their playing technique in order to cope with the pressure specific to competitions (Fett et al., 2020). This growing intensity underscores the need for a specialised type of training that can enhance ball speed and stroke accuracy.

From a biomechanical point of view, performing effective strokes requires the correct use of body mechanics. For instance, the involvement of the lower limbs through knee and ankle flexion and extension plays a decisive role. Touzard et al. pinpoint that an efficient leg push motion is fundamental for powerful strokes, using efficient movements of the lower limbs (Touzard et al., 2023). This aspect is also supported by Myers et al. (2016), who emphasise that a strong and consistent stroke derives from a player's capacity to coordinate the movements of the torso and of the upper and lower limbs (Fig. 2).



Fig. 2. Specific physical training practice (Agility)

A study conducted by Ali and Supriono (2021) investigated the impact of physical fitness on the effectiveness of tennis serves, using a sample of 15 male players from the city of Jambi. The authors assessed several fundamental physical components (i.e., arm strength, back flexibility, and hand-eye coordination) through standardised tests. Their findings showed high performances in terms of strength and flexibility; however, serve performance was weak, with 67% of the players obtaining scores below the sufficient level. The study concludes that good physical fitness is mandatory for an efficient serve and recommends that training sessions should combine the development of technical skills with specific physical exercises; the goal is to improve players' performance in competitions.

Physical training is a vital aspect in improving stroke quality. Strength training exercises, in particular, have been shown to increase their velocity, with some studies reporting significant improvements in velocity after a six-week program (Kara et al., 2015). This type of program, which includes core-strengthening exercises and the use of medicine balls, led to a 4.9% increase in stroke speed among junior players (Kara et al., 2015).

Besides the physical components, mental elements such as focus and adaptability during play are highly relevant for junior players. Tactical awareness, including ball placement and service strategy, can influence performance to a great degree. For instance, using strategies such as serving to the opponent's weaker side can be more effective when players understand the dynamics of rallies (Fernández-Fernández et al., 2020).

Structural evaluations can identify essential performance indicators for strokes, which can guide training strategies focusing on the progress of junior players (Campos & Martínez-Gallego, 2024). The development of psychomotor and cognitive abilities plays a crucial role in on-court performance. It has been demonstrated that tests such as reaction time, intersegmental coordination, and hand-eye coordination are valuable tools for pointing out aspects to improve through specific training (Fig. 3). The results of such tests contribute to the creation of an individual performance profile; when continuously monitored, the profile helps to adapt training interventions. This complementary strategy is also suggested by Fernández-Fernández et al. (2014), who underscore the value of periodic physical testing in determining individual needs.



Fig. 3. Specific physical training practice for the speed for reaction and hand-eye coordination

In addition to psychomotor abilities, general strength training has become a significant pillar in the physical training of tennis players. Research studies carried out by Mengyao and Seung-Soo (2022) and Liu (2022) report that strengthening the core muscles optimises postural stability and supports the quick, explosive motions required for powerful and precise strokes. Furthermore, Arslan and Ergin (2022) highlight the positive impact of core strength exercises on agility and technical performance, which directly reflects in better abilities related to on-court dynamism.

The integration of strength training in the routines of junior players has been proven to improve technical execution. Research suggests that the implementation of resistance-based programs increases stroke speed more effectively than traditional training methods (Dewanti et al., 2020). This multifactor approach contributes significantly to the development of physical abilities necessary for efficient technique.

Incorporating physical performance testing provides an objective perspective on progress and helps identify correlations between physical variables and technical skills. Dobos (2018) reported significant correlations between speed, agility, and explosive strength and technical performance – a finding further supported by Shakir and Kadhum (2021), who emphasised the relationship between biomechanical angles and stroke power. This approach, through the detailed evaluation of physiological and biomechanical parameters, enables the optimisation of training plans and the continuous monitoring of performance improvements.

It is also essential to maintain a balance between training demands and recovery periods in order to avoid overexertion and injuries, which are frequent among young athletes. Data indicate an increased risk of injuries caused by the high intensity and frequency of power strokes performed both in training and in competition (Colomar et al., 2023). Therefore, the integration of appropriate recovery methods is essential for maintaining performance and longevity in this sport (Fleming et al., 2023).

In general, it is considered that intensive strength efforts are not recommended before the age of 10, as the morpho-functional structure is not yet sufficiently developed to support such efforts. Most specialists agree that at this age, the most suitable exercises are those involving free movements, where resistance is provided by the athlete's own body weight. According to Baroga (2002), children can safely start using light external weights around the age of eight. The author showed that, when done carefully and kept below 30% of body weight, weight training does not interfere with growth – in fact, it helps improve overall exercise capacity. At this age, however, isometric exercises are not recommended, as children tend to get tired quickly during static efforts. Instead, most specialists recommend developing the dynamic strength of the upper and lower limbs (Fig. 4), as well as strengthening the abdominal muscles (Pițu, 2016).



Fig. 4. Physical training practice for dynamic strength development

Strength and endurance are considered motor qualities that can be systematically developed, beginning around the ages of 8–9, with a positive evolution, and reaching their highest potential after full physical maturation. In contrast, according to the literature, speed and coordination can be effectively developed as early as ages 6–7. The functional support for speed development is provided by the high plasticity of the cerebral cortex specific to this age, as well as the predominance of cortical excitability phenomena.

Up to the age of 10, plyometric exercises are an ideal way of increasing the strength and agility of athletes while avoiding excessive efforts or the use of weights. The most efficient plyometric drills for tennis include short sprints – forward, backward, and to the side – over distances of 3–5 meters, combined with various jumping exercises (Marin & Ștefănică, 2023).

Regarding the improvement of coordination, according to Macovei (2016), training between the ages of 6 and 8 can effectively target spatial-temporal differentiation and coordination under time pressure. After the age of 8, coaches should focus on developing rhythm and reaction to visual and auditory stimuli.

In terms of flexibility, the most sensitive period for its development is considered the timeframe between 6 and 12 years. After the age of 12, joint range-of-motion improvements decrease dramatically unless special measures are taken during practices, and the differences between active and passive values also diminish considerably. Studies have shown that mobility develops most rapidly between the ages of 8 and 10 in the case of boys and between 9 and 11 in the case of girls (Polevoy, 2024). Starting with the age of 12, coaches

must use mobility-centred structured training programs specific to tennis, in order to attain optimal performance and prevent mobility-related injuries (Macovei, 2016).

After the age of 12, the development of strength and endurance becomes the central aspect of practices, using physical training programs. Shi and Xuan (2023) showed that a 12-week rope-jumping training program can considerably improve strength, dynamic balance, and subsequently the stroke stability of junior tennis players. The authors mentioned above recommend using small loads and alternating landing stances while alternating the skipping rope methods (Shi & Xuan, 2023).

After the age of 16, the general guidelines include the use of periodised physical training practices and individualised physical training programs. Even though speed is a rather difficult motor quality to develop, at this age it can still be partially influenced by implementing appropriate means and methods (Simion, 2020). At this age, we can improve strength and endurance using training programs applicable to senior players. Regarding coordination, the focus will concern mainly the development of specific coordination through the practice of technical skills. Notable results can be obtained in the development of agility with the help of plyometric exercises, included in a physical training program lasting at least 12 weeks (Marin & Ștefănică, 2023).

Around the age of 16, functional training programs have also shown excellent results in improving the endurance necessary for tennis performance to the detriment of traditional endurance-oriented approaches (Xiao, 2024).

The development of mobility after age 16 varies considerably from one individual to another, depending on genetic factors, the subject's response to the methods applied, and their overall health. When following a structured training program that included both dynamic and static stretching exercises, adolescents aged 16 showed significant improvements in mobility. However, the progress was more modest compared to that observed in younger participants aged 9–12 (Donti & Konrad, 2022).

CONCLUSIONS

The integration of strength training into the routine of junior tennis players has been shown to enhance technical performance, given that a solid technical foundation in young athletes is closely related to their physical training.

Between the ages of 6 and 10, coaches typically focus on developing speed and coordination, generally achieving very good results in improving these motor qualities. Research has also shown that mobility develops more effectively during this period than at later ages. Up to the age of 10, high-intensity strength

efforts are not recommended, as the morphofunctional structure is not yet sufficiently developed to support such loads. Some authors consider that strength and endurance can be systematically developed only starting from the age of 8–9, having an upward evolution and maximum possibilities of improvement after the maturation of the body (Marin & Ștefănică, 2023). On the other hand, in this age range, bodyweight exercises and plyometric exercises can be successfully used to develop the power and agility of the athletes.

Regarding the age interval between 12 and 18, training should concern primarily strength and endurance, through systematic physical training programs. After the age of 15–16, the use of periodised and individualised training programs is recommended. While speed is one of the more challenging physical qualities to develop, it can still be partially influenced at this stage with the proper means and methods (Simion, 2020). Functional training programs have proven highly effective in building the endurance requested from tennis players, while mobility can continue to evolve through stretching exercises; however, results are usually lower than those recorded between the ages of 10 and 12 (Donti & Konrad, 2022).

AUTHOR CONTRIBUTIONS

Alexandru-Ilie Tudurache and Adrian Cojocariu contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. All authors have read and agreed to the published version of the manuscript.

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