Int. j. racket sports sci. vol. 6(2), 2024, 31-39. eISSN: 2695-4508
DOI: 10.30827/ijrss.33432 Original Investigation

Physical Growth and Biological Maturity Status of Young Table Tennis Players

Crecimiento físico y madurez biológica de jugadores jóvenes de tenis de mesa

Hasan Ödemiş [1] & Mustafa Söğüt [1]

1 Department of Physical Education and Sports, Middle East Technical University, Faculty of Education, Ankara, Turkiye

Received: 12-11-2024

Accepted: 21-02-2025

Abstract

Although table tennis is a popular sport played by millions of people regularly and competitively, and the studies devoted to table tennis are increasing, the extent of literature on the growth and maturity status of young table tennis players is not extensive. The present study aimed to assess the growth and maturity status of young medal-winning table tennis players and compare them with non-medal-winning players. A group of 117 competitive players, consisting of 57 males (12.87±1.35 years) and 60 females (12.99±1.24 years), underwent measurements of standing height, sitting height, and body mass. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (in meters), and growth status was determined using a reference database. Somatic maturity status was estimated using age at peak height velocity (APHV) and maturity offset, calculated by the difference between APHV and chronological age. The results indicated that the mean height, body mass, and BMI percentiles of both genders were higher than the 37th percentile when compared to normative references. There were no significant differences in terms of growth and maturity status between medal-winning and non-medal-winning players in both genders. The study suggests that coaches might consider closely monitoring the growth and maturity levels of their players and potentially consider adjusting training strategies based on the players' physical characteristics. These findings could contribute valuable insights into talent identification, physical development, and their potential influence on performance in youth table tennis.

Keywords: *Racket sports, talent identification, youth athletes, biological maturation, physical growth.*

Resumen

Aunque el tenis de mesa es un deporte popular practicado por millones de personas de forma regular y competitiva, y los estudios dedicados al tenis de mesa van en aumento, la literatura sobre el crecimiento y la madurez de los jugadores jóvenes de tenis de mesa no es extensa. El objetivo de este estudio fue evaluar el crecimiento y la madurez de jugadores jóvenes de tenis de mesa que han ganado medallas y compararlos con jugadores que no han ganado medallas. Se midió la altura de pie, la altura sentados y la masa corporal de un grupo de 117 jugadores de competición compuesto por 57 hombres (12,87 ± 1,35 años) y 60 mujeres (12,99 ± 1,24 años). El índice de masa corporal (IMC) se calculó dividiendo el peso (en kilogramos) por el cuadrado de la altura (en metros) y el estado de crecimiento se determinó utilizando una base de datos de referencia. El estado de madurez somática se estimó utilizando la edad al pico de la velocidad de crecimiento (PVC) y el desfase madurativo fue calculado por la diferencia entre la edad al PVC y la edad cronológica. Los resultados indicaron que la estatura media, la masa corporal y los percentiles de IMC de ambos sexos eran superiores al percentil 37º en comparación con las referencias normativas. No hubo diferencias significativas en términos de crecimiento y estado de madurez entre los jugadores ganadores y no ganadores de medallas en ambos sexos. El estudio sugiere que los entrenadores podrían considerar la posibilidad de vigilar de cerca los niveles de crecimiento y madurez de sus jugadores y, potencialmente, considerar ajustar las estrategias de entrenamiento en función de las características físicas de los jugadores. Estos hallazgos podrían aportar valiosos conocimientos sobre la identificación de talentos, el desarrollo físico y su posible influencia en el rendimiento en el tenis de mesa juvenil.

Palabras clave: *deportes de raqueta, identificación de talentos, atletas jóvenes, maduración biológica, crecimiento físico*

Corresponding author: Hasan Ödemiş, hasan.odemis@metu.edu.tr

Cite this article as:
Ödemiş, H., & Söğüt, M. (2024). Physical Growth and Biological Maturity Status of Young Table Tennis Players. International *Journal of Racket Sports Science, 6*(2), 31-39.

INTRODUCTION

Racket sports have been popular worldwide for over a century (Lees, 2003; Robertson et al., 2018) and studies have shown that practicing racket sports such as tennis, table tennis, badminton, and squash can improve the brain's ability to coordinate movements of the body, which can lead to better hand-eye coordination, reflexes, speed, endurance, flexibility, agility, and overall physical fitness (Jaworski et al., 2020; Schaefer & Scornaienchi, 2019). Racket sports are similar in that they all require players to use a racket to hit a ball or shuttlecock over a net and involve bursts of high-intensity exercise (Faber er al., 2016; Pluim, 2004). However, there are some key differences between racket sports, such as the swinging patterns used, the size of the court, and the speed of the ball (Ak & Koçak, 2010; Akpınar et al., 2012). For instance, tennis players have more time to anticipate the placement of the ball and react accordingly to the speed and spin of the shots, as the ball travels slower and has a larger trajectory than in other racket sports, whereas table tennis players have less time to react to the speed and spin of the shots, as the ball travels much faster and has a much shorter trajectory (Ak & Koçak, 2010).

Developing effective training programs for young athletes relies on a profound understanding of how growth and maturation impact a child's development (Balyi & Hamilton, 2004; Balyi et al., 2013; Ford et al., 2011). To ensure that young athletes receive training that fosters their overall growth, it is imperative to fully grasp these two biological processes since they play pivotal roles in a child's development and significantly influence their physical, mental, and emotional well-being (Beunen & Malina, 2007). Despite often being used interchangeably and mistakenly perceived as referring to the same concepts, it is crucial to recognize that growth and maturation are separate biological processes (Cameron, 2022a; Malina et al., 2004). Maturation pertains to the progression of the body's skeletal, sexual, and somatic systems towards adulthood, while growth involves alterations in size and body composition that occur as individuals age (Baxter-Jones et al., 1995; Baxter-Jones et al., 2005; Cameron, 2022b; Malina et al., 2004).

In the context of youth sports, research on the relationship between growth, maturation, and sports performance is important for talent identification and development (Malina et al., 2004). During the last decades, there has been a lot of research on this topic, especially in team sports like soccer and basketball. However, there is a gap in knowledge about this relationship in racket sports, particularly table tennis, badminton, and squash (Coelho-e-Silva et al., 2021). A recent study by Coelho-E-Silva et al. (2021) found that most young male table tennis players were early maturing based on skeletal age and average maturing based on somatic indicators. Their heights and body masses were above the reference medians from 10 to 13 years, and their skeletal ages were generally advanced relative to chronological age. Another study by Doherty et al. (2018) showed that there were significant correlations between actual performance rating and age at peak height velocity (APHV), sprint test, years of practice, positive refocusing, self-regulation in learning, and evaluation in elite youth male table tennis players. The study also found that APHV, sprint test, years of practice, self-monitoring, and evaluation were significantly correlated with progression scores.

The research on growth and maturation in racket sports has mostly focused on tennis, with only two studies on table tennis (Coelho-E-Silva et al., 2021; Doherty et al., 2018). Both table tennis studies were conducted with male players, and they did not report any information about medal-winning or ranking status. This study is original in the sense that it investigates the relationship between growth and maturity status and the medal-winning status of young competitive table tennis players at consecutive ages. Therefore, the purposes of this study are: (1) to determine the growth and maturity status of young medal-winning table tennis players, and (2) to compare these players with their non-medal-winning counterparts. The study hypothesized that medal-winning players were expected to have a more advanced growth and maturity status compared to non-medal-winning players.

METHODS

Participants

In this cross-sectional study, convenience sampling method was utilized. A total of 117 table tennis players (57 males aged 12.87 ± 1.35 years, and 60 females aged 12.99 ± 1.24 years) were measured for their standing height, sitting height, and body mass. To be included in the study, the players had to meet the following criteria: (i) they had to be registered with the Turkish Table Tennis Federation, and (ii) they had to have at least two years of training experience in organized and competitive table tennis. The study was approved by the Human Subjects Ethics Committee of Middle East Technical University, and written informed consent was obtained from the children and their parents or legal guardians after the measurements and purpose of the study were explained. Means and standard deviations for chronological age, training age, weekly training, height, sitting height, body mass, body mass index (BMI), APHV, and maturity offset of female and male table tennis players are summarized in Table 1.

Table 1
Descriptive statistics

Variables	Girls (n = 60)	Boys (n =57)
Chronological age (years)	12.9 ± 1.2	12.9 ± 1.4
Training age (years)	5.2 ± 1.3	4.9 ± 1.7
Weekly training (hours/week)	15.3 ± 5.5	14.6 ± 6.8
Height (cm)	155.9 ± 7.01	159.3 ± 9.4
Sitting height (cm)	81.5 ± 4.3	82.1 ± 45
Body mass (kg)	47.2 ± 9.6	50.9 ± 11.6
Body Mass Index (kg/m^2)	19.4 ± 3.3	19.9 ± 3.4
Height (z-scores)	0.1 ± 0.8	0.4 ± 0.8
Height (percentiles)	51.7 ± 24.9	62.9 ± 23.3
Body mass (z-scores)	0.1 ± 0.7	0.3 ± 0.7
Body mass (percentiles)	53.1 ± 23.7	58.6 ± 21.7
Body Mass Index (z-scores)	-0.03 ± 0.8	0.3 ± 0.9
Body Mass Index (percentiles)	49.4 ± 26.6	57.4 ± 26.2
APHV (years)	12.2 ± 0.5	13.7 ± 0.6
Maturity offset (years)	0.8 ± 1.04	-0.8 ± 1.2

Z-scores represent how many standard deviations a value deviates from the mean of a reference population, allowing for standardized comparisons across different age groups. Percentiles, on the other hand, indicate the relative ranking of a player's measurement within a reference data set, showing the percentage of individuals with lower values. In this context, the percentile of height indicates the relative ranking of a player's height compared to a reference population of the same age and gender, with a higher percentile suggesting that the player is taller than most of their peers and a lower percentile indicating they are shorter. Similarly, the percentiles of body mass and BMI reflect how a player's weight and BMI compare to normative values. These measures are crucial for contextualizing the physical development of young table tennis players within a broader population and for identifying potential advantages or limitations in their growth trajectories.

Procedures

Birth dates, training age, and weekly training information were collected from the players, coaches, and parents. In addition to general information about the players, anthropometric measurements, including body mass, stature, and sitting height, were taken. Height measurements were taken using a portable stadiometer (Seca 213, Hamburg, Germany) for both standing and sitting heights, and body weight was assessed using a digital weighing scale. To be used in calculation of APHV, leg length was computed by finding the difference between standing and sitting heights. BMI was calculated by dividing body mass (kg) by the squared height (m). Height-for-age, weight-for-age, and BMI-for-age were compared to reference data (Frisancho, 2008). Percentile and z-score values were calculated for height, body weight, and BMI. The APHV was estimated using the predictive equation developed by Mirwald et al. (2002). The maturity offset was calculated by subtracting the chronological age from the APHV. The chronological ages of the players were determined by subtracting their birthdate from the date of measurement.

Statistical analysis

A gender-based descriptive analysis of the data was conducted, with all values presented as means and standard deviations. The normality of the data was assessed using the Kolmogorov-Smirnov test. The results indicated no significant deviations from normality, suggesting that the data were normally distributed. Independent samples t-tests were conducted to examine differences between medal-winning and non-medal-winning players, separately for boys and girls. The effect size was quantified using Cohen's d, with the following interpretation: <0.20 (trivial), 0.20–0.59 (small), 0.60–1.19 (moderate), 1.20–1.99 (large), 2.0–3.9 (very large), and >4.0 (extremely large) (Hopkins et al., 2009). The significance threshold was set at p < 0.05. IBM SPSS Statistics for Windows, Version 26.0 (SPSS Inc., Chicago IL), was used for all statistical analyses in this study.

RESULTS

Means and standard deviations for chronological ages, height, sitting height, body mass, BMI, height z-score, height percentile, body mass z-score, body mass percentile, BMI z-score, BMI percentile, APHV, and maturity offset are presented by five age groups (U11, U12, U13, U14, and U15) in Table 2.

Figures 1, 2 and 3 show the mean values of height, body mass, and BMI for each age group, along with the corresponding percentiles within a reference population.

The mean height percentiles of players are shown in Figure 1. Female players had heights between the 45th and 57th percentiles, with the lowest mean values in U15 girls and the highest mean values in U12 girls. Male players had heights between the 54th and 69th percentiles, with the lowest mean values in U14 boys and the highest in U11 boys. The percentiles of other age groups for female players were mostly around the 50th percentile mark, while the percentiles of other age groups for male players were between the 60th and 65th percentiles.

Table 2.
Descriptive statistics by age groups

Ages	11		12		13		14		15	
Gender	Boys (M ± SD)	Girls (M ± SD)	Boys (M ± SD)	Girls (M ± SD)	Boys (M ± SD)	Girls (M ± SD)	Boys (M ± SD)	Girls (M ± SD)	Boys (M ± SD)	Girls (M ± SD)
Chronological age (years)	10.8 ± 0.3	10.9 ± 0.2	12.1 ± 0.3	11.9 ± 0.4	12.9 ± 0.3	12.8 ± 0.4	13.8 ± 0.4	13.7 ± 0.4	14.6 ± 0.3	14.8 ± 0.3
Height (cm)	149.4 ± 8.1	146.6 ± 2.8	155.8 ± 5.5	152.8 ± 6.3	159.6 ± 6.6	155.9 ± 5.6	162.2 ± 6.1	158.9 ± 5.2	169.2 ± 7.1	160.3 ± 7.7
Sitting height (cm)	77.5 ± 3.8	77.1 ± 1.6	80.5 ± 3.1	78.7 ± 4.2	81.7 ± 4.1	81.4 ± 3.3	84.2 ± 2.6	83.4 ± 2.8	87.3 ± 4.1	84.9 ± 3.9
Body mass (kg)	43.5 ± 13.9	36.3 ± 3.7	44.3 ± 4.8	40.6 ± 7.4	49.2 ± 8.4	46.9 ± 9.2	61.8 ± 12.4	53.7 ± 8.4	58.5 ± 7.3	52.9 ± 5.1
Body Mass Index (kg/m^2)	19.3 ± 4.6	16.9 ± 1.9	18.3 ± 1.8	17.4 ± 2.9	19.4 ± 3.1	19.3 ± 3.3	23.4 ± 3.3	21.3 ± 3.3	20.6 ± 2.1	20.8 ± 2.1
Stature (z-scores)	0.8 ± 1.1	0.1 ± 0.4	0.5 ± 0.6	0.3 ± 0.8	0.4 ± 0.7	0.1 ± 0.8	0.1 ± 0.7	0.1 ± 0.7	0.4 ± 0.8	-0.1 ± 1.1
Stature (percentiles)	68.7 ± 29.4	52.2 ± 14.2	65.6 ± 17.7	57.2 ± 21.1	63.0 ± 22.3	50.2 ± 24.9	53.8 ± 24.7	51.7 ± 23.9	60.7 ± 22.1	45.0 ± 35.9
Body mass (z-scores)	0.2 ± 1.1	-0.3 ± 0.4	-0.1 ± 0.4	-0.2 ± 0.7	0.1 ± 0.6	0.1 ± 0.9	0.8 ± 0.7	0.4 ± 0.7	0.4 ± 0.5	0.2 ± 0.4
Body mass (percentiles)	55.2 ± 28.1	40.5 ± 15.2	49.2 ± 15.3	44.4 ± 23.9	55.1 ± 21.8	53.3 ± 27.9	74.2 ± 18.9	64.6 ± 23.5	63.9 ± 14.9	55.7 ± 15.5
Body Mass Index (z-scores)	0.4 ± 1.3	-0.3 ± 0.7	-0.1 ± 0.6	-0.4 ± 0.9	0.1 ± 0.9	-0.1 ± 0.9	1.1 ± 0.7	0.4 ± 0.8	0.2 ± 0.6	0.1 ± 0.5
Body Mass Index (percentiles)	58.1 ± 32.9	39.0 ± 23.7	47.6 ± 21.3	37.1 ± 26.7	53.4 ± 27.1	49.4 ± 30.5	80.1 ± 15.1	61.8 ± 24.7	55.6 ± 20.7	55.1 ± 18.3
APHV (years)	13.1 ± 0.5	11.9 ± 0.1	13.5 ± 0.3	11.9 ± 0.4	13.8 ± 0.5	12.1 ± 0.5	13.8 ± 0.4	12.3 ± 0.3	13.9 ± 0.5	12.7 ± 0.5
Maturity offset (years)	-2.3 ± 0.5	-0.9 ± 0.2	-1.4 ± 0.4	-0.1 ± 0.5	-0.9 ± 0.6	0.7 ± 0.5	0.1 ± 0.5	1.4 ± 0.4	0.7 ± 0.6	2.1 ± 0.4

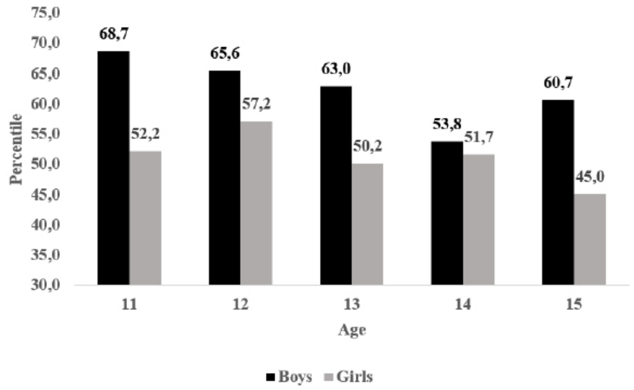

Figure 1. Mean height and corresponding percentiles by age group [1]

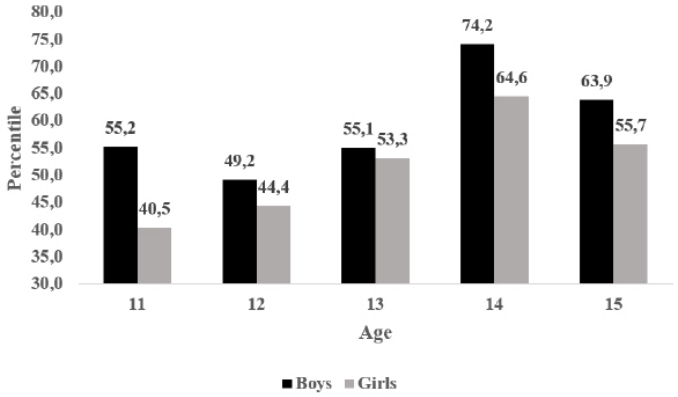

Figure 2. Mean body mass and corresponding percentiles by age group [2]

[1] Each column in the figure represents the mean value of height for a given age group, along with its corresponding percentile within the reference dataset.
[2] Each column in the figure represents the mean value of body mass for a given age group, along with its corresponding percentile within the reference dataset.

The mean body mass percentiles of players are given in Figure 2. The body masses of the female players were between the 40th and 65th percentiles, with the U11 girls having the lowest mean values and the U14 girls having the highest. The other age groups had percentiles between the 44th and 56th. The body masses of the male players were between the 49th and 74th percentiles, with the U12 boys having the lowest mean values and the U14 boys having the highest. The other age groups had percentiles between the 55th and 64th.

The mean BMI percentiles of players are given in Figure 3. The BMI values of the female players were between the 37th and 62nd percentiles, with the U12 girls having the lowest mean values and the U14 girls having the highest. The other age groups had percentiles between the 39th and 55th. The BMI values of the male players were between the 48th and 80th percentiles, with the U12 boys having the lowest mean values and the U14 boys having the highest. The other age groups had percentiles around the 55th.

Table 3 shows a comparison of medal-winning and non-medal-winning players. There were no significant differences between the two groups of girls in any of the variables measured. Among boys, there were no significant differences between the two groups in any of the variables measured except for training age. Medal-winning boys had significantly more experience in regular table tennis training than non-medal-winning boys ($p < 0.05$).

DISCUSSION

This study aimed to determine the growth and maturity status of young medal-winning table tennis players and compare them with their non-medal-winning counterparts. The study hypothesized that medal-winning players were expected to have a more advanced growth and maturity status compared to non-medal-winning players; however, the findings of the study failed to support this hypothesis. The main findings of the study highlight that, compared to normative references for the same age and gender, both boys and girls exhibited mean height, body mass, and BMI percentiles above the 37th percentile. Notably, there were no significant differences in any variable between medal-winning and non-medal-winning girls, whereas the only significant difference observed among boys was in training age.

The research revealed that female table tennis players had heights that fell between the 45th and 57th percentiles, while male players had heights ranging from the 54th to the 69th percentiles. Additionally, the study noted that female table tennis players had body masses spanning from the 40th to the 65th percentiles, whereas male players had body masses ranging from the 49th to the 74th percentiles. In terms of BMI percentiles, the study indicated that female table tennis players had BMI values ranging from the 37th to the 62nd percentiles, while male players had BMI values ranging from the 48th to the 80th percentiles. These findings are consistent with previous research conducted in racket sports (Baxter-Jones et al., 1995; Coelho-E-Silva et al., 2021; Erlandson et al., 2008; Myburgh et al., 2016; Söğüt et al., 2019; Söğüt et al., 2023).

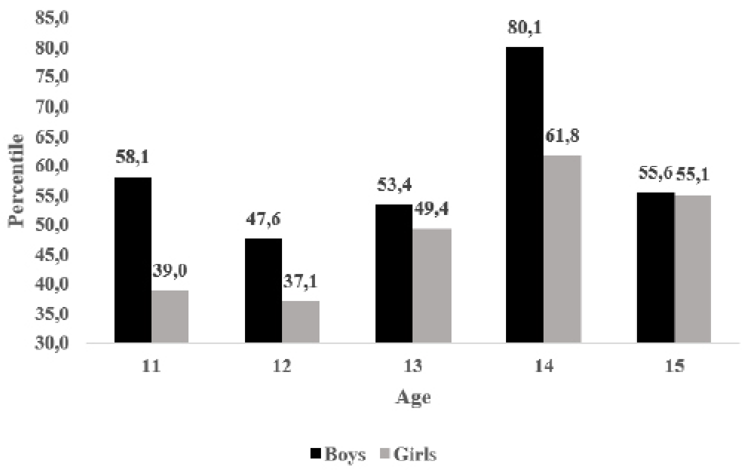

Figure 3. Mean BMI and corresponding percentiles by age group [3]

[3] Each column in the figure represents the mean value of BMI for a given age group, along with its corresponding percentile within the reference dataset

Table 3
Comparison between Medal-Winning and Non-Medal-Winning players

	Gender	Medal-winning	Non-medal-winning	t	p	d	Qualitative
Chronological age (years)	Girls	13.1 ± 1.2	12.9 ± 1.3	-0.282	0.779	0.001	Trivial
	Boys	12.5 ± 1.3	12.9 ± 1.4	1.039	0.303	0.019	Trivial
Training age (years)	Girls	5.7 ± 1.2	5.1 ± 1.3	-1.672	0.100	0.046	Trivial
	Boys	5.9 ± 1.3	4.7 ± 1.7	-2.230	0.030*	0.083	Trivial
Weekly training (hours/week)	Girls	15.9 ± 6.7	15.1 ± 5.04	-0.512	0.610	0.004	Trivial
	Boys	17.9 ± 6.2	13.9 ± 6.8	-1.833	0.072	0.058	Trivial
Height (cm)	Girls	157.9 ± 6.6	155.1 ± 7.1	-1.373	0.175	0.031	Trivial
	Boys	157.6 ± 11.9	159.7 ± 8.8	0.664	0.509	0.008	Trivial
Sitting height (cm)	Girls	82.8 ± 4.8	81.0 ± 4.1	-1.414	0.163	0.033	Trivial
	Boys	80.9 ± 5.9	82.4 ± 4.7	0.917	0.363	0.015	Trivial
Body mass (kg)	Girls	46.6 ± 9.7	47.4 ± 9.7	0.274	0.785	0.001	Trivial
	Boys	47.9 ± 12.8	51.7 ± 11.2	0.972	0.335	0.017	Trivial
Body Mass Index (kg/m^2)	Girls	18.6 ± 2.9	19.7 ± 3.4	1.130	0.263	0.022	Trivial
	Boys	18.9 ± 2.8	20.2 ± 3.5	1.047	0.300	0.020	Trivial
Height (z-scores)	Girls	0.3 ± 0.9	-0.02 ± 0.7	-1.333	0.188	0.030	Trivial
	Boys	0.5 ± 0.9	0.4 ± 0.8	-0.290	0.773	0.002	Trivial
Height (percentiles)	Girls	58.2 ± 27.7	49.3 ± 23.8	-1.224	0.226	0.025	Trivial
	Boys	63.9 ± 26.5	62.7 ± 22.8	-0.149	0.882	0.000	Trivial
Body mass (z-scores)	Girls	0.01 ± 0.7	0.1 ± 0.7	0.489	0.626	0.004	Trivial
	Boys	0.1 ± 0.8	0.3 ± 0.7	0.760	0.450	0.010	Trivial
Body mass (percentiles)	Girls	51.5 ± 24	53.7 ± 23.8	0.325	0.746	0.002	Trivial
	Boys	55.2 ± 22.5	59.4 ± 21.6	0.568	0.572	0.006	Trivial
Body Mass Index (z-scores)	Girls	-0.3 ± 0.7	0.1 ± 0.9	1.289	0.203	0.028	Trivial
	Boys	0.1 ± 0.8	0.3 ± 0.9	0.714	0.478	0.009	Trivial
Body Mass Index (percentiles)	Girls	42.7 ± 24.1	51.8 ± 27.2	1.181	0.242	0.023	Trivial
	Boys	54.8 ± 24.9	58.1 ± 26.8	0.371	0.712	0.002	Trivial
APHV (years)	Girls	12.2 ± 0.6	12.2 ± 0.4	0.564	0.575	0.005	Trivial
	Boys	13.6 ± 0.6	13.7 ± 0.6	0.311	0.757	0.002	Trivial
Maturity offset (years)	Girls	0.9 ± 0.9	0.7 ± 1.1	-0.646	0.521	0.007	Trivial
	Boys	-1.1 ± 1.3	-0.7 ± 1.1	1.102	0.275	0.022	Trivial

* $p < .05$

Parallel with the findings of the present study, in their study conducted on male table tennis players aged between 10 and 14, Coelho-E-Silva et al. (2021) displayed that the mean heights exhibited a range between the 75th and 90th percentiles for players aged 10 to 13, while U14 players had mean heights approximately at the 50th percentile. As for body masses, the mean values were around the median for both U10s and U14s, whereas for U11, U12, and U13, the average body masses were around the 75th percentile. Similar to table tennis, the study by Söğüt et al. (2019) on competitive U12 tennis players showed that both male and female players were taller than average children of the same age and gender. Additionally, the body masses of both boys and girls were above the 45th percentile, and the BMI percentiles of male and female players were higher than the average. In another study conducted on U14 competitive tennis players, Söğüt et al. (2023) found that the mean heights and body masses of both male and female players were above the 60th percentile. Moreover, the BMI percentiles of male tennis players were slightly below the median, whereas the BMI percentiles of female tennis players were above the median.

In terms of performance, there were no significant differences observed between girls across any of the variables. However, among boys, no significant differences were identified except for the training age. It was found that boys who won medals had significantly more experience in regular table tennis training compared to those who were not able to win medals. Consistent with the findings of the present study, a prior study by Söğüt et al. (2019) revealed no association between maturity status and rankings, whereas significant associations were found between factors like experience, training volume, and motor performance with rankings in both boys and girls. Conversely, another study by Söğüt et al. (2023) presented different findings. Their research found no notable disparities in all parameters among the three groups (national team, main draw, and qualifying) for boys. In contrast, among girls, both national and main draw players were observed to be significantly more advanced in terms of maturation and exhibited higher BMI values in comparison to qualifying players.

This study has several limitations that should be acknowledged. Firstly, the exclusion of tactical, technical, and psychological performance indicators limits the ability to gain a comprehensive understanding of the overall performance of the players. These factors are known to play a significant role in table tennis performance and should be included in future studies to provide a more well-rounded assessment. Secondly, it is important to note that the sample in this study is confined to young Turkish table tennis players aged between 10 and 15 years. This limited sample size and geographical focus may restrict the generalizability of the findings to a broader population of table tennis players from various regions and age groups. Including participants from diverse backgrounds would enhance the representativeness and inclusivity of analyzing physical growth and maturity in table tennis. Furthermore, the study primarily employs a cross-sectional design, offering a snapshot of the characteristics of the participants at a specific moment in time. Longitudinal studies are crucial for gaining a comprehensive understanding of the development and long-term implications of physical growth and maturity in table tennis. Long-term follow-up studies that track participants into young adulthood would provide valuable insights into the trajectory of physical growth and maturity and their influence on performance. Given these limitations, future research should encompass a broader array of performance indicators, diversify the participant pool, and utilize longitudinal designs with extended follow-up periods. Such efforts would contribute significantly to a more comprehensive understanding of the multifaceted nature of table tennis performance and the enduring effects of physical growth and maturity.

CONCLUSIONS

This study highlights the variability in growth and maturity status among young table tennis players, emphasizing that physical characteristics alone may not determine competitive success. While growth and maturity monitoring remains relevant for understanding long-term athlete development, its direct impact on medal-winning ability appears limited based on these findings. The role of growth and maturation in talent selection should be viewed in the broader context of competitiveness. Research in racket sports (e.g., table tennis, tennis, badminton) suggests that while top athletes tend to exhibit advanced growth and maturation patterns, these factors alone do not guarantee success, as technical proficiency, tactical awareness, and psychological resilience play equally crucial roles (Coelho-E-Silva et al., 2021; Söğüt et al., 2019; 2023). Similarly, studies in team sports (e.g., soccer, basketball) emphasize that although biological maturity can provide temporary advantages, long-term performance is shaped by multidimensional factors, including training experience and skill acquisition (Malina et al., 2004; Baxter-Jones et al., 2005). Therefore, a more comprehensive approach to athlete development should be adopted, integrating physical, technical, and cognitive assessments. Future studies should explore longitudinal data to determine whether growth and maturation influence performance outcomes in the long run, particularly as players transition from youth to elite levels. Incorporating these factors may provide valuable insights into best practices for talent identification and athlete development.

PRACTICAL IMPLICATIONS

The study findings hold several practical implications for coaches, trainers, and policymakers. Firstly, while physical characteristics such as height, body mass, and BMI play an important role in athlete development, they should not be used as the sole criteria for talent identification.A more holistic approach is needed, incorporating technical proficiency, tactical awareness, and psychological resilience alongside physical attributes. Secondly, given the connection between training age and winning medals, policymakers should prioritize providing ample training opportunities and structured programs to support long-term athlete development. Ensuring that young athletes receive high-quality coaching and consistent training experiences is crucial for their progression. Thirdly, although no significant differences in growth and maturity status were found between medal-winning and non-medal-winning players, monitoring these factors is still valuable. Understanding physical development trends can assist coaches in identifying long-term potential and ensuring that training programs align with individual needs. Lastly, considering these factors may yield important insights into best practices for talent identification and athlete development. A multidisciplinary approach that includes physical, technical, cognitive, and psychological factors will help create more effective athlete development pathways.

CONTRIBUTIONS

Both authors contributed to data collection, data analysis, bibliographic review, manuscript writing, revision and correction.

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

REFERENCES

Ak, E., & Koçak, S. (2010). Coincidence-Anticipation Timing and Reaction Time in Youth Tennis and Table Tennis Players. *Perceptual and Motor Skills*, *110*(3), 879-887. https://doi.org/10.2466/pms.110.3.879-887

Akpinar, S., Devrilmez, E., & Kirazci, S. (2012). Coincidence-Anticipation Timing Requirements are Different in Racket Sports. *Perceptual and Motor Skills*, *115*(2), 581-593. https://doi.org/10.2466/30.25.27.pms.115.5.581-593

Balyi, I., & Hamilton, A. (2004). *Long-Term Athlete Development: Trainability in Childhood and Adolescence—Windows of Opportunity—Optimal Trainability*. National Coaching Institute British Columbia and Advanced Training and Performance Ltd.

Balyi, I., Way, R., & Higgs, C. (2013). *Long-Term Athlete Development*. Human Kinetics eBooks. https://doi.org/10.5040/9781492596318

Baxter-Jones, A. D. (2012). Growth and Development of Young Athletes. *Sports Medicine*, *20*(2), 59-64. https://doi.org/10.2165/00007256-199520020-00001

Baxter-Jones, A. D., Eisenmann, J. C., & Sherar, L. B. (2005). Controlling for Maturation in Pediatric Exercise Science. *Pediatric Exercise Science*, *17*(1), 18-30. https://doi.org/10.1123/pes.17.1.18

Baxter-Jones, A. D., Helms, P. J. B., Maffulli, N., Baines-Preece, J., & Preece, M. A. (1995). Growth and development of male gymnasts, swimmers, soccer and tennis players: A longitudinal study. *Annals of Human Biology*, *22*(5), 381-394. https://doi.org/10.1080/03014469500004072

Beunen, G., & Malina, R. M. (2007). Growth and Biologic Maturation: Relevance to Athletic Performance. In H. Hebestreit & O. Bar-Or (eds.), *The Young Athlete* (pp. 3-17). Blackwell Publishing Ltd eBooks. https://doi.org/10.1002/9780470696255.ch1

Cameron, N. (2022a). Assessment of maturation. In N. Cameron & L. M. Schell (eds.), *Human Growth and Development* (pp. 347-369). Elsevier eBooks. https://doi.org/10.1016/b978-0-12-822652-0.00003-1

Cameron, N. (2022b). The pattern of human growth. In N. Cameron & L. M. Schell (eds.), *Human Growth and Development* (pp. 1-22). Elsevier eBooks. https://doi.org/10.1016/b978-0-12-822652-0.00004-3

Coelho-E-Silva, M. J., Konarski, J. M., Krzykała, M., Galas, S., Pluta, B., Żurek, P., Faria, J. M. S., Tavares, Ó. M., Oliveira, T. G., Rodrigues, I., Martinho, D., Valente-Dos-Santos, J., & Malina, R. M. (2021). Growth and maturity status of young male table tennis players. *Research in Sports Medicine*, *30*(1), 61-79. https://doi.org/10.1080/15438627.2021.1888099

Doherty, S. A., Martinent, G., Martindale, A., & Faber, I. R. (2018). Determinants for table tennis performance in elite Scottish youth players using a multidimensional approach: A pilot study. *High Ability Studies*, *29*(2), 241-254. https://doi.org/10.1080/13598139.2018.1496069

Erlandson, M. C., Sherar, L. B., Mirwald, R. L., Maffulli, N., & Baxter-Jones, A. D. (2008). Growth and Maturation of Adolescent Female Gymnasts, Swimmers, and Tennis Players. *Medicine and Science in Sports and Exercise*, *40*(1), 34-42. https://doi.org/10.1249/mss.0b013e3181596678

Faber, I. R., Bustin, P. M. J., Oosterveld, F. G. J., Elferink-Gemser, M. T., & Sanden, M. W. N. D. (2016). Assessing personal talent determinants in young racquet sport players: a systematic review. *Journal of Sports Sciences*, *34*(5), 395-410. https://doi.org/10.1080/02640414.2015.1061201

Ford, P. J., De Ste Croix, M., Lloyd, R. S., Meyers, R. K., Moosavi, M., Oliver, J. L., Till, K., & Williams, C. M. (2011). The Long-Term Athlete Development model: Physiological evidence and application. *Journal of Sports Sciences*, *29*(4), 389-402. https://doi.org/10.1080/02640414.2010.536849

Frisancho, A. R. (2008). *Anthropometric standards: an interactive nutritional reference of body size and body composition for children and adults*. University of Michigan Press.

Hopkins, W. D., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive Statistics for Studies in Sports Medicine and Exercise Science. *Medicine and Science in Sports and Exercise*, *41*(1), 3-12. https://doi.org/10.1249/mss.0b013e31818cb278

Jaworski, J., Lech, G., Ambroży, T., & Żak, M. (2020). Profile of coordination motor abilities in elite judokas and badminton players compared to non-athletes. *Biomedical Human Kinetics*, *12*(1), 17-24. https://doi.org/10.2478/bhk-2020-0003

Lees, A. (2003). Science and the major racket sports: a review. *Journal of Sports Sciences*, *21*(9), 707-732. https://doi.org/10.1080/0264041031000140275

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, Maturation, and Physical Activity.* Human Kinetics eBooks. https://doi.org/10.5040/9781492596837

Mirwald, R. L., Baxter-Jones, A. D., Bailey, D. B., & Beunen, G. (2002). An assessment of maturity from anthropometric measurements. *Medicine and Science in Sports and Exercise*, *34*(4), 689-694. https://doi.org/10.1097/00005768-200204000-00020

Myburgh, G. K., Cumming, S. P., Silva, M., Cooke, K., & Malina, R. M. (2016). Growth and maturity status of elite British junior tennis players. *Journal of Sports Sciences*, *34*(20), 1957-1964. https://doi.org/10.1080/02640414.2016.1149213

Pluim, B. (2004). Physiological demands and injury in racket sports: Differences and similarities. In A. Lees, J.-F. Kahn, & I. Maynard (Eds.), *Science and Racket Sports III* (1st ed., pp. 69-78). Taylor & Francis.

Robertson, K., Pion, J., Mostaert, M., Wazir, M. R. W. N., Kramer, T., Faber, I. R., Vansteenkiste, P., & Lenoir, M. (2018). A coaches' perspective on the contribution of anthropometry, physical performance, and motor coordination in racquet sports. *Journal of Sports Sciences*, *36*(23), 2706-2715. https://doi.org/10.1080/02640414.2018.1441941

Schaefer, S., & Scornaienchi, D. (2019). Table Tennis Experts Outperform Novices in a Demanding Cognitive-Motor Dual-Task Situation. *Journal of Motor Behavior*, *52*(2), 204-213. https://doi.org/10.1080/00222895.2019.1602506

Söğüt, M., De Oliveira Luz, L. G., Kaya, Ö. B., & Altunsoy, K. (2019). Ranking in young tennis players—a study to determine possible correlates. *German Journal of Exercise and Sport Research, 49,* 325-331. https://doi.org/10.1007/s12662-019-00580-7

Söğüt, M., Ödemiş, H., & Durmuş, D. (2023). Growth and maturity status of young elite and sub-elite tennis players. *ITF Coaching* & *Sport Science Review*, *31*(89), 21-26. https://doi.org/10.52383/itfcoaching.v31i89.373