The assessment of specific physical fitness of children aged 8 and 9 years participating in tennis classes using the Jindrich Hoehm test

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Summary

Study aim: The purpose of the study was to use the Jindrich Hoehm test to evaluate physical fitness in boys and girls aged 8 and 9 years participating in tennis classes.

Material and methods: A total of 40 children divided into four sample groups participated in the study. The J. Hoehm test consisting of seven components was used to measure and assess the physical fitness of the research participants. This test is used in child and adolescent tennis training to assess specific physical fitness.

Results: The *actual data* showed significant differences between 8-year-old boys and girls that were established based on the test components assessing lower extremity strength capacity and the agility assessment test. In the group of children aged 9, the differences between boys and girls emerged in the test assessing lower extremity strength capacity as well as the test component assessing the forehand and backhand footwork movement technique. Inasmuch as the test component assessing lower extremity strength capacity showed differences between 8- and 9-year-old boys, no test demonstrated statistically significant differences between 8- and 9-year-old girls. Based on the *normalized data*, 8-year-old girls are physically fitter than 8-year-old boys. In the group of 9-year-old children, the relation is reversed. The children participating in the study display a low level of physical fitness.

Conclusion: The J. Hoehm test can be a useful tool for assessing the performance of tennis coaches.

Key words: Sexual dimorphism – Junior school age

Introduction

With an infinite abundance and variety of tactical scenarios, tennis belongs to a discipline of sports with high technical complexity [2, 3, 22]. It is precisely the tactics to which both technical skills and motor preparation of a player are subordinated [5, 8, 18, 25]. Competitive tennis training is a complex and long-lasting process, divided into stages and phases [12]. The main objective of the first stage of training is to ensure children "have fun when playing tennis" as well as take care of their all-around physical and motor development. However, in this stage of training a need arises to assess not only general physical fitness, but also a specific one. This statement results from the fact that tennis tests play essential role in the training process, for two basic reasons. Firstly, they correspond to the specificity of the training process in tennis and meet the natural needs for competition. Secondly, they stimulate self-improvement attitudes in young tennis players, improve fitness and help master new skills [14].

In tennis, there are a number of tennis-specific fitness tests, designed for individuals who play tennis both professionally and recreationally. However, many fitness tests do not have a normalized point scale and are mainly used to make the classes more attractive and appealing [14].

Tennis belongs to sports of the so-called early specialization [10, 15, 16], in which entry occurs most often at the junior school age (age 7–10), colloquially referred to as "the second climax of motor skill development". Therefore, it is important to adapt tennis-specific training methods to the level of physical fitness of children, which also necessitates its objective evaluation. For this reason, tennis coaches use the Jindrich Hoehm test. A definite advantage of this test is its normalization, which allows for tracking changes in the child's physical fitness and comparing it to the norms corresponding to the child's age category.

Tennis is one of the best-known and elite sports in the world, equally popular amongst the representatives of both genders. Every coach has to remember that at every stage of training they will come across the problem of gender-

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based differentiation [4, 21, 24]. Physical fitness and sexual dimorphism, has been the subject of analysis of numerous research studies [17, 20, 23]. These research studies indicate that gender is one of the factors which considerably determine success in sport as well as gender-determined characteristic differences manifesting themselves in the combination of morphological, functional, and psychological traits. What it signifies is that from the earliest possible stage, sexual dimorphism needs to be taken into account when determining training load and assessing the effects of training on trainees [7, 13].

The purpose of the study was to use the J. Hoehm test, which takes into account sexual dimorphism as well as actual and normalized results achieved by 8- and 9-year-old children participating in tennis classes.

Materials and methods

Subjects

The study was conducted at a tennis school in the "Matchpoint" Sports Club in the town of Ślęza, near Wrocław. Forty children age 8 and 9 years, divided into four sample groups, participated in the study. The children who participated in the classes were beginner tennis players, with training experience ranging from several to more than ten weeks. Table 1 presents the characteristics of the research participants.

The children attended organized 60-minute tennis class sessions twice a week. The underlying criterion for the creation of the sample groups was the calendar and not developmental age, as the fitness test used in the study has normalized point scores taking into account the calendar age. Having reviewed tennis training programs, it can be concluded that 8- and 9-year-old children are at different stages of training [14].

Methods

The physical fitness of subjects was measured and assessed with the Jindrich Hoehm test [14]. According to the author of the test, it evaluates specific physical fitness. The test consists of seven components:

1. 30-meter run [s].
2. 2-kg medicine ball overhead throw with one hand [m].
3. Standing quadruple jump [m].
4. Oblique sit-ups within 120 seconds [count].
5. "5-wall sprint" [s] – 3-time run around a perimeter comprising of five segments of 4 meters each.
6. "Compass drill" [count] – footwork in the classic tennis strokes: forehand and backhand.
7. Long run [s] – 800-meter run (girls) and 1000-meter run (boys).

Measurements of the results achieved in all test components were conducted in accordance with the test guidelines. The instructions specifying the individual test procedures and requirements regarding the place and outfit were strictly followed. For the purposes of statistical analysis, normalized data from a table was used along with the actual data presented as running time results, the length of jump and throw, the count of sit-ups and touches of medicine ball with a racket in the compass drill test. The table with normalized data for a particular test component is scaled from 1 to 100 points and is designed for every age group in the range 8 to 18 years.

For the purposes of statistical analysis, a t-Student test was employed for dependent data in order to test the significance of mean differences between the sample groups. The level of significance was established at $\alpha = 0.05$. Statistical analysis was performed using Statistica 10.0 (Statsoft, the USA), whereas Office Excel 2003 (Microsoft, the USA) was employed to present the data graphically in a visual form.

Results

1. Differentiation in physical fitness according to the gender criterion

Actual data

Based on J. Hoehm test components, greater upper extremity strength and endurance capacity was reported in both 8- and 9-year-old boys than in girls of the same age. Conversely, lower extremity capacity and agility were greater in 8-year-old girls than boys (Table 2).

Table 1. Characteristics of the subjects

	Girls		Boys	
	8 years old N = 10	9 years old N = 10	8 years old N = 10	9 years old N = 10
Body weight (kg)	32.9 ± 4.7	34 ± 6.23	37.2 ± 12.09	36.5 ± 4.08
Body height (cm)	134.9 ± 5.38	138.3 ± 7.11	137.9 ± 9.84	141.1 ± 5.27
BMI (kg/m^2)	18.01 ± 1.79	17.63 ± 1.68	19.21 ± 3.77	18.32 ± 1.62

BMI – body mass index

Table 2. Mean values and standard deviation (Mean ± SD) of actual scores achieved by 8 – and 9-year-old boys and girls in J. Hoehm physical fitness test components

Test component	8 years old		9 years old	
	Boys $N = 10$	Girls $N = 10$	Boys $N = 10$	Girls $N = 10$
1. 30-meter run [s]	6.53 ± 0.91	6.14 ± 0.30	5.89 ± 0.70	6.55 ± 0.71*
2. Medical ball overhead throw [m]	5.04 ± 0.65	3.73 ± 0.70*	5.99 ± 0.56[a]	4.99 ± 0.72*[b]
3. Standing quadruple jump [m]	5.43 ± 0.60	6.09 ± 0.28*	6.46 ± 0.49[a]	6.63 ± 0.19[b]
4. Oblique sit-ups [count]	65.2 ± 10.32	56.3 ± 11.77	66.4 ± 6.31	62.7 ± 10.97
5. "5-wall sprint" [s]	60.42 ± 8.54	53.35 ± 4.04*	58.7 ± 5.97	59.7 ± 5.28
6. "Compass drill" [count]	36.6 ± 6.68	30.9 ± 6.96	42.1 ± 7.18	30.5 ± 4.76*
7. Long run [min]	5.21 ± 0.48	4.28 ± 0.31*	4.94 ± 0.51	4.41 ± 0.11*

N – the number of subjects; statistical differences: * – significantly different from boys; [a] – different from 8 years old boys; [b] – different from 8 years old girls

Significant differences were reported between 8-year-old boys and girls in the following test components: medicine ball overhead throw (t = 3.79, p < 0.01), standing quadruple jump (t = 2.73, p < 0.05), "5-wall sprint" (t = 2.64, p < 0.05), and long run (t = 4.66, p < 0.001). While in the group of 9-year-old boys and girls differences re-emerged in the medicine ball overhead throw (t = 3.99, p < 0.01) and long run (t = 2.94, p < 0.05), they were additionally observed in the "compass drill" (t = 5.05, p < 0.001) and 30-meter run (t = 2.73, p < 0.05).

Normalized data

The normalization of actual data allows for the subjects' physical fitness assessment against their peers. Judging from the averaged data for all test components, it can be concluded that 8-year-old girls are physically fitter

than boys of the same age (t = 2.64, p < 0.01) (Table 3). Alternatively, in the group of 9-year-olds, the difference between girls and boys decreases and is not statistically significant (Table 3).

In the group of 8-year-olds, the differences between boys and girls were reported in two out of seven test components: standing quadruple jump (t = 5.33, p < 0.001) and "5-wall sprint" (t = 2.26, p < 0.05) (Table 3). Conversely, in the group of 9-year-olds, a significant difference between boys and girls was found in the "compass drill" (t = 4.01, p < 0.01) and the standing quadruple jump test (t = 3.31, p < 0.01) (Table 3).

The averaged relative score values in all test components indicate a low level of physical fitness and uneven development of specific motor skills in the subjects.

Table 3. Mean values and standard deviation (Mean ± SD) of normalized scores achieved by 8- and 9-year-old boys and girls aged 8 and 9 years in J. Hoehm physical fitness test components

Physical fitness test components	8 years old		9 years old	
	Boys $N = 10$	Girls $N = 10$	Boys $N = 10$	Girls $N = 10$
1. 30-meter run [s]	25 ± 19.36	40.7 ± 20.21	41.1 ± 29.9	26.5 ± 26.09
2. Medical ball overhead throw [m]	48.2 ± 15.26	40.8 ± 12.97	53.8 ± 13.33	48.4 ± 13.54
3. Standing quadruple jump [m]	25.8 ± 13.01	64.8 ± 15.64*	39.7 ± 15.47 [a]	61.1 ± 9.88*
4. Oblique sit-ups [count]	60.4 ± 18.32	57.4 ± 22.3	55.5 ± 11.09	60.3 ± 20.58
5. "5-wall sprint" [s]	32.3 ± 24.58	53.6 ± 22.32*	25.7 ± 18.6	33.9 ± 25.18
6. "Compass drill" [count]	22 ± 11.52	13.6 ± 8.82	26.5 ± 14.66	8.1 ± 3.75*
7. Long run [min]	5.9 ± 3.69	7.7 ± 5.67	9.7 ± 8.57	4.4 ± 1.17
8. Overall physical fitness score	31.28 ± 17.78	39.86 ± 21.45*	36 ± 16.34	34.43 ± 23.24

N – the number of subjects; statistical differences: * – significantly different from boys; [a] – different from 8 years old boys

2. Differentiation in physical fitness according to the age criterion

Actual data

Table 2 also presents the actual scores of 8- and 9-year-old boys, as well as 8- and 9-year-old girls achieved in J. Hoehm physical fitness test components. In the group of 8- and 9-year-old boys, significant differences were reported in the medicine ball overhead throw (t = 3.48, p < 0.01) and the standing quadruple jump test (t = 4.18, p < 0.001). Similarly, in the group of 8- and 9-year-old girls, differences were reported in the same test components: the medicine ball overhead throw (t = 3.92, p < 0.001) and the standing quadruple jump (t = 4.85, p < 0.001).

Normalized data

The statistical analysis that was carried out did not indicate any statistically significant differences in the test and the individual test components between 8- and 9-year-old girls (Table 3).

When comparing 8- and 9-year-old boys, no statistically significant differences were reported in the overall test score except the test component assessing lower extremity strength capacity (standing quadruple jump test, t = 2.17, p < 0.05) (Table 3).

Discussion

The J. Hoehm test employed in this study is highly valued by tennis coaches. In their opinion it is the best-designed tennis-oriented fitness test. The test is easy to administer and provides measurable and comparable results achieved by every young tennis player. According to J. Hoehm (after: Królak [14]), the test should be carried out at least once a year, preferably during the last microcycle in the preparation period, or in the first phase of training sessions on open courts prior to the opening of the season. A definite advantage of this test is its normalization, which allows for tracking changes in the child's physical fitness and comparing it to the norms corresponding to the child's age category. The test consists of components that assess the upper and lower extremity strength capacity as well as the abdominal muscle strength. It also comprises tasks that evaluate speed, endurance, and agility. What sets this physical fitness test apart from others is a different way of performing the test components, which makes it impossible to relate the results achieved to the studies where authors employed, for instance, a EUROFIT test. As the coaches using the test argue, movement tasks comprising the test components are strictly related to a tennis movement technique, which justifies naming it a specific physical fitness test.

From the analysis of results achieved by our subjects, it transpires that both 8- and 9-year-old children in their age categories did not score 50 out of 100 points in the overall assessment, which signifies a low fitness level. Moreover, there was a great disproportion of results achieved by both girls and boys (particularly 8-year-olds) in individual test components. The test component in which the subjects scored the highest (over 50 points) was oblique sit-ups assessing abdominal muscle strength, whereas the lowest score (up to 10 points) was recorded for the long run. A long run is an endurance test measuring aerobic fitness and can pose the greatest difficulty for 8- and 9-year-old children. The test results indicate that the training program should be changed to focus on increasing the upper and lower extremity capacity in 8-year-old boys. Only abdominal oblique muscle strength capacity in 8- and 9-year-old children was above a normalized mean value. These results should be related to the movement technique in tennis. Forehand and backhand strokes occur with rotation of the body trunk, with significant involvement of the abdominal oblique muscles.

Another advantage of the test is the fact that the scores are normalized for girls and boys separately, which can be of great help for tennis coaches conducting classes for both sexes. As other authors have demonstrated in their studies, the physical fitness differentiation between girls and boys should be taken into account in the work of a coach.

In their study, Castro-Pinero et al. [1] assessed aerobic work capacity in boys and girls who ranged in age from 6 to 17 years old. The study demonstrated that boys scored significantly higher in all age groups compared to girls, with the exception of children aged 6 and 7 years who took the quarter-mile running test. Conversely, Huang and Malina [9] conducted a study involving over 100,000 Taiwanese boys and girls between 9 and 18 years of age. The age and gender dependent differences in physical fitness were related to BMI values and assessed based on the following test criteria: agility, lower extremity power, abdominal muscle strength, and cardiorespiratory endurance. These studies indicated a significant relationship between a BMI value and physical fitness. Lower physical fitness was observed in agility tests, lower extremity power, and cardiorespiratory tests, both in boys and girls with higher BMI values in every researched age group.

The study by Fjortoft et al. [6] assessed physical fitness of 195 Norwegian children (101 girls and 94 boys) between 5 and 12 years of age. For fitness assessment, the researchers suggested employing a test battery consisting of nine components and encompassing fundamental physical fitness elements, such as strength, endurance, movement coordination, balance, and agility. Despite including both boys and girls in the research, the authors of the study concentrated predominantly on assessing the age-dependent physical fitness. The results of their research indicate a linear growth of physical fitness with age.

The study by Jopkiewicz et al. [11] evaluated the psycho-physical fitness of 10-year-old children. The authors examined 166 children (80 girls and 86 boys) participating exclusively in compulsory physical education classes at school and 34 children practicing tennis. In order to assess fitness abilities, selected components of the International Physical Fitness Test were employed. Coordination abilities were evaluated with tests measuring simple reaction time, static and dynamic balance, spatial orientation, as well as upper and lower extremity movement velocity. Considering the level of fitness abilities, statistically significant differences were observed between girls and boys playing tennis and their peers participating exclusively in compulsory physical education classes. Conversely, with the exception of a simple reaction time test, no similar differences were found when assessing the level of coordination abilities. The authors associate the observed differences with the selection process and the influence of the sports discipline practiced by the children.

It is difficult to make a comparison between the results achieved by our subjects with those reported by other authors. Although they assess similar physical fitness elements, the manner in which they are performed is quite different. Currently, there are centile charts that allow for assessing physical fitness elements [19]. However, they were developed on the basis of other test components than those comprising the J. Hoehm test. The only comparable data includes body weight, body height, and BMI. By relating the results achieved by our subjects to the data gathered by Przewęda [19], we can see that against the population of Polish children, the ones participating in tennis classes scored over 50 for the aforesaid parameters.

Conclusions

1. The J. Hoehm test assesses the level of fitness in children and helps to differentiate between them. It points out the motor aspects of a child that require particular attention during sports classes.
2. The children participating in the study display a low level of physical fitness, which should be one explains the short experience classes.
3. Normalized test scores are indicative of significant disproportions of results achieved in the particular test components.
4. The 8-year-old girls participating in the study are physically fitter than their peers.
5. Significantly greater lower limb strength capacity characterizes both 8- and 9-year-old girls than boys of the same age.

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