The speed of sequential movements in table tennis studied under simulated conditions with respect to range, body involvement and direction

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Abstract The speed of specific movements in table tennis has been studied in simulated conditions. The influence of range, body involvement and direction on the speed of such movements was examined using a simulator of table tennis play. 10 members of the Polish men's national tennis table team, 4 high skilled female players and 28 children participated in the research. The speed of 7 different movements in a series of 17 measurements was examined. These movements consist of body displacement and simulated ball hitting with forehand and backhand strokes. The movement ranged from 0.4 to 2.25 meters and were executed without displacement of feet, or with a step, jump or run forwards or backwards, and to the right or left. The speed of movements was highest in men, slower in women and slowest in children. A relationship was found between the speed of movement, range, body involvement and direction. The results demonstrated the influence of direction on the speed of movements without displacement of the feet only in the men and children. Among the movements with a step, jump and run, the fastest were those performed to the right, and backwards and to the right; movements forward and to the right or left were slower, while the slowest were forward to the middle of the tennis table. The highest correlation between sporting results and the mean speed of all the tested movements (0.84) and also ball hitting movements performed close to the net on the right side (0.82, 0.76) was found for the members of the national team. High individual differences were found in the speed of movements requiring the displacement of body in all groups and also for children in the speed of movements without the displacement of body. The group and individual profiles of speed of tested movements were used to recognize the differences in this speed between particular players. The analysis of these profiles can be used to direct the training process. The investigations, presented in the paper, may have a diagnostic application and the simulator of table tennis play can be used as a training device.
(*Key words: speed, specific movements, range, body involvement, direction, table tennis, simulator*)

1 Introduction

The motor behavior in table tennis has character of motor reacting. The players react in response to the movement of an opponent and a ball. The aim of these responses is to hit a ball. The achievement of this aim requires displacement of the body to different places in the flight path of the ball and coming into contact with it. These two movements are performed sequentially. The displacement and ball hitting movement constitute a sequential movement (Łapszo and Morawski, 1994). The place of contact with the ball determines the direction and range of these movements. Modern table tennis requires the sequential movements to be executed at maximum speed, and it is the speed of these movements that is one of the most important factors of effective play. The purpose of this paper is to present a method of testing the speed of sequential movements in table tennis under simulated conditions with respect to range, body involvement and direction on the basis of group and individual profiles.

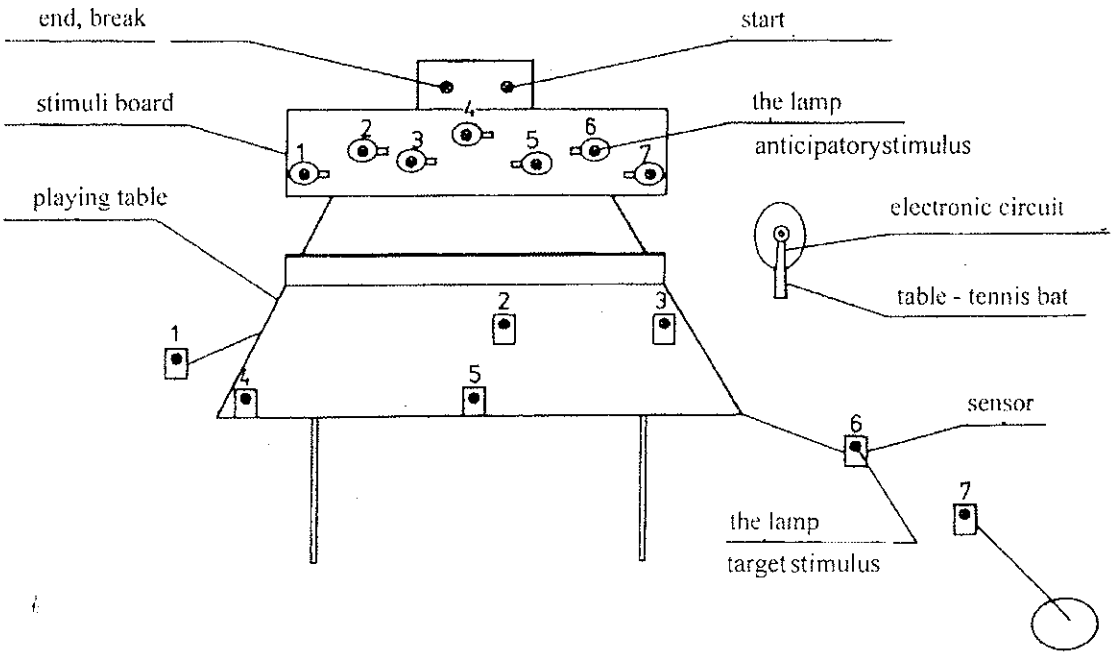

Figure 1. The specific simulator of table tennis play

2 Subjects and methods

In the research participated 10 members of the Polish men's national table tennis team, 4 highly skilled women players and 28 children (av. age 13.15) with 4.3 years of special training. All subjects were instructed in simulated ball striking.

The simulator of table tennis play was used in the research (Łapszo, 1991).

The simulator consists of a specific simulator, a controller and a computer. The specific simulator allows the speed of specific for table tennis movements to be measured.

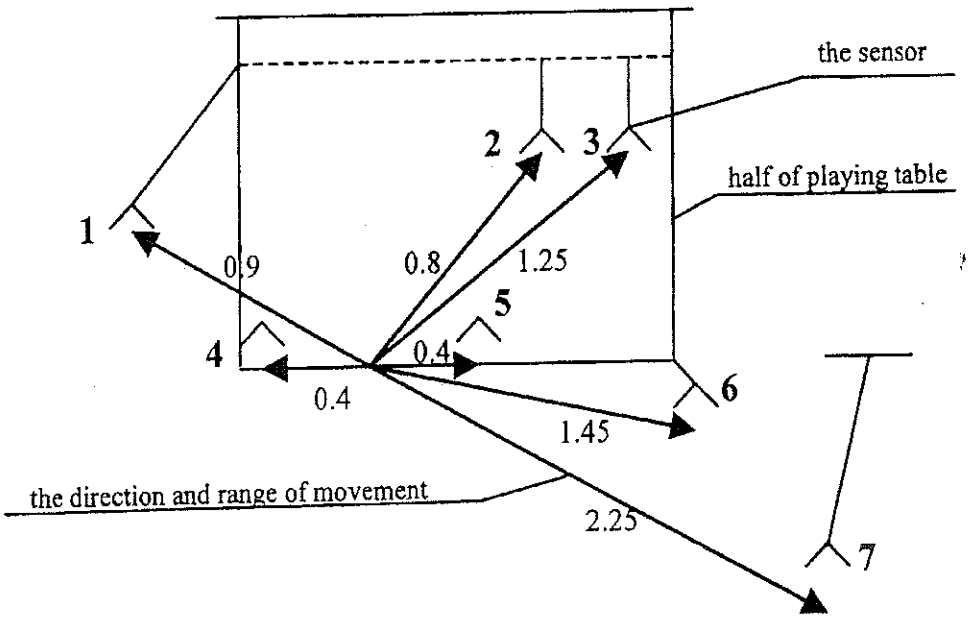

Figure 2. The direction and range of the movements tested

By means of the controller the simulator is controlled and linked up with the computer. The programming is such that measurement tests can be devised by the tester him/herself. The specific table tennis play simulator, used in this research, is presented in Figure 1. The set of sensors presented in Figure 1 was used only for the measurements. Each of the seven sensors contained a lamp the size of a table tennis ball. These lamps stimulate the displacement movements and indicate the spot where the simulated ball (lamp) should be struck. The simulated forehand or backhand strokes were performed by striking with a special table-tennis bat flexible straps attached to the sensors. The simulator measures the speed of the seven sequential movements most frequently used in the real play. The position of the sensors on that half of the playing table where they were installed, as well as the direction and range of the tested movements shows the Figure 2. The range of tested movements was from 0.4 to 2.25 meters and was measured from the starting position of the table-tennis bat to the flexible straps in the sensor. The numbers by the sensors correspond to the movements tested. The speed of a single movement was measured by the time (in seconds) elapsing from the instant the lamp in the sensor was switched on until the instant the simulated striking of the ball was executed. The sensors identified the simulated strokes photoelectrically, thereby enabling the performance of movements at maximum speed to be recorded. Sensors 2, 3, 5, 6 and 7 required a forehand stroke, 1 and 4

a backhand stroke. The range of movement determined the degree of body involvement in the simulated ball striking. Movements 4 and 5 were executed without displacing the feet, movements 1, 2 and 3 with a step forward and to the left (1) or right (2,3), movements 6 with a step to the right and 7 with jump or run backward and to the right. The speed of particular movements was measured in 2 different series (tests) of 17 movements (a combination of 7 tested movements). These two tests were repeated twice on each of the five days of the study. The results obtained were averaged for 7 tested movements.

Table 1. The mean speed (in seconds) of 7 tested movements for men, women and children.

Tested Groups	N	TESTED MOVEMENTS													
		1		2		3		4		5		6		7	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Men	10	0.63	0.05	0.60	0.11	0.79	0.13	0.41	0.07	0.36	0.07	0.53	0.09	0.87	0.12
Women	4	0.71	0.09	0.78	0.10	0.87	0.11	0.45	0.05	0.43	0.09	0.60	0.05	0.92	0.09
Children	28	0.99	0.20	0.80	0.12	0.97	0.15	0.58	0.13	0.47	0.12	0.65	0.12	1.01	0.18

M - mean, SD - standard deviation

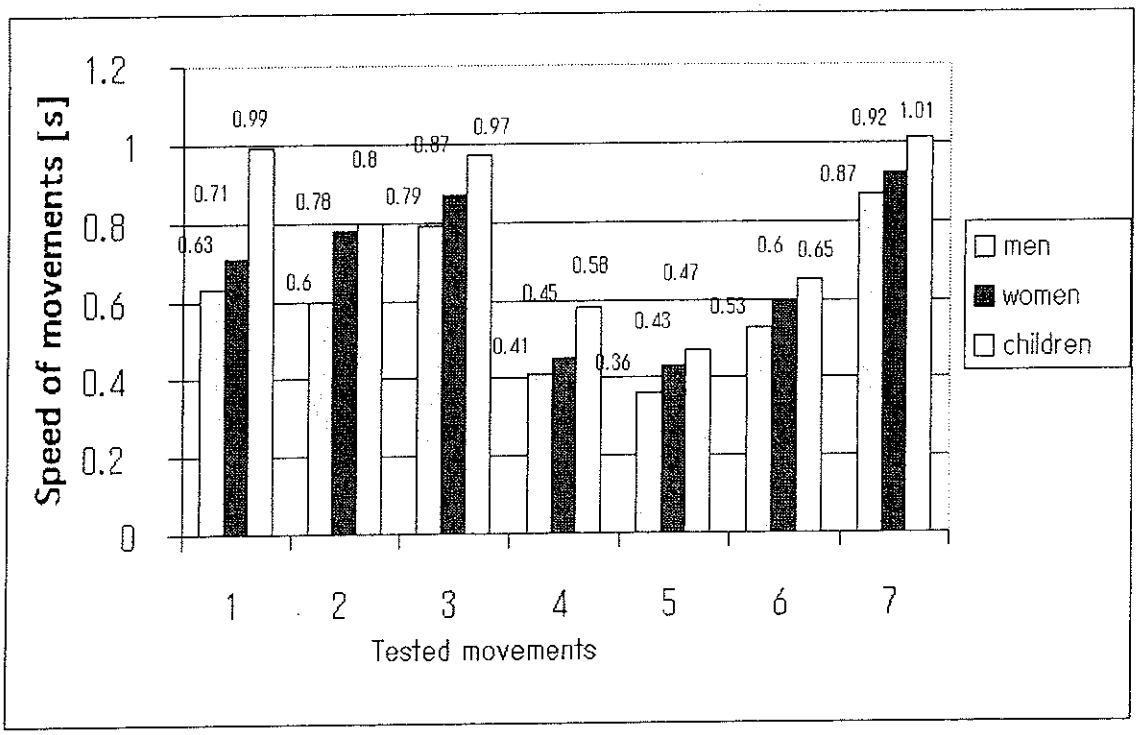

Figure 3. The profiles of speed for the tested movements and groups

3 Results and discussion

The obtained results of the research are shown in Table 1 and in form of profiles, which are graphic presentations of speeds measured for the movements and groups tested (Skorny, 1974).

Differences in the speed of the tested movements were found between the groups examined, decreasing in the order: members of Polish male national team (men) > high skilled female players (women) > children. These results are in disagreement with Keele's (1982) investigations, in which the movement time does not differentiate highly proficient and less skilled players.

The profiles of speed for the tested movements and groups was then investigated. These profiles are shown in Figure 3.

On the basis of these profiles, the tested movements can be re-ordered from the highest speed (the shortest time) to the lowest (the longest time) in the following way: for men — (5), (4), (6), (2), (1), (3) and (7); for women — (5), (4), (6), (1), (2), (3) and (7); for children — (5), (4), (6), (2), (3), (1), (7). The movements arranged in this way for the tested groups were then correlated, and the following correlation coefficients were obtained: 0.93 — men and women, 0.91 — men and children, 0.92 — women and children. These results indicate that the speed distribution of the tested movements depends not on age, sex or level of skills but on particular movements and on their range and direction. The relationship between the average speed of tested movements for all groups and range of these movements shows the Figure 4. and confirms the correlation coefficient between these factors, which was 0.75.

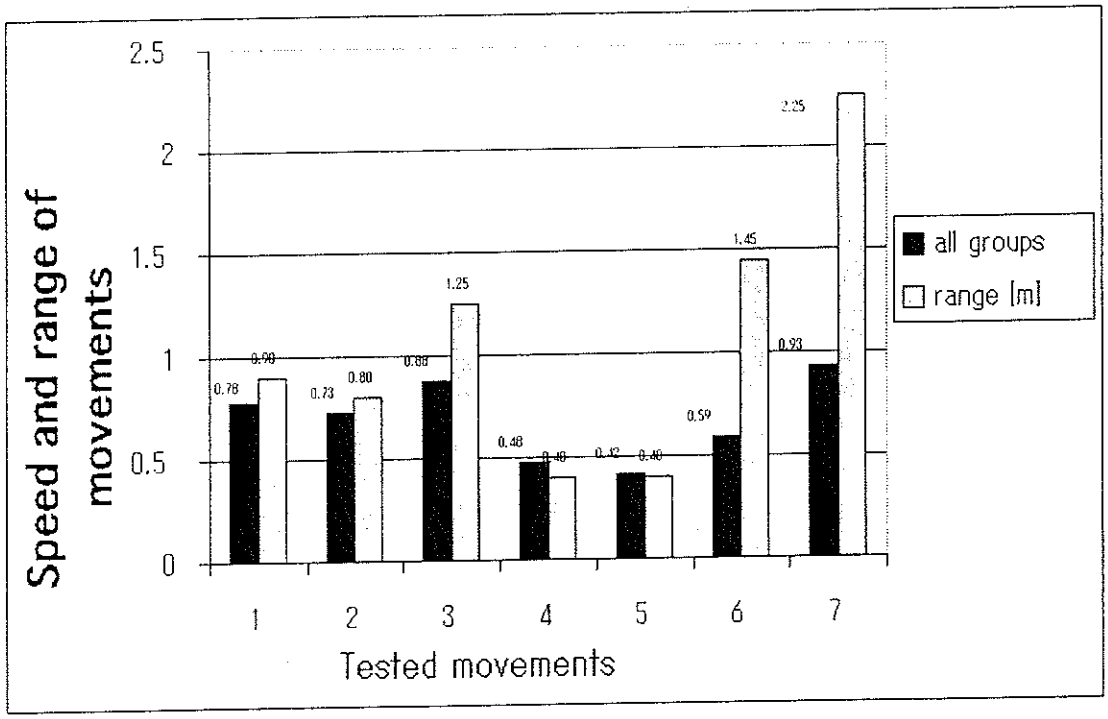

Figure 4. The profiles of range and speed (in seconds) for the tested movements and all groups

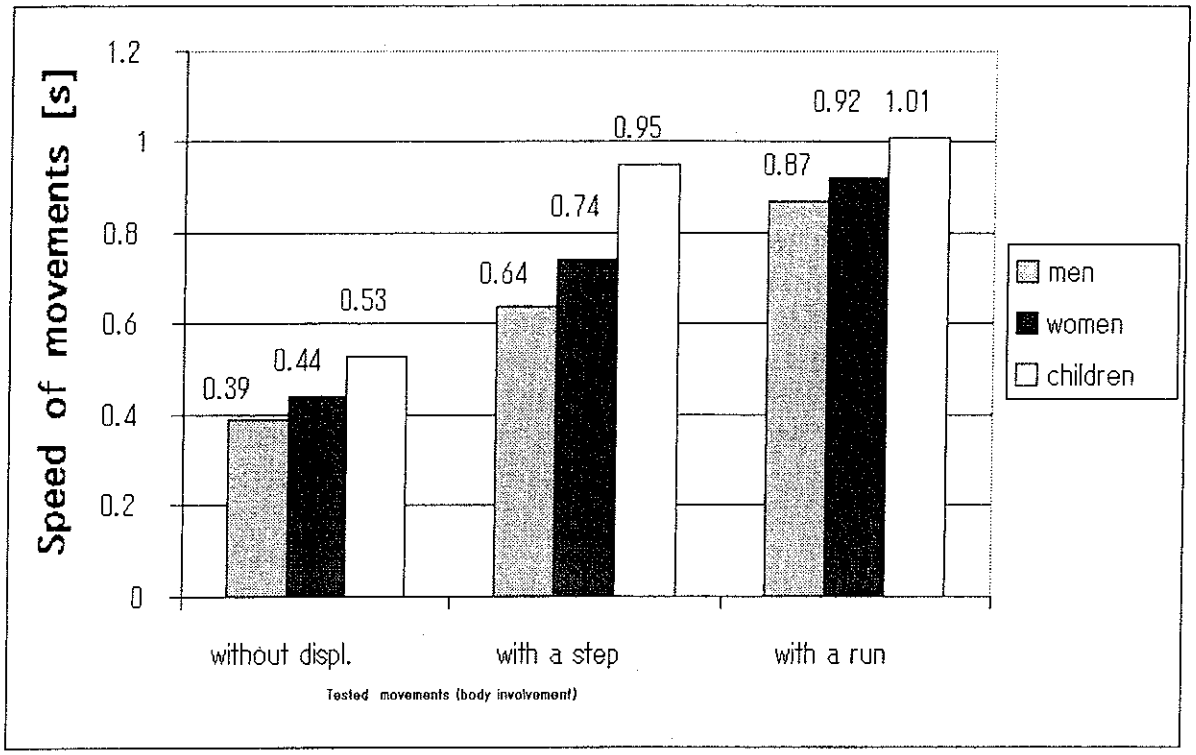

Figure 5. The profiles of tested speed for particular groups of subjects with respect to body involvement

The range and direction of the required movements determine the degree of body involvement and the groups of muscles activated. The fastest of the tested movements with respect to body involvement were those where no displacement of the feet was required (4 and 5). Those requiring a step forward and to the right and left (1, 2, 3 and 6) were slower, while the slowest were those with a jump or run backward and to the right (7). The profiles of tested speed for particular groups of subjects with respect to body involvement are presented in Figure 5.

In movements 4 and 5 there is no body displacement, only a twist of the trunk, after which the ball is struck with the arm. With respect to this particular kind of body involvement, these movements are placed in a separate category. The other category of movements constitutes striking the ball with a step, jump or run (movements 1, 2, 3, 6 and 7).

The range of standard deviation was also examined for the speed of each category of movements. The following ranges were obtained for (Table 1): movements without displacement of feet (4, 5) — men 0.07, women 0.05 and 0.09, children 0.13 and 0.12, movements with a step, jump and run (1, 2, 3, 6 and 7) — men 0.05-0.13, women 0.6-0.1, children 0.12-0.2.

The range of standard deviations indicates high individual differences in the speed of the latter category of movements in all groups, and for children also in the former category.

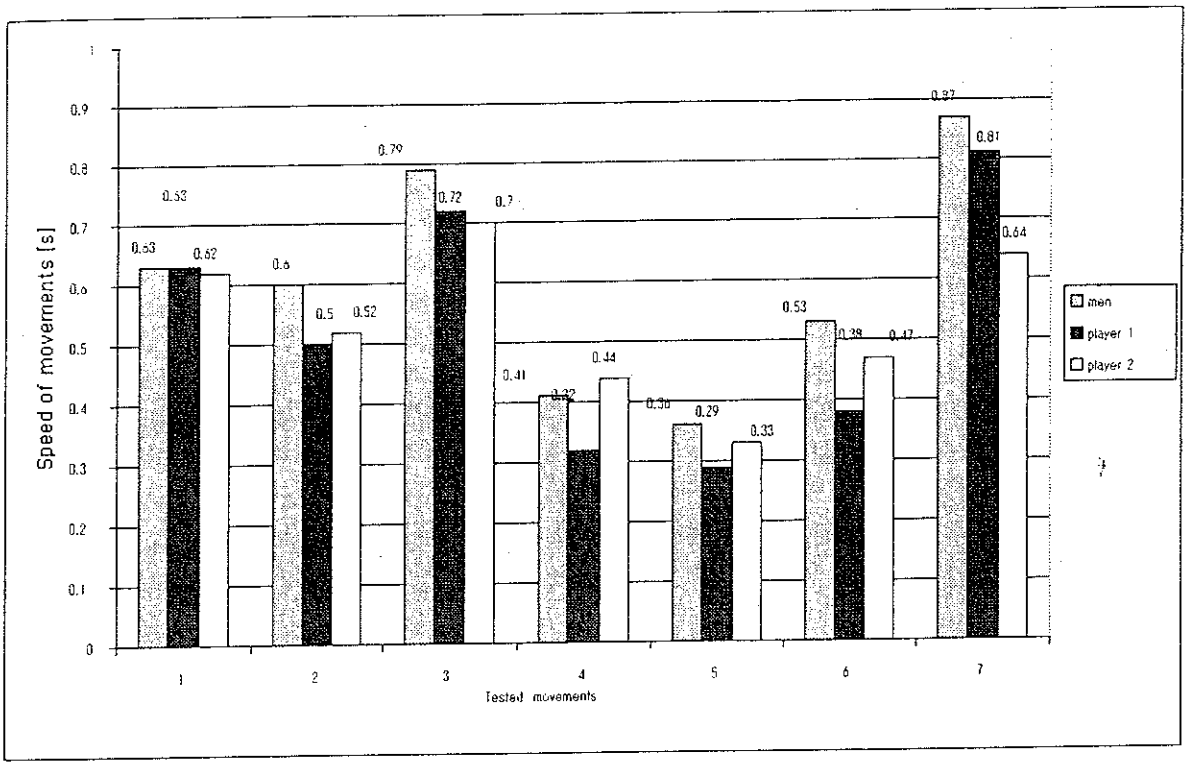

Figure 6. The profiles of speed of tested movements for a chosen group and players

The presented method of research enables recognition of the magnitude of differences in speed of particular movements between freely chosen players and a whole group. These differences can be analyzed on the basis of group and individual profiles of tested speed. The example of such profiles for members of Polish national men table tennis team is presented in Figure 6. The player 1 was one of the best players in the world few years before this research. The player 2 became one of the best players in the world shortly after this research. The speed of the most tested movements is higher for players 1 and 2 than for the whole group. The player 1 executes the movements 4, 5 and 6 much faster than the player 2. The player 2 is able to perform movements 3 and 7 with higher speed than the player 1.The speed of movement 2 is similar for both players and much higher than for the whole group. This result of the research shows that in table tennis the very high speed of performance of return is very important. The speed of movement 1 for both players is on the level of average speed for the whole group. The presented group and individual profiles of speed of examined movements can be used to direct the training process of both the whole group and particular players. For example player 2 should practice more the speed of movement 4 because it is lover than the average speed of this movement for the whole group.

The statistical differences in the speed of movements were next investigated to test the influence of direction and range on this speed. Student's t-test did not

show up any differences in the speeds of movements 1 and 2 (men), 1 and 2, 4 and 5 (women), 1 and 3, 1 and 7, also 3 and 7 (children).

The range of movements 4 and 5 was the same (0.4 m), but sensor 4 required a simulated backhand stroke, sensor 5 a forehand stroke. Statistical analysis indicates that right-handed men and children perform short strokes on the right side (forehand) faster than on the left (backhand). There is no difference in the speed of these movements among the women.

Movements 1, 2, 3, 6 and 7 have different ranges — 0.9, 0.8, 1.25, 1.45 and 2.25 m respectively (Figure 2). To test the influence of the range of these movements on their speed in tested groups, these two factors were correlated. The following coefficients were obtained: 0.83 - men, 0.76 - women, 0.64 - children. This research shows that the range has an evident impact on the speed of movements of highly skilled male and female competitors, whereas with children the impact is irregular. The lack of any statistical difference in the speed of movements 1 and 2 among the men and women was due to the small difference in the range of these movements, which was barely 0.1 m.

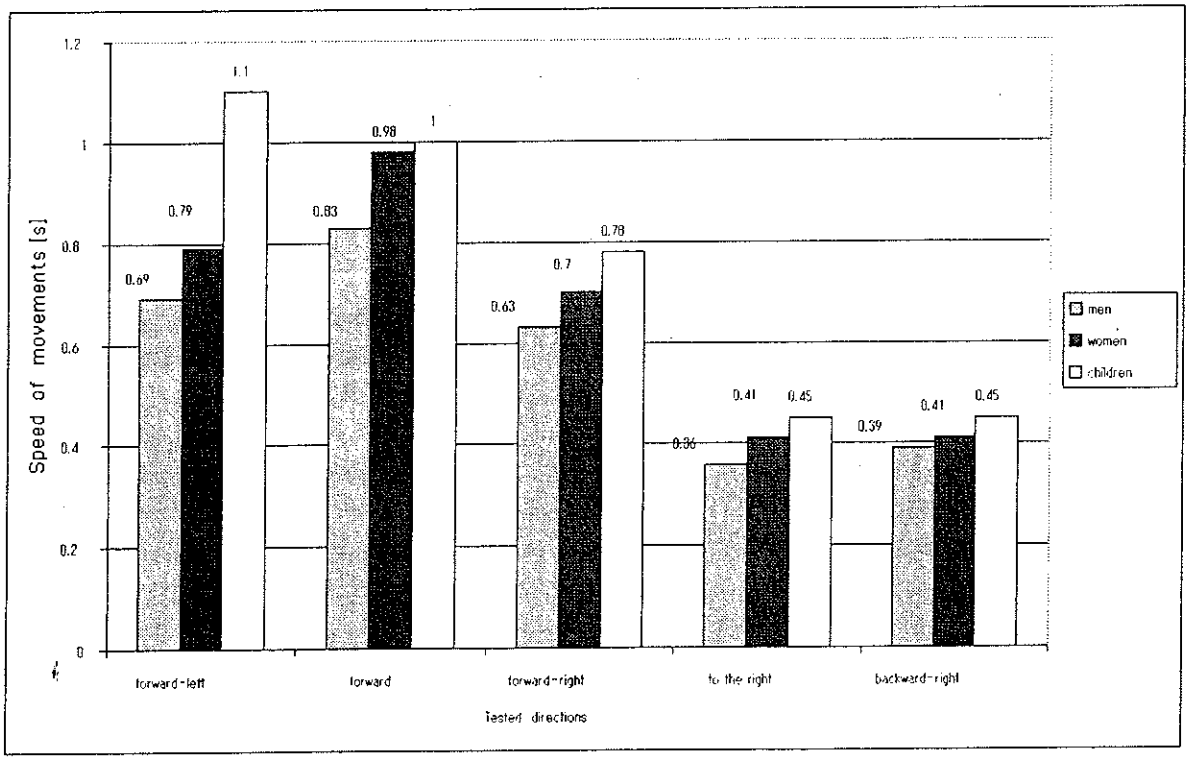

Figure 7. The profiles of tested speed for particular groups with respect to different directions

To examine the impact of direction on the speed of movements with a step, jump and run, the speed of movements 1, 2, 3, 6, 7 was calculated for a range of 1 m with the following results: men 0.69, 0.83, 0.63, 0.36, 0.39, women 0.79, 0.98, 0.70, 0.41, 0.41, children 1.1, 1.0, 0.78, 0.45, 0.45. These results indicate that

with respect to direction the fastest movements are those to the right (6) and backward and to the right (7); the movements forward and to the right and left (1, 2, 3) are slower. It was found that in men and women the slowest movement was forwards and towards the middle of the table-tennis table (2), in children forwards and to the left (1). The profiles of tested speed for particular groups with respect to different directions are presented in Figure 7.

These findings are in disagreement with Geblewiczowa's (1973) research, which indicated that forward movements are faster than those to one side, and that sideways movements to the left are faster than those to the right. The connection of the speed of the tested movements with the sporting results of top Polish table-tennis players was also investigated. A high correlation was found for the mean speed of all the movements examined (0.84) and for movements 2 (0.82) and 3 (0.76). These results show that the speed of movements in table tennis is a very important factor in effective play. Particularly important is the speed of movements forward and to the right (2, 3), which are responsible for receiving the service.

4 Conclusions

A simulator of table tennis play was used as the specific simulator in this research. It is proposed to use other specific simulators in the same way, as shown above, for investigating the speed of movements in other ball games or in combative sports. The specific simulator used should be adapted to the chosen game or sport.

The paper discusses a study of the speed of 7 selected, typical strokes of the ball in table tennis with respect to range and direction of movement.

The results of this research lead to some practical conclusions:

- highly skilled adult male and female players are able to perform specific movements in table tennis faster than children, and men are faster than women;
- the range of movements has a stronger influence on speed in elite male and female players than in children;
- short ball striking movements, performed primarily with the arm, are executed faster by men and children from the right side; in women, the speed of these movements is the same for both sides;
- there are high individual differences in the speed of movements requiring the displacement of body in all groups and also for children in the speed of movements without the displacement of body,
- the group and individual profiles of speed of tested movements can be used to recognise the differences in this speed between particular groups and players and to direct the training process,
- in the case of ball strokes performed with body displacement (step, jump, run) with respect to direction, the fastest are those to the right, and backwards and to the right; movements forwards and to the right and left are slower;
- in the group of top Polish players the speed of movements highly

correlate with sporting results;
- the simulator of table tennis play seems to be a useful diagnostic device for investigating the speed of specific for table tennis movements.

5 References

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