Original Article

Comparison of Kinematic Parameters between Professional and Non Professional Swimmers

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Objective: To compare kinematic parameters between professional and non professional swimmers.

Methodology: We took sample of 5 postgraduate students who were physically healthy and active but they were not professional swimmers. Warm up was performed for 10 minutes. Head was reference point to take readings. Data obtained from 2011 Szczecin European Short course Championships men's finals of 50, 400 and 1500m freestyle was used. We carried out Pearson's Correlation between height, SL and SF to determine the effect of height on speed of swimming.

Result: There were large differences between the groups, especially in the fast speed category, where all of the selected variables (stroke frequency, length and speed) were higher for the professional swimmers. Professionals with similar stroke frequencies to IMPAS in the remaining two speed categories produced much higher speed and stroke length values and attained more velocity and distance from same number of strokes.

Conclusion: There were different aspects that have to be taken into account in order to analyze the swimming competition. The stroke length is the most determinant factor and it would be related to the success. Stroke frequency, is not a significant factor that could explain the performance in swimming competition. However, it is has importance also for coaches and swimmers. (Rawal Med J 2014;39:145-149).

Key worlds: Swimming, kinematic parameters, professional and non professional swimmers.

INTRODUCTION

There has been significant increase on the scientific literature about competitive swimming in 1971-2006 period.[1]The main focus is to enhance performance and to identify variables that determine the performance.[2]Biomechanical variables determining the competitive swimmer's performance are kinematics variables (e.g., stroke length, stroke frequency, speed fluctuation, limbs' kinematics), kinetics variables (e.g., propulsive drag, lift force, drag force) and neuromuscular variables.[3]

Velocity (v) is the best variable to assess swimming performance. For a given distance, Front Crawl is considered the fastest swim stroke, followed by Butterfly, Backstroke and Breaststroke.[3] Swimming velocity can be described by its independent variables: stroke length (SL) and stroke frequency (SF).SL is defined as horizontal distance that the body travels during a full stroke cycle.SF is defined as the number of full stroke cycles performed within a unit of time (strokes.min-1) or Hertz (Hz). Increases or decreases in v are determined by combined increases or decreases in SF and SL, respectively.[4]

In crawl, increasing velocity was also associated with increasing in SF, but the SL decreased more than in the other swim strokes.[5] Throughout an event, the decrease of v is mainly related to the decrease of SL in all swim strokes.[2] There is a "zig-zag" pattern for SF during inter-lap. The maximum SF on regular basis happens at the final lap.[6] Comparing the swim strokes by distance, there is a trend for SF and v decrease and a slightly maintenance of SL with increasing distances.[4] Swimmer must have a high SL and therefore, v

should be manipulated changing the SF.[4] Stroke mechanics variables, including the SF and the SL are dependent from the limb's kinematics. There is a significant relationship between the hip velocity and the horizontal and vertical motion of the upper limbs.[7]

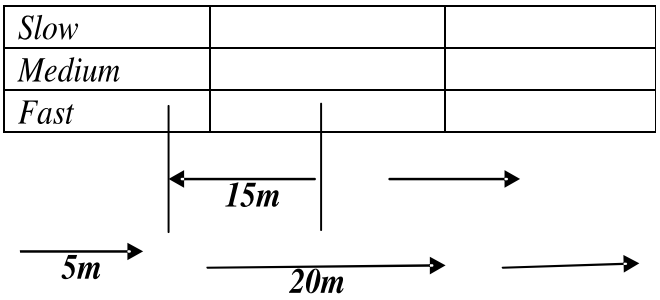
Kinetics analysis in swimming has addresses two main topics of interest: the propulsive force generated by the propelling segments and the drag forces resisting forward motion, since the interaction between both forces will influence the swimmer's speed.[8,9] Attempts are being made to understand the links between all these variables and how it is possible to enhance performance. A great effort is being made by researchers and coaches to assess, to compare and to manipulate these variables from times to times to define goals, establish milestones in the periodization program or even predict the swimmers performance. This study compared the differences between amateur swimmers and professional ones in their stroke length and stroke frequency so to understand in what attempt we can improve the swimming skills for amateurs.[10]

METHODOLOGY

Participants: We took sample of 5 postgraduate students who participated in this study. We used purposive convenient sampling technique. They performed swimming test at different speed levels. All subjects were physically healthy and active but they were not professional swimmers. The subjects had mean age of 27.6 ± 8.08 year and mean height of 177.6± 8.56 cm.

Procedure: All subjects were explained about whole procedure and warm up was performed for 10minutes before test at three different speeds i.e. slow, medium and fast speed. Total length for swimming was 25meters and two points of references were placed at 5 and 20 meters (Figure 1). Time was noted at 5, 20 and 25 meters in order to control the partial time and total time for start, swimming and finish distance. Head was reference point to take readings, as the differences exist between subjects in terms of arm lengths.[15,16] We measured total speed which is S_{25m} and speed at 15meters i.e. S_{15m} and used following formulas: $S_{25m} = e/t$: where S is speed measured in meter/second (m/s), e is distance in meters (m) and t is time in seconds (s). Same formula was used for 15meters as follow: $S_{15m} = e/t$.

Fig. 1. Length of pool and different Speeds of swimming.



Statistical Analysis: Data obtained from 2011 Szczecin European Short course Championships men's finals of 50, 400 and 1500m freestyle was used. The reason why these three distances were selected was because the stroke frequency shown by professional swimmers were very similar than the stroke frequency showed by the subjects in each speed trial. Due to the lack of data for middle race stroke frequency in 50m, the mean of start and finish stroke frequency was calculated in order to be compared to the stroke frequency registered by our subjects. For 400 and 1500m middle race stroke frequency was taken. We carried out Pearson's Correlation between height, SL and SF to determine the effect of height on speed of swimming.

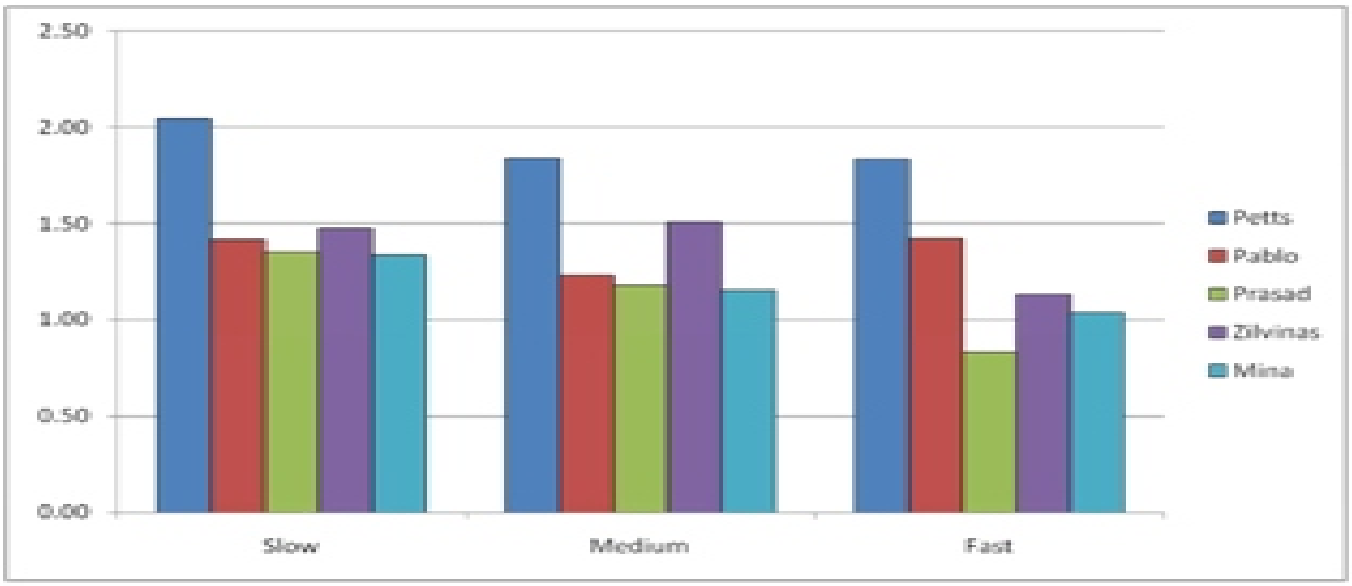
RESULTS

Speed, stroke frequency and length results are shown in Table 1. The results are broken down on participant basis and categorized into the three speed conditions (slow, medium and fast) of the task. The participant number 5 is the only female in the trial; however, due to small sample size no distinctions of the genders are considered. First two participants had faster speeds in the fast trial. A possible correlation (0.852) might exist between height and stroke length (visualization of individual values (Fig. 1) in fast trial; although p value was 0.067.

Table 1. Measured and calculated variables of IMPAS swim tests.

		Daniel Petts		height:186			
	time5m	**time20m**	**time25m**	**3str time**	**spd15m**	**strfreq**	**str length**
slow	2.46	16.47	24.94	5.72	1.07	0.52	2.04
medium	2.90	16.54	21.03	5.01	1.10	0.60	1.84
fast	2.30	13.36	16.91	4.05	1.36	0.74	1.83
		Pablo Rodriguez				height:	187
	time5m	**time20m**	**time25m**	**3str time**	**spd15m**	**strfreq**	**str length**
slow	2.60	20.60	23.30	5.10	0.83	0.59	1.42
medium	2.70	20.90	21.20	4.48	0.82	0.67	1.23
fast	2.50	15.60	16.00	3.73	1.15	0.80	1.42
		Prasad Hetiriachi				height:	169
	time5m	**time20m**	**time25m**	**3str time**	**spd15m**	**strfreq**	**str length**
slow	3.00	21.76	30.94	5.08	0.80	0.59	1.35
medium	2.85	19.16	25.56	3.85	0.92	0.78	1.18
fast	2.75	20.92	25.45	3.03	0.83	0.99	0.83
		ZilvinasDomaitis				height:	170
	time5m	**time20m**	**time25m**	**3str time**	**spd15m**	**strfreq**	**str length**
slow	2.66	17.37	21.37	4.33	1.02	0.69	1.47
medium	3.19	17.03	22.59	4.16	1.08	0.72	1.50
fast	2.89	20.64	25.71	4.01	0.85	0.75	1.13
		Mina				height:	176
	time5m	**time20m**	**time25m**	**3str time**	**spd15m**	**strfreq**	**str length**
slow	5.36	33.62	36.64	7.55	0.53	0.40	1.34
medium	3.75	26.95	30.80	5.35	0.65	0.56	1.15
fast	5.25	32.70	35.48	5.68	0.55	0.53	1.03

Fig. 1. Stroke length comparison of participants under 3 speed conditions.

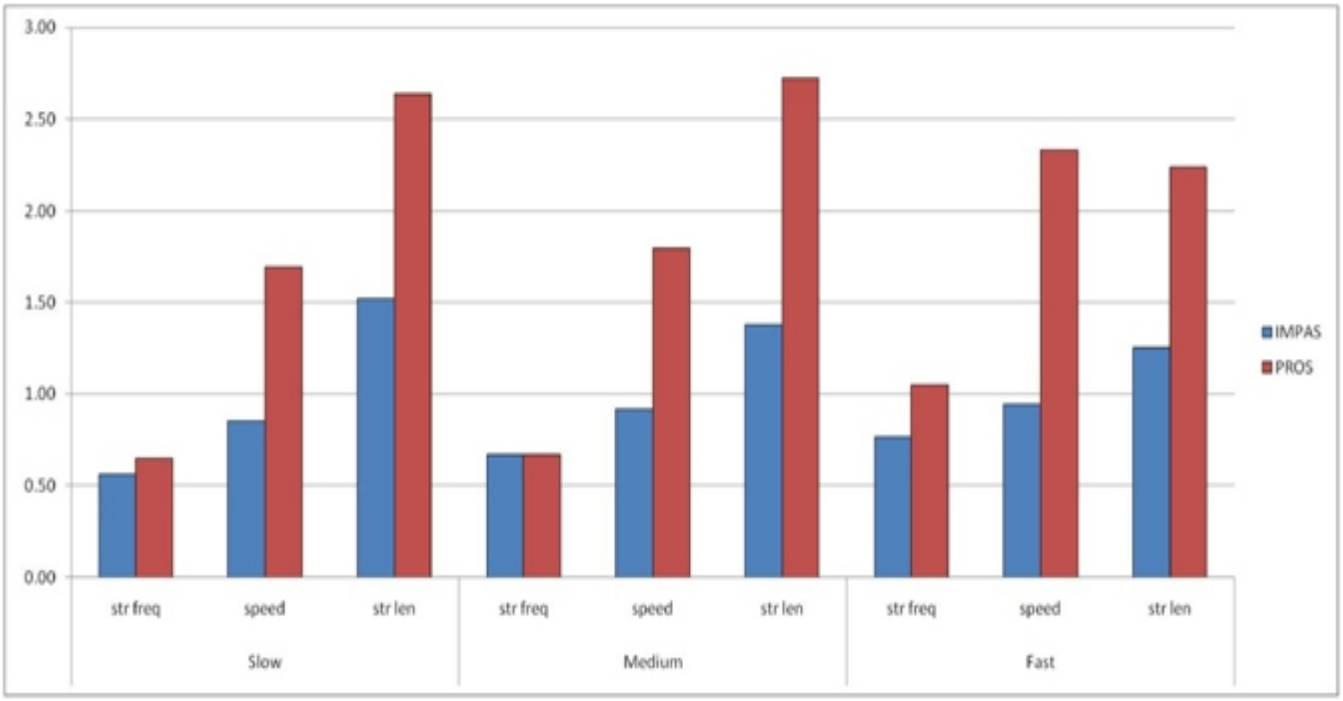


Data were compared to professional swimmers in European swimming championships. The rundown (minimum, maximum, average and standard deviation values) of calculated results are presented in Table 2, categorized by the three speeds. The average values are represented in the Fig. 2.

Table 2.Comparison of results between IMPAS participants and professional swimmers.

			Slow			Medium			Fast	
		Strfreq	Speed	strlen	Strfreq	speed	strlen	Strfreq	Speed	strlen
IMPAS	average	0.56	0.85	1.52	0.67	0.91	1.38	0.76	0.94	1.25
PROS	average	0.65	1.70	2.64	0.67	1.80	2.72	1.05	2.33	2.24
IMPAS	min	0.40	0.53	1.34	0.56	0.65	1.15	0.53	0.55	0.83
PROS	min	0.57	1.67	2.28	0.58	1.77	2.32	0.93	2.27	1.90
IMPAS	max	0.69	1.07	2.04	0.78	1.10	1.84	0.99	1.36	1.83
PROS	max	0.75	1.72	2.98	0.77	1.83	3.10	1.22	2.39	2.52
IMPAS	stddev	0.11	0.21	0.29	0.09	0.19	0.29	0.17	0.31	0.39
PROS	stddev	0.06	0.02	0.24	0.06	0.02	0.26	0.10	0.04	0.21

Fig. 2. Comparison of selected variables between IMPAS and professional swimmers under 3 speed conditions.



DISCUSSION

Not unexpectedly, there are large differences between the groups, especially in the fast speed category, where all of the selected variables (stroke frequency, length and speed) are clearly higher for the professional swimmers. Additionally, professionals having similar stroke frequencies to IMPAS in the remaining two speed categories, albeit producing much higher speed and stroke length values would suggest that professionals (again, not unexpectedly) are more efficient at swimming by attaining more velocity and distance from the same

number (or more precisely, frequency) of strokes.

It is accepted by the scientific community that a swimming race is divided in 3-4 parts depending on the length of the modality, starting, swimming, turning and finish part.[11,12] As it has been carried out in other studies where the competition has been analyzed, during the swimming phase the stroke frequency and stroke length were measured.

In our study, the most interesting finding was the relationship between the height, the stroke length and the final speed and time. We found that the highest subjects in this group were the subjects that achieved the largest stroke length. It has been demonstrated that the most successful swimmers were those whose stroke length and higher were higher.[13] Related to this, we have shown, as it has been reported in other studies, that women have worse registers in short races due to these factors.[2]

We also found that there were no great differences between the subjects that participated in our study and the professional swimmers at fast speed. It again demonstrated that the most important variable that determines the swimmer performance is the stroke length. Limitations of study are, that due to limited resources and time, sample size was not large. We had calculated different technical kinematic parameter that's why we limited on small sample size. We recommend further studies on larger sample size.

CONCLUSION

We conclude that there are different aspects that have to be taken into account in order to analyze the swimming competition. The stroke length is the most important determinant factor related to the success. Gender is another important factor. The stroke frequency is not a significant factor that could explain the performance in swimming competition.

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