COMPARATIVE STUDY AMONG THE LEVELS OF FORCE, POWER, SWIMM SPEED AND ANTROPOMETRIC CHARACTERISTICS IN YOUNG SWIMMERS

Llana, S. Tella, V. Benavent, J. Brizuela, G.
Facultad de Ciencias de la Actividad Física y el Deporte. Universitat de Valencia (Spain)

The intention of the present study was, on the one hand, to develop a method of measurement force and power during tied swimming. Secondly, to identify which variables of force and power during tied swimming, force measured in laboratory, swimming speed and antropometric characteristics are correlated with the performance, in young swimmers. The results shows that with very homogeneous groups only the kinetic variables are good indicators-predictos of performance, since antropometric variables do not allow to discriminate between good and bad swimmers

KEY WORDS: force, power, tied swimming, anthropometry.

INTRODUCTION: The swimming speed depends on the interaction of propulsive and resistive forces (Takagi and Sanders, 2000). The swimmers can increase the above mentioned speed increasing the propulsive forces or reducing the resistive forces that act on the body at a given speed. The direct measurement of propulsive forces without modifying the swimming technique needs a complex set of instruments (Takagi and Wilson, 1999). The record of the pulling power during the tied swimming has demonstrated to have very high levels of correlation with performance (Llana, Tella, Benavent, & Brizuela, 2002) beside being a cheaper set of instruments and of easy managing.

METHOD: In the study, took part a group of 69 federated swimmers of different categories, both sexes and divided in two groups according to their performance level (High = finalists in the Autonomic Championship. Down = without autonomic minim). The table 1 shows the distribution of the swimmers.

Gender	Categories	Performance level
Female (38)	Benjamines(9)	High = 3; Down = 6
	Alevines (12)	High = 6; Down = 6
	Infantiles (7)	High = 4; Down = 3
	Juniors (10)	High = 5; Down = 5
Male (31)	Benjamines (8)	High = 5; Down = 3
	Alevines (12)	High = 7; Down = 5
	Infantiles (11)	High = 5; Down = 6

The measurements consisted in:
1) Records of force in tied swimming:
The records were realized with an extensometric load cell. The subjects were taking placed a belt to which they were fixed by means of a surgical rubber of two different levels of elasticity and a rigid cable.
Every swimmer was fulfilling one test at maximum intensity during 30 seconds, in each of three mentioned conditions. The force data was registered at 100 hz.
In case of the records with cable, the signs were standarized to calculate the average force applied during the thirty seconds, the maximum values of force for every subject, as well as the instant of time in which the maximum force was applied.
In case of the rubbers the process was the following:
· Records of propulsion forces.

· Calculation of the variation of position in the time, by means of the previous calibration of the rubbers, to obtain the force-deformation constant of both types of rubber (major and minor resistance).
· Calculation of the speed of displacement of the swimmer, depending on the variation of position in the time.
· Calculation of the instantaneous power delivered by the swimmer.
2) Records of isometric force in laboratory: Test of general force (GF) and test of specific force (SF).
3) Swimming tests: swimming speed test in an interval of 15 m and best personal mark in 100 m freestyle.
4) Anthropometric characteristics.

With the primary information a computer file was created in the application SPSS (v.8), in that the following statistical treatments were realized:
· A correlacional study for all the cinematic, kinetic and antropometric variables. Using Pearson´s correlation with a level of significancia of $p < 0.05$..
· ANOVA's of one factor with Post hoc Scheff's test and with a level of significancia of $p < 0,05$.

RESULTS AND DISCUSSION: The following tables show the statistically significant correlations between the force variablesmesaured in laboratory and those of force and power measured in the pool, with the time of swimmin in 15 m (table 2), and with the best personal mark (table 3).

Test 15 m		
	r	p
FIG	-0.688	< 0.001
FIE	-0.757	<0.001
Fmax rubbers I	-0.905	<0.001
Fmax rubbers II	-0.902	<0.001
Pmax rubbers I	-0.806	<0.001
Pmax rubbers II	-0.910	<0.001

Table 2.

Better mark in 100 m		
	r	p
FIG	-0.623	< 0.001
FIE	-0.745	<0.001
Fmax rubbers I	-0.879	<0.001
Fmax rubbers II	-0.869	<0.001
Pmax rubbers I	-0.767	<0.001
Pmax rubbers II	-0.860	<0.001

Table 3.

These results indicate that the use of surgical rubbers allows to calculate few unattainable variables with the method of the rigid cable (as the specific power). On the other hand, the set of analyzed variables answers to a boss repetitive for swimmers of both sexes and ages, which allows a standard study (parametrization) of the temporary functions. Finally, the high levels of correlation indicate that it is a good method to evaluate the specific force and power in swimming (Llana, Tella, Benavent, & Brizuela, 2002).

The tables 4 and 5 show the principal results obtained in the ANOVA's for both genders.

Results by categories:
- Female alevin: significant differences ($p < 0.01$ and p.0.05) were find for all the cinematic variables between the best swimmers and the rest.. As for the kinetic variables the Fmax with rubbers tipe I, finds significant differences ($p < 0.01$ and p.0.05) between the best and the rest.
- Male alevin: significant differences ($p < 0.01$ and p.0.05) were find for all the cinematic variables between the best swimmers and the rest. In the kinetic variables the Fmax and Pmax with rubbers tipe I, and Fmax with rubbers tipe II, finds significant differences ($p < 0.01$ and p.0.05) among the best swimmers and the rest. The Height is the only antropometric variable that differentiates significantly between the best and the rest ($p < 0.01$).

- Female benjamin: significant differences ($p < 0.01$ and $p.0.05$) were find for all the cinematic variables among the best swimmers and the rest. In the kinetic variables, Pmax with rubbers tipe I, and Pmax and Fmax with rubbers tipe II shows significant differences ($p < 0.01$ and $p.0.05$) between the best and the rest.

Table 4. Average values of the cinematic, kinetic and antropometric variables for categories in female (only the statistically significant results, $p < 0.05$).

	Alevín [1]			Benjamín [2]			Infantil [3]			Junior [4]		
	N	Media	Desv. típ.	N	Media	Desv. típ.	N	Media	Desv. típ.	N	Media	Desv. típ.
M15	12	9.82	.29	9	11.06[1,3,4]	.58	7	9.54	.44	10	9.28	.43
M100	12	73.02[4]	3.45	9	89.09[1,3,4]	6.79	7	68.38	3.06	10	66.57	3.34
GF	12	70.17	14.33	9	48.22[1,4]	11.50	7	62.57	13.50	10	68.60	11.22
SF	12	24.33	7.44[4]	9	16.67[3,4]	6.08	7	34.14	8.47	10	36.30	8.55
Fmax rubbers I	12	6.09[4]	.60	9	4.06[1,3,4]	.45	7	6.97	1.18	10	7.95	.98
Pmax rubbers I	12	1.48[4]	.25	9	.85[1,3,4]	.14	7	1.76	.45	10	2.30	.82
Fmax rubbers II	12	8.00[4]	.76	9	5.31[1,3,4]	.66	7	9.00	1.59	10	10.00	1.17
Pmax rubbers II	12	12.06	2.20	9	5.65[1,3,4]	2.09	7	12.07	2.78	10	14.58	3.01
LM	12	16.78[4]	.65	9	15.42[1,3,4]	.78	7	17.67	.97	10	18.05	1.08
AM	12	9.40	.41	9	8.70[1,3,4]	.51	7	9.65	.46	10	9.92	.49
LP	12	22.53	.95	9	21.60[3,4]	1.09	7	23.47	1.19	10	23.74	1.32
AP	12	8.87	.44	9	8.42[4]	.37	7	8.92	.43	10	9.17	.59
W	12	47.75[4]	6.39	9	35.88[1,3,4]	5.67	7	50.78	6.86	10	59.75	7.07
AS	12	158.30 [4]	5.51	9	143.53[1,3,4]	8.31	7	165.38	6.57	10	171.57	7.07

Table 5. Average values of the cinematic, kinetic and antropometric variables for categories in male (only the statistically significant results, $p < 0.05$).

	Alevín [1]			Benjamín [2]			Infantil [3]		
	N	Media	Desv. típ.	N	Media	Desv. típ.	N	Media	Desv. típ.
M15	12	8.53	.30	8	9.29[1,3]	.41	11	8.47	.33
M100	12	63.32	2.69	8	72.22[1,3]	3.84	11	60.66	2.78
GF	12	103.92	24.10	8	70.63[1]	15.00	11	87.91	21.03
SF	12	39.00	8.57	8	27.38[1,3]	6.63	11	41.36	9.15
Fmax rubbers I	12	9.51	1.11	8	6.86[1,3]	1.07	11	10.43	1.08
Pmax rubbers I	12	3.68	1.37	8	1.81[1,3]	.60	11	4.92	1.24
Fmax rubbers II	12	12.25	1.83	8	8.88[1,3]	1.50	11	13.26	1.24
Pmax rubbers II	12	20.93	3.81	8	13.50[1,3]	3.88	11	21.75	2.87
LM	12	19.05	.75	8	17.20[1,3]	.81	11	18.91	.72
AM	12	11.13	.67	8	9.97[1,3]	.70	11	11.08	.48
LP	12	25.65	1.01	8	24.10[1,3]	1.36	11	25.50	1.07
P	12	60.87	8.79	8	47.18[1,3]	6.34	11	65.18	7.06
T	12	170.40	4.75	8	158.21[1,3]	6.51	11	173.75	6.26

- Male benjamin: significant differences ($p < 0.01$ and $p.0.05$) were find for all the cinematic variables among the best swimmers and the rest. In the kinetic variables the Fmax

with rubbers tipe show significant differences ($p < 0.01$ and p.0.05) between the best and the rest.

- Female infantile: significant differences ($p < 0.01$ and p.0.05) were find for all the cinematic variables among the best swimmers and the rest. In the kinetic variables the Fmax with rubbers tipe I shows significant differences ($p < 0.01$ and p.0.05) between the best and the rest. The LM, AM, LP, T and AS were the antropometric variables that differ statistically between the best and the rest ($p < 0.01$ and p.0.05).
- Male infantile: significant differences ($p < 0.01$ and p.0.05) were find in all the cinematic variables between the best swimmers and the rest. In the kinetic variables the Fmax with rubbers tipe I and the Pmax with rubbers tipe I show significant differences ($p < 0.01$ and p.0.05) between the best and the rest.
- Female junior: significant differences ($p < 0.01$ and p.0.05) were find in all the cinematic variables between the best swimmers and the rest. In the kinetic variables the Fmax and Pmax with rubbers tipe I, and Fmax and Pmax with rubbers tipe II, show significant differences ($p < 0.01$ and p.0.05) between the best and the rest.

Results by genre and categories:

- Female (table 4). Significant differences ($p < 0.01$ and $p < 0.05$) were find between the benjamin category and ther other categories in all the cinematic and kinetic variables. In the antropometric variables there were significant differences ($p < 0.01$ and $p < 0.05$) between benjamin and the rest of categories in the variables LM, AM, LP, AP, P and AS. Also significant differences between the category are alevin and junior categories in the cinematic variables; the Fmax and Pmax with rubbers tipe I and Fmax with rubbers tipe II of the kinetic variables and the LM, P and AS of the antropometric variables.
- Male (table 5). Significant differences ($p < 0.01$ and $p < 0.05$) were find between the benjamin category and the rest of categories in all the cinematic and kinetic variables. In the antropometric variables there were significant differences ($p < 0.01$ and $p < 0.05$) between benjamin and the rest of categories in the variables LM, AM, AP, LP, P and T.

CONCLUSIONS: With homogeneous groups the antropometric and kinetic characteristics are good indicators-predictores of the performance of the swimmers. With very homogeneous groups only the kinetic variables are good indicators-predictos of performance, since antropometric variables do not allow to discriminate between good and bad swimmers.

REFERENCES:

Llana, S. Tella, V. Benavent, J. and Brizuela, G (2002) Correlation between the force and power in tied swimming and the performance in young swimmers. IX Symposium Mondial " Biomécanique et Médicine de la Natation ", Saint Etienne. Accepted.

Takagi, H. and Sanders, R. (2000) Hydrodynamics makes to splash. Physics Word, n º 9, 39-43.

Takagi, H. and Wison (1999) Calculating hidrodinamic force by using preassure differences in swimming. Biomechanics and Medicine in Swimming VIII 101-106. Gummerus Printing, Jyvaskyla.