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## ORIGINAL

### DOES SWIMMING STYLES SPECIALIZATION INFLUENCE THE HAMSTRING MUSCLE EXTENSIBILITY?

### ¿INFLUYE LA ESPECIALIZACIÓN EN LOS ESTILOS DE NATACIÓN SOBRE LA EXTENSIBILIDAD ISQUIOSURAL?

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#### ABSTRACT

The aim of this research is to verify the swimming style in which swimmers are specialized, have has influences hamstring extensibility athletes who have had participated in this research. The employed test for this work was the "sits and reach" test.

It was measured hamstring extensibility of all swimmers (N = 36) of both sexes, who train in Spanish aquatic center modernization. The age of the study participants is between 13 and 17 years. This population of swimmers has been divided into four different groups, depending on the style of swimming in which they are specialized (crawl, backstroke, breaststroke and butterfly). To determine the influence of swimming style on the results obtained in the test "sit

and reach", it having had applied an initial test before, and a final test nine months later, which have had permitted also know the measurements evolution.

In conclusion, the hamstring muscle extensibility and its evolution have had being not conditioned by swimming style of the swimmers.

**KEYWORDS:** Swimming, sit and reach, hamstring extensibility, flexibility, backache, swimming strokes, butterfly, breaststroke, backstroke, front crawl.

## **RESUMEN**

El objetivo de este estudio es comprobar si el estilo de natación en el que están especializados los nadadores, influye sobre la extensibilidad isquiosural de los deportistas que han participado en esta investigación. El test empleado para este trabajo es el test "sit and reach".

Se ha medido la extensibilidad isquiosural de todos los nadadores (N=36) de ambos sexos, que entrenan en un centro de tecnificación acuático español. La edad de los participantes del estudio oscila entre los 13 y los 17 años. Esta población de nadadores ha sido dividida en cuatro grupos diferentes, dependiendo del estilo de natación en el que están especializados (crol, espalda, braza y mariposa). Para conocer la influencia del estilo natación sobre los resultados obtenidos en el test "sit and reach", se ha aplicado un test inicial y nueve meses más tarde un test final, lo que ha permitido conocer también la evolución de las mediciones.

Como conclusión, la extensibilidad isquiosural y su evolución, no está condicionada por el estilo de natación en el que están especializados los nadadores que han participado en este estudio.

**PALABRAS CLAVE:** Natación, sit and reach, extensibilidad isquiosural, flexibilidad, dolor de espalda, estilos de natación, mariposa, braza, espalda, crol.

## **INTRODUCTION**

Essentially, swimming is an Olympic sport, which involves swimming a certain distance as quickly as possible. According to the International Swimming Federation, there are currently four swimming techniques or styles which are recognized officially in order to cover the set distances (front crawl, butterfly, backstroke and breaststroke).

Although there are clear technical differences between the four styles, we can say that the practice of any of them involves the mobilization of a considerable part of the muscles and joints of the body. This statement could be partly responsible for swimming being considered a very appropriate activity to recover, maintain or improve physical fitness and health. In addition, it should be added that the environment in which this activity takes place significantly

decreases body weight of the subject and therefore the impact received in the bones and joints to perform the movements in the water is reduced.

Another feature of this sport is its cyclical nature, ie, the swimmer should perform the same sequence of movements during the time he swims in the same style, except at the start and turns. For this reason, many classic authors of aquatic competition consider that the development of flexibility is of high interest for improved performance (Costill, Maglischo, & Richardson, 1992; Counsilman, 1980; Maglischo, 2002; Navarro Arellano, Carnero, Gosálvez & 1990; & Fessenko Platonov, 1994). Thus, in the field of competition, the swimmers flexibility has traditionally been developed, in order to reduce internal joint resistance and improve the economy of swimming (Cancela, Pariente, walk, & Lawrence, 2008; Juba, 2003; Lewin, 1983; Maglischo, 2002; Morales, 2007; Wilke & Madsen, 1990).

In this sense, most of the authors specialized in competitive swimming, consider that the development of flexibility should focus on shoulders and ankles, because the improved range of specific movement of these joints will cause a more efficient swim and therefore, a decrease in the number of stroke cycles and kicks the swimmer needs to cover a certain distance (Cancela et al, 2008;.. Costill et al, 1992; Counsilman, 1980; Hagerman, 2002; Juba, 2003; Kaneoka et al., 2007; Maglischo, 2002; Morales, 2007; Navarro et al., 1990 & Fessenko Platonov, 1994).

Another reason why these same authors recommend the development of flexibility in the shoulders and ankles is injury prevention. In fact, it is known that the shoulders and ankles of swimmers are subject to high demands during training and competitions. In fact, many studies indicate that the swimmers whose flexibility in shoulders and ankles is less developed, are more prone to injuries in these joints (Ferrell, 1999; Juba, 2003; Morales., 2007; Navarro et al, 1990; Platonov & Fessenko, 1994). In short, we can say that there are many studies that explain the effect of flexibility training on the outcome of the swimmers and the decrease in the prevalence of injuries in the shoulders and ankles of these athletes.

On the other hand, very little literature has been found that talks about the effects caused by training on flexibility of joints that are not directly related to performance. According to the few studies found in the database, the specific development of flexibility in shoulders and ankles could be linked to a shortage or marked loss of joint flexibility in this capacity (Sanz, 2002, 2003). Therefore, it is possible that the asymmetrical development of flexibility in swimmers can be related to the appearance of lesions, pain and/or joint problems elsewhere in the body (Pastor, 1999; Rial & Buck, 2010; Sanz, 2002, 2003, 2011). Moreover, there are opinions that say that the constant repetition of technical gestures that occur in the different styles of swimming could compromise or injure athletes. Furthermore, some authors consider that not all swimming styles are equally suitable or healthy for everyone. Specifically, some studies indicate that the breaststroke and butterfly styles are more harmful swimming styles, so it is suggested that people who suffer or are likely to develop problems and/or back

pain do not swim intensely in butterfly or breaststroke styles ( Ferrell, 1999; Kaneoka et al., 2007; Nyska et al, 2000).

With regard to pain and back problems, you can find a lot of literature that warns of a higher trend in being prone to injury, pain or deviations of the spine, for those individuals who have limited extensibility in the lower back and/or muscle hamstring (Alter 2000; Anderson, 2007; Bompa, 2005; Delgado & Tercedor, 2002; Einsingbach & Wessinghage, 1998; Generelo & Tierz, 1995; Getchel, 1982; Lorret, Benet, Leon, & Querol, 2001; Rodríguez & Santonja, 2000; Rodriguez, Santonja, López-Miñarro, Sainz de Baranda, & Yuste, 2008).

For these reasons, in this paper we have tried to assess the extensibility of the hamstring and its evolution in specialized swimmers in different styles of swimming. In this way you can know if the hamstring extensibility of swimmers is conditioned by the swimming style in which they are specialized and therefore may provide information to help find out if a swimming style is potentially beneficial or detrimental for the back.

To know the hamstring extensibility of swimmers who participated in this study, we used the "sit and reach" test. This test has been widely used in the field of physical activity and sport, with the intention of measuring the overall flexibility (Koebel, Swank, & Shelburne, 1992). Nonetheless, its creators (Wells & Dillon, 1952) concluded that this test measures flexibility in the lower back and lower extremity.

In this regard, numerous studies indicate that the "sit and reach" test mainly measured the extensibility of the hamstring (Arregui, 2006; Cornbleet & Woolsey, 1996; Heyward, 2008; Jackson, AW, & Baker, 1986; Jackson, AW; & Langford, 1989; Liemohn, Sharpe, & Wasserman, 1994; Magnusson et al., 1997; Marques, Vasconcelos, Cabral, & Sacco, 2009; Simoneau, 1998).

Even in a recent article by Carrasco, M.; Sanz-Arribas, I.; Martinez-de-Haro, V.; Cid-Yagüe, L. Martínez-González-Moro, I. (Carrasco, Arribas Sanz-Martinez-de-Haro, Cid-Yagüe, & Martínez-González-Moro, 2013) electromyographic activity was studied during the execution of the "sit and reach" test. The results indicated that the test is determined by the strength of the agonist muscles involved in the test and the tensile strength mainly opposed by the semitendinosus muscles, hamstring and gluteus, since the trigger level of these muscles increased during the test run.

As can be seen, there are many reports indicating that the "sit and reach" test mainly evaluates the ability of the hamstring muscles to be stretched. Therefore, it seems wise to use this test in order to know the values and evolution of hamstring extensibility of swimmers who specialize in different styles.

## **PURPOSE OF THE STUDY**

- To check whether the absolute values of hamstring extensibility and evolution are influenced by the style of swimming in the swimmers who

participated in this study (crawl, backstroke, breaststroke and butterfly) in which they are specialized.

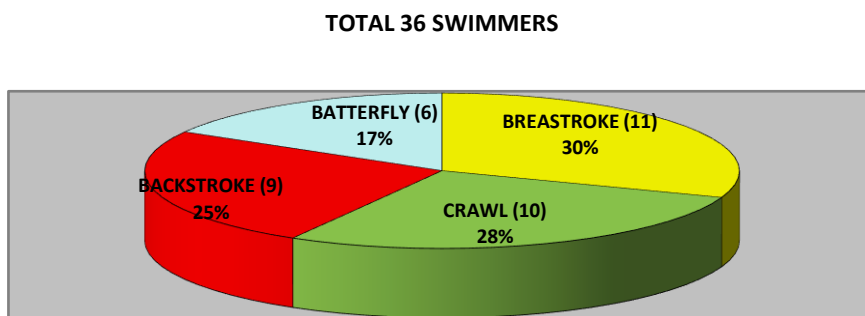
## MATERIAL & METHOD

### Characteristics of the study group

The 36 swimmers of both sexes and aged between 13 and 17 years who participated in this study represent the scope of swimmers who trained in the Spanish aquatic technical center. To be selected for this training center, athletes must have a high level of swimming and a great potential for development. Thus, the population chosen for this research is necessarily small. Consequently, the results of this study cannot be extrapolated to the general population. Swimmers who participated in this study have been training for many years in their clubs, but have only spent one at the technical center because that is the operating time the center had at the time of the research. The population which has been part of this study, is specialized in different styles of swimming:

- 11 swimmers specialized in breaststroke.
- 10 swimmers specialized in crawl.
- 9 swimmers specialized in back.
- 6 swimmers specialized in butterfly.

### Distribution of sample



*Figure 1. Swimmers grouped by swimming style in which they are specialized.*

### Design of study

In this research the linear hamstring flexibility with the "sit and reach" test has been evaluated, in a group of swimmers who trained in a technical center. This population has been divided into four groups, depending on the style of swimming in which they are specialized (front crawl, butterfly, backstroke and breaststroke)

The methodology is of experimental, observational, and non-interventionist type.

With regard to ethical standards, we have preserved the anonymity of study participants and the aquatic technical center. At the same time, permits and authorizations necessary to carry out measurements were requested. Such measurements have been made public and always in the company of group leaders (coaches), considering that we have not used any invasive or harmful methods which could affect the participants, as the method of measurement used in this work is a common assessment tool in the field of physical activity. It is noted that we have acted in compliance with all ethical standards for research, both nationally and internationally and under no circumstance have the limits of privacy and respect for people been invaded.

In this study, we have applied an initial test and nine months later, a final test to all swimmers from the technical center. Dates and times in which the test was applied were scheduled with the intent to cause minimum disturbance to the working dynamics of athletes. The initial test in early October and a final test last May was performed. Thus, it takes a sufficiently broad time for physiological adaptations generated by training in athletes to occur.

The flexibility test was conducted earlier in the day, just before training, so as to not interrupt the regular routine of the swimmers and the results of the test of flexibility has not been constrained by the short-term these previous trainings could cause.

To avoid the influence of environmental temperature on the test results of flexibility, the initial test and final test were conducted in an air-conditioned fitness center. Therefore, the ambient temperature was the same in both measurements.

All these measures have been undertaken with the intent to match the conditions in which the swimmers were evaluated in two tests that were performed, because it is known that the ambient temperature, the time of day or activity that has been performed immediately before performing test, are factors that determine the results of tests flexibility (Generelo & Tierz, 1995; Ibañez & Torrebadella, 1993; Mora, 1989).

A measurement protocol based on the one proposed by George et al., 1996 (George, Garth, & Vehrs, 1996) and Eurofit (Superior Sports Council, 1992) has also been implemented. This protocol has been added prior to the test run, to reduce the risk of injury and looking for the best result (Alter, 2000).

The warm up by all swimmers before the execution of the test is based on the model proposed by Sanz (Sanz, 2002, 2003):

1. From a standing position, trunk flexion trying to touch with the fingers the floor, but without bending the knees. (5 repetitions of the exercise are made, keeping the position for 10 seconds of maximum trunk flexion).

2. The previous exercise was carried out, but in this case we must cross one leg ahead of the other keeping the knee of the leg without bending backwards. (5 repeats are made of the exercise with each leg, holding the position for 10 seconds in maximum trunk flexion).
3. From the sitting position with knees straight and ankles together, trunk flexion is done trying to reach the toes with the fingers, if this object is achieved easily, then they should reach the toe with the knuckles or wrists. (5 repetitions of the exercise is performed while maintaining the position of maximum trunk flexion for 10 seconds).

Then we proceeded to the completion of the test, based on indications of George et al. (George et al., 1996) and EUROFIT (Superior Sports Council, 1992):

1. Perform warming as described above.
2. Leave their shoes and take a sitting position on the floor. Extending the legs straight in front of us and putting pressure to the soles of the feet against the measurement box.
3. Putting one hand next to each other and extending them forward as far as possible, to stretch and breathe.
4. Carry out three tests with the back of the legs firmly on the ground while stretching is done. Not bounce; perform stretching slowly and calmly.
5. Perform three attempts and select the best of the three trials. Ensure that the feet are flat on the drawer and the knees do not flex.

Since this research is not interventionist, it was agreed to disclose the type of training that swimmers routinely perform. It was therefore decided to interview the coaches from the center through an interview of open type. The data provided by the coaches is summarized in the following table:

<b>ASPECT TO DEVELOP IN TRAINING</b>	<b>SWIMMERS FROM THE AQUATIC TECHNICAL CENTER</b>
<b>Volume</b>	<ul style="list-style-type: none"> <li>• From 25 to 30 hours per week. Swimmers perform 45 (sprinters) and 85 (long distance runners) kms per week</li> </ul>
<b>Intensity</b>	<ul style="list-style-type: none"> <li>• High.</li> </ul>
<b>Density</b>	<ul style="list-style-type: none"> <li>• From nine to twelve weekly sessions</li> </ul>
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• Performance improvement. <ul style="list-style-type: none"> <li>• Specific resistance, depending on the distance at which it competes (from 50 to 1500 meters). <ul style="list-style-type: none"> <li>• Speed.</li> <li>• Strength.</li> </ul> </li> <li>• Specific Flexibility (ankle shoulders).</li> </ul> </li> </ul>
<b>Flexibility training</b>	<ul style="list-style-type: none"> <li>• The training is directed and focuses on the following joints: <ul style="list-style-type: none"> <li>• Shoulders.</li> <li>• Ankles.</li> </ul> </li> </ul>

*Table 1. Information relating to swimmers training.*

## **RESULTS**

In this study the sample has not been separated in terms of gender because after statistical study, no significant differences at 95% in the absolute values of flexibility of the initial test ( $p = .069$ ), or end ( $p = .441$ ) were found. Additionally, no significant differences at 95% in the evolution of flexibility by sex ( $p = .099$ ) were found. Therefore, the sample was split into four groups of swimmers, one for each swimming style (crawl, backstroke, butterfly and breaststroke).



## Descriptive statistics

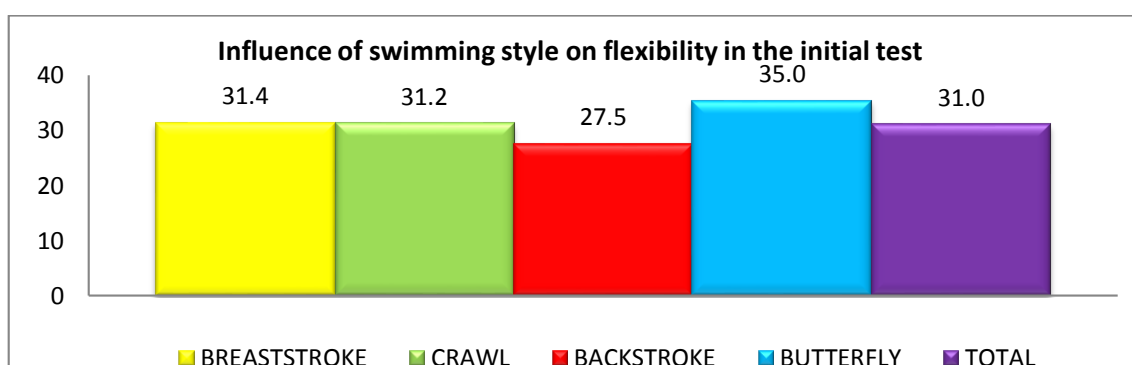
Descriptive statistic									
	SWIMMING STYLE	N	Median cm	Average deviation	Typical error	Interval of trust for median at 95%		Min	Max
						Inferior limit	Superior limit		
INITIAL TEST	Breast	11	31.4	6.1	1.8	27.2	35.5	20.1	41.8
	Crawl	10	31.2	6.2	1.9	26.8	35.7	23.7	40.1
	Back	9	27.5	8.6	2.8	20.9	34.1	15.8	40.0
	Butterfly	6	35.3	7.4	3	27.5	43.1	27.7	45.7
	Total	36	31.0	7.2	1.2	28.6	33.5	15.8	45.7
FINAL TEST	Breast	11	30.6	6.5	1.9	26.2	35.0	21	41
	Crawl	10	30.2	7.3	2.3	25.0	35.4	19	40
	Back	9	26.9	7.1	2.4	21.3	32.4	18	38
	Butterfly	6	34.8	8.9	3.6	25.4	44.1	27	47
	Total	36	30.2	7.4	1.2	27.7	32.8	18	47
FLEXIBILITY EVOLUTION	Breast	11	-7	1.5	.4	-1.7	.2	-3.8	1.8
	Crawl	10	-1.0	2.6	.8	-2.9	.8	-6.1	2.0
	Back	9	-6	2.8	.9	-2.8	1.6	-5.0	3.4
	Butterfly	6	-5	1.9	.7	-2.5	1.4	-3.0	1.6
	Total	36	-7	2.2	.3	-1.5	.0	-6.1	3.4

**Table 2.** Descriptive statistics of the Influence of swimming style on flexibility in the initial test, final test and their developments.

## Influence of swimming style on flexibility in the initial test

ANOVA						
		Sum	GI	Median	F	Sig.
INITIAL TEST	Inter-groups	226.5	3	75.5	1.516	.229
	Intra-groups	1594.2	32	49.8		
	Total	1820.8	35			

**Table 3.** Analysis of variance of the influence of swimming style on flexibility in the initial test.

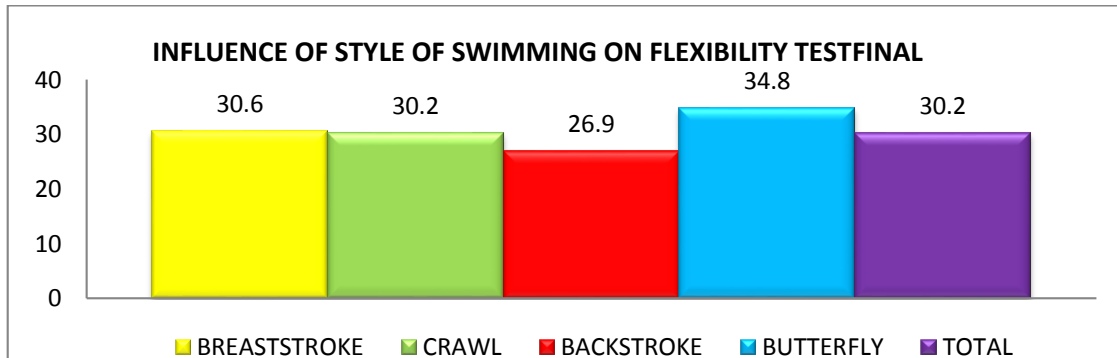


**Figure 2.** Influence of swimming style on flexibility in the initial test.

### Influence of swimming style on flexibility in the final test

ANOVA						
		Sum	gl	Median	F	Sig.
FINAL TEST	Inter-group	227.1	3	75.7	1.410	.258
	Intra-groups	1718.4	32	53.7		
	Total	1945.6	35			

**Table 4.** Analysis of variance of the influence of swimming style on flexibility in the final test.

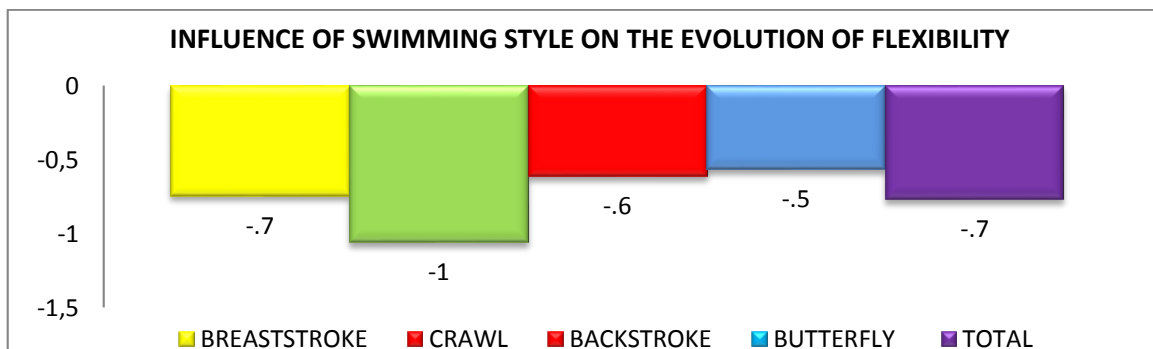


**Figure 3.** Influence of swimming style on flexibility in the final test.

### Influence of swimming style on the evolution of flexibility

ANOVA						
		Sum	gl	Median	F	Sig.
FLEXIBILITY EVOLUTION	Inter-group	1.3	3	.4	.083	.969
	Intra-groups	169.2	32	5.2		
	Total	170.5	35			

**Table 5.** Variance analysis of the evolution of the influence of swimming style on the evolution of flexibility.



**Figure 4.** Influence of swimming style on the evolution of flexibility.

## DISCUSSION

In the initial test, the swimming style in which the swimmers are specialized does not significantly influence at 95% ( $p = .229$ ) in the flexibility evaluated with the "sit and reach" test.

In the final test, the swimming style in which the swimmers are specialized does not significantly influence at 95% ( $p = .258$ ) in the flexibility evaluated with the "sit and reach" test.

The swimming style in which they are specialized swimmers, does not significantly influence at 95% ( $p = .969$ ) in the evolution of flexibility evaluated with the "sit and reach" test.

Although these results may be unexpected, it is necessary to clarify that regardless of the style in which the swimmer is specialized, the crawl is usually the style most commonly used for most of the specialized volume training. Usually the crawl is used for much of the warm up, aerobic workout and cooling down. But when they should train specifically for the competition, most swimmers swim in the training style in which they are specialized.

The dominance of the front crawl in training compared to other styles, is that the official competition distances in backstroke, butterfly and breaststroke are 50, 100 and 200 meters. Therefore, athletes who compete in tests for breaststroke, backstroke and butterfly, are specialists in fast and/or anaerobic lactic tests as the time spent by good swimmers to travel these distances is less than half a minute for shorter tests and just over two minutes for the 200 meters. In this sense, coaches from the technical Center reported that it is not appropriate to perform low-intensity work-style for competition, because the swimmer can lose frequency and gestural speed. Therefore, specialized swimmers in breaststroke, backstroke and butterfly, styles in which they often swim when the required intensity is high and distances are relatively short or similar to those that take place in the competition. Instead, the general fitness is typically performed in crawl.

On the other hand, the swimming style used by the swimmer greatly affects the speed, being the slowest style breaststroke and crawl the fastest. This indisputable fact, difficulties swimmers who share lane training to swim in different styles. Reason why smaller clubs, which do not have many lanes or space to train, usually swim in crawl most of the training.

In short, only when a specific, high-quality and intensity work is done, specialist swimmers of breaststroke, backstroke and butterfly are made to swim in their respective styles.

When interpreting the results, it should be considered the high technical level of the participants in this study. It is recalled that the target population has a high level of skill, otherwise they would not have been selected to train at the center. Therefore, it is possible to swim correctly in these styles causing some effects on hamstring extensibility and evolution, different from those that would occur in a swimmer who had a more modest technical level.

Considering the above, the reasons why in this study the style of swimming does not significantly influence the evolution of hamstring extensibility could be due to three reasons or a combination of them:

- The type of training that swimmers perform depending on the style in which they specialize is not a factor that conditions the evolution of hamstring extensibility.
- In practice, the percentage of specific training is really dedicated to a different style from crawl, it is not a sufficiently large workload, so that different effects in the evolution of hamstring extensibility.
- When the swimmer's technical level is high, the swimming style that they specialize in, has no significant influence on the evolution of hamstring extensibility.

In conclusion, the results of this study indicates that the hamstring muscle length is not conditioned by the style of swimming in which the swimmers who participated in this research are specialized. However, more research would be advisable to provide more information on this scarcely studied subject.

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