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Exercises for Self-Perception Neuromuscular Facilitation to Enhancing Flexibility of Junior Artistic Swimmers

[Ejercicios de facilitación neuromuscular propioceptiva para el desarrollo de la flexibilidad en nadadoras artísticas escolares]

[Exercícios de facilitação neuromuscular propioceptiva para o desenvolvimento da flexibilidade em nadadores artísticos escolares]

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ABSTRACT

Introduction: The practical usefulness of the self-perception neuromuscular facilitation technique is an advantage for the development of flexibility, as it permits higher movement extent of joints during training. However, in artistic swimming, the procedures and components of this technique are insufficient.



Aim: To design a set of exercises to enhance flexibility in artistic swimmers using self-perception neuromuscular facilitation techniques through active and passive stretching to improve the physical capacity of junior athletes.

Materials and Methods: the theoretical methods used were the analytical-synthetic and the systemic-structural-functional; the empirical methods were documentary review and practical pedagogic test. The statistical-mathematical procedure used was descriptive statistics.

Results: The set of exercises implemented included the scapulae-humeral and coccygeal and femoral bone, due to the broad influence of these joints in the technical work, using the stretching method.

Conclusions: The practical results showed a much faster and more harmonious progress to develop flexibility as a physical capacity.

Keywords: Artistic swimming, neuromuscular facilitation techniques, stretching.

RESUMEN

Introducción: la utilidad de la técnica de facilitación neuromuscular propioceptiva constituye una ventaja para el desarrollo de la flexibilidad, porque permite en el entrenamiento aumentar la amplitud del movimiento de una articulación. Sin embargo, en la natación artística, son insuficientes los procedimientos y componentes que lo fundamentan.

Objetivo: diseñar ejercicios para el desarrollo de la flexibilidad en nadadoras artísticas a través de técnicas de facilitación neuromuscular propioceptiva, con el empleo de dos métodos de stretching activa y pasiva, para mejorar esta capacidad física en la categoría escolar.

Materiales y métodos: se aplicaron los métodos teóricos analítico-sintético y sistémico-estructural-funcional; con respecto a los empíricos el análisis documental y test pedagógico práctico; y como procedimiento estadístico matemático la estadística descriptiva.

Resultados: los ejercicios utilizados tuvieron en cuenta la articulación escapulo-humeral



y coxofemoral debido a la gran incidencia de estas articulaciones en el trabajo técnico, con el método Stretching.

Conclusiones: los resultados alcanzados en la práctica permiten revelar un progreso mucho más rápido y armónico para desarrollar la capacidad física flexibilidad.

Palabras clave: natación artística, técnicas de facilitación neuromuscular, stretching.

RESUMO

Introdução: a utilidade da técnica de facilitação neuromuscular proprioceptiva constitui uma vantagem para o desenvolvimento da flexibilidade, pois permite, no treinamento, aumentar a amplitude de movimento de uma articulação. Entretanto, na natação artística, os procedimentos e componentes nos quais ela se baseia são insuficientes.

Objetivo: elaborar exercícios para o desenvolvimento da flexibilidade em nadadores artísticos por meio de técnicas de facilitação neuromuscular proprioceptiva, com a utilização de dois métodos de alongamento ativo e passivo, a fim de aprimorar essa capacidade física na categoria escolar.

Materiais e métodos: foram aplicados os métodos teóricos analítico-sintético e sistêmico-estrutural-funcional; quanto aos métodos empíricos, análise documental e teste prático pedagógico; e a estatística descritiva foi utilizada como procedimento estatístico matemático.

Resultados: os exercícios utilizados levaram em conta as articulações escápulo-umeral e coxofemoral, devido à alta incidência dessas articulações no trabalho técnico, com o método Stretching.

Conclusões: os resultados obtidos na prática revelam um progresso muito mais rápido e harmônico no desenvolvimento da capacidade física de flexibilidade.

Palavras-chave: nado artístico, técnicas de facilitação neuromuscular, alongamento.



INTRODUCTION

Artistic swimming may be defined as the movement performed in aquatic conditions by one or more swimmers of either sex, provided they are synchronized through music. This sports activity combines strength and flexibility, aerobic conditioning, musical performance, stage performance, and teamwork. The fast pace of this specialty in the international arena demands improvements in flexibility.

In that sense, physical training in artistic swimming is thought of as one of the most significant directions of sports training starting in the early ages of development through high performance. To many coaches, this activity never ceases. Undoubtedly, every coach makes use of physical preparedness in their training. However, not all of them use proper science in its application to achieve higher and lasting results.

Moreover, well-known authors of the theory and methodology of sports training, like Matvéev (2001), Bomba and Buzzichelli (2016) Capote *et al.* (2017), Padilla (2017), Camacho *et al.* (2019) and Vladimir (2019), have used different terminology, such as mobility and flexibility uniformly, as the capacity of the body's morph-functional structure to perform broad movements of the joints.

Consequently, one of the new trends in physical capacity development is the method of stretching, which has changed mobility or flexibility. González (2010) specifies the relations and differences between mobility as a capacity and stretching as a simple and effective method to enhance mobility somehow.

Hence, González (2010) acknowledges that stretching is a new scientific method through which mobility or flexibility can be practiced easily and effectively. Stretching looks to condition the athlete's body for training and competition, with a certain level of flexibility development, but its difference lies in that it is a method based on tension-relaxing-extension that must never be exercised in the threshold of pain.



In that very same direction, stretching is widely used to develop flexibility through techniques of self-perception neuromuscular facilitation (PNF). It is a psychophysiological intervention alternative used in sports training. Nevertheless, the current integrated sports training plans for artistic swimming athletes lack indications and procedures for implementation.

Bueno *et al.* (2015) noted that the most significant ground to recommend the utilization of this technique is that it permits the realization of the particular sports movements in every discipline to make muscle reinforcement in every movement pattern. It also produces a functional improvement of the motor efferent and can be used as an element to raise flexibility and mobility.

Several research studies have been conducted due to the technical importance of PNF for flexibility in artistic swimming. Accordingly, various bibliographic sources were consulted, including Cancio and Cortéz (2003), Ayala, and Sainz (2008), Ayala *et al.* (2012), Bueno *et al.* (2015), FINA (2017), Mula and Sainz (2020), Christian *et al.* (2021), Fons and Ruiz (2021), Podrihalo *et al.* (2021), Ponciano *et al.* (2021), Nápoles and Ruiz (2022), FINA (2022), Chirino *et al.* (2022) and Hernández *et al.* (2023). All these authors have studied the muscles stretching techniques, as well as PNF. They have also conducted in-depth studies on the development of flexibility as a physical capacity; the acquisition and development of basic skills, and their contribution to exercise methodologies and alternatives for the physical and technical preparedness of artistic swimmers.

In all cases, these are significant contributions; however, the self-perception neuromuscular facilitation techniques through the stretching methods (active and passive) have not been customized for artistic swimming. Therefore, according to this research, the existing theoretical referents do not explain the problems presented in this paper fully.



Accordingly, this paper aims to design a set of exercises to enhance flexibility in artistic swimmers using self-perception neuromuscular facilitation techniques through active and passive PNF stretching to improve the physical capacity of junior athletes.

MATERIALS AND METHODS

This study was done in Havana, at the "Mártires de Barbados" Starter Sports School. The sport selected was artistic swimming. This is an explicative study with an experimental design; the population consisted of nine female junior artistic swimmers part of the competition team and went through the starting and reserve stages.

The following scientific research methods and techniques were used.

The theoretical techniques were the analytical-synthetic method to perform in-depth analysis through the research. The systemic-structural method was used to determine the hierarchy and structure of each exercise, as well as its dynamics and functioning.

The empirical methods used were documentary analysis, which facilitated the bibliographic review of the possible background related to this topic, and helped determine the theoretical assumptions of the study. The practical pedagogic test consisted of the shoulder dislocation and split test using the right leg, frontal position, and left leg, to measure flexibility.

The results were processed through descriptive statistical methods, such as the arithmetic mean to correlate the results from the instruments applied. Excel 2000 Spreadsheet was used for data quantification and processing. This software was used as well to determine the mean and significance of test results, and sample comparisons at the different stages evaluated.



RESULTS AND DISCUSSION

Tests performed and evaluation scales

1. Shoulder dislocation

Standing, frontal position, legs together, extended arms downward holding a rope; the arms are moved upward-backward, still extended, and back to the initial position (Table 1).

Table 1. - Shoulder dislocation evaluation scale

Dislocation	Score
Nipple to nipple	5
Shoulder width	4
Arm length	3
Hand to nipple	2
Hand to the center of the chest	1

A 0.5 deduction was performed in case the execution lacked fluency and rhythm, which means abrupt execution.

2. Split

Split cm: the swimmer assumed the split position for 30 seconds (on the sides with each leg and in frontal position), backed by the feet, between two jump cages. The swimmer made a grip from parallel bars on the sides of the body, so the athletes had greater space (proper body positioning) based on the influence of their bodies (Table 2).



Table 2. - Split evaluation scale

Score	Position	
	Frontal	Lateral
5	19 cm	25 cm
4	17 cm	20 cm
3	15 cm	15 cm
2	13 cm	10 cm
1	10 cm	5 cm

This test also measured the cm reached, and the tens were deducted for every fault observed, according to the table below. Each split was evaluated separately.

Penalty	Execution fault
0.10	Scoring fault
0.20	Slight leg flexion
0.50	Legs rotated inward
1.0	Hip torsion
0.10/0.30	Trunk leaning

Exercises using self-perception neuromuscular facilitation techniques through active and passive PNF stretching to improve flexibility in artistic swimming (Figure 1).

Exercises for scapulae-humeral joint (Figure 1).

- Dosage (active PNF): (6-10 seg. T) (2-3 seg. R) (6-10 seg. E) 4-6 repetitions.
- Dosage (passive PNF): (6-10 seg. T) (2-3 seg. R) (6-10 seg. E) 6-8 repetitions.






Exercises	Methodological Guidelines
	<p>Exercise 1 Standing with arms to the front, The coach will cross their arms seeking the greatest width. the body stays erect, with no arm flexions (sustained push).</p>
	<p>Exercise 2 Standing with arms behind. The coach will cross their arms seeking the greatest width. The body stays erect, with no arm flexions (sustained push).</p>
	<p>Exercise 3 Standing with flexed arms behind. the coach will try to join the elbows (sustained push). The body stays erect, with no flexions of the trunk. Variant 3.1. Sitting with flexed arms behind. Variant 3.2. Lying face up with flexed arms behind.</p>

Fig. 1. - Exercises for the scapulae-humeral joint

Exercises for coccygeal and femoral bone (Figure 2).

- Dosage (active PNF): (6-10 seg. T) (2-3 seg. R) (6-10 seg. E) 4-6 repetitions.
- Dosage (passive PNF): (6-10 seg. T) (2-3 seg. R) (6-10 seg. E) 6-8 repetitions.






Exercises	Methodological Guidelines
	<p>Exercise 1 Sitting with flexed legs (closed butterfly). The swimmer places the arm between the two knees, making tension inward to join the legs. The trunk stays erect (sustained push).</p>
	<p>Exercise 2 Lying face down, making a butterfly. The coach will press upward by the knee, keeping the hip from rising. The trunk should be erect, and the abdomen on the mattress (sustained push). The exercise includes the two legs. sostenido). Se realiza el ejercicio con ambas piernas.</p>
	<p style="text-align: center;">Ejercicio 3</p> <p>Exercise 3 Lying face up, making a butterfly. The coach will press the legs seeking the greatest width. The trunk must be erect and the back on the mattress. The trunk must not make an arc (sustained push).</p>

Fig. 2. - Exercises for the scapulae-humeral joint

Specific in-water exercises for flexibility (Figure 3).

- Dosage (active PNF): (6-10 seg. T) (2-3 seg. R) (6-10 seg. E) 4-6 repetitions.
- Dosage (passive PNF): (6-10 seg. T) (2-3 seg. R) (6-10 seg. E) 6-8 repetitions.






Exercises	Methodological Guidelines
	Exercise 1 Inverted support on the overflow, with flexion of the belly, leg extension (sustained push).
	Exercise 2 Held from the overflow area and make a frontal split. The trunk must be erect, the legs extended and pointed (sustained push).
	Exercise 3 Held from the overflow area, on a corner of the pool, make a frontal split. The trunk must be erect, the legs extended and pointed (sustained push).

Fig. 3. - In-water exercises

Results analysis

Results of tests performed using the traditional methods and the active and passive PNF methods.

Table 3. - Results of the tests performed at first

Test No. 1					
Athletes	Split			Ave.	Disl.
	R	L	F		
1	3.7	3.5	3.5	3.57	3.0
2	3.2	3.7	3.0	3.30	3.5
3	3.3	4.0	4.5	3.93	3.5
4	2.8	2.8	3.5	3.03	2.5
5	4.0	4.2	4.0	4.07	4.5
6	3.5	3.0	3.5	3.33	4.5
7	3.7	3.7	3.7	3.70	3.0
8	3.5	3.2	3.4	3.36	3.1
9	3.4	3.5	3.2	3.36	3.4
	3.45	3.51	3.58	3.51	3.44



Table 3 shows the behavior of the tests performed at the beginning of the training of female swimmers when the course starts.

The nine swimmers were tested, and the score consisted of five points. The tests were the right split, which averaged 3.45 with athlete No. 5 as the most outstanding. The left split averaged 3.51, with athlete No. 3 reaching a 0.7 difference compared to the right split results, though the most flexible athlete was No 5, with 4.2.

The frontal split showed athlete No. 3 with the highest score, though the general average of the three splits determined the most outstanding athlete at the beginning of training (No 5), steady above 4. Concerning the dislocation, swimmers 5 and 6 were observed to be much higher than No 5 and 6, with 4.5 (Table 3).

Table 4 - Results of the tests performed at a second moment

Athletes	Test No. 2				
	Split			Ave.	Disl.
	R	L	F		
1	4.2	4.0	3.7	3.97	3.5
2	3.5	3.8	3.0	3.43	4.0
3	3.8	4.0	4.8	4.20	4.0
4	3.4	3.0	3.8	3.40	3.0
5	4.3	4.3	4.2	4.27	4.5
6	3.9	3.5	3.8	3.73	4.6
7	4.2	4.2	3.8	4.07	3.0
8	3.7	3.4	3.5	3.53	3.2
9	3.6	3.5	3.5	3.53	3.7
	3.84	3.74	3.78	3.79	3.76

Table 4 shows the behavior of the tests after four months of training, using the traditional methods to enhance flexibility. The evaluations were weighed and compared to test 1 (Table 3), showing improvements. However, some athletes maintained their results with very similar scores, with no significant improvements.



The three splits were under 4. As to the dislocation, swimmers 5 and 6 were way above the mean shown in Table 3, with similar results (Table 4).

Table 5. - Results of the tests performed at a third moment

Test No. 3					
Athletes	Split			Ave.	Disl.
	R	L	F		
1	4.5	4.7	4.0	4.40	4.0
2	4.2	4.1	3.7	4.00	4.5
3	4.7	4.5	5.0	4.73	4.0
4	4.2	4.0	4.2	4.13	4.0
5	4.7	4.6	4.5	4.60	4.8
6	4.5	4.3	4.2	4.33	4.9
7	4.3	4.5	4.0	4.27	4.0
8	4.1	4.4	4.1	4.20	4.0
9	4.1	4.0	4.2	4.10	4.4
	4.36	4.34	4.21	4.30	4.28

Table 5 shows a significant increase in all the values in the tests and individually. The nine swimmers were able to reach more than four points as a general average. Individually, swimmer No. 5 stood out, with a positive performance in the three splits, whereas No. 3 made the greatest progress, averaging 4.73, the best on the team (Table 5).

Test No. 3 was performed two months after the second, using the new set of exercises suggested, through the active and passive PNF, both general and special.

This study contributed to the existence of higher outcomes in all the tests (from the second one), and it was even greater in the last control, demonstrating the effectiveness and efficiency of the proposal.

This study corroborated that the exercises introduced were favorable to training flexibility in artistic swimming. As shown by several authors, like Ayala and Sainz (2008), González (2010), Ayala *et al.* (2012), Bueno *et al.* (2015), Mula and Sainz (2020), and FINA (2022).



In addition to the above, other authors, such as Cancio and Cortéz (2003) and Chirino *et al.* (2022) stated that apart from flexibility training of all joints in artistic swimming require stretching on the coccygeal and femoral bone and the back bone. Flexibility training is known to be essential for broader movements. However, these authors did not include PNF-related exercises.

Consequently, the different terminology used by the previous scholars shows that the epistemological shortcomings observed in their methods reveal the absence of certain procedures. Hence, the novelty of this study lies in the much faster and harmonious progress to develop flexibility as a physical capacity.

The exercises implemented helped establish a planning and application guide of training for flexibility enhancements, considering the combination of in-water and ground exercises. The outcomes of this preliminary study showed higher performance of female junior artistic swimmers.

CONCLUSIONS

The implementation of a set of exercises with the inclusion of a higher number of artistic swimmers in different settings may lead to similar results in practice, and constitute a working guide for artistic swimming coaches.

The results of this research evidenced the importance of applying new exercises to train flexibility. It is a necessary methodological contribution to the physical preparedness and higher performance of female junior artistic swimmers.



BIBLIOGRAPHIC REFERENCES

- Ayala, F. y Sainz, P. (2008). Efecto de la duración y técnica de estiramiento de la musculatura isquiosural sobre la flexión de cadera. *Revista Cultura, Ciencia y Deporte*, 3(8), pp. 93-99. <https://www.redalyc.org/pdf/1630/163017596005.pdf>
- Ayala, F.; Sainz de Baranda, P. y Cejudo, A. (2012). El entrenamiento de la flexibilidad: técnicas de estiramiento. *Revista Andaluza de Medicina del Deporte*, 5(3). pp. 105-112. <https://pdf.sciencedirectassets.com/282182/1-s2.0-S1888754612X70035/1-s2.0-S1888754612700163/main.pdf?X-Amz-Security->
- Bomba, T. y Buzzichelli, C. (2016). *Periodización del entrenamiento deportivo*. Barcelona: Paidotribo. https://www.canariasbooks.com/libro/periodizacion-del-entrenamiento-deportivo_305290
- Bueno, E.; González, S; Aparicio, D y Aloma, G. (2015). La facilitación neuromuscular propioceptiva en la mejora de algunas capacidades físicas. *Revista Digital Buenos Aires*. 20 (204). <https://www.efdeportes.com/efd204/la-facilitacion-neuromuscular-propioceptiva.htm>
- Camacho, J., Ochoa, N. y Rincón, N. (2019). Revisión teórica de la planificación tradicional y contemporánea en el entrenamiento deportivo. *Revista Digital: Actividad Física y Deporte*. 5 (2). <https://revistas.udca.edu.co/index.php/rdafd/article/view/1265>
- Cancio, S. y Cortés, K. (2003). La flexibilidad en el nado sincronizado. *Revista Digital Buenos Aires*, 9(65). <https://www.efdeportes.com/efd65/nado.htm>
- Capote, G; Rodríguez, A.; Analuiza, E.; Cáceres, C. y Rendón, P.(2017). El deporte, el entrenamiento deportivo y los entrenadores. *Revista Digital Buenos Aires*, 22(234). <https://www.efdeportes.com/efd234/el-deporte-el-entrenamiento-deportivo-y-los-entrenadores.htm>



- Chirino, Y.; Zamora, M. y Fernández, J. (2022). Sistema de ejercicios para desarrollar la flexibilidad en la natación artística en categorías infantiles y escolares. *Revista Olimpia*. <http://portal.amelica.org/ameli/journal/429/4292987023/html/>
- Christian, F.; Gustavo, P. y Guallasamín, F. (2021). Efectividad de la flexibilidad activa y pasiva en el entrenamiento de gimnasia rítmica. *Podium. Revista de Ciencia y Tecnología en la Cultura Física*, 16(3). http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1996-24522021000300871
- Federación Internacional de Natación Amateur (2017, 11 de octubre). *Reglamento de Natación Artística*. Real Federación Española de Natación. <https://resources.fina.org/fina/document/2021/01/08/e9bfaa2e-3bd5-4127-8ad2-29c51d71fdf4/ARTISTIC-SWIMMING-2017-2021.pdf>
- Federación Internacional de Natación Amateur (FINA). (2022). *Reglamento de Natación Artística*. <https://resources.fina.org/fina/document/2022/11/01/4b3598b6-18cd-411e-ac09-16e49965df3a/00-AS-Rules-2022-2025-Confirmed.pdf>
- Fons-Cabrera, K., & Ruiz-Sánchez, J. I. (2021). Sistema de preparación para desarrollar fuerza explosiva en miembros inferiores de atletas de natación artística. *Ciencia Y Deporte*, 6(3), 3245. <https://doi.org/10.34982/2223.1773.2021.V6.No3.003>
- González, R. (2010). Aspectos teóricos a tener en cuenta para el desarrollo de una sesión de stretching en el ámbito escolar. *Revista Digital Buenos Aires*. 14 (141). <https://www.efdeportes.com/efd141/sesion-de-stretching-en-el-ambito-escolar.htm>
- Hernández Soutelo, L., Brito Vázquez, E., & Bestard Revilla, A. (2023). Las figuras: su preparación en la natación artística escolar. *PODIUM - Revista De Ciencia Y Tecnología En La Cultura Física*, 18(1), e1145. <https://podium.upr.edu.cu/index.php/podium/article/view/1145>



- Matveev, L. (2001). *Teoría general del entrenamiento deportivo*. Barcelona: Paidotribo.
https://books.google.com.do/books/about/Teor%C3%ADa_general_del_entrenamiento_deport.html?id=Fj5HEuuJyToC
- Mula, A. y Sainz, P. (2020). Efectos de la aplicación de programas de estiramientos sobre la musculatura isquiosural en escolares: Revisión bibliográfica. *Revista JUMP*, (1). pp. 53-66. <https://doi.org/10.17561/jump.n1.6>
- Nápoles, A. y Ruiz, J. (2022). Alternativa metodológica para entrenar la posición de vertical en flotación en la natación artística. *Revista Ciencia y Deporte*, 7(3): 100-111. <https://doi.org/10.34982/2223.1773.2022.V7.No3.008>
- Padilla, J. (2017). *Planificación del entrenamiento deportivo. Un enfoque metodológico de la estructura clásica*. Barinas-Venezuela: Episteme.
https://www.researchgate.net/profile/Jose-Alvarado-5/publication/321085436_Planificacion_del_Entrenamiento_Deportivo_Un_enfoque_metodologico_de_la_estructura_clasica/links/5a0ca6f10f7e9b9e33a9d76e/Planificacion-del-Entrenamiento-Deportivo-Un-enfoque-metodologico-de-la-estructura-clasica.pdf
- Podrihalo, O., Podrigalo, L., Jagietto, W., Iermakov, S. y Yermakova, T. (2021). Substantiation of Methods for Predicting Success in Artistic Swimming. *International Journal of Environmental Research and Public Health*.18,8739. <https://doi.org/10.3390/ijerph18168739>
- Ponciano, K., Tosini, L., Sousa, C., Barbosa, R., Gomes, A. y Meira, C. (2021). Personality traits and competitive preferences of artistic swimming athletes. *Academia Letters*, Article 936. <https://doi.org/10.20935/AL936>



Vladimir, I. (2019). *Entrenamiento Deportivo. Periodización en bloques*. Barcelona: Paidotribo. <https://www.casadellibro.com/libro-entrenamiento-deportivo-periodizacion-en-bloques/9788499100852/1893139>

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The authors declare having competing interests.

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The authors have participated in the redaction of the manuscript and the documentary review.



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