



## Using Proprioceptive Neuromuscular Facilitation Stretching Method to Improve the Flexibility of Hip Joint of Amateur Rhythmic Gymnastics Students

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### Abstract

The purposes of this study are 1) to improve the flexibility of hip joint of amateur rhythmic gymnastics students by PNF stretching method and 2) compare the flexibility of students' hip joints before and after PNF stretching teaching. The sample group includes 30 amateur rhythmic gymnastics students from Xi 'an Art Power Club. Research tools include: 1) Teaching plan based on PNF stretching method and 2) Flexibility test of hip joint. The relevant samples were statistically analyzed by means of mean, standard deviation and t test. The results show that the use of PNF stretching method can effectively improve the flexibility of hip joint of rhythmic gymnastics students. The course content includes Chapter 1 Adaptation and mastery period, Chapter 2: Proficiency and Application Period, and Chapter 3 consolidation and improvement period. The course consists of 3 chapters, totaling 12 hours. It is found that PNF stretching method can improve the flexibility of hip joint of rhythmic gymnastics students. After PNF stretching teaching, the flexibility of students' hip joint is obviously higher than that before teaching, and the statistical significance reaches 0.01 level.

**Keywords:** PNF Stretching, Rhythmic Gymnastics, Hip Flexibility

### Introduction

In recent years, China has attached great importance to the construction of a healthy China. In the Opinions of the State Council on Implementing the Healthy China Action issued in the State Council on July 15, 2019, one of the main tasks is to maintain the health of the whole life cycle, including the implementation of health promotion actions in primary and secondary schools (Xinhua News Agency, 2019). The opinions suggest that primary and secondary school students are in a critical period of growth and



development, and families, schools and society should be mobilized to jointly safeguard the physical and mental health of primary and secondary school students. Guide students to develop healthy living habits and exercise healthy physique from an early age. It points out the direction for the implementation of Healthy China Action. The importance of primary and secondary school students' physical health has been clarified.

For most children, rhythmic gymnastics teaching can improve children's bad body posture and shape beautiful body lines and figure; It plays a promoting role in improving physical quality and physical function; At the same time, it can effectively improve children's mental health level and improve their psychological problems such as "learning anxiety" and "loneliness tendency"(Cao Xinyue, 2023). Because of its unique and rich functions, such as fitness, mental health, aesthetic education, economic value and competitive value, today, countless people take part in the study and competition of rhythmic gymnastics. Under this upsurge, some primary and secondary schools all over the country also popularize rhythmic gymnastics as the learning content of class exercises.

Childhood is the initial stage of learning rhythmic gymnastics and the best time for children to develop flexibility (Mary, 2017). If we actively develop the flexibility of hip joint at this time, it will not only conform to the current law of children's physical development, but also lay a solid foundation for rhythmic gymnastics teaching in the future. The traditional flexible teaching method of rhythmic gymnastics is relatively simple, although the effect is good, but the pain is strong, which leads to the loss of many children with certain artistic gymnastics talent because they can't stand the pain of flexible teaching. To improve this situation, teachers need to pay more attention to the law of rhythmic gymnastics students' physical and mental development, and adjust the teaching content and teaching methods appropriately, to enhance students' interest in learning and reduce unnecessary physical injuries. PNF stretching method was founded and developed by Herman Kabat, Maggie Knott and Dorothy Voss in the United States in the 1940s. This technique was invented for patients with neuromuscular paralysis, and then it was used by more and more people in the flexibility training of the human body. PNF stretching method is an effective stretching method, which can effectively improve flexibility in a short time by constantly resisting resistance and enhancing the neuromuscular response.

To sum up, using PNF stretching method can significantly promote the flexibility of hip joint of rhythmic gymnastics students. Therefore, I chose "using PNF stretching method to improve the flexibility of hip joint of amateur rhythmic gymnastics students" as my research topic. Our goal is not only to improve the flexibility of students' hip joints, but also to have a positive impact on rhythmic gymnastics teaching in the future classroom. The main problem of this paper is to verify the effectiveness of PNF stretching method to improve the flexibility of hip joint of amateur rhythmic gymnastics students, and to explore



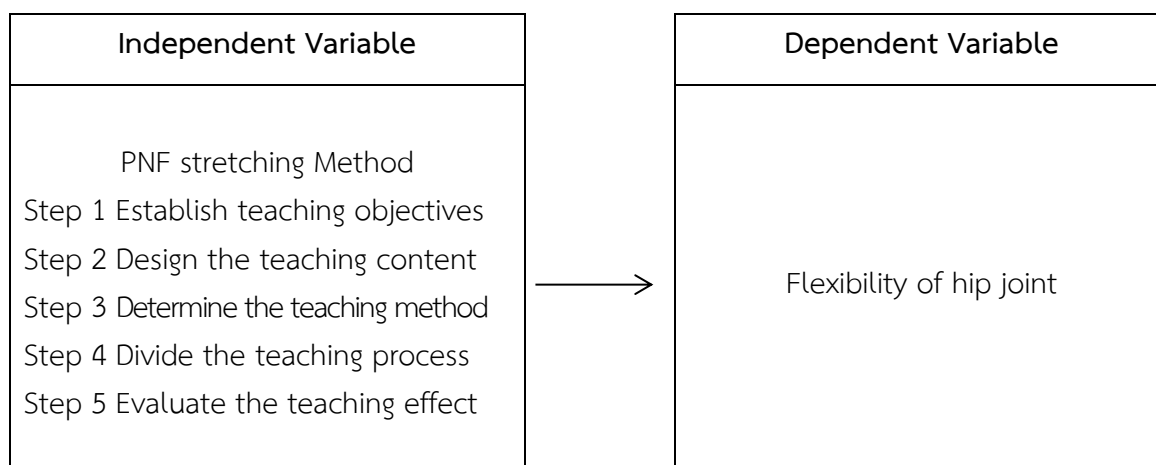
the teaching method of rhythmic gymnastics with good teaching effect and easy acceptance by children.

### Objectives

1. To use PNF stretching method to improve the flexibility of hip joint of amateur rhythmic gymnastics students in Xi 'an Art Power Club.
2. To compare students' flexibility of hip joint before and after the implementation based on the PNF stretching method.

### Concept theory framework

Using PNF stretching method to improve the flexibility of hip joint of amateur rhythmic gymnastics students. The research concept framework is as follows:



### Theory

1. The theory of human genesis and development.

"Human Genesis and Development" proposes that there are two types of embryonic cells, namely, the process of autonomy and gradual specialization. Cell development is the basis of human embryo formation, and human nerve formation and development play an important role in the whole embryonic development. It is considered that the nervous system is an important guarantee to maintain the stability of human internal environment, and it unifies and coordinates human internal environment and external environment. The functions of human organs and systems are all controlled by the coordination of the nervous system. The muscles and tissues of the human body are not independent, and they cooperate with each other, while the nervous system dominates, leads and regulates various organs. When the receiver obtains stimulation (internal and external stimulation), the receptor transmits the collected information to the



central nervous system through afferent neurons, and the central nervous system makes judgments according to the functions and properties of each organ, and transmits "commands" to the effector through efferent neurons, and the effector responds according to the outgoing information. The whole process is called "reflex arc".

## 2. Emotional activation theory

The Theory Of Emotion Activation was put forward by Lindesler in 1951. It is believed that emotions are produced by different degrees of activation, high arousal produces strong emotions, and low arousal produces mild emotions. The degree of awakening includes excitement, attention, relaxation, drowsiness, etc. until death. Effective information can only be generated after nerves are activated, so the theory of emotional activation emphasizes that people should be in two States: "excitement" and "attention" when transmitting information efficiently, and the state after "relaxation" can not transmit real-time information efficiently.

## 3. Event group training theory

The theory of event group training was put forward by Chinese sports expert tian maijiu and his team. The theory of event group training is based on the similarities and differences between events caused by the essential attributes of different events, and a group of sports with similar competitive characteristics and training requirements are put together for comparative study. According to the classification standard of event group theory, rhythmic gymnastics belongs to the event group of "expressing difficulty in beauty", and the basic requirements of changing event group are that the figure is symmetrical to express the beauty of posture, the basic skills are strong to express the beauty of action, and various shapes, novel arrangements and difficulty changes.

### **The population and sample group**

This paper mainly adopts the experimental method, with 90 students in Xi 'an Art Club, 3 classes and 30 students in each class as the research population, and 30 students randomly selected from a specific group as the sample group.

## **Methods**

Using PNF stretching method to improve the flexibility of hip joint of rhythmic gymnastics students. The research tools used by researchers include curriculum plan and hip flexibility scoring standard. The research tools are as follows:

1. Make teaching plans according to PNF stretching method. The researchers designed three chapters using the theory of PNF stretching method, which lasted for 12 hours.

1.1 Used as a guide to formulate learning objectives, contents and organize the measurement and evaluation of curriculum activities.



1.2 According to the core learning content of a group, it is necessary to set learning objectives, determine learning content and estimate teaching time.

1.3 Learn related concepts and theories from literature, books, teaching materials and related research, and make corresponding learning plans.

1.4 The teaching course of using PNF stretching method to improve the flexibility of hip joint of amateur rhythmic gymnastics students includes three chapters. Chapter 1: Adaptation and mastery period, 4 hours; Chapter 2: profitability and application period, 4 hours; Chapter 3: consolidation and improvement period, 4 hours, 12 hours in total. Each chapter is made according to PNF stretching method: 1) establishing teaching objectives; 2) designing teaching content; 3) determine the teaching method; 4) dividing the teaching process; 5) Evaluate the teaching effect.

1) Establish teaching objectives. According to the teaching principles and research priorities of rhythmic gymnastics, the teaching objectives are set.

2) Design the teaching content. According to the characteristics of rhythmic gymnastics teaching content and the content of rhythmic gymnastics, this paper analyzes and finds feasible teaching strategies and makes specific teaching design.

3) Determine the teaching methods. According to the characteristics and requirements of PNF stretching, different teaching methods are adopted to facilitate the implementation of PNF stretching method.

4) Divide the teaching process. According to students' cognitive development ability and physiological development characteristics, training is carried out and the teaching process is divided.

5) Evaluate the teaching effect and objectively evaluate the flexibility of students' hip joints.

1.5 Study the process of making instrument quality checklist.

1.6 Measurement and evaluation of the flexibility of hip joint.

1.7 Submit the completed teaching plan to the tutor, check the consistency and applicability of the content, and modify it according to the suggestions in the tutor's reply.

1.8 Submit the revised teaching plan to three experts for review, to verify the accuracy and applicability of the teaching content, and the consistency of learning objectives, contents, learning activities, teaching media, measurement and evaluation. Find IOC (Index Target Consistency).

**Table 1:** Evaluation Results of Chapter

Using PNF stretching method to improve hip joint flexibility of amateur rhythmic gymnastics students	hours	IOC	Evaluation results
Chapter 1: Adaptation and mastery period	4	1.00	accept
Chapter 2: Profitability and application period	4	1.00	accept



1.9 Each curriculum activity plan had a consistency index greater than or equal to 0.50 and was considered suitable for use in research. The analysis result of the IOC (Index Objective Congruence) is that each chapter is 1.00.

## 2. Hip Flexibility Measurement Table

2.1 The content of analyzing the flexibility of hip joint is consistent with the curriculum activity plan.

2.2 Learn the theory and method of evaluating the flexibility of hip joint from literature and related research.

2.3 Determine the scoring standard of hip joint flexibility test: All 10 evaluation points have established scoring standards and corresponding scores: 1, 2 and 3. The perfect score is 30. Different scores represent different degrees of hip flexibility. 27-30 points means strong; 23-26 points represent relative strength; 18-22 points represent average; 14-17 points means relatively weak; A score of 10-13 means weak.

2.4 Submit the designed evaluation standard of hip joint flexibility to the thesis supervisor, check its accuracy and modify it.

2.5 Submit the established evaluation standard of hip flexibility to three experts for measurement and inspection. Experts check the effectiveness of the content and calculate the project objective consistency index (IOC). The consistency index of each evaluation content is greater than or equal to 0.50, which is considered suitable for research. The IOC (objective consistency index of projects) value of each project in this evaluation standard is 1.00.

2.6 Revise and improve the grading standards, and then conduct experiments on non-sample students to ensure the quality of evaluation.

2.7 Cronbach's  $\alpha$  coefficient is 0.81 to check the reliability of the measurement standard, which can be used for research.

## Symbols and Abbreviations

Represent data analysis results based on symbols and semantics. The details

$\bar{X}$	Means	average value
SD.	Means	standard deviation
n	Means	number of students
D	Means	scores of difference between pre and post class
Df	Means	degree of freedom
t	Means	statistical data for t-test value
**	Means	statistical significance at level .01



## Results

The study process of 30 rhythmic gymnastics students in Xi'an Art Power Club was analyzed by using PNF stretching method. The researchers conducted their studies in the following order:

Part 1. The study process of 30 rhythmic gymnastics students in Xi'an Art Power Club was analyzed by using PNF stretching method.

Firstly, the researcher analyzed the important role of hip flexibility in rhythmic gymnastics teaching and the function of PNF stretching method through literature research, and expounded the constituent elements, necessity and method content of PNF stretching method teaching through the current teaching purpose and requirements of rhythmic gymnastics and the current research situation under the current background. Finally, the teaching course based on PNF stretching method is developed to improve the flexibility of hip joint of amateur rhythmic gymnastics students.

Secondly, to improve the flexibility of hip joint of amateur rhythmic gymnastics students, PNF stretching method is adopted in this teaching course. This teaching course is divided into the following three parts, with a total of 12 class hours. This course consists of three chapters. Chapter 1: adaptation period and mastery period, 4 hours; Chapter 2: Design the teaching content, 4 hours; Chapter 3: Learning content: consolidation and improvement period, 4 hours. Each lesson plan is made based on PNF stretching method: 1) establishing teaching objectives; 2) designing teaching content; 3) determining the teaching method; 4) dividing the teaching process; 5) Evaluate the teaching effect.

Thirdly, based on the specific situation of the above-mentioned teaching courses, the researcher conducted a research experiment on 30 rhythmic gymnastics students in Xi'an Art Power Club by random grouping sampling. This paper compares and analyzes the flexibility of students' hip joints before and after PNF stretching teaching class to understand the changes of students' hip joint flexibility. Observe students' performances before and after teaching, and record students' changes and performances.

Part 2. The PNF stretching method was used to implement pre-class teaching, and the flexibility of hip joint was tested after class.

The second part. According to PNF stretching method, the flexibility of students' hip joints before and after implementation was compared. In this section, we aim to evaluate the effectiveness of the PNF stretching method. The researchers tested and analyzed the hip flexibility of 30 amateur rhythmic gymnastics students before and after attending a 12-hour teaching course. The teaching effect of the teaching course is analyzed as follows. The researchers used the PNF stretching method to analyze the flexibility of hip joint before and after implementation. In this study, 30 rhythmic gymnastics students were selected as experimental subjects. The evaluation standard of hip flexibility consists of 10 evaluation items. 1-3 points for each evaluation item, totaling 30 points. The results are summarized in Table 2 below.

As can be seen from Table 2, by applying the teaching theory based on PNF stretching method, the average score of hip joint flexibility of amateur rhythmic gymnastics students before and after





class is 18.7 points, and the average score after class is 23 points, with an average difference of 4.3 points, indicating that the hip joint flexibility after class is higher than before class. According to the students' hip joint flexibility scores before and after class, the researchers used mean value, standard deviation and dependence T test for data analysis. The data analysis results are shown in Table 2.

**Table 2:** Students' Hip Flexibility before and after PNF Stretching Teaching

Student ID	Pre-test Scores (Full Score=30)	Post-test Scores (Full Score=30)	Difference Scores (D)
1	16	23	7
2	18	24	6
3	17	25	8
4	22	25	3
5	24	27	3
6	16	23	7
7	27	28	1
8	26	27	1
9	19	22	3
10	15	21	6
11	16	21	5
12	18	22	4
13	22	25	3
14	18	23	5
15	20	24	4
16	15	22	7
17	10	18	8
18	15	20	5
19	18	21	3

**Table 2:** Students' Hip Flexibility before and after PNF Stretching Teaching (Continue)

20	18	22	4
21	19	21	2
22	19	23	4
23	17	20	3
24	16	21	5
25	19	22	3
26	21	22	1





27	26	27	1
28	20	24	4
29	18	22	4
30	16	25	9
$\bar{X}$	18.70	23.00	4.30
SD.	3.70	2.62	0.24

**Table 3:** Comparison of Flexibility of Hip Joint

Flexibility of hip joint	n	full score	$\bar{X}$	SD.	df	t	p
Pre-test	30	30	18.70	3.70	29	12.56**	.00
Post-test	30	30	23.00	2.62	29		

\*\* Statistically significant at the level. 01 ( $p < .01$ )

The purpose of this paper is to improve the flexibility of hip joint of amateur rhythmic gymnastics students in Xi 'an Art Club by using PNF stretching method, and to compare the flexibility of hip joint of students before and after the implementation of PNF stretching method. Table 4 compares the flexibility of students' hip joints before and after the implementation of PNF stretching method. The comparison results show that the flexibility of students' hip joints after class is higher than the average level before class, which is statistically significant at the level of ( $P < 0.01$ ), indicating that PNF stretching method can effectively improve the flexibility of students' hip joints and verifying the research purpose of this paper.

The flexibility of hip joint in rhythmic gymnastics teaching is very important for students' performance and achievement, and it is one of the key factors to achieve excellent performance. The common stretching method is based on the mutual inhibition of muscles, and the inhibition of antagonistic muscles on stretching muscles is inevitable in stretching, while PNF stretching method can relax antagonistic muscles through resistance, and the target muscles can be further stretched, thus achieving better stretching effect. In this study, the researchers used PNF stretching method to teach. According to the working principle of PNF stretching method and the characteristics of rhythmic gymnastics course, a teaching scheme of the influence of PNF stretching method on hip flexibility of rhythmic gymnastics students was constructed. The scheme includes establishing teaching objectives, designing teaching content, determining teaching methods, dividing teaching process and evaluating teaching effect, to achieve better teaching effect of PNF stretching method.

Through the pre-evaluation process, the students' hip joint flexibility is tested before class, so that students and teachers can understand the actual situation of hip joint flexibility, and then



strengthen learning, optimize students' motor skills, stimulate students' interest in learning and improve hip joint flexibility. After-class tests improved the flexibility of hip joint.

## Conclusions and Discussion

### Conclusion

According to the research topic, the research summary of amateur rhythmic gymnastics students using PNF stretching method to improve the flexibility of hip joint is as follows:

1. Using the PNF stretching method to improve the flexibility of hip joint includes five steps: step 1: establishing teaching objectives, according to the teaching principles and research priorities of rhythmic gymnastics, The teaching objectives are set. Step 2: Design the teaching content. According to the characteristics of rhythmic gymnastics teaching content and the cons. tent of rhythmic gymnastics, this paper analyzes and finds fearful teaching strategies and makes specific teaching design. Step 3: Determine the teaching methods. According to the characteristics and requirements of PNF stretching, Different teaching methods are adopted to facilitate the implementation of PNF stretching method. Step 4: Divide the teaching process. According to the students. cognitive development ability and physiological development characteristics, Training is carried out and the teaching process is divided. Step 5: Evaluate the teaching effect and objectively evaluate the flexibility of students' hip joints.

2. Comparing the hip flexibility of students before and after PNF stretching teaching, the average score of students in pre-class evaluation is 18.70 (out of 30), and the average score in after-class evaluation is 23.00. The score of after-class evaluation was significantly higher than that of before-class evaluation, and the statistical significance level was 0.01. This is consistent with the research hypothesis.

### Discussion

Using PNF stretching method, the research results of improving the flexibility of hip joint of 30 amateur rhythmic gymnastics students in Xi 'an Art Power Club are discussed as follows:

1. The PNF stretching method of rhythmic gymnastics is based on the theory of human development, emotional activation and event group training, and the scientific stretching teaching method based on the special sports characteristics of rhythmic gymnastics is superior to the traditional teaching method to some extent. The reason is that the PNF stretching method combines the advantages of static stretching and dynamic stretching. The hip joint soft tissue of rhythmic gymnastics students has been stretched for a long time in the process of static stretching, and students will not feel tired as long as they keep still during the training process, but the pain will be very strong. Then dynamic stretching just makes up for this deficiency. Students relax and stretch the soft tissue of hip joint rhythmically again and again under dynamic conditions, so that it has achieved better stretching.



Therefore, PNF stretching method has a certain effect on the training effect of students' hip joint flexibility quality. Guo Zhenfang (2017) thinks that PNF stretching method can improve flexibility and muscle strength, relax muscles and eliminate fatigue more effectively than static stretching method and elastic stretching method. This is because Gorky golgi tendon organ in the tendon of the target muscle group or the antagonistic muscle of the target muscle group, after receiving the dangerous signal, releases the signal to inhibit its activity, thus relaxing the target muscle group and increasing the motion range of the hip joint. Xiong Haixiu (2022) thinks that PNF stretching method can develop students' flexibility and arouse students' enthusiasm more than traditional stretching method. The PNF stretching method requires close cooperation between peers, which makes this training process more interesting. Stretching teaching no longer makes students feel too monotonous and boring, and at the same time, it can effectively avoid muscle injuries during stretching, reduce muscle pain during flexible training, reduce fatigue and speed up the repair of muscle minor injuries.

2. The researcher studied many documents related to PNF stretching method, and according to the characteristics of PNF stretching method, it was integrated into five steps to formulate the teaching plan for amateur rhythmic gymnastics students. The PNF stretching teaching scheme of rhythmic gymnastics is mainly constructed from five aspects: training objectives, training contents, training methods, training process and effect evaluation. Among them, the training goal is the basic point, the training content is the core, the training method is the key, the training process is the guarantee, and the effect evaluation is the result. Data analysis is to evaluate the quality of classroom teaching plan by three experts according to PNF stretching method, and the evaluation results reflect the quality of classroom teaching plan by experts; Generally speaking, the suitability of research objectives is the most appropriate. This is because the learning plan is consistent with the concept of PNF stretching teaching method, and the curriculum plan contains the key elements of the curriculum plan. PNF stretching method can better improve the flexibility of students' hip joints. Wei Xiaomei (2021) thinks that PNF stretching method combines the advantages of traditional stretching method to some extent and will also adopt the static stretching characteristics of static, but at the same time it also emphasizes muscle confrontation and conforms to the dynamic stretching characteristics. The combination of the two features enables people to do stretching exercises with less pain and make muscles stretch for a longer time. This method can effectively reduce the sensitivity of proprioceptors, reduce the stretching reflex of muscles during stretching, and then improve the ductility of muscles and promote the development of hip flexibility. Ge Tianlun (2019) believes that the physiological theoretical basis of PNF is to use anti-stretch reflex to achieve the purpose of muscle relaxation. Muscle isometric contraction will produce strong stimulation to muscles, and tendon spindles in muscles will transmit signals to the central nervous system, which is reflective to muscle relaxation, leading to the generation of anti-stretch reflex. That is to say, the active contraction of the pulled muscle can offset the generated stretching emission, and its relaxation increases after contraction.



3. After using PNF stretching method, the average score of students' hip flexibility before teaching is 18.7, and after teaching it is 23, with an average difference of 4.3. The flexibility of hip joint after teaching is higher than that before teaching. The results showed that the flexibility of hip joint after PNF stretching teaching was significantly higher than that before teaching, which was statistically significant at the level of ( $P < 0.01$ ), which was consistent with the hypothesis. This is because PNF stretching method can change the flexibility by changing the state of nervous system dominating skeletal muscle, improve the coordination between antagonistic muscle and target muscle during stretching, and make the antagonistic muscle relax enough to achieve the stretching effect and improve the flexibility of hip joint. The appearance of teaching effect also proves that the teaching scheme and experimental design constructed before teaching are reasonable, scientific and feasible.

At present, many studies at home and abroad have confirmed that PNF stretching is an important training means to increase flexibility. Previous studies mainly focused on competitive sports and athletes and adults. There is not much research on PNF stretching method in rhythmic gymnastics. Yu Yunzhen (2020) took 27 rhythmic gymnastics students as the research object and found that after 12 weeks of PNF stretching intervention, the effect of PNF stretching method was obviously higher than that of static and dynamic combined training method and traditional static stretching flexible training method. Zhang Feng (2021) took 24 female children's Latin dance students aged 7-10 in Aiwu training institution as the experimental object and conducted an experimental intervention on 12-week hip joint flexibility quality training. The PNF stretching method was compared with the traditional flexible training method. After 12 weeks of PNF stretching intervention, the stretching method had a positive impact on the special technical ability of children Latin dancers. The above results suggest that PNF is an important training method to improve the flexibility of students' hip joint. This study confirmed that 12 weeks of PNF stretching can obviously improve the flexibility of hip joint of amateur rhythmic gymnastics students. Compared with before the intervention, after the intervention, the flexibility of the subjects such as supine hip flexion, lateral abduction, prone hip extension, ground horizontal fork, ground vertical fork, standing and moving legs has been improved, which is consistent with the research of Yu Yunzhen (2020). PNF stretching training can be used as an important training method to improve the flexibility of hip joint of rhythmic gymnastics students.

To sum up, PNF stretching method can effectively improve the flexibility of hip joint of amateur rhythmic gymnastics students. In the resistant stretching stage of PNF stretching method, the effect of resisting muscle can be inhibited by antagonistic muscle contraction, which makes the stretched muscle more easily stretched to a larger range and increases the flexibility of hip joint.

## Recommendations

### Suggestions on the application of research results

1. In order to better popularize the PNF stretching method, it is suggested that relevant schools or institutions strengthen the training of teachers, establish a perfect



professional training system and provide systematic training courses for teachers. The training content should include the principle, skills and safety precautions of PNF stretching method, to ensure that teachers have professional knowledge and skills, deepen teachers' understanding of PNF stretching method and make it better applied to amateur rhythmic gymnastics teaching. It is suggested that teachers should revise the teaching plan in time according to the actual teaching and competition needs and combine PNF stretching method with other stretching methods to create more effective and targeted flexible quality training methods, so as to give full play to the advantages of PNF stretching method and ensure the best teaching effect.

2.As a new stretching method, the principle and mechanism of PNF stretching method are quite different from those of ordinary stretching methods. Based on the painless principle, PNF stretching method has a strong advantage in stretching practice and is more easily loved by students. If this stretching method can be popularized in amateur rhythmic gymnastics teaching, it may improve the flexibility of students' hip joints. Therefore, in daily teaching, we should make full use of the PNF stretching method and give full play to its advantages. This method can be applied to warm-up before exercise, relaxation after exercise and special flexibility teaching, to better improve the flexibility quality of athletes. In the future, with the accumulation of students' learning, when their hip joint flexibility reaches a certain level, more complex PNF stretching technology can also be applied to improve students' hip joint flexibility.

3.Studies have confirmed that PNF stretching method can effectively improve the flexibility of hip joint of amateur rhythmic gymnastics students. However, the PNF stretching method is a teaching method based on the traditional static stretching method, which is a supplement and extension to the traditional static stretching method. Therefore, in the future teaching, it should be combined with the traditional static stretching method and the existing traditional flexible quality teaching method in amateur rhythmic gymnastics teaching, to enrich the teaching method of hip flexibility in rhythmic gymnastics and popularize PNF stretching method reasonably and effectively.

4.When using the PNF stretching method, the partner's operation is very critical. Whether amateur rhythmic gymnastics teachers or peers, we must control the strength and time of stretching to avoid injury and achieve better stretching effect. The teaching of hip joint flexibility should be organically combined with other physical quality teaching, and complement each other, to make students develop in an all-round way and contribute to the national sports cause. Teachers should always put the safety of students first in the teaching process. Avoid injuries caused by overstretching or improper operation, pay attention to students' feedback and adjust the teaching intensity in time to ensure the



safety and effectiveness of teaching. Teachers should have relevant safety knowledge and skills to ensure that students are well protected in the learning process.

5. At present, the traditional static stretching method and dynamic stretching method are still the main flexibility training methods in amateur rhythmic gymnastics teaching, and there are few teaching methods using PNF stretching method, so we should increase the publicity of PNF stretching method. The practice of this method often needs the cooperation of peers, which enriches students' interest in class, improves their enthusiasm in class, and enables them to use it in preparation and warm-up activities, so that students can understand PNF stretching method and popularize this technology in flexibility.

### Recommendations for future research

1. Further promote the PNF stretching method in rhythmic gymnastics teaching, and at the same time, fully consider the differences of students, teach students in accordance with their aptitude, and make a reasonable PNF stretching method teaching plan according to the different conditions of students.

2. In the future, PNF stretching method can be combined with other teaching methods (such as strength teaching and balance teaching) in amateur rhythmic gymnastics teaching to explore the effect of comprehensive teaching on improving flexibility.

3. This experiment was influenced and limited by the number of experimenters, time and economic ability, and only the flexibility quality of the hip joint was tested. In the 12-week flexibility quality teaching, only the contraction and relaxation technology in the special technology of PNF stretching teaching method was selected. The experiment has certain limitations. It is suggested that relevant scholars and experts can further study other key parts such as knee joint and shoulder joint in future teaching and explore other technologies of PNF.

4. Because this study is short, it is suggested that a long-term follow-up study can be conducted in the future to observe the long-term changes of hip flexibility of amateur rhythmic gymnastics students after using PNF stretching method. It can be designed as a long-term experiment for several months or one year to evaluate the lasting effect of PNF stretching method on flexibility more comprehensively.

5. Compare the changes of hip flexibility of rhythmic gymnastics students of different ages after using PNF stretching method. Students can be divided into different age groups, and their responses to PNF stretching method can be observed, to better understand the flexibility teaching needs of students of different age groups.

6. Analyze the factors that affect the effect of PNF stretching method, such as training frequency, duration and tensile strength. By systematically investigating the





influence of these factors on the improvement of flexibility, it can provide a basis for the design of future training programs.

7. Combined with biomechanical analysis method, the mechanism of PNF stretching method on the flexibility of hip joint was deeply studied. Through biomechanical analysis, we can clearly understand the ways and effects of PNF stretching on the flexibility of hip joint.

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