Proceeding

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"Cognitive PNF" to implement adolescent muscle-tendon flexibility

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ABSTRACT

The purpose of this research is to evaluate the significance of concept of proprioceptive neuromuscular facilitation "*Cognitive PNF*" training in increasing muscle-tendon flexibility over the course of 4 weeks (8 training sessions) in a group of 10 participants aged between 13 and 14 years old, comparing it with another group of 10 participants of the same age, subjected instead to 8 sessions of static stretching. The 20 participants underwent a series of entrance tests, in order to identify the level of flexibility and relative joint mobility of the hip, lumbar spine and shoulder joints: Thomas test, hip extension test, lumbar spine flexion, shoulder range test. Subsequently, through the flexibility index, a lack of flexibility in the participants emerged. The statistical model used for both samples is the T-Test for dependent samples. In the control group, the value of the Stat t (-1.17) falls within the acceptance region which is given by the two-tailed critical t (-2.30; 2.30), therefore, the difference between two averages is not significant. In the experimental group, the value of the Stat t (-5.73) falls outside the acceptance region which is given by the two-tailed critical t (-2.26; 2.26), in other words, in the rejection region rejecting the null hypothesis which states that the difference between the two averages is not significant.

Keywords: Cognitive PNF; Static stretching; Muscle flexibility; National guidelines.

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INTRODUCTION

The starting point of the research is represented by the epistemological basis of Exercise and sport sciences (Raiola, 2020ab, Raiola 2019, abc), with specific reference to the field of physical education (Cerini, 2012) such as in the Guidelines of curriculum by Italian minister of education, research and university. In this way the concept of proprioceptive neuromuscular facilitation (Cognitive PNF) is the basis to develop the flexibility of muscles (Elia et al, 2020, Raiola et al, 2020). We will consider the learning objectives at the end of the third grade of lower secondary school (Gaetano, 2012ab) relating to the section: "*Health, well-being, prevention and safety*", specifically:

- Being able to distribute the effort in relation to the type of activity required and to apply respiratory control and muscle relaxation techniques at the end of the work (Altavilla et al., 2019, 2018).
- Knowing how to properly arrange, use and store tools while safeguarding their own and others' safety.
- Practicing movement activities to improve one's physical efficiency, recognizing the benefits, education himself at school and also according to special needs (Raiola, 2017, 2015abc, 2013, 2011ab).

Muscle-tendon flexibility plays a significant role in sports training (Gollin et al., 2011). It emphasizes the extensibility characteristics of the movement actors, the muscles, capable of contracting and, thanks to their elastic properties, of returning to the starting state when the deforming cause ceases (Gussoni et al., 2009). Flexibility is an important component, often overlooked, as it is considered boring, of physical fitness (Cereda, 2009). Flexibility can be both static and dynamic. Static flexibility is defined as the range of motion (ROM) achievable by a single joint or a series of joints (Gleim et al., 1997). The most important measure of dynamic flexibility is stiffness, a mechanical term defined as the resistance of a structure to deform (Halbertsma et al., 1996). The capacity of muscle flexibility is interconnected with that of joint mobility, as mobility depends on the anatomical-structural characteristics of the joints but also on the ability of the antagonist muscles that affect their movements to stretch easily (Colella, 2009). The flexibility of each of us varies according to the following factors: congenital individual factors linked to the elastic-structural characteristics of the joint capsules, ligaments and muscles; factors related to development, age and sex (Altavilla, 2014) such laxity and yielding of ligaments and joint capsules is greater in children than in adults and females, compared to males, show greater mobility (Martorelli, 2015). Flexibility, in addition to being one of the learning objectives set out in the 2012 Indications, is an important quality for physical well-being, correct posture, improvement of sports performance (D'Elia, 2021ab), development of strength and prevention of muscle-tendon joint injuries (Chiarelli et al., 2004, Tiziana et al, 2017). There are different techniques for flexibility training: some aim to alter the viscoelastic properties of muscles and muscle-tendon units (static stretching), while others target neurophysiological reflexes, such as proprioceptive neuromuscular facilitation (PNF) and ballistic stretching techniques (Bandy & Irion, 1994). Through the flexibility index, a poor muscle-tendon flexibility capacity was detected in 20 boys between 13 and 14 years of age. A problem is to establish the adequate educational protocol to apply in physical education (Viscione et al, 2019) and activity in school and outside of it. Thus, aim of the research design is to evaluate the significance of PNF training (Konrad et al., 2015) combined with mental training (Cognitive PNF) in increasing muscle-tendon flexibility, compared to a control group. who performed static stretching sessions (Fivela, 2011).

MATERIAL AND METHODS

Considered two samples composed of 10 units each, of a third grade of a lower secondary school (13/14 years), both were subjected to a series of incoming and outgoing tests to verify the level of mobility and

flexibility (Thomas test to evaluate the extensibility of the hip flexor muscles (boy / girl is supine on a bed, so that the leg protrudes outwards and the possible lifting of the thigh in question with respect to the table is measured, index of a reduced extensibility of the hip flexors); hip extension test (boy is in the prone position, the limb under examination is raised, keeping the knee in extension); flexion test of the lumbar spine (boy / girl stands on a stool and from the standing position bends the torso forward, keeping the knees extended and the arms dangling; the distance between the floor of the stool and the fingertips is measured. room is positive if the fingers go beyond the floor of the stool); wand test that evaluates the flexibility of the shoulders (boy / girl holds a one meter long wand at the ends with both hands and carries out forward-up-back-down circling movements until bringing the wand backwards, keeping the elbows extended, then return to the starting position).

The teaching method chosen by the physical education teacher, in this specific case, is the prescriptive one, which gives great importance to the role of the teacher (coach-instructor) who not only proposes specific exercises, in this case of stretching and mobility. articulate, but also indicates the solution of the motor task to be solved. The main advantage of this method is related to the fact that through it, it is possible to facilitate the control over the development of the program by reducing the learning time, which will take place through observation / imitation, making corrections more targeted to individual actions and / or to the single gesture. The statistical model used is the t-test for dependent samples: a test to evaluate the significance of the differences between the means of the same sample consisting of 10 units over a period of one month (January-February); the purpose of this test is to demonstrate that the higher the value achieved, the greater the flexibility.

I also envisaged the creation of a flexibility indicator given by the sum of the flexibility tests previously carried out.

1) Experimental group
The experimental group carried out 8 sessions of "*Proprioceptive Neuromuscular Facilitation*" (Kabat) (proprioceptive stimulus) combined with mental training (neuronal stimulus) in order to improve the neuronal adaptation of flexibility with respect to motor learning, thus also improving proprioception.

The PNF provides a stretching system divided into 4 times:
1) Stretch: maximum stretching of the muscle is achieved gradually and slowly
2) Voluntary contraction: an isometric contraction is performed for about 15/20 seconds (always in the position of maximum elongation);
3) Relaxation: the isometrically contracted muscle is relaxed for about 5 seconds;
4) Re-Stretch: the muscle is stretched again (previously contracted) for at least 30 seconds.

The cycle will be repeated 2-3 times and the entire sequence will be repeated for 2-3 sets with abundant recovery times.

The control group performed 8 static stretching sessions at the end of the physical education lesson for the following joints: hip, spine and shoulder. The method involves various stages of tensioning the muscles involved:
1) Easy tension: at the beginning of the stretch it is necessary to stop 10 "-*30*" without springing;
2) Medium tension: relax and try to feel the sensation of relieving tension;

3) Development tension: move slowly until you feel a good tension and maintain the position for 10"-*30*"; repeat the exercise at least 3 times. Breathing during exercise must be slow, rhythmic and under control, never hold your breath during the stretch.

Hip joint:
- Leg extensions with torso flexed (keeping the feet together, flex the torso by slightly bending the knees and placing the hands behind the ankles. Then extend the knees trying to keep the torso as flexed as possible, helping with the pressure of the hands on the ankles.
The muscles most affected are the extensors of the thighs on the pelvis. The trunk extensors are also involved);
-Divarations of the thighs from complete bending of the legs (with the legs well apart, push with the elbows on the thighs trying to move them as far as possible towards the back.
The muscles most affected are the adductors of the thighs on the pelvis);
- Side bends (go to the maximum bend. In order not to create stress on the joint structures of the knee of the outstretched limb, turn the tip of the foot upwards.
The muscles most affected are the thigh adductors on the pelvis).

Spinal joints:
- Torso flexions on your knees (bend your torso forward trying to touch the ground with your shoulders.
The muscles most affected are the trunk extensors, with particular reference to the lumbar region.
The extensor muscles of the thighs are also involved, with the exception of the bi-articular ones which are inserted beyond the knee);
- Flexions of the thighs and pelvis from supine (keeping the thighs parallel, bring the knees as close as possible to the chest, helping with the hands placed on the legs, at the height of the knees.
The muscles most affected are the trunk extensors, with particular reference to the lumbar region.
The extensor muscles of the thighs are also involved, with the exception of the bi-articular ones which are inserted beyond the knee);
- Torso rotations from sitting on the ground with one leg stretched forward and the other bent (rotate the torso with the help of an arm placed outside the leg in flexion.
The muscles most affected are the extensors and the lateral inclinators of the trunk).

Shoulder joints:
-Horizontal flexions of an arm from standing position (helping with the hand of the counter-lateral limb, close the arm forward keeping it at shoulder height.
The muscles most affected are those that place the shoulder back and that open the arm and bring it back on the horizontal plane);
- Lateral inclinations of the torso from standing position with one hand gripping above the head (With one hand gripping above the head and feet beyond the perpendicular to the handle, tilt the torso laterally.
The muscles most affected are the forearm extensors, arm adductors and shoulder lowers.
The muscles that flex the torso laterally are also affected, especially in the lumbar region);
-Circulations of the arms with a stick (keeping the elbows always extended, perform circles by stopping in the joint position of greatest tension.
Grasp with a step (hand distance) as tight as possible.
The muscles most affected are those that place the shoulder back and close the arm in the horizontal plane).

RESULTS

Table 1. Results for the control group.

Flexibility January		**Flexibility February**	
Alessio	55	Alessio	58
Cristiano	65	Cristiano	65
Francesca	70	Francesca	68
Rosita	75	Rosita	73
Stefano	73	Stefano	74
Gerardo	62	Gerardo	65
Antonio	56	Antonio	59
Annalaura	69	Annalaura	69
Morena	75	Morena	76
Giorgia	72	Giorgia	72

Table 2. T-test: two paired samples for means.

	Flexibility January	**Flexibility February**
Average	66.66666667	67.44444444
Variance	58.75	40.27777778
Remarks	9	9
Pearson's correlation	0.977322093	
Difference assumed for the means	0	
gdl	8	
Stat t	-1.174853902	
P (T <= t) 1 tail	0.136917435	
t critical 1-tailed	1.859548038	
P (T <= t) 2 tails	0.27383487	
t critical 2-tailed	2.306004135	

Table 3. Results for the experimental group.

Flexibility January		**Flexibility February**	
Elisabetta	60	Elisabetta	90
Annalucia	70	Annalucia	87
Laura	75	Laura	80
Andrea	55	Andrea	60
Giovanni	44	Giovanni	55
Luca	33	Luca	60
Giorgio	50	Giorgio	60
Rossella	90	Rossella	120
Marco	32	Marco	50
Jessica	100	Jessica	120

Table 4. T-test: two paired samples for means.

	Flexibility January	Flexibility February
Average	60.9	78.2
Variance	523.4333333	671.2888889
Remarks	10	10
Pearson's correlation	0.930885528	
Difference assumed for the means	0	
gdl	9	
Stat t	-5.73104676	
P (T <= t) 1 tail	0.00014149	
t critical 1-tailed	1.833112933	
P (T <= t) 2 tails	0.000282979	
t critical 2-tailed	2.262157163	

DISCUSSION

Hypothesis test
$\alpha = .05$;
H0: $\mu 1 = \mu 2$;
H1: $\mu 1 \neq \mu 2$.

Control group: starting from the analysis of the Stat t (-1.17), it falls within the acceptance region which is given by the two-tailed critical t (-2.30; 2.30), therefore, the difference between the two averages it is not significant.

Experimental group: starting from the analysis of Stat t (-5.73), it is evident that it falls outside the acceptance region which is given by the two-tailed critical t (-2.26; 2.26), i.e. in the rejection region, being able, therefore, to reject the null hypothesis which states that the difference between the two averages is not significant. To confirm that the difference between the two averages is actually significant, we will look at the two-tailed *p*-value, in this case .0002, which is lower than alpha level (.05), certifying that it is significant.

The results obtained show that the difference between the groups is significant, therefore, the PNF technique, combined with mental training (Surian, 2021), is significantly effective in improving muscle-tendon flexibility since the mental reproduction of movement from performing also increases awareness of the movement itself (Penati, 2015). Mental training is based on repetition, focused commitment and discipline; through the union of knowledge, experiences and desires, it is possible to expand one's limits towards new possibilities, reaching new challenging and conscious goals (Nyberg et al., 2006).

Basically, it is about speeding up performance development. By combining physical and mental training, it has been scientifically proven that the latter significantly accelerates performance development. That is, it gets better, faster (Amler et al., 2006).

CONCLUSION

The objective of the study was achieved because PNF training combined with mental training (Cognitive PNF) proved to be more effective than traditional stretching techniques (static stretching).

Through internal kinaesthetic images, therefore with a first-person perspective, the boys of the experimental group were able to imagine themselves while reproducing all 4 phases of the PNF method which, combined, then, with the motor execution of the same, showed a 'greater effectiveness in terms of increased flexibility compared to the physical training of the control group alone.

From the study, therefore, the usefulness of the correct practice of stretching exercises with the technique of "*Cognitive PNF*" emerges in physical education lessons at school and also in daily life, verifying the improvements in muscle-tendon flexibility through the index of flexibility theorized in this study.

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