Using an experimental technique to develop children's flexibility
Usando una técnica experimental para desarrollar la flexibilidad de los niños

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Abstract. The purpose of the study is to increase the level of flexibility in children 9-10 years old in physical education classes at school. Materials and methods: Quasi-experimental, non-randomized study. The pedagogical experiment was conducted based on the Ilyinskaya rural school in Russia from September 3 to December 27, 2022. The study involved students from the third grade in the number of 36 people. Children from the control group were engaged in the usual physical education program at school, and children from the experimental group, after a short running warm-up, performed a set of exercises to develop flexibility. To determine the flexibility indicators, control standards from the physical education program at school were used sit and reach tests, lateral spagat and shoulder rotation test with a cane. Results. After the study, the indicators of children from the experimental group showed a significant increase in all 3 tests. The indicators of flexibility in the "Sit down and reach" test increased by 36.4% (p<0.05), the indicators of the "Lateral spagat" test increased from 12.5±2.1 to 8.9±1.9 (p<0.05), and the data of the "Shoulder rotation test" test increased by 18.7% (p<0.05). The children in the control group also improved, but not significantly, on all three tests. The indicators in the "Sit down and stretch" test decreased by 7.4% (p>0.05), the indicators in the "Lateral spagat" test decreased from 12.8±1.8 to 11.7±2.0 (p>0.05), and the data in the "Shoulder rotation test" test changed for the better by 9.9% (p<0.05).

Conclusion. If used a set of exercises to develop flexibility in physical education classes at school when working with children 9-10 years old, then their indicators will significantly improve joint mobility, passive flexibility, active flexibility, schoolchildren, physical culture, sensitive periods.

Keywords: Physical Fitness; Motor Skills; Range of Motion, Articular; Child.

Resumen. El propósito del estudio es aumentar el nivel de flexibilidad en niños de 9 a 10 años en las clases de educación física en la escuela. Materiales y métodos: Estudio cuasiexperimental, no aleatorizado. El experimento pedagógico se llevó a cabo con base en la escuela rural Ilyinskaya en Rusia del 3 de septiembre al 27 de diciembre de 2022. En el estudio participaron estudiantes de tercer grado en número de 36 personas. Los niños del grupo de control participaron en el programa habitual de educación física en la escuela, y los niños del grupo experimental, después de un breve calentamiento, realizaron una serie de ejercicios para desarrollar la flexibilidad. Para determinar los indicadores de flexibilidad, se utilizaron estándares de control del programa de educación física en la escuela, pruebas de sentarse y alcanzar, espagueti lateral y prueba de rotación de hombros con bastón. Resultados. Después del estudio, los indicadores de niños del grupo experimental mostraron un aumento significativo en las 3 pruebas. Los indicadores de flexibilidad en la prueba "Sentarse y alcanzar" aumentaron un 36.4% (p<0.05), los indicadores de la prueba "spagat lateral" aumentaron de 12.5±2.1 a 8.9±1.9 (p<0.05) y los datos de la prueba "Prueba de rotación del hombro" aumentaron de 18.7% (p<0.05). Los niños del grupo de control también mejoraron, pero no significativamente, en las tres pruebas. Los indicadores en la prueba de "Sentarse y estirarse" "disminuyeron en un 7,4% (p>0,05), los indicadores en la prueba de "espagueti lateral" disminuyeron de 12.8±1.8 a 11.7±2.0 (p>0.05) y los datos en la prueba de "Prueba de rotación del hombro " cambiaron para mejor en un 9,9% (>0,05). Conclusión. Si se usan un conjunto de ejercicios para desarrollar flexibilidad en las clases de educación física en la escuela cuando se trabaja con niños de 9 a 10 años, sus indicadores mejorarán significativamente la movilidad articular, la flexibilidad pasiva, la flexibilidad activa, los escolares, la cultura física y los períodos sensibles.

Palabras clave: Aptitud Física; Habilidades Motoras; Rango de Movimiento Articular; Niño.

Introduction

Flexibility is one of the five basic physical qualities of a person. It is characterized by the degree of mobility of the links of the musculoskeletal system and the ability to perform movements with a large amplitude. This physical quality must be developed from early childhood and systematically (Carter & Greenwood, 2015; Gogolev et al., 2018; Mocanu & Dobrescu, 2021).

The external manifestation of flexibility reflects internal changes in the muscles, joints, and cardiovascular system. Lack of flexibility leads to disorders in posture, the occurrence of osteochondrosis, changes in gait. Good flexibility provides freedom, speed and economy of movements, increases the path of effective application of efforts when performing physical exercises. Under normal conditions, a person uses only a relatively small part of anatomical (marginal) mobility and constantly retains a huge reserve of passive mobility, which can be used at any time. Even during sports such as athletics, gymnastics, swimming, which place increased demands on joint mobility, only 80-90% of anatomical mobility is used. Insufficient analysis of flexibility in athletes leads to injuries, as well as to imperfect technique. Insufficient mobility in the joints limits the level of strength, speed and coordination abilities, leads to deterioration of intramuscular and intermuscular coordination, a decrease in economic work is often the cause of damage to muscles and ligaments (Malliaropoulos et al., 2015; Patil et al., 2016; Opplert & Babault, 2018; Masliak et al., 2019; Djalolov, 2020; Donti et al., 2022).

To date, it is known about passive and active flexibility. Active flexibility depends on the strength of the muscles that produce movement in the joint and develops through exercises in which movements in the joints are brought to
the limit by pulling their own muscles or creating a certain force of inertia. With passive flexibility, the amplitude of movements in the joint is greater than with active passive flexibility is developed by exercises in which external force is applied to increase flexibility: weight, strength, weight of various objects. Stretching exercises for muscles and ligaments should be performed, perhaps more often, especially in childhood, when flexibility decreases (Koziris, 2015; Mayorga-Vega et al., 2016; Kum & Martin, 2017; Tomkinison et al., 2018; Ávalos-Ramos & Vega-Ramírez, 2020).

Joint mobility in children is greater than in adults because the bony joint head has more cartilage, while in adults the mobility of the joint surface is limited, leading to conservation of range of motion when flexibility exercises are prescribed. From childhood, where the presence of a sliding surface on the joint head allows movement with greater amplitude, increasing the required range of motion, while muscle stretching exercises should be performed when the muscles are more elastic and less influenced by environmental temperature. The most accepted proposed prescription being the application of these types of exercises after the warm-up (Tokmakidis et al., 2006; Drozdowska et al., 2021; Mukataeva et al., 2022).

Flexibility develops most intensively up to in primary school age. At the same time, the age of 9-10 years will be a sensitive period for the development of flexibility. Purposefully, the development of flexibility should begin from the age of 6-7. In children aged 9-14, flexibility develops almost 2 times more effectively than in high school age. This is due to the high extensibility of the musculoskeletal system in children of this age. The younger school age is characterized by a relatively uniform development of the musculoskeletal system, but the intensity of growth of its individual dimensional features is different. So, the length of the body increases during this period to a greater extent than its mass. The joints of children of this age are very mobile, the ligamentous apparatus is elastic, the skeleton contains a large amount of cartilage tissue. The vertebral column retains great mobility up to 8-9 years. Studies show that the primary school age is the most favorable for the directed growth of mobility in all major joints (Van Hooren & De Ste Croix, 2020; Fuentes-Barría et al., 2021).

When cultivating flexibility, the repeated method is the leading one. Since the main task when performing flexibility exercises is to achieve the maximum amplitude, it is necessary to consider the type of exercise, the number of repetitions (Patil et al., 2016; Braun, 2018; Masliak et al., 2019; Djalolov, 2020; Donti et al., 2022). Unfortunately, many students and teachers underestimate the importance of flexibility in their physical education and sports activities. At the same time, the education of flexibility is of particular importance in general for the education of motor qualities and physical condition of people since it is limited by a rigid age framework. At the same time, it is recommended in schools to perform exercises to develop flexibility in the preparatory and final parts of each lesson. Despite this, in our opinion, insufficient attention has been paid to the development of flexibility in primary school age in standard school programs (Kainov & Kuryerova, 2019). Thus, the education of flexibility in children remains one of the urgent problems of physical culture and sports. For this reason, the aim is to increase the level of flexibility in children 9-10 years old in physical education classes at school.

The problem of reducing flexibility in children aged 9-10 years is quite relevant, in this regard, the pandemic and sedentary lifestyle, obesity had a great impact. Also, in modern physical education programs of the Ministry of Education, there is a low percentage of activities in schools that promote the development of flexibility.

Objective

This work was set out as an objective the aim is to increase the level of flexibility in children 9-10 years old in physical education classes at school. This work was set as a hypothesis the use of complexes of physical exercises would contribute to the development of flexibility in physical education lessons for students aged 9-10 years.

Methods

Study participants

The study was conducted children based who attend Ilyinskaya Rural School (Russia). The experiment involved children aged 9-10 years, who formed a control group (n=18) and an experimental group (n=18). The eligibility criteria were as follows.

Ethical Statement

It should be noted that all procedures were carried out in accordance with the ethical standards of the Helsinki Declaration of 1964 and approved by the special Ethics committee of the University

Inclusion criteria
- Children ages of 9-10 years old in physical education classes at school.
- Children who do not present acute or chronic diseases that prevent them from participating in the experiment.

Exclusion criteria
- Children who did not agree to participate in the experiment if their parent or legal guardian did not sign the informed consent.
- Children who did not have a doctor’s admission to physical education classes at school.

The research procedure

The pedagogical experiment took place at the Ilyinskaya Rural School (Russia) from September 3 to December 27, 2022. The study involved children aged 9-10 years in the number of 36 people who were differentiated into 2 equal groups. The eligibility criteria were as follows.
The control group (n = 18) were engaged in the usual physical education program at school (Kainov & Kuryerova, 2019). This is a running warm-up, a set of general developmental exercises, the study of the material and the final part of the lesson. The experimental group (n = 18) were engaged in the usual program, but additionally performed a set of physical exercises for flexibility. Then there was the study of new material and the final part of the lesson. Before applying a set of flexibility exercises, the children performed a warm-up - running at a moderate pace for 3 minutes. After that, it was necessary to perform 10-12 exercises from the complex to develop flexibility. An approximate set of exercises for the development of flexibility in schoolchildren aged 9-10 years looks like this:

Starting position - the left leg to the side, resting on the gymnastic wall, its foot parallel to the floor: slow turns (8-10 times) of the left leg in the hip joint, holding the poles with your hands. Without changing the starting position, proceed to exercise # 2.

From the starting position of exercise No. 1: springy flexion of the left leg in the knee joint (5-6 times). Grab the poles with your hands, assuming a stable position. The foot of the left foot is parallel to the floor. Without changing the position of the legs, proceed to exercise No. 3.

From the starting position of exercise No. 2, hand grip to the left and right of the left foot to the floor: slow and smooth slopes of the trunk to the straightened left leg (8-10 times), without changing the position of her foot. Without lowering the left leg from the gymnastic wall, proceed to exercise No. 4. Perform the whole set of exercises for the other leg.

Starting position - right lunge with the emphasis on the poles of the gymnastic wall: flexion-extension of the leg with the emphasis on the poles with the hands. Perform 8-10 times on each leg.

Starting position – the left leg is straightened forward in the emphasis on the gymnastic wall: slow springy body tilts forward (6-10 times), fix the hands on the foot of the left foot. In the last tilt, you can fix the final position of the trunk for 10-15 seconds, then perform the exercise for the other leg.

Starting position – the left leg to the side in the emphasis on the gymnastic wall: the trunk bends to the straight supporting leg (8-10 times). Use your fingers or palms to reach the floor. In the last tilt, you can fix the final position for 10-15 seconds, then perform the exercise for the other leg.

Starting position – standing facing the gymnastic wall in a wide stance, feet parallel, grab the poles with your hands at chest level: alternate turns forward-inward with your right and left leg in the hip joint (8-12 times), gradually spreading your legs apart to the maximum (up to the transverse twine). Without changing the position, proceed to the next exercise.

Starting position from exercise No. 7: turn to the left and with springy movements descend into the left splits. Turn around and go into the splits with the other foot.

Starting position – standing with the right side at the gymnastic wall, legs together, take hold of the pole with the right hand: perform 10 swings forward with the straightened left leg with a gradual increase in the amplitude of movements. Turn your face to the gym wall and proceed to exercise No. 10.

Starting position – standing facing the gymnastic wall, legs together, take hold of the pole with your right hand at chest level, and with your left at belly level: perform 10 swings towards the straightened right leg with a simultaneous deviation of the trunk to the left, the foot is parallel to the floor, and the fingers are unbent (take "on yourself"). Turn to the gym wall with your right side and perform exercise No. 11.

Starting position – standing with the right side at the gymnastic wall, legs together, with the right hand take hold of the pole at chest level, and with the left – at the level of the abdomen and slightly ahead of the projection of the body: perform 10 swings backward with the straightened right leg while bending the trunk forward, turn the head half-turned to the right and control the trajectory of the heel movement with a glance. Perform exercises #9-11 for the other leg.

Starting position – standing with your back against the gymnastic wall on your left leg, right straight leg resting on the pole, her foot parallel to the floor, with your right hand take hold of the pole at shoulder level. Submit the pelvis forward, bend in the lower back and perform 10 turns back and forth in the hip joint. Then repeat the exercise for the other leg. When performing flywheel exercises, it is necessary to relax the leg muscles as much as possible, because only in this case it is possible to achieve the maximum amplitude of movement. Performing a stretching exercise, the amplitude of movements should be increased gradually, because otherwise, even after a good warm-up, damage to muscles and ligaments is possible. A gradual increase in the amplitude of movement allows the body to adapt to special work.

Variable

The basic pedagogical tests for assessing the mobility of various joints are the simplest control exercises.

Sit-and-Reach Tests (Kainov & Kuryerova, 2019): It is determined by the degree of inclination of the trunk forward. The subject in the sitting position on the floor leans forward to the limit, without bending his legs at the knees. The flexibility of the spine is evaluated using a ruler or tape by the distance in centimeters from the zero mark to the third finger of the hand. The zero mark is the line between the subject's heels. If the fingers do not reach the zero mark, then the measured distance is indicated by the minus sign (−), and if they fall below the zero mark, then the plus sign (+)

Lateral spagat (Kainov & Kuryerova, 2019): The subject strives to spread his legs as wide as possible to the sides with support on his hands. The level of mobility in this joint is estimated by the distance from the floor to the pelvis (coc-
cxy); the smaller the distance, the higher the level of flexibility.

Shoulder rotation test with cane (Kainov & Kuryerova, 2019): The subject, taking hold of the ends of the gymnastic stick, performs a turn of the straight arms back. The mobility of the shoulder joint is estimated by the distance between the hands when turning: the smaller the distance, the higher the flexibility of this joint. The greatest distance from the floor to the fingertips is measured.

Allocation method

Each subject was assigned to an experimental group or a control group in a non-probabilistic way, this designation being made by pairing in two groups of equivalent size. In such a way that each group was made up of 18 participants.

Analysis unit

Groups of children were considered the lowest administrative unit used to assess the effects of the intervention. This consists of the comparison of sit and reach tests, lateral spagat and shoulder rotation test with cane.

Methods of mathematical statistics

The data were analyzed with the statistical software IBM SPSS Statistics version 27.0 for Windows operating system. The normality of the data distribution was determined using the Shapiro-Wilk test and the homogeneity of the variances using the Levene test, with the data reflected through the descriptors of central tendency and dispersion, mean, standard deviation and percentage. The differences between groups were determined with the T Student test considering for all the analyses an alpha level of 0.05.

Results

In the initial stage of the pedagogical experiment, the initial tests revealed that the experimental (n =18) and control (n =18) groups did not have significant differences in the three flexibility indicators (p>0.05). The results obtained allow us to talk about the homogeneity of the groups of children at the beginning of the experiment (Table 1).

Table 1.
Baseline characteristics of flexibility development in primary school children before the experiment in the control group (n =18) and experimental group (n =18).

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Groups</th>
<th>Before</th>
<th>After</th>
<th>%</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sit and Reach Tests (cm)</td>
<td>EG</td>
<td>5.5±0.6</td>
<td>7.5±0.8</td>
<td>36.4%</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>5.4±0.7</td>
<td>7.0±0.9</td>
<td>7.4%</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Lateral spagat (cm)</td>
<td>EG</td>
<td>12.5±2.1</td>
<td>8.9±1.9</td>
<td>28.8%</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>12.8±1.8</td>
<td>11.7±2.0</td>
<td>8.6%</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Shoulder rotation test with cane (cm)</td>
<td>EG</td>
<td>42.2±5.3</td>
<td>34.3±2.5</td>
<td>18.7%</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td>CG</td>
<td>44.3±4.9</td>
<td>39.9±4.6</td>
<td>9.9%</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>


Table 2 shows that during the period of the pedagogical experiment, the indicators in the control group improved on all tests, however, the improvement was not significant and not reliable. The indicators in the "Sit down and stretch" test decreased by 7.4% (p>0.05), the indicators in the "Lateral spagat" test decreased from 12.8±1.8 to 11.7±2.0 (p>0.05), and the data in the "Shoulder rotation test" test changed for the better by 9.9% (p>0.05).

In the experimental group of schoolchildren, there was a significant and reliable increase in indicators for all tests. The indicators of flexibility in the "Sit down and reach" test increased by 36.4% (p<0.05), the indicators of the "Lateral spagat" test increased from 12.5±1.1 to 8.9±1.9 (p<0.05), and the data of the "Shoulder rotation test" test increased by 18.7% (p<0.05).

To illustrate the results of the experiment, they can be presented in the form of a diagram, all indicators from the beginning to the end of the study in both groups are presented in percentage terms in Figure 1.

Discussion

Any movement of a person is made due to mobility in joints. It is difficult to overestimate the importance of mobility in joints in cases of impaired posture, correction of flat feet, after sports and household injuries. Usually, a
person rarely uses all his maximum mobility and is limited to any part of the available maximum amplitude of movement in the joint. However, insufficient mobility in the joints limits the level of manifestation of strength, negatively affects speed and coordination abilities, reduces the efficiency of work and is often the cause of damage to ligaments and muscles. In some movements, human flexibility plays a fundamental role (Merino-Marban et al., 2015; Schwanke et al., 2016; Lopes et al., 2017; Polevoy & Sadbin, 2022).

The analysis of scientific and methodological literature shows that the development of flexibility in children of primary school age has differences due to the age characteristics of the child's body. Flexibility is actively developing up to 15-17 years old. At the same time, purposefully influence the development of flexibility effectively in 9-10 years (Van Hooren & De Ste Croix, 2020; Fuentes-Barria et al., 2021). This is also confirmed by our study, since minor but positive changes in flexibility indicators during the study period were obtained in both groups.

In children of primary and secondary school age, active mobility in the joints increases, and in the future it decreases. This is due to the gradual deterioration of the elasticity of the musculoskeletal system, intervertebral discs and other morphological changes. Age-related features of joints must be considered in the process of development and flexibility (Drozdowska et al., 2021; Estivaleti et al., 2022; Maliccevic et al., 2022; Yip et al., 2022). In the process of preparing a pedagogical experiment, a set of physical exercises was developed aimed at developing flexibility in physical education lessons for elementary school students. The use of the developed sets of physical exercises contributed to the development of flexibility in elementary school students. According to the results of the study, it was revealed that children who performed a special set of exercises for the development of flexibility were able to improve performance significantly and reliably on all tests. Despite the rather short period of time of the study, an impressive result was achieved. This indicates not only the effectiveness of the use of a set of flexibility exercises, but also the appropriate age of children who were selected for the study. However, it should be noted that children from the control group who did not perform exercises to develop flexibility were able to show a positive result, albeit not significant. In our opinion, this justifies the use of a regular program in physical education classes at school, as well as the fact that the natural increase in flexibility falls on the younger school age. This is confirmed by previous studies (Willems et al., 2014; McKay et al, 2017; Donti et al., 2018; Yin et al., 2019; Warncke et al., 2023).

It is recommended to include flexibility exercises in a small amount in the morning hygienic gymnastics, in the introductory (preparatory) part of the physical education lesson, in the warm-up during sports. The load in flexibility exercises in individual classes and throughout the year should be increased by increasing the number of exercises and the number of their repetitions.

Even though the research tasks have been completed and the goal has been achieved, we assume that the issue of flexibility development can be studied additionally by applying an expanded set of exercises for schoolchildren of different ages and genders.

It should be noted that modern research often mentions the problem of a sedentary lifestyle and raises the problem of obesity (Ortiz Sánchez et al, 2021; Curotto-Winder et al, 2022; Rodriguez-Cáceres et al, 2023; Dávila-Morán et al, 2024). Physical education at school (Hall-López, 2020; Giakoni et al, 2021; Rocha et al, 2022; Balcázar, 2024) plays a great role in solving this problem for school-age children. Flexibility is the most important physical quality of a person, which affects the development of other physical qualities, such as speed, endurance, strength, coordination of movement (Gómez-Rossel & Merellano-Navarro, 2024; Polevoy, 2024). Flexibility needs to be developed from primary school age and increased attention should be paid to this quality, including in physical education classes at school. Of course, the current study could be improved by comparing the results of both flexibility and other physical qualities of schoolchildren in urban and rural schools in Russia.

Conclusion

In the process of physical education classes at school, it is necessary to develop physical qualities. The age period for the development of certain qualities is limited, including flexibility. The present study proves that if a set of exercises for the development of flexibility in primary school children is introduced in physical education lessons, their indicators will significantly improve.

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Conflict of interest

None. The authors declare no conflict of interest

Author contributions

Author Contribution: Study design; Data collection; Statistical analysis; Manuscript Preparation; Funds Collection – Georgiy Polevoy.

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References

2024, Retos, 58, 1006-1013


Malicic, S., Mirkov, D., Milanovic, I., Radisavljevic-Janic, S., Batez, M., & Mazic, S. (2022). Is the physical fitness of schoolchildren dependent on their physical activity levels and nutritional status? The experience from
lar: revisión sistemática de estudios longitudinales (Effects of sedentary school-age children: a systematic re-
view of longitudinal studies). Retos, 40, 404–413. https://doi.org/10.47197/retos.v40i4.83028

Patil, S. S., Manjunath, A. M., & Swamy, K. (2016). Ef-

Polevoy, G. G., & Sabin, A. B. (2022). Development of Flexibility of Children with Different Types of the Nervous System Using Speed-Strength Exercises. Ar-
chives of Pharmacy Practice, 13(2), 7-10. https://doi.org/10.51847/1urdpfmgPw


Rodríguez-Cáceres, A., Sánchez-Vera, M. A., Alfonso Mo-
a, M., Sarmiento-Gonzalez, P., Lever Méndez, J., García Becerra, A. M., Guerra-Balic, M., & Sánchez-
Martin, R. (2023). Relación entre la exposición a pant-
tallas, el comportamiento sedentario y el dolor muscu-
loesquelético en adolescentes: revisión sistemática (Re-
lationship between screen exposure, sedentary behavior and musculoskeletal pain in adolescents: a systematic re-
view). Retos, 50, 1064–1070. https://doi.org/10.47197/retos.v50i0.99865


Tomkinson, G. R., Carver, K. D., Atkinson, F., Daniell, N. D., Lewis, L. K., Fitzgerald, J. S., Lang, J. J., & Ort-
tega, F. B. (2018). European normative values for phys-

Van Hooren, B, & De Ste Croix, M. (2020). Sensitive Per-
iods to Train General Motor Abilities in Children and


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