Issue Rehabil. Orthop. Neurophysiol. Sport Promot. 2021; 36: 17–29. ISSN 2300-0767
DOI: 10.19271/IRONS-000140-2021-36

RESEARCH REPORT

DISTANT MOTOR EFFECTS OF DISCONTINUATION OF RHYTHMIC GYMNASTICS

ODLEGŁE SKUTKI ZMIAN W SPRAWNOŚCI RUCHOWEJ W NASTĘPSTWIE PRZERWANIA UPRAWIANIA GIMNASTYKI ARTYSTYCZNEJ

Aleksandra Bieniaszewska[1], Ewa Gajewska[1], Wojciech Manikowski[2], Barbara Steinborn[1]
[1]Department of Developmental Neurology, Karol Marcinkowski University of Medical Sciences in Poznań, Poland
[2]Department of Physiotherapy and Rehabilitation, Karol Marcinkowski University of Medical Sciences in Poznań, Poland

ABSTRACT

Introduction

Rhythmic gymnastics is a discipline intended only for women with above-average motor skills such as speed, coordination and jumping ability. Advanced training begins in early childhood, and the selection of candidates is motivated by innate predispositions required by coaches, i.e. appropriate physical conditions, adaptation of the body to exercise and sense of rhythm. Selected gymnasts train by learning to perfectly perform routines with devices such as a ball, ribbon, rope, clubs or hoops.

Aim

The aim of the study is t show distant motor effects of discontinuation of rhythmic gymnastics.

Material and methods

Two groups of female gymnasts were compared in the study. The first of them consisted of current training, competitive gymnasts, while the other – female athletes who stopped practicing this discipline. The study checked, among others, the occurrence of possible injuries, pain and their location as well as the consequences of discontinuation of training. All of the obtained results were compared between the groups.

Results

Currently, training gymnasts suffer from less pain than former female gymnasts, however, already at such a young age, they experience first problems both in the spine and lower limbs. In both groups, the most common conditions are hypermobility, spinal overload syndromes and ankle sprains.

Conclusions

The results of former female gymnasts clearly show that problems with former female gymnasts are a consequence of practicing rhythmic gymnastics, and their intensity increases over time, leading to long-term effects of practicing this discipline.

Keywords: rhythmic gymnastics, sports injuries, consequences of competitive sports, early competitive training.

Author responsible for correspondence:
Aleksandra Bieniaszewska
Department of Developmental Neurology
Karol Marcinkowski University of Medical Sciences in Poznań, Poland;
Przybyszewskiego 49
60-355 Poznań, Poland
email: aleksandra.wlodarczyk.94@gmail.com
https://orcid.org/0000-0002-8298-6920

Authors reported no source of funding
Authors declared no conflict of interest

Date received: 26th May 2021
Date accepted: 17th August 2021

STRESZCZENIE

Wstęp

Gimnastyka artystyczna to dyscyplina skierowana wyłącznie dla kobiet charakteryzujących się ponadprzeciętnymi zdolnościami motorycznymi takimi jak szybkość, koordynacja, gibkość i skoczność. Zaawansowany trening rozpoczynany jest we wczesnym dzieciństwie, a wybór kandydatek motywowany jest wymagającymi przez trenerów wrodzonymi predyspozycjami tj. odpowiednimi warunkami fizycznymi, adaptacją organizmu do wysiłku czy poczuciem rytmu i dobrym słuchem muzycznym. Wybrane gimnastyczki trenują ucząc się idealnego wykonywania układów z przyborami takimi jak piłka, wstążka, skakanka, maczugi czy obręcz.

Cel

Celem pracy jest ukazanie odległych skutków ruchowych zaprzestania uprawiania gimnastyki artystycznej.

Materiał i metody

W pracy porównano dwie grupy zawodniczek. Pierwszą z nich tworzyły aktualnie trenujące, wyczynowe gimnastyczki, natomiast drugą – zawodniczki, które zaprzestały uprawiania tej dyscypliny. W badaniu sprawdzano m.in. występowanie ewentualnych kontuzji, dolegliwości bólowych i ich lokalizacji oraz następstw wynikających zaprzestania trenowania. Dodatkowo wykonywano testy diagnostyczne potwierdzające występowanie ewentualnych dolegliwości. Wszystkie uzyskane wyniki porównano między grupami.

Wyniki

Obecnie trenujące gimnastyczki charakteryzują się mniejszymi dolegliwościami bólowymi niż byłe zawodniczki, jednakże już w tak młodym wieku odczuwają pierwsze problemy zarówno w obrębie kręgosłupa, jak i kończyn dolnych. W obu grupach najczęściej występującym schorzeniem są hipermobilność, zespoły przeciążeniowe kręgosłupa oraz skręcenia stawów skokowych.

Wnioski

Wyniki byłych zawodniczek wyraźnie ukazują, że problemy dotyczące byłych zawodniczek są następstwem trenowania gimnastyki artystycznej, a ich nasilenie potęguje się w czasie prowadząc do odległych skutków uprawiania tej dyscypliny.

Słowa kluczowe: gimnastyka artystyczna, sportowe kontuzje, następstwa wyczynowego sportu, wczesny wyczynowy trening.

Introduction

Rhythmic gymnastics is a discipline intended for girls aged 4–24. It focuses on developing such motor skills as speed, coordination, agility, jumping ability and endurance, as well as manual dexterity, harmonious movement and the ability to move aesthetically. As a sport, it combines elements of acrobatic routines with elements of classical dance. It consists in performing individual or collective routines with the use of five types of apparatus: ribbons, ropes, hoops, clubs and a ball (Kuźmińska, 1991; Flessas, 2015; Batista, 2018).

Girls who want to practice this discipline must have innate predispositions. These include appropriate physical conditions, motor condition, the body's adaptation to physical effort, speed to develop motor skills, above-average jumping ability, agility, motor

coordination (Vernetta, 2017). In addition, when recruiting a gymnast, attention is paid to the ability to quickly learn and remember movement, sense of rhythm, good hearing as well as impeccable appearance. Lack of these predispositions basically eliminates a person from the further recruitment process (Kuźmińska, 1991; Fernandez-Villarino, 2013). All gymnasts have a slender body type, they are tall, they have very long limbs, a specific type of muscles, high arches of the feet and well-developed flexibility of the legs and torso. Each of them shows above-average mobility in all joints. Female gymnasts with predispositions, strong psyche, natural talent and a good training program in combination with regular training have a chance to achieve the best results (Kuźmińska, 1991).

There is a lot of controversy about children doing sports so early. Many doctors emphasize the significant impact of bad training on the development of diseases, malformations or sports injuries. The intensity of exercise has a slight impact on the delay in physical development, height reduction or delayed sexual maturation (Malina *et al.,* 2013; Antualpa, 2017). There is also a noticeable effect of training intensity on the acceleration of the process of ossification of cartilage growth elements in long bones (Kuźmińska, 1991; Rutkowska-Kucharska *et al.,* 2018). In addition, it is pointed out that there are unequal proportions between the sense of responsibility and ambition in children on the one hand, and skills and psyche on the other (González-Valero *et al.,* 2020). It is worth mentioning, however, that this sport, through the easy acquisition of new motor skills, significantly affects the development of motor skills, leading to the so-called "motor excellence." Physical activity also helps to get rid of excess energy, which is a common phenomenon in predisposed children. In addition, a positive impact of training on shaping the correct, aesthetic body posture and developing artistic sensitivity has been noticed (Kuźmińska, 1991).

Among all factors predisposing to practicing rhythmic gymnastics, hypermobility is the most important one. Mild joint hypermobility syndrome, otherwise known as joint laxity, is characterized by excessive mobility above the accepted standards and affects both the upper and lower limbs and the spine, consequently leading to instability within these structures (Zimmermann-Górska, 2007; Mirska *et al.,* 2011). Over time, it can cause chronic pain and an increased risk of joint dislocation or subluxation. It is a predisposing factor to injuries. The lack of proper bending makes it impossible for the gymnast to properly perform the elements of the exercise, thus eliminating the chance to practice rhythmic gymnastics. Deepening the spine bending or stretching the muscles begins from the very beginning of training and is maintained throughout the time of practicing the discipline. After discontinuation of training, excessive mobility is gradually reduced, but nevertheless these ranges are still higher than the generally accepted standards (Sands *et al.,* 2016).

Training injuries are most often caused by repetitive forces acting chronically on the musculoskeletal system. As a result of the repeated reproduction of the same elements in above-average ranges, i.e. jumps, turns, somersaults or hyperextensions, there is a potential risk of acute neurological damage. Injuries in women practicing competitive sports most often occur in the area of the spine and lower limbs. This contributes to the temporary elimination of an athlete from training, and some of them lead to the long-term effects of movement disorders in later years (Lennard and Crabtree, 2007; Kruse and Lemmen, 2009; Hinds *et al.,* 2019;). The basic ailments of rhythmic gymnasts in the area of the spine include, among others: spondylolisthesis and spondylolysis, discogenic pain, pain in the sacroiliac joint, sprains of the intervertebral joints, fractures of the vertebral shafts, arches and articular processes, spinal overload syndromes and scoliosis (Garlicki and Kuś, 1988; Kuźmińska, 1991; Tanchev *et al.,* 2000; Lennard and Crabtree, 2007). Among lower limb injuries, on the other hand, sprains of

the ankle joints, injuries of the knee ligaments, longitudinal and transverse flat feet and halluxes are found (Kusz, 2010; Złotkowska *et al.,* 2015; Edouard *et al.,* 2018;).

Aim

The aim of the study is to show distant motor effects of discontinuation of rhythmic gymnastics.

Material and methods

Twenty of the examined women were divided into two equal groups. The first of them consisted of professional athletes practicing rhythmic gymnastics. Their average age was 12.9 years, ranging from ten to fifteen. The vast majority of gymnasts in this group (70%) are underweight, while 30% of them have healthy body weight, while they started their professional training at the age of six, practicing for around four to eight years. The other group consisted of gymnasts who have stopped practicing the discipline. The mean age of the former gymnasts was 29.2 years on average, ranging from twenty-seven to thirty-three. BMI values differ significantly from the group of current female gymnasts, as only 20% of them are underweight, 10% are overweight, and 70% are of normal body weight. They started their professional training at the average age of seven, while the average training time was about 11 years (in individual cases up to 14 years). Female gymnasts stopped training on average 12 years ago, most often due to the lack of willingness to continue practicing the discipline or progressing age and the related awareness of achieving worse results than younger gymnasts (Table 1).

The study was conducted once between December 2018 and April 2019. It consisted of two parts: a questionnaire and a study. The questionnaire contained 23 questions and was divided into two parts. The first of them was addressed to both groups of subjects (12 questions), while the second part (11 questions) concerned only former gymnasts. The initial part of the questionnaire took into account the age of starting the discipline, the training time, the time of injury, diseases of the skeletal system and pain ailments along with their location. The second part focused on the possible consequences of practicing the discipline, including increasing or reducing the mobility and pain, the time that elapsed since the subject stopped training, because of giving up the discipline and the possible connection of current ailments with previous sports practice.

The study part included diagnostic tests, such as the toe-floor test with modification (distance in centimeters below 0), the fingertip test, Mennell's, Patrick's, Childress's, Otto's and Schober's symptoms. The generalized laxity was also examined on the basis of the 9-point Beighton score and the mobility of the collateral ligaments of the knee joint.

Results

In order to assess the long-term motor effects resulting from the discontinuation of rhythmic gymnastics, both groups were compared in terms of the number of injuries, their type, the level of pain along with their location, changes in the range of motion and positive results of diagnostic tests.

Injuries

The vast majority of gymnasts suffered injuries during training. Out of the 20 surveyed gymnasts, as many as 16 suffered an injury, which constituted 80% of the surveyed gymnasts, and nine of them suffered more

Table 1. Comparison of study groups.

Training	Former gymnasts
Average age around 13 70% underweight, 30% normal Having trained since the age of 6–7 For a period of 4–9 years	Average age around 29 20% underweight, 70% normal, 10% overweight Having trained since the age of 6–7 For a period of 10–12 years

than one injury. Taking into account the location of the injuries, out of the total of 28 injuries, as many as 75% concerned the lower limbs, and the remaining number was located within the spine. The vast majority of lower limb injuries (almost 60%) concerned the foot, while the most common location in the spine was the lumbosacral region (80%).

When comparing the two groups, some differences can be seen. There were 12 injuries in the group of gymnasts currently exercising. The ratio of the lower limb injuries to the spine was 6:4. A much greater disproportion was noticed in the former gymnasts, who had 17 injuries, and the ratio of lower limb injuries to the spine is 15 : 1. This may indicate a difference in the way the younger generation of gymnasts train or a change in regulations.

The most common injury in both groups was ankle sprain. This ailment occurred in eight of the examined gymnasts, of which three former athletes had already been diagnosed with habitual sprains within this joint. In addition, fractures within the foot bones were observed, including fracture of 3rd-5th metatarsal bones or fracture of distal phalanges in two subjects and fracture of the patella. Other injuries also included injuries of the anterior cruciate ligament (2 cases), acute L-S pain ailments (2 cases), muscular injuries (5 cases), including cervical torticollis, rupture of the iliotibial band, rupture of the quadriceps, slender and biceps muscles of the thigh or inflammation of the groin area. In addition, there were two cases of shoulder subluxation and single injuries, such as: a herniated intervertebral disc, dislocation of the patella and damage to the medial meniscus of the knee joint. The injuries occurred at various training periods, and the duration of absence ranged from a week to a year depending on the type of injury. Most often, however, the lack of training was limited to 2 weeks to a month. In three gymnasts, despite the presence of an injury, there was no break in training – only a decrease in its intensity.

Most frequent diseases found in gymnasts

During the survey, the surveyed gymnasts provided answers about ailments, diseases or symptoms which, according to the literature, most often occur in this types of athletes. Among the surveyed, 100% of female athletes have had generalized polyarticular laxity, which is a feature that predisposed them to train gymnastics. Taking into account all of the diseases, the most common ailments in this group were spinal overload syndromes and they affected as many as fourteen out of twenty subjects. Nine persons were diagnosed with at least one episode of an ankle sprain, and eight had a problem with sacroiliac joints. Transverse flat feet are diagnosed in 50% of female athletes, while longitudinal flat feet concerned a smaller group – six gymnasts. Scoliosis occurred in 30% of subjects. The collective results of diseases characteristic of the gymnasts are presented in Table 2.

Table 2. Diseases characteristic of gymnasts.

Disease	Total number of gymnasts	Percentage of gymnasts
Generalized polyarticular laxity	20	100%
Spine overload syndromes	14	70%
Ankle sprains	9	45%
Pain in the sacroiliac joints	8	40%
Transverse flat feet	10	50%
Longitudinal flat feet	6	30%
Scoliosis	6	30%
Halluxes	6	30%
Knee ligament injuries	3	15%
Discogenic pain	2	10%
Spondylolisthesis	1	5%
Fractures of arches, shafts and articular processes of vertebrae	0	0%
Sprains of the intervertebral joints	0	0%

The incidence of scoliosis and ankle sprains was comparable in both groups. However, there were significant differences in other conditions. Halluxes affected six subjects, all of whom were a part of the second study group. The comparable results were those for spine overload syndromes (only four out of fourteen subjects belonged to the group of people currently training) and pain in sacroiliac joints: 88% of them were former gymnasts. Moreover, in this group, many more subjects had transverse flat feet (seven out of ten) and knee ligament injuries (100% of injuries in this group). Former gymnasts confirmed the presence of diseases such as discogenic pain (in two cases) and spondylolisthesis (in one), which were not found in the first group. The only disease predominant in the currently training gymnasts is that of longitudinal flat feet (4/6 of the diagnosed). The above results comparing the most common diseases are presented in Figure 1.

the current sensations. The visual analog scale (VAS) for pain was used for this. Additionally, they were asked to identify the location of the pain taking into account the spine, hip and knee joints as well as symptoms within the foot. Taking into account the results of all gymnasts, the average value in the VAS scale during training was defined as 4/10. Taking into account the location, as many as 75% of subjects suffered from back problems. Symptoms around the hips, knees and feet were constantly present. In all cases, these ailments were experienced by 40% of subjects.

However, when comparing the two groups, some differences were visible, which was emphasized by the histogram of the VAS scale (Figure 2). On average the currently training gymnasts rated the pain during training as 3/10 on the VAS scale, while the former gymnasts estimated it as 5/10. The pain felt after giving up competitive sports also reaches higher values, reaching 6/10,

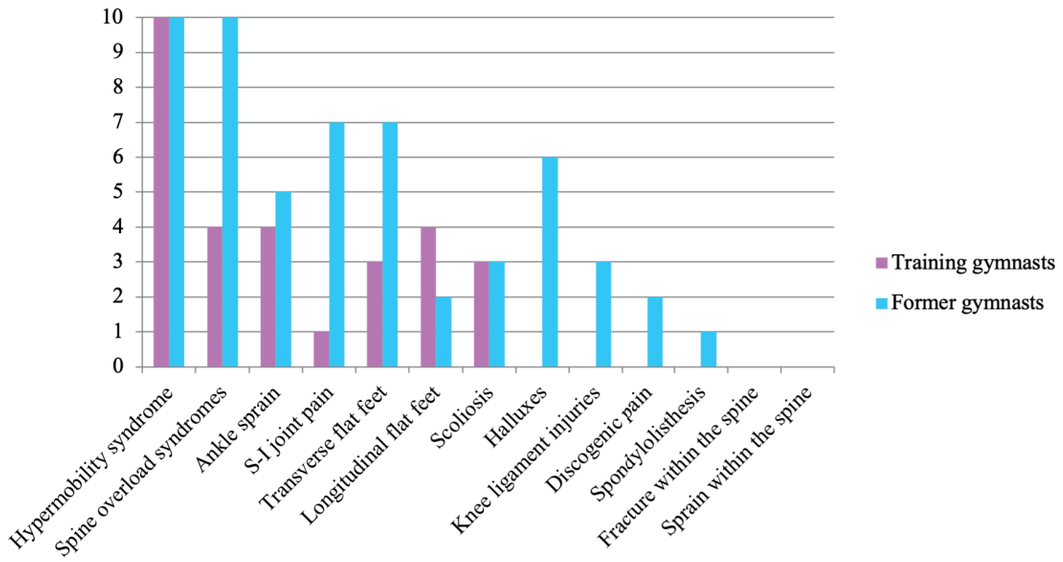

Figure 1. Comparison of groups in terms of the most common diseases occurring in gymnastics.

Pain

During the survey, the subjects answered questions on pain ailment. The current gymnasts were to assess the perceived pain, while the former gymnasts determined both the pain during practicing the discipline and but individually were showing much higher results – the values of 8/10 appeared twice and 9/10 once.

Taking into account the location, as many as 100% of the former gymnasts suffered from back pain, 50% from hip pain, 30% from knee

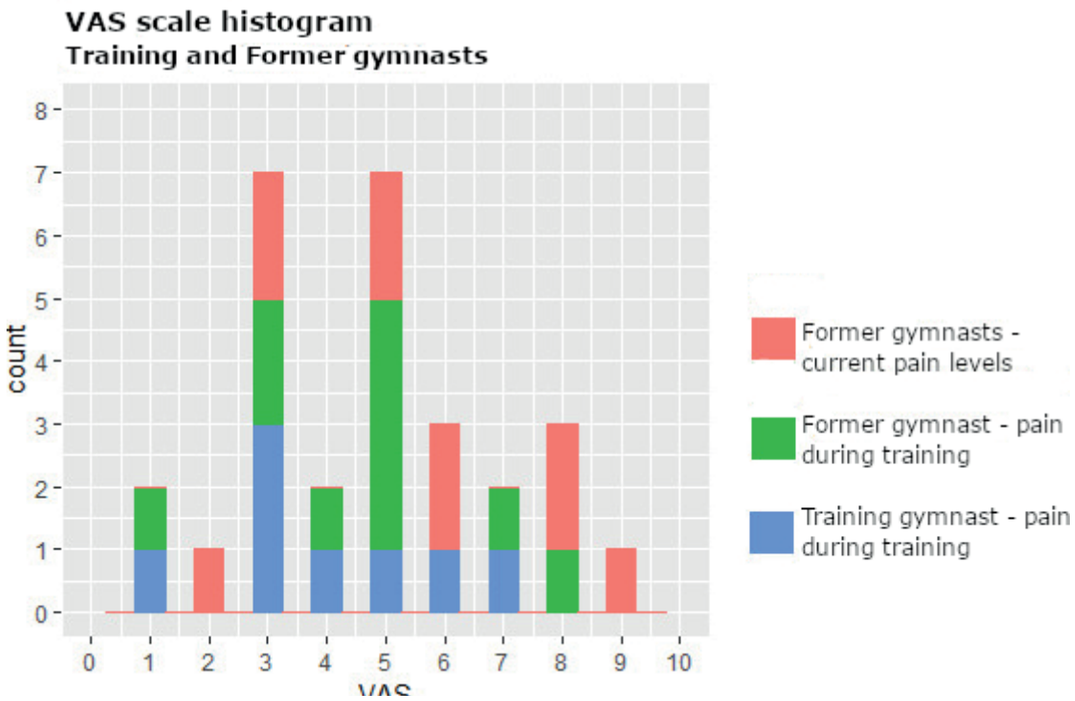

Figure 2. Comparison of VAS scale in training gymnasts and former gymnasts divided into now and before.

pain, and 40% from foot pain. The situation was different for the currently training gymnasts. In this case, 50% suffered from spine pain, 30% from hip pain, 40% from foot pain, and conversely to the former gymnasts – as many as 50% from knee pain. The results comparing the location of the ailments are presented in Figure 3.

Diagnostic tests

During the study, functional tests were carried out for, among others, confirmation of generalized polyarticular laxity, checking the mobility of the thoracic and lumbar

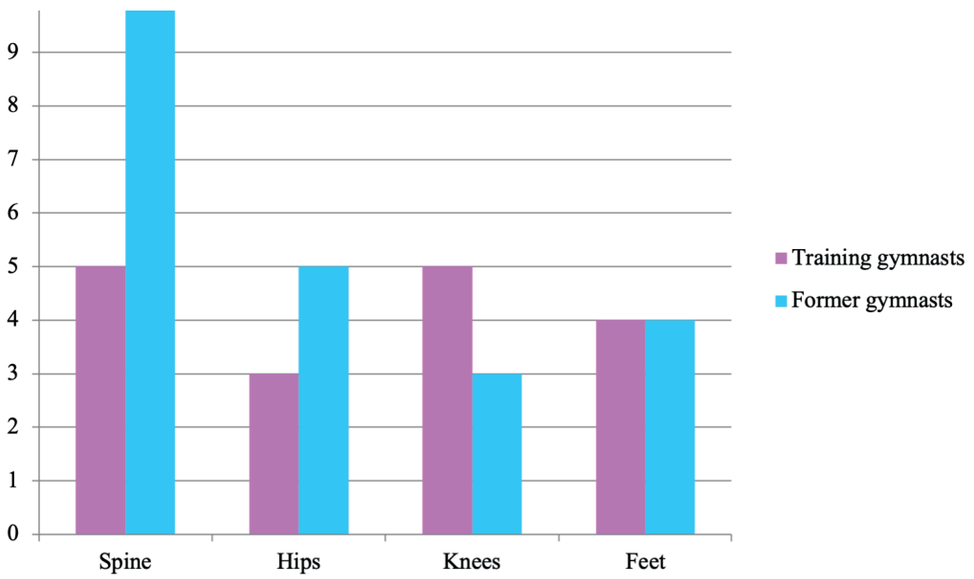

Figure 3. Comparison the of pain location in both groups of studied subjects.

sections, complaints within the sacroiliac joints or menisci.

The first assessed parameter was the Toe-floor Test. Out of 20 subjects, none of the gymnasts had a problem with their hands touching the floor, so an additional parameter has been taken into account. The modified Toe-to-floor Test assessed the distance below 0 which the gymnasts were able to reach when performing the forward bend. The average value for the current gymnasts was 17.5 cm, while for the former gymnasts it was surprisingly 23.5 cm. Another assessed parameter differentiating the mobility of the lumbar spine from the stretching of the hamstring muscles was the fingertip test. The average results in the group of current gymnasts for both limbs was 11 cm. Among the former female gymnasts, these values were 10 cm for the leading limb and 9.5 cm for the non-leading limb, respectively. This may suggest that the mobility of the lumbar spine is higher in current gymnasts than in former female gymnasts.

In order to confirm the generalized polyarticular laxity, the nine-point Beighton Score was used. For the purpose of obtaining a diagnosis, it was necessary to score five points, which was obtained by 100% of the subjects. For the current gymnasts this result was on average 9, while for the former 7.5 points. Moreover, the mobility of the medial and lateral ligaments in the knee joint was assessed. All of the subjects presented excessive mobility in these structures.

The final test was the assessment of the mobility of the spine. The physiological standard of Otto's Symptom examining the mobility of the thoracic segment during forward flexion ranges from 2–4 cm, while during the hyperextension of the spine, a shortening of 1–2 cm is observed. In training gymnasts, the first of these values was on average 5 cm, while when extending backwards, the results range between 7 and 12.75 cm. In both cases, these results were much higher than the prescribed standard. When comparing the results with the former gymnasts, similar relationships were visible. During the forward flexion, the average value presented by this group was 3.5 cm, thus complying with the standard, but during the hyperextension movement, the value was between 5 and 6.5 cm, thus again exceeding the physiological standard. Thus, we can notice significantly increased segmental mobility in both groups. The Schober's Symptom, during which the mobility of the lumbar region was similarly tested, has given the following results. In the group of female athletes who were currently training, the average value during flexion was 7 cm, and 4 cm during extension. Both values also exceed the assumed standard of 5 cm for flexion and 1–2 cm for extension. Comparing the results with former gymnasts during flexion, the group was in the range between 8.25–12 cm. The extension range was similar – between 2.25 and 4 cm. For a better comparison of the results, both parameters of the Otto-Schober's Symptom were combined, assuming the physiological standard of flexion as values from 7–9 cm, while during extension – shortening of 2–4 cm. Comparing both values, it was significant that only one of the subjects presents a value lower than the assumed standard – which was 15% of gymnasts, while as many as 80% of female gymnasts had much higher results. The extension parameter looks similar – with the difference that in this case 100% of gymnasts exceed the standard. The comparative results of the Otto-Schober's Symptom are presented in Figure 4.

At the end of the study, provocation tests were used. During the Mennel's Test only one competitor tested positive for both sacroiliac joints twice. The other group is clearly different. 50% of the former gymnasts had at least one positive result, of which 60% showed bilateral symptoms. Two gymnasts obtained a single result for the non-dominant limb. The results comparing both groups of female gymnasts are presented in Figure 5.

The Patrick's test was used as another provocation test. 40% of currently training gymnasts show a positive result of this

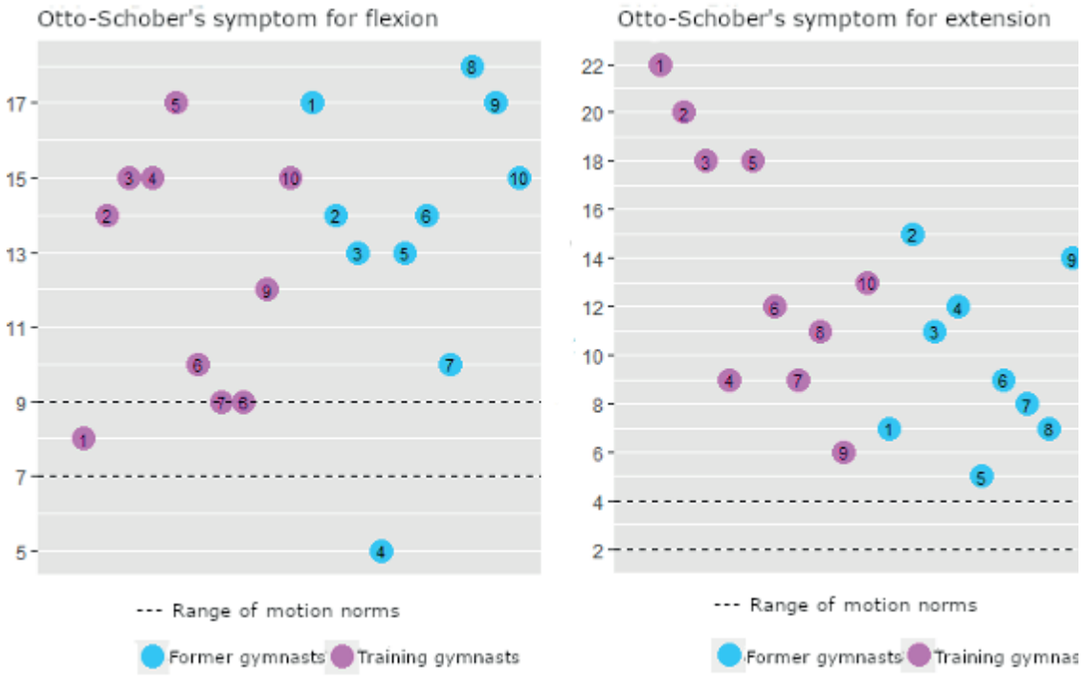

Figure 4. Comparison of the Otto-Schober's symptom for flexion and extension.

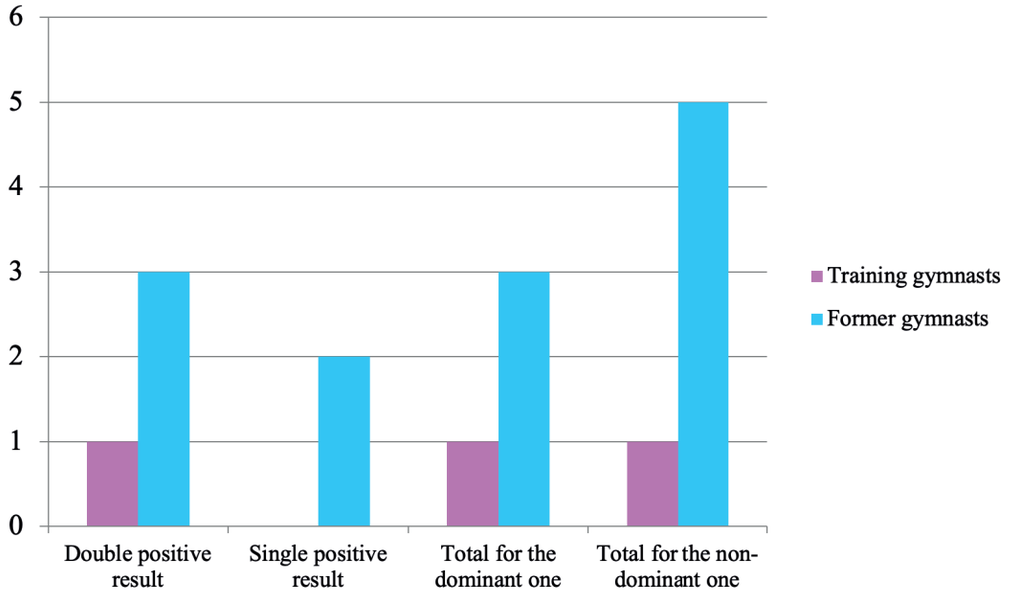

Figure 5. Comparison of the results for the Mennell's Test.

test, with each of them having the change in the non-dominant limb. Among the former gymnasts, a positive result can be observed in as many as 80%. A double positive result can be seen in four female gymnasts. The results are presented in Figure 6.

The Childress Test for pain in the meniscus was used as the last provocation test. In the currently training gymnasts, only 1 of them obtained a positive result. In the case of former gymnasts, this result varied and applied to 30% of gymnasts.

Discussion

Rhythmic gymnastics training has long-term consequences such as Innate predispositions,

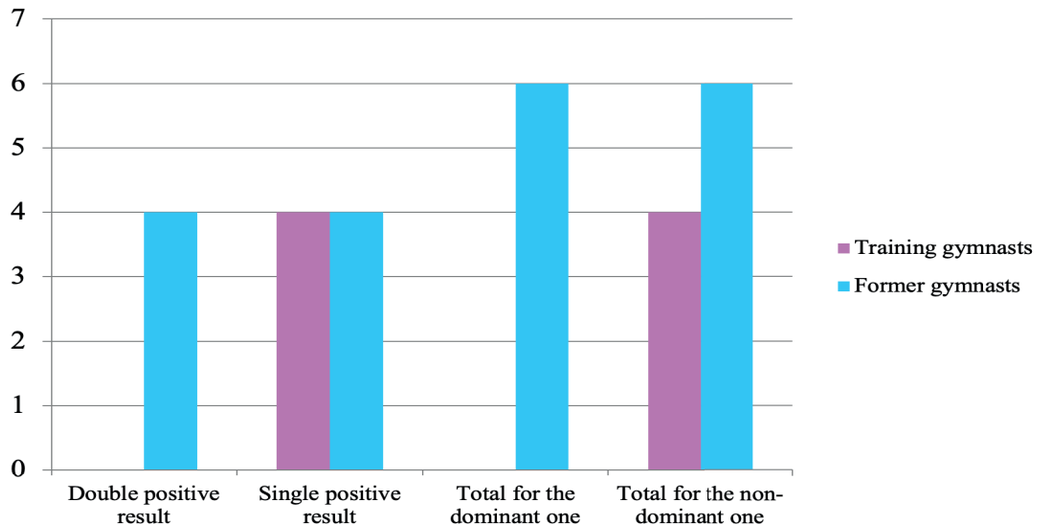

Figure 6. Comparison of the Patrick's Test results.

early specialization, many hours of intense training, regular overloads or past injuries that may have an impact on the subsequent formation of pathologies, the long-term effects of which significantly deteriorate both the present and long-term quality of life (Hutchinson, 1999; Zetaruk *et al.,* 2006; Mirska *et al.,* 2011; Sands *et al.,* 2016; Kolar *et al.,* 2017; Edouard *et al.,* 2018).

In the presented results, these changes are clearly emphasized, the confirmation of which can be found in the available literature. The study showed that among the group of twenty gymnasts – sixteen suffered at least one injury contributing to temporary discontinuation of training. Zetaruk *et al.* (2006) in their publication came to similar conclusions – among his subjects, as many as 65% of the gymnasts suffered an injury requiring a break in training, of which 20% required discontinuation for more than 7 days. At the same time, he emphasizes that the gymnasts surveyed by him reported at least one injury a year. The author associates these injuries with an excessive number of hours of training, which increases fatigue and the formation of micro-injuries in the area of muscles and joints, while simultaneously the time for regeneration is too short, which increases the risk of injury. In addition, he notes that injuries among younger gymnasts most often result from the lack of maturity of the musculoskeletal system and a lower physical condition, while older gymnasts problems arise due to faster aging of the tissues and the passing years of training. These changes intensify over time, as evidenced by, for example, the increase in pain among the group of former gymnasts Zetaruk *et al.* (2006).

Taking into account the locations of the damage shown in the study, it was noticed that 75% of injuries are located in the lower limbs, while the remaining number of injuries concerns the spine. This is confirmed by Edouard *et al.* (2018) showing that among their study group, the vast majority of injuries concerned the lower limbs (60%), while 20% were located within the spine. The most common injury found among the surveyed gymnasts was ankle sprain occurring in 40% of subjects, which is confirmed by a study by Zetaruk *et al.* (2006) and Rutkowska-Kucharska *et al.* (2018). Sabeti *et al.,* (2015) also reached similar conclusions. In their study, they noticed that gymnasts training competitively mainly complain of pain in the ankle joint and the lumbar region. They explain that 65% of these ailments result from too intensive training and performing thousands of repetitions of excessive flexion and extension of the lumbar spine, as well as landing and performing maneuvers with fingers.

Additionally, Edouard *et al.*, (2018) emphasize that the next frequent locations of injuries were the feet, hips and the groin, which was also confirmed in this study. In addition, 8 participants (most of whom belonged to the group of former gymnasts) had pain in the sacroiliac joints, which is in line with the assumptions of Jagucka-Mętel *et al.* (2017) on the impact of the specificity of training and hypermobility on the occurrence of these ailments in the group of rhythmic gymnasts.

In all of the investigated participants, a generalized polyarticular laxity was found, which was a predisposition to train this discipline. This feature significantly increases the flexibility and extensibility of the connective tissue, leading to increased ranges of mobility and flexibility within the spine. In their study, Sands *et al.* (2016) showed that female athletes with hypermobility have a clearly greater advantage over gymnasts without this feature, hence 100% compliance of the occurrence of this feature among both former and current female gymnasts. Mirska *et al.* (2011) showed that with the discontinuation of intensive training, hypermobility gradually decreases. The study showed that former gymnasts have much smaller ranges of mobility than those currently training, but still present higher values than the physiological standard. However, despite the desirable predisposition and its seemingly positive effects, it has consequences. Mirska *et al.* (2011) points to the relationship between hypermobility and diseases such as: longitudinal and transverse flat feet, scoliosis or hallux valgus. Their presence was found in at least 30% of gymnasts (both former and current). In addition, polyarticular laxity may secondarily contribute to the formation of spondylolysis and spondylolisthesis, the presence of which was confirmed in one of the subjects. Hypermobility also increases pain. Mirska *et al.* (2011) noted that pain in people suffering from generalized laxity may appear after the age of 10 and intensify over time. Even young gymnasts rate their pain ailments on average as 3/10 on the VAS scale, while their non-training peers do not have any ailments at this age.

In an independent study by Zetaruk *et al.* (2006) and Hutchinson (1999) it was noticed that in 80% of the surveyed competitors there was pain in the back and spine. This is confirmed by the above studies, emphasizing that spinal overload syndromes are the second most common diseases among the studied groups, following generalized laxity, which is one of the causes of these ailments. Hutchinson (1999) notes that athletes training for about 20 hours a week increase the risk of chronic back pain. At the same time, Hutchinson recognizes that rhythmic gymnastics is a sport with an increased risk of spinal injuries. Repetition and improvement of the same elements a number of times – especially flexion-hyperextension and torsion, combined with increased mobility within the spine, significantly overloads the lumbar section, leading to increased tension, bone stress reactions or accelerated spondylosis, the impact of which on pain ailments can be seen especially among the group of former female gymnasts (Hutchinson MR, 1999). At the same time, Mirska *et al.* (2011) states that chronic or recurrent back pain is the result of irritation of the intercostal nerves and/or roots at the level of the lumbar spine, the intensity of which is visible in the group of former female gymnasts.

Main study limitation was small study group (due to constrained number of former rhythmic gymnasts) which could affect this works results. It would be best to reenact study with more participants.

Conclusions

1. Severity of pain ailments in young female rhythmic gymnastic competitors increases after training discontinuation.
2. The most common injuries in gymnastics concern the lower limbs, while pain is sensed strongly the most in the area of the spine.
3. Generalized polyarticular laxity is at the same time a predisposition to practicing gymnastics and the main reason for the formation of pathologies that are long-term

consequences of practicing rhythmic gymnastics.

REFERENCES

Antualpa, K., Aoki, M. S., & Moreira, A. (2017). *'Salivary steroids hormones, well- being, and physical performance during an intensification training period followed by a tapering period in youth rhythmic gymnasts'.* Physiology and Behavior, 179, 1–8.

Batista A., Gomes T. N., Garganta R., Ávila-Carvalho L. (2018) *'Training intensity of groupp in rhithmic gymnastics'.* Sci. Move. Health, 18, pp. 17–24

Edouard, P., Steffen, K., Junge, A., Leglise, M., Soligard, T., Engebretsen, L. (2018) *'Gymnastics injury incidence during the 2008, 2012 and 2016 Olympic Games: analysis of prospectively collected surveillance data from 963 registered gymnasts during Olympic Games'.* Br. J. Sports Med., 52, pp. 475–481.

Fernandez-Villarino M. A., Bobo-Arce M., Sierra-Palmeiro E. (2013) *'Practical skills of rhythmic gymnastics judges'.* J. Hum. Kinet. 39, pp. 243–249.

Flessas K., Mylonas D., Panagiotaropoulou G., Tsopani D., Korda A., Siettos C., *et al.* (2015) *'Judging the judges' performance in rhythmic gymnastics'.* Med. Sci. Sports Exerc. 47, pp. 640–648.

Garlicki J., Kuś M. (1988) *„Traumatologia sportowa"*, PZWL. ed. Warszawa.

González-Valero, G., Zurita-Ortega, F., Ubago-Jiménez, J.L., Puertas-Molero, P. (2020) *'Motivation, Self-Concept and Discipline in Young Adolescents Who Practice Rhythmic Gymnastics'.* An Intervention. Children., 7 (135), pp. 1–13.

Hinds, N., Angioi, M., Birn-Jeffery, A., Twycross-Lewis, R. (2019) *'A systematic review of shoulder injury prevalence, proportion, rate, type, onset, severity, mechanism and risk factors in female artistic gymnasts'.* Phys. Ther. Sport., 35, pp. 106–115.

Hutchinson M.R. (1999) *'Low back pain in elite rhythmic gymnasts'.* Med Sci Sports Exerc., 31, pp. 1686–1688.

Jagucka-Mętel, W., Machoy-Mokrzyńska, A., Nowicki, A., Sobolewska, E. (2017) *„Dolegliwości bólowe wynikające z zaburzeń stawów krzyżowo-biodrowych oraz więzadeł działających bezpośrednio i pośrednio na stawy."* Pomeranian J Life SCI., 63, pp. 23–25.

Kolar, E., Pavletič, M.S., Smrdu, M., Atiković, A. (2017) *'Athletes' perception of the causes of injury in gymnastics'.* J. Sports Med. Phys. Fitness., 57(8), pp. 703–710.

Kruse, D., Lemmen, B. (2009) *'Spine Injuries in the Sport of Gymnastics'.* Curr. Sports Med. 8, pp. 20–28.

Kusz, D. (2010) *„Kompedium traumatologii."* PZWL. ed. Warszawa.

Kuźmińska Olga (1991) *„Podręcznik gimnastyki artystycznej."* Sport i Turystyka. ed. Warszawa.

Lennard T.A., Crabtree H.M. (2007) *„Sportowe urazy kręgosłupa."* Urban&Partner. ed. Wrocław. s. 183–201.

Malina, R.M., Baxter-Jones, A.D.G., Armstrong, N., Beunen, G.P., Caine, D., Daly, R.M., *et al.* (2013) *'Role of Intensive Training in the Growth and Maturation of Artistic Gymnasts'.* Sports Med. 43, pp. 783–802.

Mirska, A., Kalinowska, A.K., Topór, E., Okulczyk, K., Kułak, W. (2011) *„Łagodny zespół hipermobilności stawów (BHJS)."* Neurol. Dziecięca 20, pp. 135–140.

Rutkowska-Kucharska, A., Szpala, A., Jaroszczuk, S., Sobera, M. (2018) *'Muscle Coactivation during Stability Exercises in Rhythmic Gymnastics: A Two-Case Study'.* Appl. Bionics Biomech. 2018, pp. 1–8.

Sabeti, M., Jeremian, L., Graf, A., Kandelhart, R. (2015) *'Elite level rhythmic gymnasts have significantly more and stronger pain than peers of similar age: a prospective study'.* Wien. Klin. Wochenschr, 127, pp. 31–35.

Sands, W.A., McNeal, J.R., Penitente, G., Murray, S.R., Nassar, L., Jemni, M., *et al.* (2016) *'Stretching the Spines of Gymnasts: A Review'.* Sports Med. 46, pp. 315–327.

Tanchev, P.I., Dzherov, A.D., Parushev, A.D., Dikov, D.M., Todorov, M.B. (2000) *'Scoliosis in Rhythmic Gymnasts'.* Spine, 25, pp. 1367–1372.

Vernetta M., Montosa I., Beas-Jiménez J.,

López-Bedoya J. (2017) *'Batería funcional ARISTO en Gimnasia Rítmica: protocolo de test específicos para la evaluación de jóvenes gimnastas en un ámbito de entrenamiento saludable'.* Rev. Andal. Med. Dep. 10, 112–119.
Zetaruk, M.N., Violan, M., Zurakowski, D., Jr, W.A.M., Micheli, L.J. (2006) '*Injuries and training recommendations in elite rhythmic gymnastics'.* Apunts Medicinal' Esport, pp. 100–106.
Zimmermann-Górska, I. (2007) *„Nadmierna ruchomość stawów a choroby reumatyczne"* Reumatologia, 45, pp. 397–403.
Złotkowska, R., Skiba, M., Mroczek, A., Bilewicz-Wyrozumska, T., Król, K., Lar, K., *et al.* (2015) *„Negatywne skutki aktywności fizycznej oraz uprawiania sportu."* Hygeia Public Health, 50, s. 41–46.