Comparison of Beighton score and Brighton Criterion in order to diagnosis of joint hypermobility in children

Oksana Kulik[1], dr n. zdr. Magdalena Gębska[2]

1 Student of Physiotherapy, Pomeranian University of Medical Science

2 Department of Musculoskeletal System Rehabilitation, Pomeranian University of Medical Science

Address for correspondence:

Dr n. zdr. Magdalena Gębska, Department of Musculoskeletal System Rehabilitation, Pomeranian University of Medical Science, mgebska@pum.edu.pl

Abstract

Introduction

Joint hypermobility is a rarely diagnosed condition, mostly because its symptoms are frequently overlooked, usually because there is no proper and unequivocal diagnostic method. Joint hypermobility can lead to serious health issues, especially if the proceeding with this ailment is inappropriate. Underdiagnosis of this condition makes prevention of complications impossible in most cases. Currently, Beighton and Brighton are one of the most frequently used scores in joint hipermobility diagnostic. The tests are based on the same joints hipermobility assessment, but Brighton scale is extended by few more health issues, hence the results may diverge.

Aim

The main purpose of the study was to assess the prevalence of joint hypermobility in children using the Beighton and Brighton scores. The additional aim was to compare the diagnostic sensitivity of both scales.

Materials and methods

The study covered a group of 102 students (60 boys, 42 girls) aged between 6 to 11 years. A questionnaire was given to all children. Body height and weight measurements, hip and waist circumference measurements (WHR index) were also performed. In order to determine the occurrence of joint hypermobility in children, two standardized diagnostic tests were carried out: the Beighton score and the Brighton score.

Results

There was a statistically significant difference ($p \leq 0.05$) in the results of the Beighton and Brighton test based on the number of points obtained by the subjects, which is noticeable in the results. According to the Beighton test 35 children suffer from hypermobility. On the contrary according to the Brighton score hypermobility was observed only in one examined child (a boy).

Conclusions

The occurrence of joint hypermobility in children using the Beighton score is higher than using the Brighton criteria. The Beighton score and Brighton's criteria are not well correlated, therefore the methods for diagnosing hypermobility should be improved.

Key words: hypermobility, occurrence of joint hypermobility in children, diagnostic tests for joint hypermobility

Introduction

Hypermobility is defined as excessive joint mobility over normal values. Its occurrence depends on age, sex and race [1]. The highest rates are observed in Asian and African populations, in women and in patients with family history positive for hypermobility. It is more frequent in children than in adults [2]. First symptoms of joint hypermobility present in patients aged between 3 and 55 years old, however most of the cases is observed before 15th year of life [3].

Joint hypermobility is a rarely diagnosed condition, mostly because its symptoms are frequently overlooked, possibly because proper diagnostic tools are lacking. Joint hypermobility, if dealt with improperly, can lead to serious health issues, such as joint pain, early degenerative disease, coordination and proprioception impairment, lowered tolerance for static forces, soft tissue trauma and locomotor apparatus abnormalities. Underdiagnosis of this condition makes prevention of complications impossible in most cases [4,5,6,7]. Join hypermobility cannot be classified as a separate disease entity, as it is only a sign of an functional impairment of connective tissue and can also occur in other diseases, such as Down Syndrome, Marfan Syndrome, Ehlers - Danlos syndrome and Benign Hypermobility Joint Syndrome (BHJS) [1].

Joint hypermobility frequently happens to be difficult to determine. Currently diagnostics is based both on general and specific tests designed to determine the presence of this condition. General tests are applied to initially confirm or rule out the occurrence of joint hypermobility; These methods include Beighton score, Brighton criteria, Carter's and Wilkinson score, Hakim and Graham patient questionnaire, Marshall test and Bulbena score [8,9,10]. Characteristics of the chosen methods is done underneath.

Primary score used to describe joint hypermobility is international Beighton score. It bases on examination and evaluation of five specific functions: a passive extension of the V finger of the hand above 90^0, ability to passive adduct the thumb to the inner surface of the forearm, elbow joint hyperextension above 10^0, hyperextension of the knee joint of above 10^0 and a possibility to place palms on the ground with legs straight. Joint hypermobility is diagnosed if one's score is equal or exceeding 4 points of 9 possible [7,8,11,12].

Another standardised and common tool used to assess joint hypermobility is Brighton score. It assesses all functions included in Beighton score criteria, as well as joint pain occurrence, degeneration of spine joints, subluxations of joints, skin symptoms and eye symptoms, occurrence of hernias, varicose veins, rectal prolapse and general physique. Whole Brighton score consist of major and minor criteria; BHJS is diagnosed when: at least 2 major criteria are present, one major and two minor criteria are present, or if four minor criteria are present [13,14].

Another diagnostic test for joint hypermobility is the Carter and Wilkinson method, which is based on criteria similar to Beighton score. The difference between them is that the Beighton scale includes the assessment of the hyperextension of the 5th finger and the assessment of bending forward, and the Carter and Wilkinson method include the evaluation of passive hyperextension of fingers II -V and the assessment of dorsiflexion [10].

According to Hakim and Grahame, joining a five-part questionnaire into the study allows to assess changes in joint mobility, which are age-related. The following questions are included in the questionnaire [10,15,16]:

1. Can you now (or could you ever) lay your hands flat on the floor during a forward bend without flexing your knees?

2. Can you touch (or have you ever been able to touch) your forearm with your thumb?

3. As a child, have you been able to bend your body in different shapes or could you make a split?

4. Did you have a sprained shoulder or patella more than once as a child or teenager?

5. Do you think you are a flexible person?

Hypermobility (with a sensitivity of 80-85%) is strongly indicated if the examined person answered "yes" to at least twice [16].

Another commonly used diagnostic test for joint hypermobility is the Marshall test. It is known for its simplicity, because it is based only on an assessment of the range of motion of thumb towards the forearm. Its weak point is that it focuses only on this one joint.

On the other hand, the Bulbena 10-point score takes into consideration the symptoms occurring in lower limbs, upper limbs and skin. The most important elements of assessing hypermobility of joints in this scale are: passive external rotation of the shoulder >85; bending the knee joints to the point in which touching the gluteus muscles is possible; passive lateral dislocation of the patella; passive hip abduction >85; hyperextension in metatarsophalangeal joint >90; the appearance of petechiae after small injury; dorsiflexion of the foot >20; abduction of the thumb; elbow joint hyperextension more than 10; V finger hyperextension > 90 in the metacarpophalangeal joint. Results: ≥ 5 points in women and ≥ 4 in men strongly indicates joint hypermobility [17].

As it can be seen basing on characteristics of the most frequently used diagnostic methods presented above, they all contain some common features. In clinical practice, the most crucial factor is quick assessment of probability of joint hypermobility. Currently, Beighton and Brighton are one of the most frequently used scores. Now we a have few studies comparing this two methods [18]. This fact prompted the authors to take up this topic.

Aim

The main goal was to assess the prevalence of joint hypermobility in children using the Beighton and Brighton scores. The additional goal was to compare the diagnostic sensitivity of both scales.

Materials and methods

The study covered a group of 102 students (60 boys, 42 girls) aged between 6 to 11 years attending Primary School No. 2 in Szczecin. The children's caregivers were informed about the purpose and expressed their written consent for the child to participate in the study. A questionnaire was given to all children to obtain information about physical activity at physical education classes at school, the frequency of extra sports activities, the type of sport practiced and the occurrence of injuries. Body height and weight measurements (to determine BMI body mass index) and hip and waist circumference measurements (waist hip ratio - WHR index) were also performed.

In order to determine the occurrence of joint hypermobility in children, two standardized diagnostic tests were carried out: the 9-point Beighton score (Table 1) and the Brighton score (Table 2).

Table 1. The Beighton score [11]

Studied movement	Right side	Left side
Passive dorsiflexion of the metacarpophalangeal joint $> 90^0$	1 p.	1 p.
Passive pulling of the thumb to the palmar surface of the forearm	1 p.	1 p.
Passive elbow extension $> 10^0$	1 p.	1 p.
Passive knee extension $> 10^0$	1 p.	1 p.
Putting the whole hands on the ground during the forward bend with straight knee joints	1 p.	

Minimum of 4 points is needed to diagnose joint hypermobility syndrome.

Table 2. The Brighton criteria [11]

Major criteria:
- Beighton score 4 points or more
- Joint pain lasting> 3 months in four or more joints

Minor criteria:

- Beighton score of 1, 2 or 3 points

- Arthralgia (lasting longer than 3 months) in one to three joints or back pain ($\geq$ 3 months), spondylosis, spondylolysis / spondylolisthesis

 - Dislocation / subluxation in more than one joint or in one joint more than once

- "Rheumatism" of soft tissues with three or more lesions (epicondylitis, tenosynovitis, bursitis)

 - Marfanoid phenotype

- Changes in the skin: stretch marks, excessive stretch, thin skin, parchment scarring

- Ophthalmic symptoms: drooping eyelids, myopia, antimongoloid setting of the eyelid bumps

- varicose veins, hernia or prolapse of the anus or vagina

Diagnosis of hypermobility when patient fulfilled at least one of following:

- two major criteria

- one major and two minor criteria

- four minor criteria

- two minor criteria, if patient is a first-degree relative to a person diagnosed with joint hypermobility

The test was carried out in the gym at room temperature oscillating around 20^0C. All of the children were examined by the same person.

The obtained data was analysed using Statistica 13.1 Software. The non-parametric Wilcoxon signed-rank test was used to compare results on the Beighton and Brighton score (for $p \leq 0.05$). The Mann-Whitney U test was performed to compare the results of the Beighton test within the sex of the examined group of people (for $p \leq 0.05$). In addition, Spearman's correlation coefficients (for $p \leq 0.05$) were calculated for the results of the tests and survey data including: frequency of attendance to physical education classes at school, frequency of

attendance to extra sport activities, the period of practicing extra sport activities, biometric data (BMI).

Results

In the first paragraph below the results obtained from questionnaire are presented.

Table 3. Occurrence of contusion in relation to the period of participation in extra sports activities in tested subjects with the Beighton test.

	Participation in extra sports activities (n = 71)	The occurrence of sport injury (n = 31)
Occurrence of hypermobility (according to the Beighton score) (n = 35)	77.1%	37.1%
Lack of hypermobility (according to the Beighton score)(n=67)	64.2%	25.4%
All subjects (n=102)	69.6%	29.4%

The study involved healthy children, regularly participating in physical education classes (between 3 to 5 times a week). Their physical activity outside the school and in their free time was different. As many as 69.6% of the surveyed children participated in additional activities such as gymnastics, dance, team sports, martial arts and swimming. Most of the examined children attend additional sports activities. Nevertheless, in the group of children with established hypermobility (Beighton scale) up to 77.1% of children attend to extracurricular sports activities in various disciplines, which is reflected in more injuries in relation to the group of children attending only physical education classes at school (Table 3).

Below the results obtained after applying Beighton and Brighton scores are presented.

Table 4. The results of Beighton and Brighton Tests performed on the studied group

	Beighton Score		Brighton Score	
	Number of children	% of all subjects	Number of children	% of all subjects
Occurrence of hypermobility	35*	34.3%	1*	0.98%
No hypermobility	67	65.7%	101	99.02%
*statistically significant difference (p≤0.05)				

There was a statistically significant difference (p≤0.05) in the results of the Beighton and Brighton test based on the number of points obtained by the subjects, which is noticeable in the results. According to the Beighton test 35 children suffer from hypermobility. On the contrary according to the Brighton score hypermobility was observed only in one examined child (a boy) - Table 4.

Based on the Beighton score criteria, over 30% of the examined children suffer from hypermobility (Tab.4). This is both true regardless of person's gender, because no statistically significant difference was found (Mann-Whitney U test, p = 0.085) in Beighton test results for boys and girls.
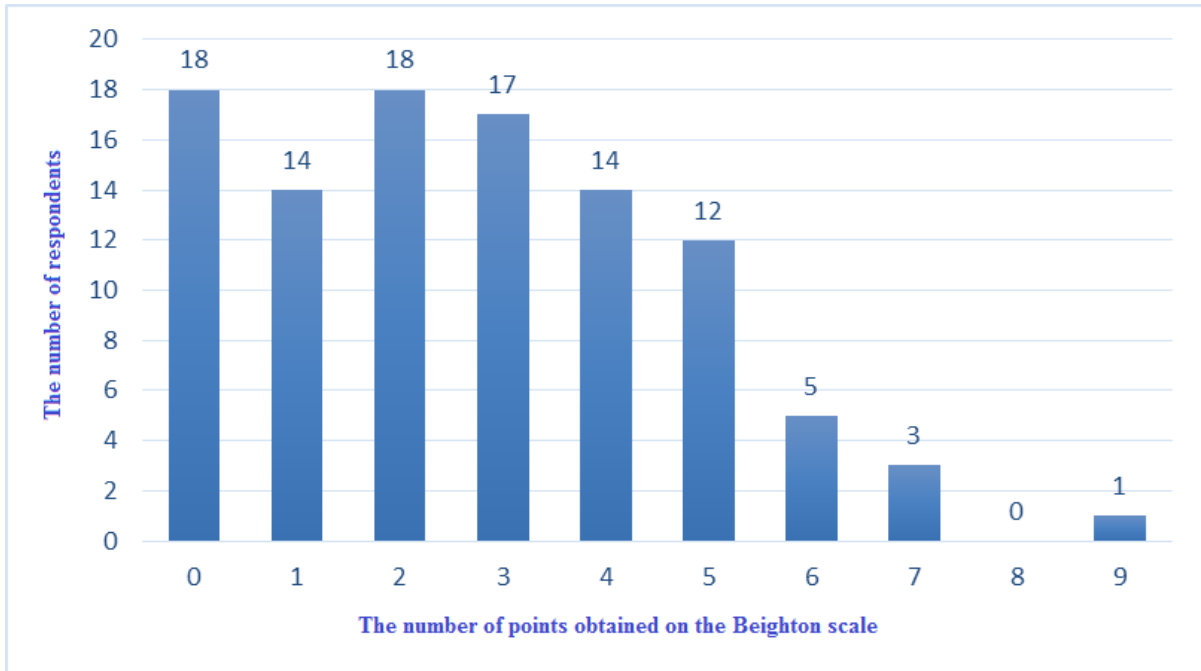
Figure 1. The distribution of number of points obtained in Beighton test and the number of subjects

As shown in Figure 1, the majority of respondents achieved 0, 2 or 3 points on the Beighton score, which is 18, 18 and 17 patients, respectively. Among patients suffering from hypermobility according to Beighton, 4 people reached 4 points, which is 40%. A little less, because about 34% of children with articular hypermobility got 5 points on the Beighton score. Only one patient received 9 points. Interestingly, this person did not fulfil the criteria for hypermobility in the Brighton score.

The values of Spearman's correlation coefficients for the tested parameter are presented below in table 5.

Table 5. Evaluation of correlation between Beighton test and selected parameters.

Parameter	Beighton score result				
	1	2	3	4	5
Age (in years)	0.035	-0.071	0.073	0.220*	0.105
Frequency of physical education classes per week	-0.051	-0.033	0.06	0.125	0.089
Frequency of extra sports activities per week	0.229*	0.166	0.172	0.065	0.17
Period of participation in extra sports activities [number of years]	0.202*	0.262*	0.178	0.095	0.293*
BMI	0.243*	-0.096	0.089	0.046	0.038
WHR	0.139	-0.016	0.075	-0.023	0.008
Where numbers from 1 to 5 are marked: 1-Beighton test - the possibility of placing the hand flat on the floor during the bending forward; 2- passive finger extension above 90^0- left side; 3-passive finger extension above 90^0- right side; 4- passive adduction of the thumb to the palmar side of the forearm - left side; 5 - sum of points obtained in the Beighton test; *statistically significant correlations ($p \leq 0.05$).					

The results presented in Table 5 show statistically significant positive correlations, but with low strength ($r \approx 0.2$-0.3, for $p \leq 0.05$) between the tested parameters:
- passive adduction of the thumb to the palmar side of the forearm on the left side to the age of the examined group,
- the possibility of placing the hand flat on the floor during the forward bend and the frequency and duration of extra sports activities and BMI value;
-·passive finger extension above 90^0 on the left side and period of attendance on extra sports activities;
-·the sum of points obtained in the Beighton test and the period of attendance on extra sports activities, which is also illustrated in the figure (Figure 2).

Figure 2. The dependency of sum of points obtained in Beighton test and the period of extra sport activities.
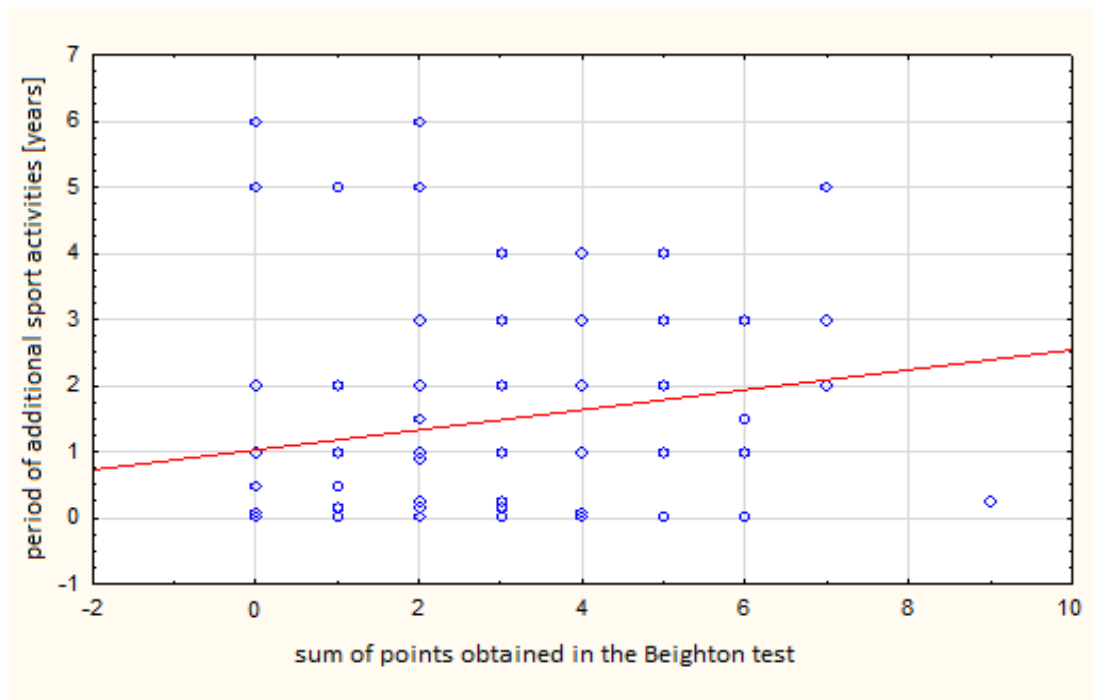
From Fig. 2 it can be concluded that the longer period of regular attendance to extra sports activities of the examined children translated into higher Beighton score, thus more identified features of joint hypermobility in this group are observed.

Figure 3. The variation of sum of points obtained in Beighton test against diagnosis of hypermobility according to Beighton and Brighton scores
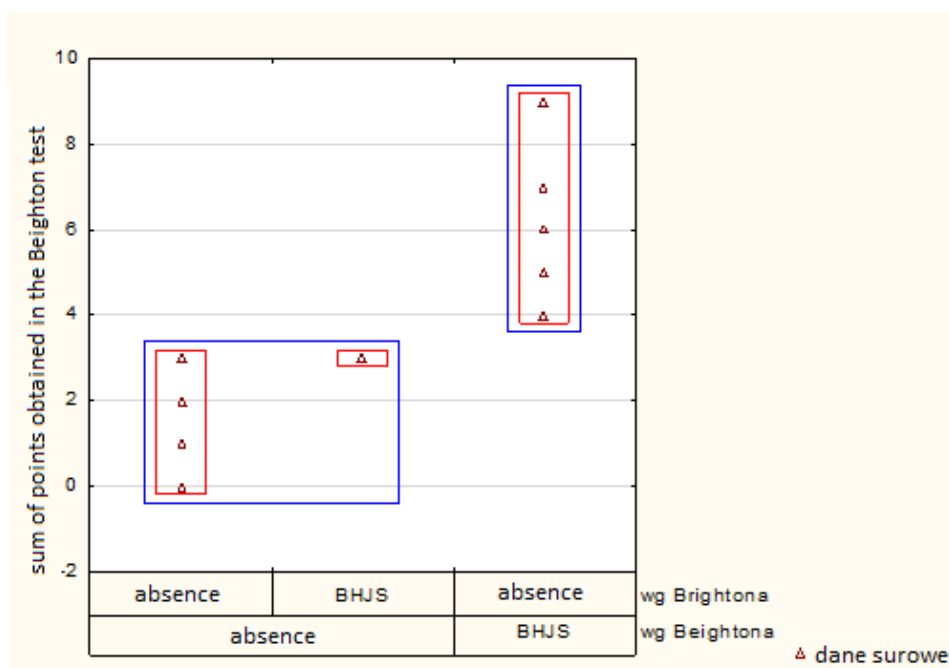
It was observed that despite obtaining a high number of points on the Beighton score (from 4 to 9), joint hypermobility was not found in these patients if Brighton's criteria were applied (Fig. 3). On the other hand, a patient who was diagnosed with hypermobility according to the Brighton scale did not fulfil requirements of the Beighton criteria, because only 3 points were scored (Fig. 3). Nonetheless, this person fulfilled a major criterium according to Brighton (joint pain lasting over 3 months in four or more joints) and 2 minor criteria (result = 1,2,3 on the Beighton scale and pain lasting for 3 or more months within 1 to 3 joints).

Discussion

Joint hypermobility is a very rarely diagnosed abnormality. It can be due the fact that the excessive joint mobility is common amongst teenagers and sometimes it can be considered as an advantage. The main problem in hypermobility diagnosis is its dependence of currently approved classification system. This is a genetic disease of connective tissue, which is characterized by excessive joint mobility exceeding normal values, laxity of joint capsules and ligaments, joint and spine pain.

Physical activity is a necessary element of proper development of children and adolescents. It can benefit all children, healthy, those with reduced range of movement, and those with hypermobility. For the physical activity to have a positive effect on the child's development, proper prophylaxis of the locomotor apparatus injury is necessary, i.e. early detection of diseases and adjustment of the exercises. In any case of children with joint hypermobility, an improperly chosen form of physical activity can lead to various types of musculoskeletal injuries.

In 2013, Brewecki et al.examined 96 high school girls aged 16-18 for joint hypermobility occurrence using the Brighton criteria (based on the Beighton score) and Bulbena score [4]. According to the Beighton score about 28% of girls suffered from hypermobility of the joints, whereas according to the Bulben score almost 45% of the respondents. It is clearly visible that the difference between the assessment is noticeable, as it seen is in this study - the Beighton and Brighton score assessment results were very different, which means that different research methods (evaluation scores) are poorly correlated with each other.

Both in study group and in the research conducted by Brewecki et al. 2013, it was found that the highest number of respondents achieved 2 or 3 points on the Beighton score (23 and 21 out of 96 examined people).

Brewecki et al. 2013 noticed that the Beighton scale is less compound, faster and easier to conduct, which is the principal factor for practicing physiotherapists [4]; this is confirmed by

the research conducted here. The Beighton score is based on five quick and simple tests, which quickly provide reliable results, while the Brighton score contains problematic criteria and requires more commitment from the patient.

According to Smith et al., the criteria used in the Brighton assessment method are not suitable for epidemiological studies and have not been approved for use in diagnosing children [13]. During the Brighton score evaluation, it is difficult to obtain reliable information about the joint pain in children. Some information should be asked in front of parents or carers, for example embarrassing questions about haemorrhoids and vaginal or rectal prolapse. In addition, parents could correct the answers given by children.

Differences in diagnostic criteria make it especially difficult to analyse the information available in published literature [8,9]. As it can be seen Beighton and Brighton scales are not closely correlated, which means the other scales may also be unreliable. Differences in the obtained results are too large. Smits-Engelsman and others (2011) examined children from 6 to 12 years old and found that the Beighton score is an ideal tool for assessing joint hypermobility in Caucasian children. However, the authors suggested that diagnosis should be stated only when patient scored more than 6 points to be diagnosed with hypermobility. In all the studies presented here, hypermobility was diagnosed when patient's score was equal at least 4 points out of 9 on the Beighton score, as in the criteria used by Dawn M. et al. [11]

Krzewski et al. noticed that type of assessment criteria chosen will make an impact on the frequency of diagnosis of joint hypermobility. Using the Beighton score, joint hypermobility was diagnosed twice as frequent as using Brighton score. [20] In the present studies, there are great differences in the frequency of diagnosing joint hypermobility using various methods.

To eliminate the possibility of making diagnostic mistakes, it would be necessary to develop a competent test adapted to a specific study group, which will take into consideration primarily: age, joint mobility, skin symptoms, physical activity and the occurrence of pain and injuries.

Due to the increase in the frequency of joint hypermobility occurrence in children, it is necessary to have this disease diagnosed doctors and physiotherapist [10]. This could prevent the subsequent consequences of this condition and give the possibility of rehabilitation, especially that according to the Beighton score more than one third of examined children suffer from joint hypermobility.

Conclusions

The occurrence of joint hypermobility in children using the Beighton score is greater than using the Brighton criteria. The Beighton score and Brighton's criteria are not well correlated, so a standardized method for diagnosing hypermobility should be developed.

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