Prevalence of joint hypermobility in preschool children

Prevalência de hipermobilidade articular em crianças pré-escolares

Prevalencia de hipermovilidad articular en niños pre-escolares

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ABSTRACT | Joint hypermobility is the ability to perform movements with a range of motion that is wider than normal. This study aimed at establishing the prevalence of joint hypermobility in junior kindergarten and senior kindergarten children from the Municipal Education System of Londrina, Paraná, Brasil. The study was cross-sectional, with a sample of 366 children aged between 5 and 6 years. The detection of joint hypermobility was based on the criteria proposed in literature. It was found that 198 (54.1%) of the children evaluated had joint hypermobility, 96 (59.6%) were girls and 102 (49.8%) were boys. Joint hypermobility was found more frequently in the elbow and knee joints, where hyperextension occurred. There was no statistically significant difference between the male and female groups in relation to joint hypermobility (χ^2=3.539, p=0.072). We can conclude that joint hypermobility found in the junior kindergarten and senior kindergarten children evaluated was common and compatible with the age of the population evaluated in this study.

Keywords | joint hypermobility; joint instability; JK and SK children.

RESUMO | A hipermobilidade articular é a capacidade de realizar movimentos em amplitudes maiores que a normal. O presente estudo teve como objetivo estabelecer a prevalência de hipermobilidade articular em crianças pré-escolares da Rede Municipal de Educação de Londrina/PR. O estudo foi do tipo transversal com amostra constituída de 366 crianças, de 5 e 6 anos de idade. Verificou-se que, das crianças pré-escolares avaliadas, 198 (54,1%) apresentaram hipermobilidade articular, sendo 96 (59,6%) do sexo feminino e 102 (49,8%) do masculino. A hipermobilidade articular foi encontrada com maior frequência nas articulações de cotovelo e joelho, onde ocorreu a hiperextensão. Não houve diferença estatisticamente significante entre os grupos masculino e feminino em relação à hipermobilidade articular (χ^2=3,539, p=0,072). Pode-se concluir que a hipermobilidade articular nas crianças pré-escolares foi achado comum, compatível com a faixa etária da população avaliada no estudo.

Descritores | hipermobilidade articular; instabilidade articular; crianças pré-escolares.

RESUMEN | La hipermovilidad articular es la capacidad de realizar movimientos en amplitudes mayores que lo normal. El presente estudio tuvo como objetivo establecer la prevalencia de hipermovilidad articular en niños pre-escolares de la Red Municipal de Educación de Londrina/PR. El estudio fue de tipo transversal con una muestra constituida de 366 niños, de 5 a 6 años de edad. Se verificó que los niños pre-escolares evaluados, 198 (54,1%) presentaron hipermovilidad articular, siendo 96 (59,6%) de sexo femenino y 102 (49,8%) de sexo masculino. La hipermovilidad articular fue encontrada con mayor frecuencia en las articulaciones del tobillo y rodilla, donde ocurre la

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hiperextensión. No hubo diferencia estadísticamente significativa entre los grupos masculino y femenino en relación a la hipermovilidad articular (χ^2=3,539, p=0,072). Se puede concluir que la hipermovilidad articular en los niños pre-escolares fue encontrada normal, compatible con la línea etaria de la población evaluada en el estudio.

Palabras clave | hipermovilidad articular; inestabilidad articular; niños pre-escolares.

INTRODUCTION

Joint hypermobility was first mentioned by Hippocrates as the Celts' inability to pull a bow string or throw darts because they had "loose limbs", according to Egri[1]. Joint hypermobility is caused by tissue loosening or excessive length, which leads to an increase in motion range beyond what is considered normal, and it might be followed, in children, by complaints about pain voiced in the afternoon or at night[2,3]. We highlight that complaints about musculoskeletal pain is common in pediatric practice, especially in relation to joint hypermobility syndrome[4].

The British Rheumatology Society (1992) defines joint hypermobility based on the presence of althralgia or musculoskeletal pain with an evolution of at least 3 months, associated with hypermobility[5]. Connective tissue hereditary diseases might be associated with the syndromes of Down, Marfan, and Ehlers-Danlos[6]. More frequent in girls, joint mobility[7] decreases with age[8,9]. Besides these conditions, the prevalence of hypermobility varies according to age, sex, ethnicity, and genetic factors, and it is, therefore, multifactorial.

It is believed that the primary cause of hypermobility is ligament loosening associated with musculoskeletal dysfunction, given that the maximal excursion of each joint is influenced by ligament tension. Ligament loosening is determined by genes that codify collagen, elastin, and fibrin, making the individual more susceptible to trauma[10]. For Hall[11], individuals with joint hypermobility present lower proprioceptive response, and might adopt positions that are biomechanically unfavorable to the limbs, thus predisposing themselves precociously to degenerative conditions.

Hypermobility must be differentiated from joint instability. The first is the ability to perform a series of movements in a range that is wider than normal[2,3]; the latter refers to the amplitude of excessive movements performed without protective muscle control[11]. Excessive hypermobility can provoke joint instability, which might generate sprains, osteoarthritis, pain, difficulties in controlling the body[12], and decreased body perception, predisposing the individual to lesions in soft tissues[13]. It is believed that there is an alteration in the structure of type 3 collagen[1], characterized by a higher ratio in relation to type 1 collagen[14], and proteoglycan alteration, generating disturbance in proprioception.

The first quantitative system created to analyze joint hypermobility was devised by Carter and Wilkinson[15], who conducted a comparative study between healthy children and children with hip congenital dislocation, both in school age; they found a prevalence of joint hypermobility of 7% in normal children of both sexes, and in 29.2% of the girls and 71.1% of the boys with hip congenital dislocation. Araújo[16] pointed a prevalence of joint hypermobility of 36.31% among children in public schools of São Paulo. The parameters provided by Beighton, Solomon, and Soskolne[17] are the modification of Carter and Wilkinson's theory[15], with criteria established by the British Rheumatology Society (1992) to identify hypermobility, currently the most disseminated method in the world.

Joint hypermobility is an important variable to be associated with the postural assessment of children. The individual with an excessive increase of joint mobility suffers alterations in muscle and body posture[18], which causes degenerative processes prompted by the use of irregular strength, that is, the excessive lengthening of soft tissues that compromise joint integrity might occur. Therefore, the detection of joint hypermobility in school children is necessary, considering that it might cause, on a long-term basis, postural alterations, pain, and joint instability. Another aspect that involves the necessity of establishing the prevalence of hypermobility among children results from the lack of studies in the country. We also highlight that the involvement in physical activities through playing has changed in our current society, that is, children spend more time sitting down, and are, consequently, more sedentary, which might cause alterations in mobility. Thus, this study aimed at investigating the prevalence of joint hypermobility in junior kindergarten (JK) senior kindergarten (SK) children of the Municipal Education System of Londrina/PR.

METHODOLOGY

A transversal study was developed in the schools of the Municipal School System of Londrina/PR, in partnership with the research project "*Detecção precoce de alterações porturais em crianças na idade pré-escolar: diagnóstico e orientações*" ("Early detection of postural alterations in JK and SK children: diagnosis and guidelines"), approved by the University Hospital/UEL's Ethics Committee (report number 240/09), and authorized by the *Secretaria Municipal de Educação* (Municipal Education Secretariat). The parents and/or responsible for the children were informed about the study and signed the free and informed consent form. The study was conducted between February 2011 and May 2012.

In 2011, there were 3,666 children enrolled in the JK and SK programs of Londrina's Municipal Education System, according to data from the Municipal Education Secretariat. Considering 0.05 a tolerable sampling error, the sample size (N) was estimated in 360 participants from schools of the northern, southern, western, eastern, and central regions of the city, with an equitable number of students enrolled. The inclusion criteria were JK and SK children enrolled in the municipal system, who were 5 and 6 years of age, of both sexes. Children with chronic or acute diseases in convalescent stage, with Down, Marfan or Ehlers-Danlos[19] syndromes, who presented difficulty to remain in the orthostatic position during the tests, and those recovering from recent surgeries were excluded. In order to detect joint hypermobility, we used a goniometer to measure the angles, and the criteria proposed by Beighton, Solomon, and Soskolne[17]. These criteria bilaterally evaluate the joints in different parts of the body, described below, considering the individuals that present three positive maneuvers as hypermobile without specifying, however, whether the maneuvers must be unilateral or bilateral. Unilateral maximal amplitude was scored with one point, and bilateral with two points[20]. Thus, the children with a minimum score of six and a maximum score of nine points in the sum of the five criteria were considered hypermobile, according to Fórleo[20].

1. Passive approximation of the thumbs over the forearm anterior region;
2. Passive extension of the fifth finger (>90°);
3. Hyperextension of the elbows beyond 10°;
4. Hyperextension of the knees over 10°;
5. Spine flexion while keeping the knees straight until touching the floor with the palms.

The procedures for data collection were initiated by means of contacting the schools' principals, and scheduling the days for assessment. The teachers of each classroom were informed about the study and helped explaining the evaluation to the children. Before starting the joint hypermobility assessment, all test items were demonstrated to the children with the purpose of facilitating comprehension and execution. The tests were actively performed by the children in the orthostatic position while they were barefoot on an inflexible mat, with feet parallel in line with the width of the hips. The exam was conducted by a previously trained evaluator.

For the evaluation of musculoskeletal pain in the areas analyzed, and for the detection of joint hypermobility, we used a face scale with Maurício de Sousa's characters (Cebolinha and Mônica), composed of five facial expressions that vary from no pain to unbearable pain (0=no pain, 1=light pain, 2=moderate pain, 3=severe pain, 4=unbearable pain)[21]. A human body scale was also used, on which the child was oriented to indicate the painful spot and its origin[22]. These scales had the purpose of verifying the presence and localization of musculoskeletal pain in the children evaluated; depending on the spot indicated, the pain could be related to joint hypermobility.

The statistical analysis of the variables was performed using the program SPSS version 20.0. First, we performed descriptive data analysis, and verification of normal data distribution through Shapiro-Wilk's test. The results are presented on graphs, tables, and absolute and relative values. Sampling error and confidence interval were also calculated. The categorization of the variables allowed an associative analysis among them through the chi-square test (χ^2). A significance level of 5% was applied to all analyses.

RESULTS

We assessed 366 children, 161 (44.0%) girls and 205 (56.0%) boys. With regard to age 194 (53.0%) children were 5 years old and 172 (47.0%) were 6 years old (Table 1).

Joint hypermobility was identified in 198 (54.1%) children, 96 (59.6%) girls and 102 (49.8%) boys.

Table 1. Prevalence of hypermobility

	JK and SK children		Hypermobile	
Sex	n	%	n	%
Male	205	56.0	102	49.8
Female	161	44.0	96	59.6
Total	366	100.0	198	54.1

The male and female groups did not present statistically significant difference in relation to hypermobility (p=0.072 and χ^2=3.539). Out of the 366 children, only 8 (2.2%) children, 4 boys and 4 girls, reported musculoskeletal pain. The presence of pain was pointed in the following parts: knees, elbow, thumb, and lumbar spine. Pain intensity was rated as severe (level 3), followed by moderate (level 2), and lastly light pain (level 1) (Table 2).

Among the children in JK and SK age assessed in this study, 300 (81.9%) presented elbow hyperextension beyond 10°. Out of these children, 278 (92.7%) present joint mobility bilaterally, while 22 (7.3%) presented elbow mobility beyond 10° unilaterally (Table 3).

Knee hyperextension exceeding 10° occurred in 298 (81.4%) children, and in 244 (81.9%) the increased joint mobility was bilateral, and in 54 (18.1%) it was unilateral; with regard to the passive extension of the fifth finger (>90°), hypermobility was identified in 243 (66.3%) children; 206 (84.8%) presented it bilaterally, and 37 (15.2%) unilaterally. The passive approximation of the thumbs over the forearm anterior area occurred in 171 (46.7%) of the children assessed, 128 (74.9%) bilateral, and 43 (25.1%) unilateral. Lastly, flexing the spine while keeping the knees straight until the palms touched the floor occurred in 91 (24.8%) children (Table 3).

During the tests, we found that the highest occurrence of hypermobility was elbow hyperextension (81.9%), followed by knee hyperextension (81.4%), pinky finger extension (66.3%), approximation of the thumb over the forearm anterior area (46.7%), and spine flexing while keeping the knees straight until the palms touched the floor (24.8%) (Figure 1). Bilateral mobility was more frequent than unilateral mobility, with a higher prevalence in female children.

Association analyses were performed among the five hypermobility areas in relation to pain, to sex, and to pain and sex, but these were not statistically significant and they all presented Cramer's V, which indicates a weak association among them.

DISCUSSION

Joint hypermobility was identified in 54.1% of the children assessed, which differs from the findings in literature. This fact might be related to the narrow and young age range. The presence of pain was identified in 2.2% of the children evaluated, located in the knees, elbows, thumb, and lumbar spine, and the intensity varied from light to severe. Therefore, the majority presents joint hypermobility, but not joint hypermobility syndrome. In literature, most findings on joint mobility in children are results of studies conducted with older ages[24,25].

Table 2. Prevalence of unilateral and bilateral hypermobility

	Elbow hyperextension		Knee hyperextension		Passive extension of the fifth finger		Passive approx. of the thumbs over the forearm		Spine flexion with knee extended	
	n	%	n	%	n	%	n	%	n	%
Bilateral	278	92.6	244	81.8	20	84.7	128	74.8	-	-
Unilateral	22	7.4	54	18.2	37	15.3	43	25.2	-	-
Total	300	81.9	298	81.4	243	66.3	171	46.7	91	24.8

Table 3. Joint hypermobility and musculoskeletal pain

Criteria	Musculoskeletal pain		Pain intensity	Boys		Girls	
	n	%		n	%	n	%
Passive approximation of the thumbs over the anterior forearm area	1	0.3	1	1	12.5	0	0
Passive extension of the fifth finger (>90°)	0	0	0	0	0	0	0
Elbow hyperextension beyond 10°	1	0.3	3	1	12.5	0	0
Knee hyperextension beyond 10°	5	1.3	2-3	2	25	3	37.5
Spine flexion keeping the knees straight until the palms touch the floor	1	0.3	2	0	0	1	12.5
Total	8	2.2		4	50	4	50

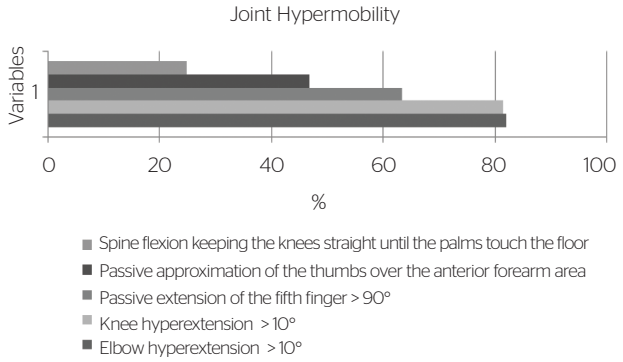

Figure 1. Percentage of children who presented hypermobility in the different joints evaluated. n=366

Roberto et al.[23], detected the manifestation of joint hypermobility in 51 (56.9%) children, aged between 5 and 10 years, with musculoskeletal pain.

Oster and Nielsen[24] showed the prevalence of joint hypermobility in 15.4% of school children. Gedalia et al.[25], reported a 12% rate of hypermobility in a population of 260 school children. The results found in JK and SK children are probably related to the fact that, during childhood, the bones have more collagen, and are therefore more flexible. Concerning the prevalence of joint hypermobility among female children, our study is in accordance with Cavenaghi[8] and Lamari[9]. Although there are not many explanations for the differences among the sexes, Lamari, Chueire and Cordeiro[2], suggest the influence of bodily makeup, given that girls have higher fat and water percentage, favoring mobility, while boys have more muscles, which results in less joint mobility.

Increased joint mobility might cause postural alteration. Silva[26] points that knee hyperextension can be related to a stretching in the length of ischiotibial muscles, which might result in lumbar hyperlordosis. Some illnesses or postural alterations, such as intoed knees or obesity, might be associated with knee hyperextensions that can cause patellar micro traumas, originating, in turn, patellar chondromalacia, characterized by the softening and deterioration of the patellofemoral joint cartilage[27,28].

The low index observed in the score of spine flexing with straight knees until touching the floor with the palms possibly reflects a decrease in the posterior mobility of the torso, which can occur because of long periods of time spent in the sitting position or because of sedentariness[29].

Joint hypermobility was a common finding in this study, and it is probably related to the fact that JK and SK children do not have completely mature musculoskeletal systems. For Nóbrega et al.[30], the neuromuscular system reaches maturity when the person is between 20 and 30 years old, and, as time goes by, the structure and function of the muscles change. Therefore, it seems to be a normal and physiological condition, considering that the JK and SK children in this study were undergoing a stage of maturation, with structural alterations in the collagen fibers. It is expected that hypermobility declines as time goes by, with a loss of 20–30% between 30 and 70 years of age, regardless of sex. For Dantas[31], biological changes emerge, such as modification of joint capsules or muscles, responsible for mobility decline as age advances, due to an enlargement of muscle fibers and reduction in the quantity of water. Misner et al.[32], report that, as time goes by, the calcification of cartilage and surrounding tissues occurs, thus reducing elasticity. However, 45.9% of the children assessed did not present joint hypermobility, in contrast to what is proposed in the literature in relation to age and maturation process, probably due to the influence of intrinsic and extrinsic factors.

We highlight that the increase of unilateral mobility in children in growth stages, especially during growth spurts, might lead to asymmetry, and, consequently, to inadequate postural alignment. For instance, the persistence of unilateral knee hyperextension might lead to the evolution of scoliosis. Kendall[33] and Teixeira[34] point that, to have an adequate posture, a balance between body segments used in positions of less effort and maximal endurance is necessary.

On the course of human development, joint hypermobility might promote physiological alterations in the child's posture during growth stages, and an inadequate posture brings higher energy spending in daily activities as a consequence, predisposing the child to early fatigue[28]. According to Teixeira[34], isolated hypermobility does not cause bad posture, since other factors are involved, such as excessive body weight, insufficient or inadequate physical activity, bad postural habits, bone anomalies, protein deficiency characteristics. Barden et al.[35], add that joint instability caused by mobility excess might compromise the proprioceptive systems.

It is necessary to follow the evolution of joint hypermobility during childhood and adolescence through longitudinal studies, because it is essential to establish its resolution period. If hypermobility is prolonged or excessive, it may cause postural alteration, pain, and lesions. In addition, the occurrence of unilateral joint hypermobility as a probable cause of postural alterations must be investigated with the purpose of promoting its prevention.

CONCLUSION

The prevalence of joint mobility was high among JK and SK children, but it did not present statistically significant difference between the sexes, and was more frequent in the elbow and knee joints, where hyperextension occurred. The presence of pain was not prevalent in the study, and it might be a result of the narrow and young age range. Moreover, the difficulty of assessing children between 5 and 6 years old must also be considered.

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