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Original article

Hiperlaxity ligamentous (Beighton test) in the 8 to 12 years of age school population in the province of Granada

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ABSTRACT

The Beighton test is the most commonly used tool for detecting ligamentous hiperlaxity, characterized by excessive joint mobility. This descriptive cross-sectional study examined a sample of 2956 children (49.9% boys and 50.1% girls), from eight to twelve years of age, living in the province of Granada, The aim of the study is to show the incidence level of hiperlaxity among the school-aged population, while establishing its frequency in relation to gender and age, and determining the area with the highest number of cases within the province of Granada. The Beighton test was employed for data collection. The sample showed that 25, 4% of individuals got a positive Beighton result (laxity), and girls had a higher incidence level (62.1%) than boys. The results show a similar level of incidence among boys and girls between eight and ten years of age as well, however the incidence decreases among young children (under 8 years). Regarding the geographical areas, the distribution is quite heterogeneous, but we were able to highlight the difference between a result of 50% in area 4 and 12% in area 2, due to genetic and racial factors. In conclusion, the results obtained through this study show a lower incidence of hiperlaxity compared to the results found in the American continent being slightly higher than those from other European and African countries.

Hiperlaxitud ligamentosa (test de Beighton) en la población escolar de 8 a 12 años de la provincia de Granada

Palabras clave:
Hipermovilidad
Hiperlaxitud ligamentosa
Test Beighton
Escolares
Laxitud

RESUMEN

El test de Beighton es la herramienta más utilizada para la detección de la hiperlaxitud ligamentosa, que es la movilidad articular de rango excesivo. A través de este estudio de carácter descriptivo transversal llevado a cabo con una muestra de 2.956 niños/as (el 49,9% de chicos frente al 50,15% de chicas) de 8 a 12 años de la provincia de Granada se pretende detectar la prevalencia de la hiperlaxitud en la población escolar, determinar en qué sexo y a qué edad es más frecuente y en qué área geográfica de la provincia de Granada se establece mayor número de casos. En la recogida de datos que se realizó se empleó el test de Beighton, obteniendo que un 25,4% de los sujetos presentaron Beighton positivo (laxitud), que las chicas tenían proporciones más altas (62,1%) que los chicos, que entre los ocho y los diez años los valores son similares y disminuyen a partir de esa edad. En cuanto a las zonas, la distribución es bastante heterogénea, destacando el 50% de la zona 4 frente al 12% de la zona 2, debido a factores genéticos y raciales. Por último, este estudio pone de manifiesto que los datos obtenidos son inferiores a los hallados en el continente americano y ligeramente superiores a los encontrados en otros países europeos y africanos.

Introduction

Since ancient times it is common for circuses to incorporate contortionists among its star attractions, where the artists (often women and / or young subjects) are able to make movements and adopt body postures impossible for the vast majority of the population. Undoubtedly, the development of such skills requires hard training and learning specific skills, but could hardly reach the spectacular levels cited if the subject does not have some unique features that promoted an exaggerated anatomo-physiological increase in joint range of motion or joint hypermobility.

Although Kirk[1] in 1967 described the hypermobility syndrome, it is not until the early 1990s when Grahame[2] coined the term ‘benign joint hypermobility syndrome’ (BJHS), characterized by the presence

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of hypermobility of joints, associated with musculoskeletal discomfort in the absence of demonstrable systemic rheumatic disease.

Bravo[3] states that joint hypermobility is the result of a hereditary disorder of the collagen fibers that is transmitted as an autosomal dominant disorder that causes a lower resistance of the soft tissues of the joint (ligaments, tendons and capsules), that consequently leads to instability, dislocations and subluxations.

Scott,[4] Gedaliah,[5] Mikkelsson,[6] among others, have found a relationship between joint hypermobility and musculoskeletal pain. Also, Grahame[2] and Gedaliah[5] suggested that BJHS is a common cause of joint pain and transient arthritis in childhood, which often coincides with more severe rheumatic processes.

Other studies (Al-Rawi,[7] Binns,[8] Al Graf,[9] Qvindersland,[10] Aracena,[11] and Menéndez[12]) have also associated joint hypermobility joint pain with sprains, flat feet, Raynaud's phenomenon, fragile skin, high palate and varicose veins. Table 1 shows the main clinical conditions associated with hypermobility.

As for the prevalence of this disease, Grahame[13] considers that this condition can be found to a greater or lesser extent in all population groups. In Europe the proportion of affected individuals stands at 10% of the population, which would be consistent with the values given by Carter[14] for England (10.5%). In the Americas, the various studies undertaken provide much higher percentages: 34% in the U.S. (Arroyo[15]), 37.3% in Argentina (Knupp Feitosa de Oliveira[16]) and 36% in Brazil (De Cunto[17]), recording all data in healthy schoolchildren. The figures for the Middle East come from studies by Gedaliah in Israel,[5] which determines a prevalence of 13% and El Garf[9] in Egypt with 16%. Cheng's[18] work in China allowed them to show the relationship and age prevalence of this syndrome, because while the value of children under 10 years would reach 67%, the figure drops significantly to 28% among people over 10 years. The fact that joint hypermobility in healthy schoolchildren decreases with age is confirmed in studies of El Garf[9] and Grahame.[19] The latter also shows a highest incidence in women than in men and in relation to ethnicity, orientals and Asians are more lax than black Africans, and they, in turn, more than Caucasians.

Therefore we consider the following study objectives:

1) Identify the prevalence of ligamentous laxity in the school age population in the province of Granada.
2) Establish relationships between age groups (8-12 years) and gender in the population using the positive Beighton test (hypermobility).
3) To determine the prevalence of hypermobility in certain geographic areas of the province of Granada (Spain).

Material and methods

The study was carried out following a cross sectional design, done on the entire school population of 8 to 12 years in the province of Granada, which analyzed a sample structure representative and proportional to the number of children attending school in the area of each of the six regions defined within the province, according to figures provided by the Ministry of Education of the Junta de Andalucía.

Table 1
Main clinical conditions associated with hypermobility

Clinical conditions		
Musculoskeletal	Joint	Pain effusions of the knees
	Bursitis	Flat feet
	Tendinitis	Osteoarthritis
	Joint subluxations	Sprains
Spine	Idiopathic scoliosis	
	Pectum excarvatum	
	Pectum carinatum	
	Low back pain	
Syndromes	Marfan	
	Ehlers-Danlos syndrome (type iii)	
	Osteogenesis imperfecta (osteoporosis)	
Others	Blepharoptosis (droopy eyelids)	
	Myopia	Capillary fragility
	Anxiety	Muscle tears

As an evaluation technique to determine the presence or absence of joint hypermobility in the subject, we used the Beighton test (initially proposed by Carter[14] and subsequently revised by Beighton,[20] who eventually gave it its name) because not only is the method the most widely used by specialists, but the small number, simplicity and noninvasive nature of the maneuvers applied make it the most suitable for working with large groups of population, especially if they are children.

Because of the breadth of the sample and the need to interfere as little as possible in the normal dynamics of schools, a team of physiotherapists, doctors and scientists did the evaluation work. To minimize interobserver error, the team underwent a training process prior to the standardized protocol of the Beighton test (see below), which analyzed nearly 500 subjects with similar characteristics to those of the study. The first hundred scans were recorded on video and then analyzed by the group, commenting on methodological aspects due to differences and / or error in the data collection process. The rest was analyzed in a series of 60 subjects for the different values, contrasting in each case the number of matches, which at the end of the process was above 90%, setting the corresponding test (r=0.92) which established low interexaminer variability.

Once agreement was reached with the school heads regarding space and work schedule, the research team worked during the months of February and March 2007. The processing and data analysis were performed using the SPSS 13.0 statistical package.

Sample selection

The sample analyzed in the school population was made in response to a combination of layering techniques, proportionality and randomization of variables: students enrolled in each of the regions, age and gender.

The segmentation of the province in different geographical areas or regions used in the study (see Figure 1) was based essentially on the definitions and classifications made by the Ministry of Tourism and Sports of the Junta de Andalucia and the Granada Tourist Office.

It selected a total of twenty education centers in different areas previously identified, according to their characteristics (lines, type of school and student characteristics), in order to collect a population representative enough. They were chosen depending on the area, denominating one school the principal one and other so-called reserve centers to attend to them in case of a negative response from the main centers. We subsequently arranged a personal interview of the program manager with the directors of selected primary schools and medical services for the area and they were informed of what the research intended to accomplish. Attached to this, a letter of request was given to the school director explaining the whole process and requesting the cooperation of the school, with the acceptance of all sectors involved (school board, teachers, parents, medical services, etc.) also asking them to review a sample letter to request authorization information from the parents of schoolchildren.

Upon acceptance of the proposal with the center, time and space was agreed upon (gym or multipurpose room with a room attached), school rules to be respected (mostly sportswear) and the possible collaboration of some school staff (teachers, psychologists, etc.) in conducting the test. In all cases, and to maintain anonymity, digital coding in the registration form performed the identification of subjects, and its coherence and resolution allowed for the issuing of

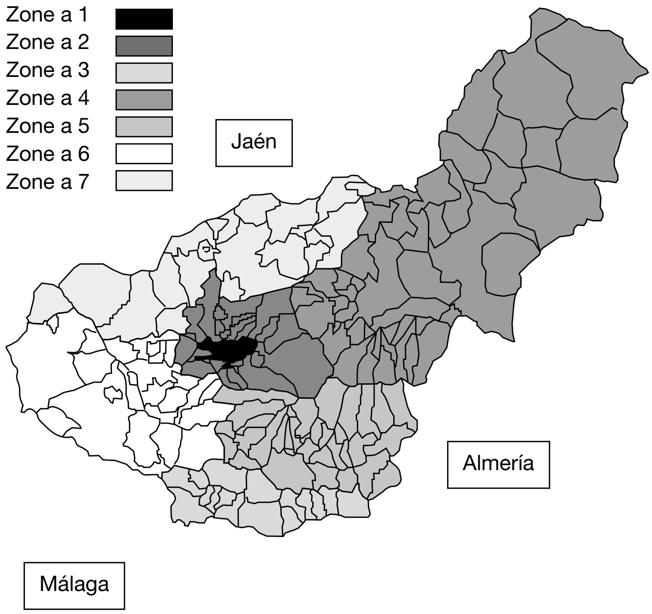

Figure 1. Sectorization of the study areas of the province of Granada.

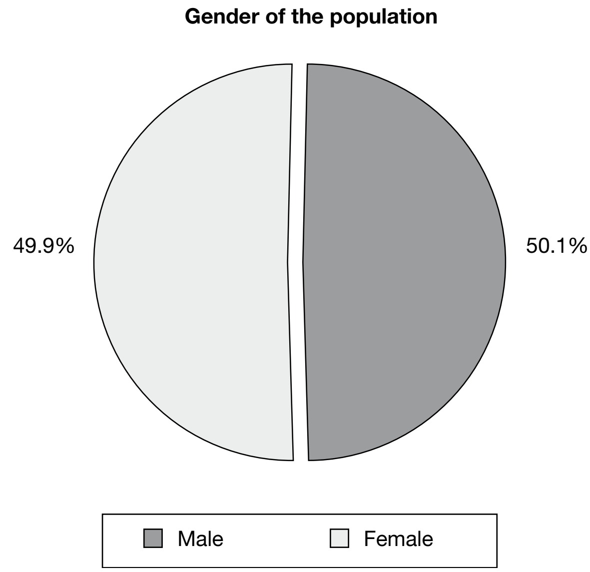

Figure 2. Distribution of the population according to gender.

the corresponding custom resolution reports to schools and parents of schoolchildren in relation to detections. Data was collected between February and March 2007.

The selection of the final sample of schools was conducted by sampling, reflecting the natural composition of the groups' requested centers, with no other criterion of inclusion or exclusion in the conformity with the participation in the study, recruiting 100% of groups. The final sample used in the study was of 2956 subjects, aged from 8 to 12 years, in the province of Granada, of both genders, with the sample reflecting the natural composition of the groups, with a ratio of 50.1% of boys and 49.9% of girls (Figure 2).

The distribution of children between 8-12 years was fairly homogeneous, whereas the sample was taken in the second and third cycle of the primary level; however, children under 12 years were the least representative (repeaters, students who have lost a year of schooling or had been enrolled after the required minimum age), but were taken into account and included in our study to establish the groups at 100% (Table 2).

Variable

As already mentioned, the technique used for the assessment of joint hypermobility was the Beighton test. The test proposed by Carter[14] in 1964 and modified by Beighton[20] in 1973, it has been used by a multitude of scientists (Gedaliah,[21] Larsson,[22] Beighton,[23] Grahame,[19] Balagué,[24] and De Cunto[17]) and is based on presenting a "positive Beighton score" which requires having 4 or more points out of nine. Subjects are rated on a scale of 9 points, considering 1 point for each hypermobile site, performing the test in both halves of the body and measuring the following:

- Hyperextension of the elbows (+10º), with the subject seated on a stool and extension by the examiner of the explored arm.
- Touching in a passive manner the forearm with the thumb, with the wrist in flexion, and the individual in the same position.
- Passive extension of the index finger over 90º, with the subject seated and with the palm of the hand fully extended on the table.

Table 2
Age distribution by frequency and percentages in the study

Age	Frequency	Percent
8 years	731	24.7
9 years	650	22.0
10 years	744	25.2
11 years	704	23.8
12 years	127	4.3
Total	2,956	100.0

- Hyperextension of the knees (10º or more) with the subject supine. The examiner explores the joint, determining its strength.
- Bending the trunk forward touching the floor with the palms of the hands without bending the knees.

Figure 3 shows the embodiment of each of the tests.

Getting four or more of these maneuvers positive (Table 3) will establish, in a generalized manner, the presence of ligamentous laxity (positive Beighton).

Results

Tables 4-6 detail the results obtained for the Beighton test in the entire study population, by gender and age groups.

It can be seen that a little over a quarter of the students tested were classified as having a positive Beighton test (presence of joint hypermobility), with significantly higher rates in girls than in boys.

Table 5 shows the relations of the Beighton tests and gender on the basis of age, only analyzing those individuals with the presence of hypermobility.

No significant association (P=.19) were seen in hypermobile individuals in terms of gender and age, with a greater prevalence in females (62.1%) (n=466), where age is very similar in the percentages, but laxity in male subjects is less frequent (37.9%) (n=285).

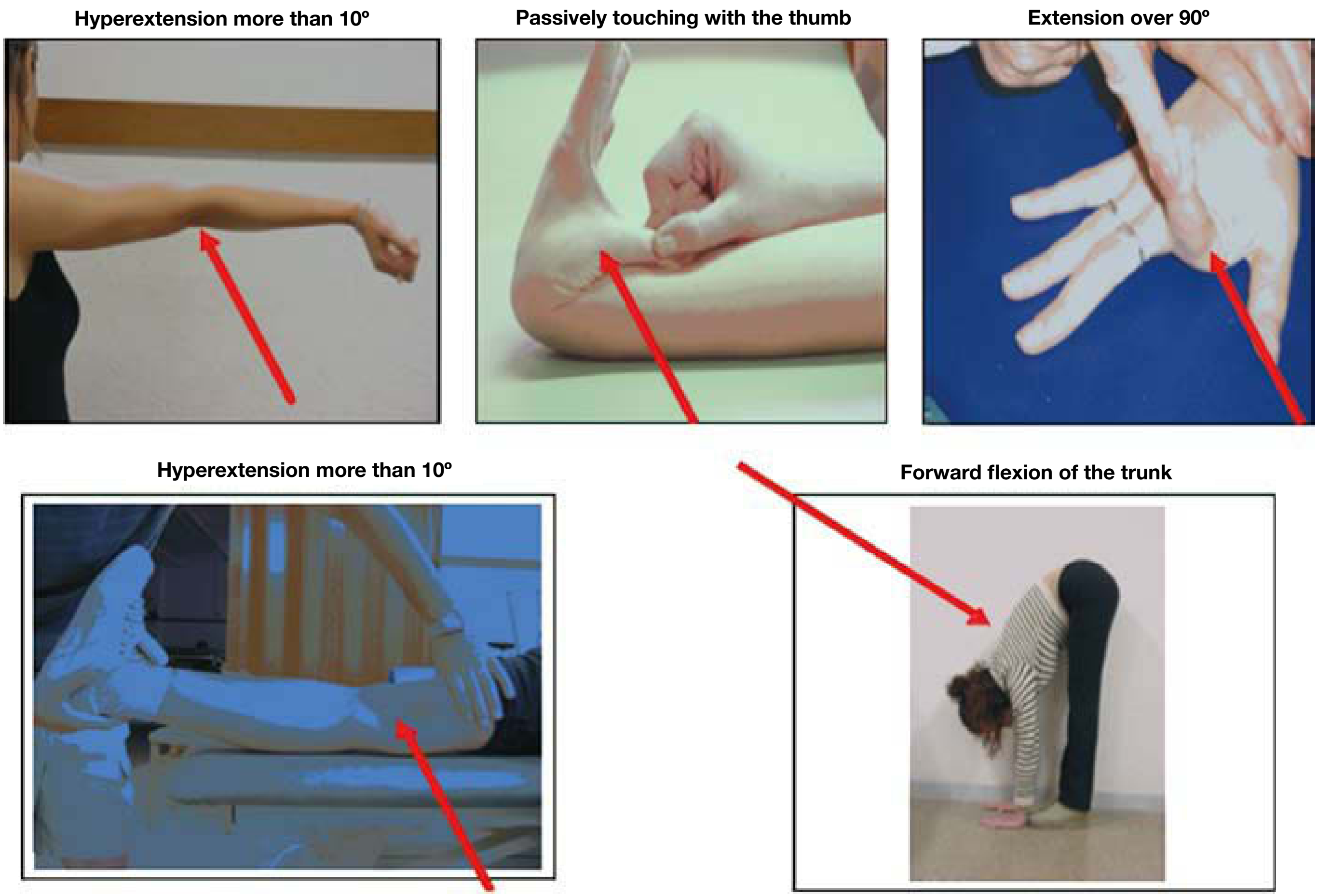

Figure 3. Parameters measured in the Beighton test.

In Figure 4 shows, on the one hand, individuals who had hypermobility (positive Beighton) and compared them by gender, finding that in all ages the percentage of females with hypermobility is much higher than males, as cited for the previous table, showing a high significance (*P*=.00).

In the above mentioned table and figure (Table 4 and Figure 4) the highest value is for joint hypermobility in girls at 8 years (28.1%) and in boys at age 9 (29.5%), the proportions being very similar during the ages of 8-10 years are, and no statistically significant differences (*P*=.18), resulting in a decrease in rates from age 10 to age 12 (4.5% in females and 3.9% in males).

The last section determined the relationship between joint hypermobility and designated areas of the province of Granada.

The results of the joint hypermobility according to the study areas provide us with significant differences in terms of the geography (*P*=.00). Zone 4 (Guadix-Baza) with 50.4% (n=191) was the area with the largest number of cases compared to 11.6% in Zone 2, with more extreme values concerning positive Beighton, found in areas 5 and 6 with values above 35% in the presence of ligamentous laxity, while the capital and suburbs (zone 1 and 2) had values below 17%.

In Figure 5 we highlight the 11.6 and 16.2% of positive Beighton zones 1 and 2 compared to 50.4% in Zone 4, which we statistically determined a high coefficient of heterogeneity between areas in terms of the presence of hypermobility (*P*=.00), as discussed in the next section.

Table 3
Determination of positive Beighton tests

Member	Beighton points	
	Right	Left
Hyperextension of the elbow	*	*
Playing with the thumb forearm	*	*
Passive extension of the index finger	*	*
Hyperextension of the knee	*	*
Flexion of the trunk	*	

Table 4
Distribution of joint hypermobility in the study population

Beighton	Frequency	Percent (%)
Positive	751	25.4
Negative	2,205	74.6
Total	2,956	100.0

Discussion of results

The results of our study show that the prevalence of joint hypermobility among schoolchildren in Granada as a whole (25.4%)

Table 5
Distribution of ligamentous laxity in the five age groups by gender

Beighton	Gender		Age					Total
			8	9	10	11	12	
Positive	Male	Count	75	84	79	36	11	285
		% of sex	26.3	29.5	27.7	12.6	3.9	100.0
		% age	36.4	43.5	39.3	30.3	34.4	37.9
	Women	Count	131	109	122	83	21	466
		% of sex	28.1	23.4	26.2	17.8	4.5	100.0
		% age	63.6	56.5	60.7	69.7	65.6	62.1
	Total	Count	206	193	201	119	32	751
		% of sex	27.4	25.7	26.8	15.8	4.3	100.0
		% age	100.0	100.0	100.0	100.0	100.0	100.0

Table 6
Distribution of ligamentous laxity according to the study areas

Area	Beighton				Total
	Positive		Negative		
	No.	%	n	%	
1	126	16.2	652	83.8	778
2	78	11.6	597	88.4	675
3	93	26.7	255	73.3	348
4	191	50.4	188	49.6	379
5	69	35.2	127	64.8	196
6	138	42.6	186	57.4	324
7	56	21.9	200	78.1	256
Total	751	25.4	2,205	74.6	2,956

is significantly higher than that obtained for other European populations (Carter,[14] Gedaliah,[5,25] and El Garf[9]) but without reaching the levels established for the American populations (Arroyo,[15] Knupp,[16] De Cunto,[17] and Torres[26]) (Figure 6).

However, the study also shows significant differences between the different regions of the province, still well above the rates of joint hypermobility obtained in more predominantly rural areas (Baza, Loja, and Alpujarra) than in the capital or metropolitan area. We do not have enough information to attribute this geographical heterogeneity a specific factor or factors, but if we consider the genetic component studied by Bravo, the association could be due to higher levels of inbreeding, in particular among Roma subjects (area Loja) and/or the education of children of South American immigrants (Baza area).

Moreover, our data is consistent with those of other studies in the Spanish school population (Duro[27]) regarding a greater presence of joint hypermobility in females than males in all age groups and regions studied.

Finally, the comparative analysis of the frequencies of hypermobile subjects according to age shows, as has already been incorporated into various international studies, an inverse association between the two up to 10 years of age, although there are some differences these are not statistically significant (P=.18). But after 11 years of age for both boys and girls, there was a significantly reduced prevalence for the group of 12 years, and while maintaining the same trend, in absolute terms, they should be taken with caution, since it is a group with a small number of subjects. Once again we say that our study, because it is eminently descriptive, does not provide sufficient information to establish the causality of that relationship, although it seems logical to think that it is linked to the levels of maturation and consolidation of stabilizing the joint, thereby leading to a progressive reduction of articular hypermobility in older girls and boys, except in the case of persons carrying the gene variant modifying the collagen fibers that would in any case be much lesser. Consequently, we might consider the diagnosis of a 'real' hypermobility for such an early age if the criteria are sufficient for it.

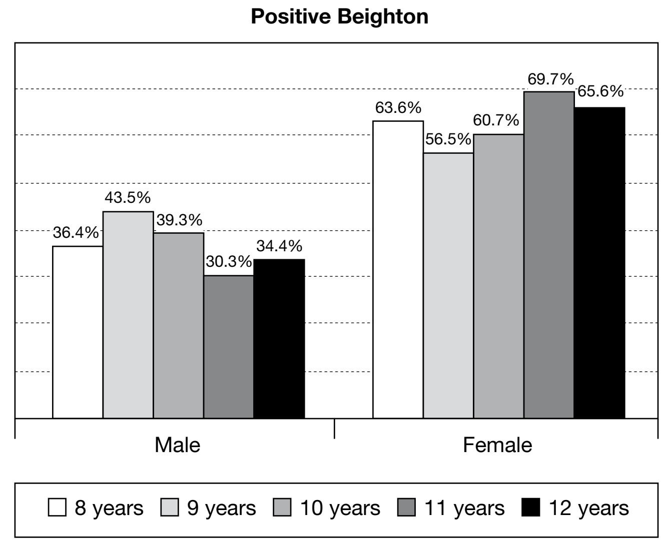

Figure 4. Percentages of positive Beighton tests (hypermobility) by age and gender in the study population.

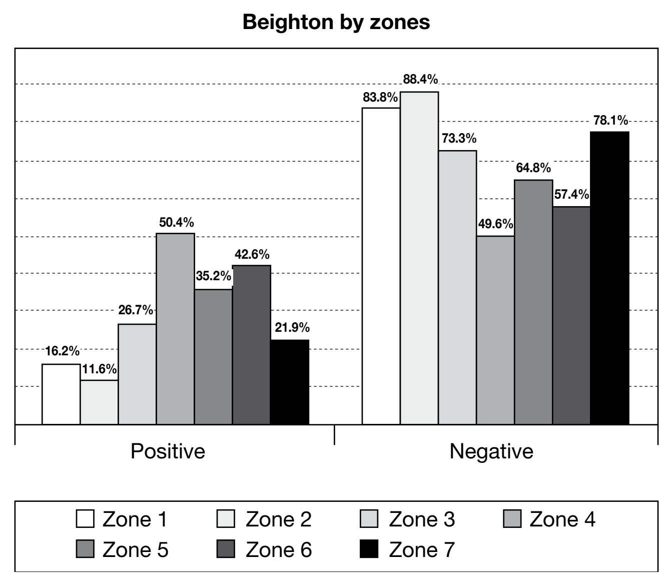

Figure 5. Distribution of ligamentous laxity in the study areas.

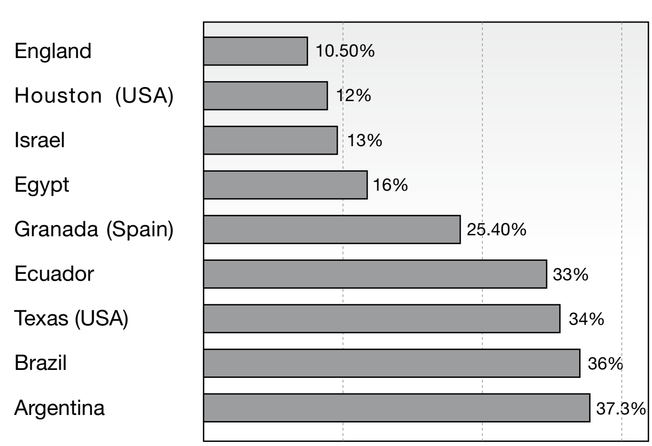

Figure 6. Distribution of ligamentous laxity in the world.

Conclusions

1) Approximately one quarter of the school population of 8 to 12 years in the province of Granada has joint hypermobility (Beighton rated as positive), which is higher than in other European populations.
2) The prevalence of hypermobility in the different study areas of the province of Granada has produced a different pattern, therefore in the rural areas, where inbreeding is probably more pronounced and / or immigrant groups are higher (zone 4 and zone 6), the percentages are significantly higher (about 50%) than in urban areas, where values were below 17%.
3) In accordance with what is reflected in most of the studies on the subject, in our population there is a higher prevalence of hypermobility in women than in men, and a decrease in the frequency of hypermobile individuals is seen with age.

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