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Evaluation of interrater and intrarater reliability of Beighton and Horan Joint Mobility Index

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Research Report

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Purpose: The aim of the current study was to determine interrater and intrarater reliability of Beighton and Horan Joint Mobility Index (BHJMI) which is used to describe hypermobility in university students. **Materials and methods:** Seventy-two physiotherapy students with an average age of 20.36±1.24 years (ranges 18 to 25) were included in the study (29 females and 43 males). To detect interrater reliability, all the subjects were examined by two raters at different sessions at the same day. For intrarater reliability of the BHJMI, the students were assessed and reassessed by the same rater with an average of 12.84±7.41 days (6-28 days) apart. Two types of scores for BHJMI, including composite scores (ranges 0 to 9), and categorized scores in three categories (0 to 2, 3 to 4, 5 to 9) were calculated. Intraclass correlation coefficient (ICC) was used to analyze the BHJMI composite score. Percentage agreement was also calculated for BHJMI composite and categorized scores. **Results:** ICC for interrater reliability of the BHJMI composite score was 0.82 and for intrarater reliability of the composite score was 0.92. The percentage agreement for interrater and intrarater reliability of the BHJMI category scores (75% and 86%) were higher than the BHJMI composite scores (42% and 43%). **Conclusion:** The results of this study suggest that the BHJMI was a practical and reliable method for defining hypermobility among healthy young subjects.

Key words: Hypermobility; joint, Beighton and Horan Joint Mobility Index, Reliability.

Beighton ve Horan Eklem Mobilite İndeksi'nin güvenilirliğinin değerlendirilmesi

Amaç: Bu çalışmanın amacı, sağlıklı üniversite öğrencilerinde hipermobilitenin tanımlanmasında kullanılan Beighton ve Horan Eklem Mobilite İndeksi'nin (BHEMİ) interrater ve intrarater güvenirlik düzeyini belirlemekti. **Gereç ve yöntem:** BHEMİ'nin güvenirliğini değerlendirmek için yaş ortalaması 20.36±1.24 yıl (18-25 yıl) olan 72 üniversite öğrencisi (29 kız, 43 erkek) çalışmaya dahil edildi. İnterrater güvenirliğin test edilmesinde tüm olgular iki araştırmacı tarafından aynı gün içerisinde farklı zamanlarda değerlendirildi. İntrarater güvenirlik için bir araştırmacı olguları ortalama 12.84±7.41 gün (6-28 gün) ara ile ikinci kez değerlendirdi. Puanlama toplam puan (0-9) ve sınıflandırılmış puan (0-2, 3-4 ve 5-9) olarak hesaplandı. Toplam puanlar için interrater ve intrarater güvenirlik düzeyinin hesaplanmasında İntraclass correlation coefficient (ICC) değeri kullanıldı. Ayrıca toplam puanlar ve sınıflandırılmış puanların yüzdesel uyumu değerlendirildi. **Sonuçlar:** Toplam puanlara göre interrater güvenirliği için ICC değeri 0.82 olarak bulundu. Test - tekrar test sonuçlarında ise toplam puanlar için ICC değeri 0.92 olarak hesaplandı. Sınıflandırılmış puanlar açısında yüzdesel uyum (% 75 ve % 86), toplam puanlamanın uyumundan (% 42 ve % 43) daha yüksekti. **Tartışma:** Elde edilen sonuçlara göre, sağlıklı gençlerde hipermobilitenin değerlendirilmesinde kullanılan Beighton ve Horan Eklem Mobilite İndeksi'nin güvenilir ve kolay uygulanabilir bir yöntem olduğu düşünüldü.

Anahtar kelimeler: Hipermobilite; eklem, Beighton ve Horan Eklem Mobilite İndeksi, Güvenirlik.

The term of joint mobility has been described as "the joints are unduly lax and the range of motion is in excess of the accepted normal in most of the joints examined" by Kirk et al.[1] The tightness of the capsule and the restraining ligaments play an important role for the stability of any joint, and ligamentous laxity is often the primary cause of a hypermobile joint.[2] Joint laxity differs markedly between sexes and among races, women being generally 1.5 to 3 times more lax jointed than men, and the condition is more prevalent among Asian and African races than Caucasians. Epidemiologic studies have shown a prevalence of joint hypermobility of 0.6-31.5%, depending on the criteria used (i.e. race, age, and sex).[3-5] Joint hypermobility also has a strong genetic component, with female twin studies showing that at least 70% of the variance in phenotype can be attributed to genetic factors.[6]

It is important to distinguish hypermobility (or general joint laxity), which describes the often asymptomatic increased range of joint or spinal movement, from hypermobility syndrome (HMS), its symptomatic counterpart.[7] Some authors state that the term HMS should only be used when dealing with symptoms.[1,2] Joint hypermobility is not a disease in itself, and many hypermobile individuals do not have clinical symptoms. Indeed, hypermobility is an asset to musicians, dancers, and athletes. It may, however, be found as a part of well-defined monogenic connective tissue disorders such as Marfan's syndrome, Ehlers-Danlos syndrome, and hypermobility syndrome.[8] Recently, major and minor criteria for HMS have been defined.[7]

Criteria assessing hypermobility as first described by Carter and Wilkinson in 1964.[9] This score ranges from 0-5 and the cut-off point for hypermobility was set at 3 out of 5 positive manoeuvres. In 1969 Beighton and Horan modified this score[10] and in 1973 Beighton et al, amended this score which today appears to be the most used to estimate hypermobility world-wide.[11] The Beighton and Horan Joint Mobility Index (BHJMI) is easy to use and requires no special equipment other than a goniometer. The index includes examination of fifth finger extension, opposition of the thumb to the forearm with wrist flexion, elbow extension, knee extension, and trunk and hip flexion (Table 1).[11]

Table 1. Criteria for hypermobility according to Beigthon and Horan.

Criterion	Score
Hyperextension, knee >10º	2
Hyperextension, elbow >10º	2
Passive opposition of the thumb to the flexor aspect of the forearm	2
Passive hyperextension of the 5th metacarpophalangeal joint ≥ 90º	2
Forward flexion of the trunk, with knees straight, so that the palms of the hands rest easily on the floor	1
Maximum possible score	**9**

A potential consequence of hypermobility is the HMS.[12] The HMS has been widely recognized in the rheumatology literature, but it has seldom been discussed in the orthopaedic literature and has only recently been described in the physical therapy literature[13], especially in Turkey.[14,15] Laxity of joint ligaments predisposes to ligamentous injury and it leads to joint instability, subluxation and dislocation.[7,16] There is indirect evidence that HMS is a risk factor for development of premature osteoarthritis. Postulated mechanisms include overuse, errors in collagen genes, or linkage between the genes for osteoarthritis and collagen abnormalities.[7] Associations with osteoarthritis,[17,18] chondramalasicia patella,[19] temporomandibular joint dysfunction,[20] and fibromyalgia[21] have been reported. And also, clinical decisions regarding intervention, specifically therapeutic exercise and education, may be affected by the presence of hypermobility and an effective way of screening for hypermobility is necessary.[12,13] Although the BHJMI has been used since 1969 in numerous studies in a wide variety of settings, its reliability among healthy young subjects has been described in one study from USA.[12] To our knowledge, there is no study on reliability of a hypermobility screening tool in both female and male young adults in Turkey. Consequently, this prompted us

to describe the intrarater and interrater reliability of the BHJMI in Turkish healthy young subjects.

Materials and methods

Subjects

A total of 72 undergraduate physical therapy students, aged 18 to 25 (29 females and 43 males) were examined for intrarater and interrater reliability of the index. The students were recruited from the School of Physical Therapy and Rehabilitation at Pamukkale University, Denizli, Turkey. The demographics are presented in Table 2. Before participating in this study, all the students were informed concerning aim of the study and procedures. All gave their verbal consent to participate in the study.

The inclusion criteria were; (1) being under age of 25 years, (2) no diagnosis of neuro-musculoskeletal diseases, (3) having no acute disease.

Raters

Two physiotherapists from Pamukkale University participated in this study as raters. The first rater (UBA) was a physical therapist with 15 years of experience in orthopaedic physiotherapy. The second rater (EÇ) was an orthopaedic physical therapist with 6 years experience from the same school. Training of raters consisted two hours of practice together. During the practice session, raters performed BHJMI on each other and on ten physiotherapy students for familiarization with the BHJMI before testing.

Measurement

All subjects were examined in a gym by the raters. All subjects were examined for interrater reliability on two occasions during the same day. Both raters were blinded to previous results. An average of 12.84±7.41 days later, the students were reexamined by one rater (EÇ) for intrarater reliability of BHJMI. A 8 inch goniometer (for fifth-finger extension) and a 12 inch goniometer (for knee and elbow extension) were used.

BHJMI

Five manoeuvres were used to assess hypermobility according to Beighton and Horan. All measurements were performed bilaterally, except for trunk flexion. Each hypermobile joint gives 1 point, the maximum score being 9 points (Table 1).[3]

Table 2. The demographic characteristics of the sample.

	Female (N=29) Mean±SD	Male (N=43) Mean±SD
Age (yrs)	20.2±0.9	20.5±1.5
Body weight (kg)	53.6±7.4	71.6±8.3
Height (cm)	163.5±4.9	177.9±5.0

Fifth-finger Extension

The fifth-finger extension test was demonstrated by the rater, and then the fifth finger was passively extended by the subject. The distal portion of the fifth metacarpal was stabilized with the thumb of the opposite hand while the tip of the fifth finger was extended by the subject using the index or middle finger as far as possible without pain. Goniometric measurements were taken with the fulcrum over the center of the metacarpophalangeal joint, the distal arm along the length of the finger, and the proximal arm along the fifth metacarpal. A fifth-finger hyperextension greater than 90 degrees resulted in a score of 1. Hyperextension of 90 degrees or less resulted in a score of 0.[12]

Wrist Flexion and Thumb Opposition

The thumb-opposition test was demonstrated by the rater, and then done passively by the subject. The subject stabilized the distal portion of the forearm with the thumb of the opposite hand, and the thumb being tested was passively abducted by the fingers of the opposite hand toward the volar aspect of the forearm with the wrist in flexion. If the thumb could be abducted to touch the forearm, then the score was 1. Opposition less than this resulted in a score of 0.[12]

Elbow Extension

The elbow-extension test was performed with the subject's shoulder abducted to approximately 80 degrees and the forearm supinated. The rater then stabilized the proximal elbow from the posterior side while applying a gentle force to the subject's palmar wrist to achieve passive end-range

extension. The center of the fulcrum was placed over the lateral epicondyle of the humerus, and the distal arm of the goniometer was positioned along the lateral midline of the forearm and aligned with the radial styloid process. The proximal arm was positioned along the lateral midline of the subject's humerus. Hyperextension of the elbow greater than 10 degrees resulted in a score of 1. Hyperextension of the elbow less than 10 degrees resulted in a score of 0.[12]

Trunk and Hip Flexion

The trunk-flexion test was demonstrated by the rater and then repeated by the subject. The subject attempted to touch the palms flat to the floor while keeping the knees either extended or hyperextended. If the subject was able to flex the trunk so that the palms were flat on the ground, then trunk flexion received a score of 1; otherwise, a score of 0 was assigned.[12]

Knee Extension

The knee-extension test was conducted in supine with 1 or 2 towel rolls placed under the ankle. The fulcrum of the goniometer was placed over the lateral epicondyle of the femur, and the proximal arm was aligned with the lateral midline of the femur, using the greater trochanter for reference. The distal arm was aligned with the lateral malleolus. Hyperextension of the knee greater than 10 degrees resulted in a score of 1. Hyperextension of the knee less than 10 degrees resulted in a score of 0.

All 5 components of the BHJMI (right and left fifth fingers, right and left wrist and thumb, right and left elbows, right and left knees and trunk and hip) were measured and assigned either a 0 or 1. The scores, either 0 or 1 for each component of the BHJMI were totalled for the composite score. Composite scores were then placed into 1 of 3 categories (0 to 2= category 1, 3 to 4= category 2, and 5 to 9= category) to allow us to analyze the reliability of category scores.[12]

Statistical Analysis:

The data were analyzed using SPSS for Windows statistical analysis program. ICC test was used to analyze interrater and intrarater reliability of the BHJMI composite score. Percentage agreement for interater and intrarater reliability calculated manually for the BHJMI composite and categorized scores.

Table 3. Percentage agreement of the BHJMI composite scores.

Difference in composite BHJMI scores	Interrater reliability (%)	Intrarater reliability (%)
Perfect agreement	42	43
Agreement within 1 points	33	39
Agreement within 2 points	22	14
Agreement within 3 points	3	4

Results

The percentage agreement for interrater and intrarater reliability of the BHJMI category scores (75% and 86%) (Table 4) were higher than the BHJMI composite scores (42% and 43%) (Table 3).

Table 5 and Table 6 were presented number of cases differed between categories 1 and 2, 1 and 3, 2 and 3. Only 3 cases differed between categories 1 and 3 according to results of raters (Table 5), while no case differed between categories between 1 and 3 according to intrarater examination (Table 6).

ICC for interrater reliability of the BHJMI composite score was 0.82, and this correlation was a moderate level. However, a high level correlation was found for intrarater reliability of the composite score (0.92).

Discussion

Hypermobility has been recently discussed in physiotherapy literature. Although, it is associated with several musculoskeletal disorders, its identification using a reliable and valid clinical diagnostic tools is very important. In addition to physical therapy program for patients with hypermobility syndrome should be designed including therapeutic exercises, protective and supportive devices etc.[13]

Table 4. Percentage agreement of the BHJMI categorized scores.

Difference in categorised BHJMI scores	Interrater reliability (%)	Intrarater reliability (%)
0	75	86
1	21	14
2	4	0

Table 5. Interrater reliability of the BHJMI categorized scores.

Rater 2 Category	Rater 1 Category 1	2	3
1	28	5	0
2	4	9	3
3	3	3	17

Table 6. Intrarater reliability of the BHJMI categorized scores.

Second Examination Category	First Examination Category 1	2	3
1	30	3	0
2	1	11	4
3	0	2	21

The aims of integrated physiotherapy program in subjects with hypermobility consist of (1) improving spinal posture by developing core stability, (2) enhancing joint stability by encouraging joint-stabilizing exercises, (3) improving joint proprioception by suitable exercises, (4) avoiding resting in harmful end-of-range postures, (4) using pacing, coping and behavioural strategies in severe or widespread chronic pain, (5) reversing deconditioning and enhancing fitness and stamina by aerobic exercise, (6) invoking self-management, thereby restoring self-esteem and self-efficacy.[7,13]

Stewart and Burden investigated that whether ligamentous laxity increases seasonal incidence of injury in male first division club rugby players. They determined ligamentous laxity using the BHMJI and graded with an overall laxity score ranging from 0 (tight) to 9 (hyperlax). The incidence of injuries was significantly higher in hypermobile than tight players reported in this study. They concluded that BHMJI was simple and took about two minutes to complete, and it was ideal for collecting information in athletes at higher risk of joint injury and establishing appropriate preventive rehabilitation programmes.[22]

A previous study by Sauers et al detected correlation between subjects' Beighton Mobility Scores and several measures of glenohumeral joint laxity in 51 recreational athletes without a history of shoulder injury or long-term participation in overhead sports participated.[23] A modified Beighton Mobility Score was used to quantify generalized joint laxity in their study. Their results showed that no moderate or stronger correlations between laxity, passive range of motion, and generalized joint laxity were seen. They concluded that the presence of a wide spectrum of symmetric laxity in subjects failsed to correlate strongly with passive range of motion or generalized joint laxity.[23]

In the present study, we detected intrarater and interrater reliability for BHJMI composite scores. The results of our study showed a good interrater reliability and an excellent intrarater reliability for BHJMI composite and categorized scores. Boyle et al investigated intrarater and interrater reliability for BHJMI composite and categorized scores in 15 to 45 years old female subjects. They found an excellent intrarater (0.86) and interrater reliability (0.87) of BHJMI composite scores, and good to excellent intrarater (0.81) and interrater (0.75) reliability of the BHJMI category scores in 15 to 45 years female students.[12]

To our knowledge, there are two studies regarding the BHJMI in Turkish population. However, the interrater and intrarater reliability of the BHJMI in categorised scores has not been studied in healthy young subjects. In a previous study by Seçkin et al, 11.7% of the students, aged 13 to 19 years, were found to be hypermobile according to BHJMI. In their study, it was also

more pronounced in females than males.[14] In another study by Erkula et al, from Turkey, 1273 children with a mean age of 10.4±1.2 years were assessed by BHJMI for relation between joint laxity and scoliosis. Although the number of patients with scoliosis was limited, a relation was found between joint laxity and scoliosis. At the same time, they also examined the interrater and intrarater reliability of the BHJMI composite scores. They reported an excellent interrater reliability (0.86) and a good intrarater reliability (0.62) of the BHJMI in composite scores.[15]

Hicks et al examined the interrater reliability of the BHJMI in 63 patients with lumbar segmental instability, then ICC value was found 0.79 in the study.[24] This value was similar to our result of interrater reliability.

Boyle et al explained several sources of error for BHJMI testing. These sources included the time interval among measurements, goniometric measurement error, experimenter error, weather changes, variability in verbal instructions to the subjects for testing technique and position (i.e., the amount of pressure during the wrist-flexion and thumb-opposition test and the location of the pressure at the thumb tip or the thumb interphalangeal joint), and soft tissue surrounding joint having been warmed up or not before testing. These conditions, however, are more consistent with a clinical environment rather than precisely controlled experimental conditions and, therefore, yield results with greater external validity.[12]

Our results indicate that the intrarater reliability of the BHJMI composite is excellent and interrater reliability of the BHJMI composite scores is good for female and male healthy subjects, 18 to 25 years of age. Also, we observed this index to be an easy and practical method for screening hypermobility in healthy subjects.

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