Research Article / Araştırma Makalesi

The Health-Related Physical Fitness of University Female Students with and without Generalized Joint Hypermobility: A Case-Control Study

Jeneralize Eklem Hipermobilitesi Olan ve Olmayan Üniversite Kız Öğrencilerinin Sağlıkla İlişkili Fiziksel Uygunluğu: Bir Vaka Kontrol Çalışması

Hande Özdemir, Filiz Tuna, Derya Demribağ Kabayel

Trakya University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Edirne, Türkiye

Abstract: To evaluate the effect of generalized joint hypermobility (GJH) on health-related physical fitness. Female university students between the ages of 18-23. Cardiorespiratory fitness (maximal cycling ergometer tests, six-minute walking (6MW) tests), respiratory function tests, respiratory muscle strength (maximal inspiratory and expiratory pressure) (MIP and MEP), body composition (bioelectrical impedance analyses), flexibility (sit and reach tests (SRT), muscle strength and endurance (isometric and isokinetic tests) were evaluated for health-related physical fitness. The mean value of maximal oxygen uptake (VO2max) (23.6 vs. 21.8, p=.049), metabolic equivalent for task (MET) (6.7 vs. 6.3, p=0.049), W/kg (1.6 vs. 1.5, p=0.035), and SRT scores (23.3 vs. 18.7, p=0.016) were higher in 39 students with asymptomatic GJH compared to 42 non-GJH students. No significant differences found between groups for 6MW distance, forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), MIP, MEP, body composition, muscle strength, and endurance (p>.05). Females with generalized joint hypermobility have the same or even higher levels of physical fitness capacity as those without the hypermobility.
Keywords: Joint Hypermobility; Physical Fitness; Health

Özet: Jeneralize eklem hipermobilitesinin (JEH) sağlıkla ilişkili fiziksel uygunluk üzerindeki etkisini değerlendirmek. Katılımcılar: 18-23 yaş arası kadın üniversite öğrencileri. Sağlıkla ilgili fiziksel uygunluk açısından kardiyorespiratuar fitness (maksimum bisiklet ergometre testleri, altı dakika yürüme (6DY) testi), solunum fonksiyon testleri ve solunum kas gücü (maksimum inspiratuar ve ekspiratuar basınç) (MİP ve MEP), vücut kompozisyonu (biyoelektrik empedans analizleri), esneklik (otur ve eriş testi (OET), kas gücü ve dayanıklılık (izometrik ve izokinetik testler) değerlendirildi. Ortalama maksimum oksijen tüketimi (VO2max) (23,6'ya karşı 21,8, p=0,049), metabolik eşdeğer (MET) (6,7 'ya karşı 6,3, p=0,049), W/kg (1,6 'ya karşı 1,5, p=0,035) ve OET skorları (23,3 'ya karşı 18.7, p=0.016) asemptomatik JEH'li 39 öğrencide JEH olmayan 42 öğrenciye göre daha yüksekti. 6DY mesafesi, zorlu vital kapasite (FVC), birinci saniye zorlu ekspirasyon volümü (FEV1), MİP, MEP, vücut kompozisyonu, kas gücü ve dayanıklılık açısından gruplar arasında anlamlı fark bulunamadı (p>0,05). Jeneralize eklem hipermobilitesi olan kadınlar, hipermobilitesi olmayanlarla aynı veya hatta daha yüksek düzeyde fiziksel uygunluk kapasitesine sahiptir.
Anahtar Kelimeler: Eklem Hipermobilitesi; Fiziksel Uygunluk; Sağlık

ORCID ID of the authors: HÖ. 0000-0002-1717-9604 FT. 0000-0002-9563-8028 , DDK. 0000-0003-1974-8054

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Correspondence: Filiz TUNA– Trakya University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Edirne, Türkiye e-mail drftuna@hotmail.com

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1. Introduction

Generalized joint hypermobility (GJH) is the presence of an excessive range of motion in specific joints beyond normal limits(1,2). It is based on differences in connective tissue and genetic factors(3). GJH occurs in 41.6% of asymptomatic female students when evaluated using the Beighton evaluation items with a cut-off of 4 out of 9(4). This common physical feature in this population may predispose to musculoskeletal problems and is associated with eating behaviors(5). However, a significant portion of hypermobile individuals are asymptomatic, and this feature may even predispose them to certain activities and sports such as gymnastics, combat sports, and dance(6-8). The fact that flexibility is one of the health-related physical fitness parameters brings to mind the question of whether GJH, which is characterized by ligamentous or capsular looseness in the joints, has an effect on the fitness level(6).

In this study, we aimed to compare the health-related physical fitness components of females with GJH to those without. This includes cardiorespiratory fitness (CRF), body composition, flexibility, muscle strength, and muscle endurance. The null hypothesis stated that there were no differences between female students with GJH and those without it, in terms of their cardiorespiratory fitness (measured through maximal cycling ergometer tests, six-minute walking tests, respiratory function tests, maximal inspiratory and expiratory pressure measurements), body composition (measured through skin fold thickness and bioelectrical impedance analyses), flexibility (measured through sit and reach tests), muscle strength, and endurance (assessed through isometric and isokinetic tests). On the other hand, the opposite hypothesis stated that female students with GJH differed from those without it, in terms of their cardiorespiratory fitness, body composition, flexibility, muscle strength, and endurance.

Determining the effectiveness of GJH on the health-related fitness of hypermobile individuals can guide safe daily, sports, and exercise activities.

2. Materials and Methods

Participants

A cross-sectional case-controlled, and observational study was conducted at Trakya University Faculty of Medicine, Physical Therapy and Rehabilitation Polyclinic between July 1, 2017 and November 1, 2017. The study included 39 asymptomatic physical therapy and rehabilitation female students between the ages of 18-23 who were previously diagnosed with GJH, and 42 female volunteers who were determined not to have GJH. Controls were matched by age with females with GJH. A group of students with Beighton scores ≤3/9 was selected as controls (non-GJH). Controls were matched by age with females with GJH. Participants with Beighton scores ≥4/9 were included in the GJH group (9). All voluntiers were selected from the same sources (Trakya University Faculty of Health Sciences (Edirne/Turkey)). The exclusion criteria were continuous medication use, neurological disease (stroke, spinal cord injury, cerebral palsy), mental retardation, serious emotional disorder, adjustment disorder, physical disability that would prevent safe and appropriate testing, anti-flu medication in the last week, and the presence of a hypertension, cardiac arrhythmia-conduction disorder, coronary artery disease, heart failure, diabetes mellitus, hyperlipidemia, cardiovascular diseases, unstable angina, pulmonary embolism, chronic obstructive pulmonary disease, pulmonary infection, active infection and malignancy in both groups. Males, and females below 18 or over 23, without consent or pregnant, were also excluded(1). The Ethics Committee of Trakya University Medical Faculty approved the study (TÜTF-BAEK-2017/21), and all participants provided written informed consent.

Clinical Evaluation

After meeting the study criteria and agreeing to participate, individuals were evaluated three times, one week apart, following their written consent. During the first evaluation, the patients' age, height, body weight, and body mass index (BMI) were recorded.

Additionally, bioelectrical impedance analysis, skinfold thickness measurement, and a maximal bicycle ergometry test were performed. The second evaluation included a sit-and-reach test, elbow flexor and extensor muscle strength measurement using a hand-held dynamometer, a 6-minute walk test, and a respiratory function test. Finally, the third evaluation consisted of knee muscle strength and endurance evaluation, maximal inspiratory and expiratory pressure measurement, hand grip strength measurement, and an isokinetic test.

Evaluation of Generalized Joint Hypermobility

The Beighton score of all individuals was determined to confirm whether GJH was present. Brighton criteria with cut-off Beighton scoring ≥ 4/9, are used to define GJH(3,10).

Beighton scoring was performed by evaluating nine joints and the following items (Figure 1):

I- Passive dorsiflexion of the fifth metacarpophalangeal joint to ≥90° (Figure 1A)

II- Opposition of the thumb to the volar aspect of the ipsilateral forearm (Figure 1B)

III- Hyperextension of the elbow to ≥10° (Figure 1C)

IV- Hyperextension of the knee to ≥10° (Figure 1D)

V- Placement of hands flat on the floor without bending the knees (Figure 1E) (11).

All participants were evaluated by the same investigator (the first author).

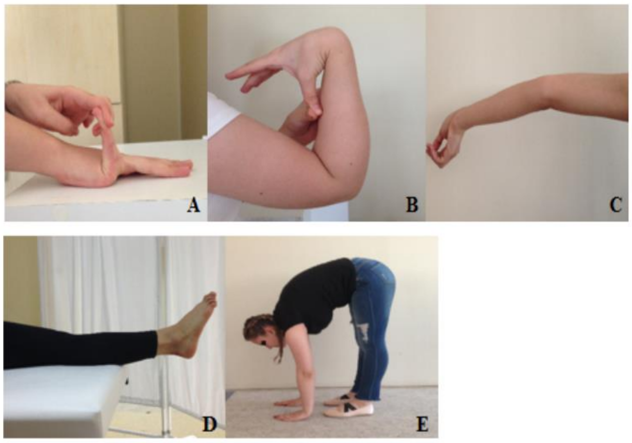

***Figure 1. Beighton scoring items; (A)** Passive dorsiflexion of the fifth metacarpophalangeal joint to ≥90°, **(B)** Opposition of the thumb to the volar aspect of the ipsilateral forearm. **(C)** Hyperextension of the elbow to ≥10°. **(D)** Hyperextension of the knee to ≥10°. **(E)** Placement of hands flat on the floor without bending the knees*

Determining Cardiorespiratory Fitness Level

All participants underwent a bicycle ergometry test, a 6-minute walk test, a respiratory function test, and respiratory muscle strength measurements.

The bicycle ergometry (Ergoline Ergoselect 200) test was applied in the WHO protocol, characterized by a workload starting with 25 W and increasing by 25 W every 2 minutes until reaching the maximum heart rate determined using the "220-age" formula. After the cooling period, the heart rate continued to be recorded for 1 minute, and the difference between the heart rate at the end of the 1st minute and the maximum heart rate reached during the test was recorded as the heart rate recovery index (HRRI). HRRI below 12 beats/min is considered abnormal(7). Maximal oxygen uptake (VO_2max), metabolic equivalent of task (MET), and maximum watt/kg (W/kg) values at the time he completed or had to quit the bicycle ergometry test were recorded on a computer.

During the 6-minute walk test, which is another test applied to determine cardiac capacity, patients were asked to walk as briskly as possible for 6 minutes in a 30-meter corridor marked at 5-meter intervals. their 6-minute walking distance (6MWD) was recorded in meters.

To measure lung volumes, forced vital capacity (FVC) in liters and forced expiratory volume in the first second (FEV1) values were determined by applying a respiratory function test (PFT) with the MIR Spirobank II Model computerized respiratory function test device.

To measure the strength of respiratory muscles, we used a portable manometer from CareFusion MicroRPM brand to determine maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) values in cmH_2O(8) . The measurements were repeated twice for both pulmonary function tests and respiratory muscle strength and the highest values were recorded.

Determining Body Composition

TANİTA MC 780 multi-frequency segmental body composition analyzer was used to determine body composition. Body weight (kg), body mass index (kg/m²), body fat percentage (%), total muscle mass (kg), trunk fat mass (kg), trunk muscle mass (kg), dominant leg fat mass (kg), and dominant leg muscle mass (kg) values were recorded(12). In addition to determining body composition with bioimpedance analysis, skinfold thickness measurements were made taken on the triceps, suprailiac, and thigh regions of participants using a caliper device (Baseline 12-1110)(13).

During flexibility assessment, a modified Baseline 12-1086 meter was used for a sit-and-reach test. During the test, each participant was asked to sit on the bench without wearing shoes and with their feet shoulder-width apart. They were then instructed to fully extend their knees and place the soles of their feet on the bench. After that, they were asked to stretch their arms with their palms facing down and place their head between their arms. Finally, they were asked to lean their body forward and hold the maximum reaching position for one to two seconds. The furthest distance his fingers can reach has been determined. The test was repeated twice and the highest value was recorded (14,15).

Determining Muscle Strength

While the participants' hand grip, elbow flexion, and extension muscle strength were evaluated using the isometric method, isokinetic evaluations were used for knee flexion and extension muscle strength and lower extremity muscle endurance measurements. Measurements were made from the dominant upper and lower extremities.

To measure hand grip strength, participants were asked to adduct and neutrally rotate their shoulders, flex their elbows to 90°, bring their forearms and wrists to a neutral position, then grasp the Jamar dynamometer (Sammons Preston) with their hands and squeeze it as hard as possible. The best result was recorded after three repetitions(16).

To evaluate elbow flexion and extension muscle strength, participants were asked to flex their elbows to 90° in the supine position, with their shoulders in neutral, and a Lafayette brand hand-held dynamometer was placed just proximal to the styloid process. They were asked to bring their wrists to a neutral position for elbow flexion muscle strength measurement, wrist supination, and elbow extension muscle strength measurement. In the measurements, the "break test" technique, which is a method based on the practitioner gradually overcoming the strength of the person being tested, was applied. The higher value of two measurements made 1 minute apart was recorded(17-19).

Lower extremity muscle torque production was evaluated with an isokinetic testing device (CSMI Cybex HUMAC/NORM). Before each test, the isokinetic test device was calibrated in accordance with the manufacturer's recommendations. Knee flexion and extension peak torque were measured at low (60°/sec) and high (240°/sec) angular speed. After warming up with a 10-minute bicycle ergometry exercise, knee flexion and extension repetitions were performed for these two angular velocities, first for practice purposes and then for measurement purposes. Measurements were performed in all participants at knee joint range of motion between 0-90 degrees. Additionally, knee flexor and extensor torque ratios were recorded as the hamstring/quadriceps (H/Q) ratio (20,21).

Analytic strategy

Statistical analyses were conducted using the SPSS 20.0 (License No: 10240642) package program. The results are presented as mean ± standard deviation and number (%). The One-Sample Kolmogorov-Smirnov test was used to examine the suitability of quantitative data to normal distribution. The Student's t-test and Mann-Whitney U test were used to compare differences between groups. A p-value of <0.05 was considered statistically significant.

3. Results

Demographic Characteristics

Complete data were obtained from 81 female students, 39 of whom had GJH and 42 did not. The median value of the Beighton score is 5 in the GJH group and 2 in the control group without GJH. No significant differences were found between the two groups in terms of age, height, body weight, or BMI. The characteristics of the participants are detailed in Table 1.

Cardiorespiratory Fitness

When the two groups were compared based on their cardiorespiratory fitness markers, we found that the group with GJH had significantly higher values for VO_2 max (23.6 vs. 21.8, p=0.049), MET (6.7 vs. 6.3, p=0.049), and W/kg (1.6 vs. 1.5, p=0.035) as compared to the control group. However, when we compared the two groups in terms of 6MWD, HRRI, lung volumes (FVC and FEV1), and respiratory muscle forces (MIP and MEP), we found no significant difference between them as shown in Table 2.

In the group with GJH, the maximum heart rate value was not reached in any students in the bicycle ergometry test. The test could not be completed in 38 students due to muscle fatigue, and in 1 student due to both breathing difficulty and muscle fatigue. In the control group, 37 students could not complete the test due to muscle fatigue, 1 student could not complete the test due to respiratory difficulty and 3 students could not complete the test due to both respiratory difficulty and muscle fatigue. One student in this group reached the maximum targeted heart rate at the end of the test and completed the test.

Body Composition

No statistically significant difference was detected between the groups in terms of body fat percentage, total muscle mass, trunk fat and muscle mass, dominant leg fat and muscle mass, and triceps, suprailiac, and thigh skinfold thicknesses (Table 3).

Flexibility

Sit-and-reach test results were found to be significantly higher in the group with GJH than in the control group (23.3 vs. 18.7, p=0.016) (Table 3).

Muscle Strength

No statistically significant difference was detected between the two groups in terms of hand grip strength measured from the dominant extremities, elbow flexor and extensor isometric muscle strength, knee flexor, and extensor peak torque values at 60°/sec and 240°/sec angular speed, and H/Q ratios (Table 3).

Table 1. Comparison of demographic characteristics of females with GJH and controls

	GJH group (n=39) Mean (SD) (min-max)	**Control group (n=42) Mean (SD) (min-max)**	**p**
Age, year	20.5 (1.1) (19-23)	20.6 (1.2) (18-23)	0.817
Height, m	163.9 (6.6) (148-178)	163.5 (4.6) (156-175)	0.756
Weight, kg	55.6 (10.4) (36.2-81.6)	57.4 (9.5) (42.7-88.9)	0.416
BMI, kg/m^2	20.6 (3) (15.3-27.9)	21.5 (3.1) (16.5-29.7)	0.182

GJH; generalized joint hypermobility, BMI; body mass index, SD; standart deviation

Table 2. Comparison of cardiorespiratory fitness, respiratory function, and respiratory muscle strength parameters of groups

	GJH group (n=39) Mean (SD) (min-max)	**Control group (n=42) Mean (SD) (min-max)**	**p***
VO_2max (mL/kg/min)	23.6 (3.5) (17.1-33.7)	21.8 (4) (9.7-34.4)	**0.049**
MET	6.7 (1) (4.9-9.6)	6.3 (1.2) (2.8-9.8)	**0.049**
W/kg	1.6 (0.3) (1.1-2.4)	1.5 (0.3) (0.5-2.5)	**0.035**
6MW (m)	583.4 (53.1) (464-725)	567.2 (57.8) (420-690)	0.172
HRRI (beat/min)	26.4 (9.8) (9-50)	26.1 (7.9) (11-50)	0.973
FVC (L)	3.4 (0.6) (1.9-5.0)	3.2 (0.5) (1.7-4.0)	0.195
FEV1(L)	2.9 (0.5) (1.6-4.0)	2.8 (0.4) (1.6-3.6)	0.326
MIP (cmH_2O)	61.2 (19.2) (35-119)	61.2 (21.8) (33-129)	0.210
MEP (cmH_2O)	74.1 (19.4) (52-165)	83.4 (30.4) (51-179)	0.751

GJH; generalized joint hypermobility, SD; standard deviation, MET; the metabolic equivalent of task, 6MW; six-minute walking test, HRRI; heart rate recovery indexes, FVC; forced vital capacity, FEV1; forced expiratory volume in one second, MIP; Maximum inspiratory pressure, MEP; Maximum expiratory pressure

Table 3. Comparison of body composition, flexibility, and muscle strength parameters of groups

	GJH group (n=39) Mean (SD)	Control group (n=42) Mean (SD)	p*
Body fat percentage (%)	22.3 (6.9)	23.4 (6.3)	0.427
Total muscle mass (kg)	40.5 (4.8)	41.3 (4.1	0.405
Trunk fat mass (kg)	5.5 (3.6)	6 (3.3)	0.365
Trunk muscle mass (kg)	22.9 (4)	23.8 (2.4)	0.365
Dominant leg fat mass (kg)	3.1 (1)	3.3 (1)	0.432
Dominant leg muscle mass (kg)	6.9 (0.8)	7 (0.7)	0.580
Skin fold thicknesses (mm)			
Triceps	21.8 (8.7)	23.7 (7)	0.080
Suprailiac	18 (5.9)	19.6 (5.5)	0.155
Thigh	32.9 (7.8)	35.1 (7.7)	0.150
Sit and reach test (cm)	23.3 (7.7)	18.7 (7.8)	**0.016**
Hand grip strength (kg)	25.8 (4.9)	27.3 (4.4)	0.194
Elbow flexion muscle strength (kg)	14.4 (2.6)	14.6 (3.2)	0.647
Elbow extension muscle strength (kg)	9.8 (2.0)	10.5 (1.8)	0.075
Low (60°/sec) angular speed			
Knee flexion peak torque (Nm)	116.9 (25.1)	114.4 (29.5)	0.435
Knee extension peak torque (Nm)	73.5 (14.5)	75.4 (15.6)	0.072
H/Q ratio	63.8 (10.5)	67.8 (13.6)	0.212
High (240°/sec) angular speed			
Knee flexion peak torque (Nm)	49.2 (18.9)	48.8 (12.3)	0.487
Knee extension peak torque (Nm)	43.7 (13.9)	44.6 (11.1)	0.267
H/Q ratio	100 (14.7)	92.8 (16.2)	0.710

H/Q; hamstring/quadriceps, Nm; Newton-metre

4. Discussion

In this cross-sectional study, we compared cardiorespiratory fitness, respiratory function tests, body composition, flexibility, muscle strength, and endurance scores between female students with asymptomatic GJH and non-GJH controls. To the best of our knowledge, the current study is the first to report that females with asymptomatic GJH have similar or even higher levels of physical fitness capacity as those without GJH. However, there were no significant differences in respiratory function tests, body composition, muscle strength, and endurance scores between the two groups.

Although joint hypermobility is a very common condition in society, it is often overlooked. This physical feature, the underlying mechanism of which has not yet been explained, holds various mysteries in terms of its effect on people. While it may predispose individuals to important musculoskeletal system problems such as pain and fatigue, the fact that flexibility is one of the health-related physical fitness parameters raises the question of whether hypermobility is an advantage or a disadvantage for individuals.

Cardiorespiratory Fitness

In terms of cardiorespiratory fitness markers, females with GJH had higher VO2max, MET, and W/kg values compared to those without GJH. This may be related to arterial compliance, which refers to the ability of arteries to expand and contract in response to cardiac activity (contraction and relaxation), stabilizing blood pressure and flow(22). Structurally, the smooth muscles in the arteries and the elastic properties of the connective tissue, which is also the basis of joint hypermobility, also determine arterial compliance(23). The literature has shown that there is a positive correlation between GJH and arterial compliance(24,25). Additionally, studies have suggested that tenascin X deficiency, which is believed to play a role in the development of GJH, could have beneficial effects on cardiovascular health. It has also been proposed that individuals with low levels of Tenaskin-X may not develop abnormal arterial stiffness(26). Binder et al.(27), stated that there was an inverse relationship between arterial stiffness and cardiorespiratory fitness in male individuals without known cardiovascular disease. Boreham et al.(28), conducted a study to investigate the relationship between arterial stiffness and cardiorespiratory fitness. They similarly found an inverse and significant relationship between VO_2max level and arterial stiffness, suggesting that a higher VO_2max level is associated with lower arterial stiffness. This relationship was found to be independent of lifestyle changes, body fatness, and physical activity level. In the present study, although the values obtained for VO_2max, MET, and W/kg differed between the two groups, the 6MWD value - another indicator of cardiorespiratory fitness - was noted to be similar. This finding suggests that GJH does not have a negative impact on cardiorespiratory capacity. However, we believe that studies with larger populations are needed to determine whether it is associated with higher cardiorespiratory capacity.

As a result of the evaluation in terms of respiratory functions in our study, lung volumes, and respiratory muscle strength values were found to be similar between the groups. However, in a previous study on this subject, it was stated that GJH was associated with lower 6MWD, lung volume (FEV1 and FVC) and MEP. It is thought that the fact that a significant portion of the individuals included in this study, conducted during the Coronavirus-19 (COVID-19) pandemic, were infected with COVID-19 before the study may have an impact on the results(29). In the current study, HRRI, an indicator of cardiac autonomic activity, was found to be similar between the groups. When the literature is examined, it can be seen that there are many studies and even large-scale reviews published on this subject showing that Ehlers-Danlos Syndrome and hypermobility spectrum diseases are associated with dysautonomia(30,31). However, it should not be overlooked that the participants in these studies were symptomatic individuals with GJH.

Body Composition

The current study found similar body composition and skinfold thickness across all regions. There have been a few studies in the literature that examined the impact of joint hypermobility on body composition(32,33). Among these studies, a positive correlation was found between GJH and BMI in children and teenagers with GJH. However, Ewertowska et al.(34) evaluated the body composition of young adult individuals with GJH and found no significant difference between those with and without GJH in terms of BMI, fat percentage, and fat-free mass, which is similar to the results of our study. In addition to the previously mentioned research, the current study evaluated regional body compositions, trunk, dominant lower extremity muscle, and fat mass, which were found to be similar between the groups.

Flexibility

In the present study, the sit-and-reach test was used to assess hamstring and lumbar flexibility, key components of health-related physical fitness parameters, and it was found that females with GJH had higher levels of flexibility compared to controls. This is an expected result since joint hypermobility is a condition characterized by excessive flexibility in the joint capsule and ligaments. On the other hand, Ewertowska et al.(34) stated that there was no difference between college-aged young women and men with and without GJH in terms of pelvic-hip complex flexibility. The differences in evaluation methods used for measuring flexibility in studies may have caused variations in results.

Muscle strength

Based on the idea that hypermobile individuals are at a higher risk of upper or lower extremity injuries probably related to strength during sporting activities, there have been many studies evaluating their muscle strength(34-37). The results of these studies differ from one another. According to the authors, factors such as the age, gender, and symptoms of the participants, the method of force measurement used, and whether the measurements were taken on the dominant extremity can influence the variability in results(34,38).

In the current study, no significant difference was found between the two groups in terms of the hand grip, elbow flexion and extension isometric muscle forces, and knee flexion and extension isokinetic peak torque values evaluated at both low (60°/sec) and high (240°/sec) angular speed. Massy-Westropp et al.(35,39) conducted two studies that yielded results parallel to ours, indicating no relationship between hand grip and pinch grip strength and GJH. Similarly, as a result of studies comparing young individuals with and without GJH in terms of elbow and knee isometric strength(29,37,40), knee flexion and extension isometric and isokinetic strength in dominant and non-dominant extremities(34), GJH in female individuals was reported to be unrelated to muscle strength. On the other hand, males with GJH were found to have significantly lower elbow and knee isometric extension muscle strength in their dominant extremities(37), as well as lower isokinetic knee flexion and extension muscle strength in their non-dominant extremities at high angular speed (180°/sec), compared to non-GJH males (34). In a study by Juul-Kristensen et al.(36), it was found that individuals with GJH had lower knee flexion and extension isokinetic muscle strength values compared to those without GJH. The study evaluated male and female participants together, with an average age of 40.3 years, which was higher than the age range of our study. Additionally, half of the participants in the mentioned study had complained of knee pain in the last week, which may have influenced the results. Muscle strength in individuals with joint hypermobility syndrome, generally known as the pain-characterized form of EHM, was stated lower than in the control group, expressing that pain-related inactivity had an impact on this result(21).

The current study evaluated the balance between knee flexors and extensors, which is critical for knee stability, in asymptomatic female individuals with and without GJH. The H/Q ratio parameter was utilized in the isokinetic test to assess the balance, and there was no significant difference observed between the two groups. Previous research has shown that the agonist/antagonist ratio in hypermobility is influenced by limb dominance and pain presence. In a study conducted by Ewertowska et al.(34), it was found that females with GJH showed a similar H/Q ratio to non-GJH females at both low and high angular velocities under isokinetic conditions in the dominant extremity, as was observed in the current study. However, in the non-dominant extremity, females with GJH were found to have a higher H/Q ratio at high angular speed. In another study conducted by Şahin et al.(21), it was found that individuals with joint hypermobility syndrome had a statistically different H/Q ratio in their dominant and non-dominant extremities when performing isokinetic exercises. The study also revealed that the H/Q ratio in the dominant extremity was higher than the control group's at high angular velocities. Jensen et al.(40) evaluated the H/Q ratio under isomeric conditions and stated that there was no difference between individuals with and without GJH. They also examined agonist and antagonist activation values and coactivation rates during knee extension and flexion of the participants using superficial electromyography in their study. As a result of the measurements, it was stated that the agonist activation of the hamstring muscle during isometric knee flexion was decreased and the coactivation rate was higher in individuals with GJH. This situation has been explained by the need to stabilize the hypermobile knee in the anteroposterior direction, and it has been suggested that the high coactivation rate is due to decreased activation of the agonist's muscle, not increased activation of the antagonist's muscle. However, no difference has been reported in the rate of coactivation during knee extension.

Limitation

Nevertheless, this study has some limitations. First, the current research focused on individuals with asymptomatic GJH in order to minimize the potential impact of pain and reduced activity level on key physical fitness parameters such as muscle strength and cardiorespiratory function. Second, while some studies have assessed individual components of physical fitness in GJH, ours is the first to evaluate them in combination. We also assessed muscle strength in multiple muscle groups in both the upper and lower extremities. Third, this study, which used convenience sampling of young females from a local university, may not be representative of the entire young female population. Conducting larger-scale studies across different age groups and including male hypermobile individuals will help to expand our understanding of this subject.

5. Conclusion

Females with GJH exhibit similar or even higher levels of health-related fitness parameters such as VO2max, MET and W/kg, and flexibility, compared to females without GJH. This implies that they are not at a disadvantage in terms of fitness levels. However, it is important to note that their loose capsules and ligaments make them more vulnerable to trauma and degeneration, which can lead to musculoskeletal problems. Therefore, in clinical practice, individuals diagnosed with GJH should be informed about its advantages and disadvantages, and evaluated for any related conditions. Despite their superior performance in tests, females with GJH should take necessary precautions to avoid injuries and maintain their physical wellbeing

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Ethics

Ethics Committee Approval: The study was approved by Trakya University Clinical Research Ethical Committee (Decision no: 03/27, Date: 15.02.2017

Informed Consent: The authors declared that it was not considered necessary to get consent from the patients because the study was a retrospective data analysis.

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