Correlation between Hypermobility Score and Injury Rate in Artistic Gymnastics

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ABSTRACT

Aim: Generalized Joint Hypermobility (GJH) is suggested as a contributing factor for injuries in young athletes and adults. It is presumed that GJH causes decreased joint stability, thereby increasing the risk of joint and soft tissue injuries during sports activities. The aim of this study was to determine the correlation between the hypermobility rate (using the Beighton`s modification of the Carter-Wilkinson criteria of hypermobility) in gymnasts and injury rate, during the period of one year.

Methods: This study observed 24 artistic gymnasts (11-26 years old), members of Qatar National Team in artistic gymnastics. We examined the Beighton joint hypermobility screen and a seasonal injury survey. The gymnasts characteristics (age, gender) and gymnastics characteristics (training per day and number of years in training artistic gymnastics) and its' relations to injury rate were also included.

Results: The most common injury was the lower back pain injury, followed by knee, shoulder, hip and ankle injuries. We found strong correlation of number of years gymnastics training and injury rate ($p<0.001$). There is no significant correlation in the numbers of hours training during one week and hypermobility score to numbers of injuries ($p>0.05$).

Conclusion: According to this study there is no correlation between GJH rate and injury rate in artistic gymnasts in Qatar. Total training period in gymnastics have greater contribution in injury rate.

Key words: flexibility, training, association, injuries

Introduction

Flexibility is an important component of physical fitness related with sport performance[1] and various health outcomes.[2] However, hypermobility in joints may be a recognized feature of many heritable disorders of connective tissue.[3] A hypermobile joint is the one whose range of motion exceeds normal limits, considering the age, sex, and ethnicity of young athlete.[4] General joint hypermobility (GJH) occurs most often in children and diminishes during growth.[4] GJH decreases in children around 9 to 12 years of age, again increases in adolescent girls (around the age of 15 years), and decreases in both sexes after maturation.[5] It was suggested that the peak at 15 years in adolescent girls is due to release of the relaxin hormone.[5] Because of different study conditions and definitions, the prevalence of GJH in published reports varies from 5% to 43% in adults and 2% to 55% in children.[6]

Children with GJH have greater possibility to increase the incidence of joint dislocations, subluxations, soft tissue injuries, painful joints syndromes and degenerative disorders.[4, 7] Moreover, the higher incidence of joint sprain is observed in individuals with GJH.[4] On the other side, GJH can have some performance advantage in some sports, like in gymnastics and ballet in which excessive range of motion is preferable.[8] Gymnastics' rules, interpretations and fashions change rapidly and systematically. [9] Accordingly, there is a considerable increase in fitness demands following the progressive rules changes. Extreme ranges of motion performed by gymnasts have produced reactionary debate among physicians, fans, coaches, athletes, parents and scientists.[10-12] There is no clear consensus on

the advantages of GJH or association with increased injury risk. However, it appears important to identify GJH in children and athletes.[13]

Findings in the current literature are inconclusive. Moreover, there is a marked difference between contact and other sporting activities concerning the risk of injury related to type of sport .[6] While one study showed advantage of GJH for gymnasts,[8] several other studies showed strong association of GJH with a higher risk of injury.[14-16] In one study of male first division club rugby players [17] GJH was related to an increase in the injury rate. In a study of junior netball players, Smith et al.[7] observed a relationship between the proportion of players who sustained an injury and the Beighton hypermobility score. The authors concluded that GJH is associated significantly with an increased incidence of injuries in these athletes. Recently a cohort study of a sample of 54 elite-level professional soccer players from an English Premier League club provided evidence that hypermobile participants had a higher incidence of injuries and were more likely to experience a severe injury, experience a recurrence of injury over the season, and miss more days of training and matches.[18] A recent meta-analysis by Pacey et al.[6] showed that for those with GJH, there is a significantly increased risk of injury to the knee during participation in contact sports, which was not the case with the ankle. Some studies showed contradictory results. Kujala et al.[19] and Hopper et al.[20] found no higher prevalence of injury in hypermobile people. Krivickas and Feinberg[21] found a significant association between tight ligaments and an increased rate of injury in the group of male athletes but not among women. Furthermore, Decoster et al.[14] found no significant difference in overall injury rates between hypermobile and nonhypermobile lacrosse players. In addition, Collinge and Simmonds[22] found similar injury rates in both hypermobile and nonhypermobile male professional soccer players. Conflicting evidence were also reported among ballet dancers[15, 23].[15, 23]

Findings in the current literature are inconclusive as to whether the risk of lower limb joint injury during sport is greater in hypermobile participants compared with their nonhypermobile peers. Generalized joint hypermobility may indeed be protective against injury in some limited contact and noncontact sports; Although findings seem to be unhelpful, one cannot argue about specificity in the movement patterns in gymnastics and how this impact the probability of injuries in specific joints. Based on clinical experience and the fact that there is no clear link between flexibility and gymnastics injury, the rational for this is to provide a basis for exploring relationships between generalized joint hypermobility and injuries in gymnastics. Having in mind the importance of injury prevention, it is important to recognize any conditions that could contribute to injuries in sport. According to complex nature of joint hypermobility and the prevalence injury in athletes, the purpose of our study was to determine the relationship between generalized joint hypermobility and injury rate in artistic gymnastics athletes.

Materials and methods

Participants

In this retrospective study we observed 24 artistic gymnasts, aged from 11-26 years old (median age 15.83 years), during one season. The period of observation was from March 2015 to February 2016. The gymnasts included in the study were members of Qatar National Team in artistic gymnastics. All gymnasts were available to train on a full time basis and were eligible for selection for National team. Demographic information for the participant group can be seen in Table I. Ethical approval was granted by the Institutional Human Research Ethics Committee, Aspetar Hospital, Doha, Qatar. Written informed consent was obtained from each child and a parent prior to entering the study.

Procedures

The most widely used criteria for detecting GJH are the Beighton criteria,[24] which require the performance of five maneuvers with a total of nine points (four bilateral and one unilateral). A value of four or more is considered suggestive of GJH in men and five or higher in women.[25] The Brighton criteria for the diagnosis of hypermobility score is a validated set of criteria, which considers a combination of the Beighton hypermobility score, symptoms, and other indications of connective tissue deficiency. The same certified trainer was involved in screening all the athletes.

Certified trainers were recruited to prospectively record injury data. One researcher met individually with each data collector to review data collection forms and procedure. The certified trainers prospectively recorded on a standard form injuries and time lost from participation during the season 2015/2016, including preseason preparation. Only injuries that required the athlete to miss at least one practice or competition were included. Time missed was counted until athletes returned to full participation. Information obtained about injuries included body part, mechanism of injury, activity at the time of injury, and practices, and competition missed because of the injury. However, body part was only included for analysis in this study. To account for exposure differences, athletic trainers also recorded hours of practice and competition participation for their athletes.

We observed the correlation between GJH score according to Beighton`s modification of the Carter-Wilkinson criteria of hypermobility (Table I) and injury rate, in association to characteristics of gymnastics players (age, sex) and gymnastics specificities (number of years of training, number of hours practicing gymnastics during the week).

Hypermobility was measured using goniometer and the results were presented as a number (from 5 till 9), as the hypermobility score.

Table I around here

The following parameters were compared in relation to number of injuries: age, numbers of years in training, number of training hours per week and hypermobility score.

Statistical analysis

Statistical analyses were conducted in SPSS for Windows, release 16.0 (SPSS Inc., Chicago, IL). The results are expressed as the mean ± SD unless otherwise indicated. The Mann-Whitney test was used to compare gender, and $p < 0.05$ was considered significant. Simple correlations between injury rate and independent variables were examined using Spearman's correlation coefficient. Statistical significance was set at $p<0.05$.

Results

Observing age, number of years in training, number of training hours during the week, hypermobility score and number of injuries, there is no statistical significant difference between male and female gymnasts, as Table II presents. Comparing the hypermobility score between male and female gymnasts, male have the higher hypermobility score (average 7.33) then female gymnasts (average 7.28).

Table II around here

If we correlate the number of injuries and characteristics of players and sport, there is a strong correlation in number of years in gymnastic training and injuries ($p<0.001$). Also, depending of the age of gymnasts in correlation to numbers of injury, there is a statistical significance, as it is presented in Table III. As Table III presents also, there is no significant correlation in the numbers of hours training during one week and hypermobility score to numbers of injuries ($p>0.05$).

Table III around here

If we analyse the types of injury in gymnasts, the most common injury was the lower back pain injury (25%), followed by knee (14%), shoulder (12%), hip (10%) and ankle (8%) injuries. Also, other anatomic parts constituted 31 per cent of all injuries.

Discussion

Generalized joint hypermobility is very common in childhood, occurring in 8–39% of school age children[12, 26, 27]. Prevalence of GJH depends on age, gender and ethnicity and it decreases during growth.[3] Generally, girls are more hypermobile than boys.[28] In our study, we found no statistical significance in hypermobility score depending of the gender.

The most common injury in sports is ankle sprain, accounting for 15-20% of all sports injuries.[29] Similar results were found in gymnastics, with lower extremity injuries composing the largest proportion of injuries.[30] According to Decoster et al.,[31] athletes with hyper mobile joints have a greater risk of ankle injury (26%) compared with 9% of ankle injuries in athletes with normal joint mobility. High rates of ankle injuries in gymnastics could be explained by the landing from great heights during dismounts,[32] especially after

somersaults, as one of the most injury-producing moves in gymnastics.[33] However, according to Marshall et al.,[34] the lower back could be an area of concern for gymnasts. Our results confirm the findings with aforementioned authors concerning the lower back injuries.

The lower back is often injured in gymnastics as well as in acrobatic sports [35, 36, 34, 35]. Accordingly, lower back pain and spine injury (25%) was the most common injury in our study. Aetiology of low back pain is difficult to establish, with the duration of training as important contribution in young athletes.[19] In addition, muscular injuries could be induced by the hyper flexion and extension of the spine during the realization of twist vault.[37] Moreover, the high pressure applied on the low back, aggravated by an incorrect position, might significantly generate injuries.[38]

Our results disagree with one previous study where the lower extremities were more frequently injured (54.1%–70.2%) than the upper extremities (17.1%–25.0%),[39] however agrees with findings [40] that the upper extremities (40.9%) sustained more injuries than the lower extremities (33.4%). It is unclear why there are disagreements among studies. Possible reason for the high frequency of upper extremity injuries in younger gymnasts could be attributable to improper training in correct falling procedures. Moreover, some previous studies reported injury rates among male and female gymnasts, defining injury as any damaged body part that would interfere with training.[39, 41, 42] Also, there is a problem of providing objective information regarding the presence and qualifications of a spotter or coach at the time of injury, the gymnast's level of experience, and whether the gymnast was injured during competition or practice.[40] One study [43] reported association of injury risk was relatively low shoulder flexion and high lumbar extension. However, according to aforementioned authors, exposure patterns in injured and uninjured gymnasts were not identified as a basis for determining reasons for injury occurrence. Nevertheless, success in

gymnastics depends on a certain minimum of joint looseness, beside the fact that flexibility is specifically difficult to define and its relationship to injury remains hypothetical.[39] The relationship of hypermobility to injuries depended on the demands placed on the hypermobile body part.[11] Therefore, the abovementioned fact needs to be considered when deciding appropriate activities for hypermobile individuals. Also, according to Norkin,[44] female athletes with GJH are at greater risk than male athletes for developing injuries. Our study presented no differences in injury rate depending of the gender (2.12 injuries in male and 2.00 injuries in female).

According to results of this study the most predispose factor in injury rate is numbers of years in gymnastics training and with no correlation between injury rate and hypermobility score. Older gymnasts may be more likely to sustain injury because of more complex and difficult skills and greater accumulated exposure to training.[39] A study of highly trained female gymnasts and swimmers showed that gymnasts had a greater incidence of spinal abnormalities that were correlated with training hours.[45] Age-related association identified in this study is also consistent with that reported in other study.[40] Therefore, as age increases, there is greater possibility that frequency of injuries will increase.

Conclusions

This study indicates that GJH is not a risk factor for injuries in elite gymnastics with cutoff point for the Beighton score more than 5. However, we found the statistical significance between injury rate and the number of years in gymnastics training. According to results of our study, we can conclude that the most important factor for injury rate in artistic gymnastics was the number of years in gymnastic training and that the hypermobility score did not predispose the injury rate. Although the research literature does not provide a clear consensus on the advantages or disadvantages of hypermobility in gymnastics, our

findings could provide valuable information for coaches and other professionals when considering the prevention of injuries but also the extended timescales of rehabilitation in hypermobile individuals. Nevertheless, the authors suggest the implementation of specialized stretching programs to enhance thoracic and hip extension and that hyperextension represents a saviour of the gymnasts' body rather than a contributor to increased injuries.

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Table I . - Beighton's modification of the Carter-Wilkinson criteria of hypermobility

Table II .- Basic characteristics of the participants (mean ± SD)

Table III .- Spearman coefficient of correlation between independent variables and number of injuries.

Table I. Beighton's modification of the Carter-Wilkinson criteria of hypermobility [10].

Criteria of hypermobility	Score
Palms flat on the floor with knees extended	1
Opposition of thumb to flexor aspect of forearm	1-2
Hyperextension of fingers parallel to extensor aspect of forearm	1-2
Hyperextension of elbows by more than 10◦	1-2
Hyperextension of knees by more than 10◦	1-2
Total Score (1 mark for each, including left and right, hypermobile if ≥5) 9	5-9

Table II. Basic characteristics of the participants (mean ± SD)

Characteristics	Total (N=24)	Males (N=17)	Females (N=7)	p-value
Age (yrs)	15.83±4.47	16.29±4.88	13.86±2.85	0.446
Number of years in training (yrs)	9.71±3.77	9.35±4.09	10.57±2.93	0.546
Number of trainings (hours/week)	19.67±5.13	19.53±6.14	20.00±0.00	0.127
Hyperelasticity score	7.33±1.68	7.35±1.32	7.28±0.75	0.505
Number of injuries	2.08±2.59	2.12±3.00	2.00±1.29	0.391

*Mann-Whitney test: significant differences between boys and girls

Table III. Spearman coefficient of correlation between independent variables and number of injuries.

Characteristics	Number of injuries	p-value
Age (yrs)	0.532	0.007
Number of years in training (yrs)	0.740	<0.001
Number of trainings (hours/week)	0.365	0.080
Hyperelasticity score	0.330	0.116