ORIGINAL ARTICLE

Benign joint hypermobility syndrome in soldiers; what is the effect of military training courses on associated joint instabilities?

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Background: Hypermobile joints are joints with beyond normal range of motion and may be associated with joint derangements. This study aimed to evaluate the prevalence of benign joint hypermobility syndrome (BJHS) among soldiers and effect of training courses on related joint instabilities. **Materials and Methods:** In a prospective cohort study on 721 soldiers of Iran Army in Isfahan in 2013 the prevalence of joint hypermobility was obtained by using Beighton criteria. Soldiers divided in two groups of healthy and suffered based on their scores. The prevalence of ankle sprain, shoulder and temporomandibular joint (TMJ) dislocations identified before beginning service by history-taking and reviewing paraclinical documents. After 3 months of military training, a recent occurrence of mentioned diseases was revaluated in two groups. The collected data were analyzed using SPSS-20 software using Independent-T and Chi-square tests. **Results:** The frequency of BJHS before military training was 29.4%. After passing military training period, the incidence of ankle sprain was significantly higher in suffered group achieving the minimum Beighton score (BS) of 4 (4.3%, $P = 0.03$), 5 (5.5%, $P = 0.005$) and also 6 out of 9 (6.5%, $P = 0.01$). The incidence of TMJ dislocation was not significantly different based on a minimum score of 4, while it was higher in suffered group when considering the score of 5 (2.1%) and 6 (2.6%) for discrimination of two groups ($P = 0.03$). There was no significant difference between two groups in case of shoulder dislocation anyway. **Conclusion:** Military training can increase the incidence of ankle sprains and TMJ dislocations in hypermobility persons with higher BS in comparison with healthy people. Therefore, screening of joint hypermobility may be useful in identifying individuals at increased risk for joint instabilities.

Key words: Dislocation, joint hypermobility, joint instability, military training course

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INTRODUCTION

Joint hypermobility is often described as an extreme variation of joint laxity causing a complex of musculoskeletal symptoms. The most common criteria often used to identify individuals with joint hypermobility is a modification of the original score reported by Beighton *et al*.,[1] which developed based on the primary work of Carter and Wilkinson.[2] Joint hypermobility with associated musculoskeletal symptoms such as osteoarthritis, joint derangements and instabilities, joint effusions and muscular pain is characterized as benign joint hypermobility syndrome (BJHS) but based on recent studies naming this syndrome as a "benign" disorder is disputed because of its co-morbidities.[1-4] Previous studies on generalized joint hypermobility, defined by the criteria of Beighton, show an overall wide range of prevalence between 11.2% and 64.6% in children and adolescents.[5-7] The variability of these results can be due to various methods of evaluation and stringency of criteria among previous studies.

Excessive joint laxity, or hypermobility, should be considered as a common finding of clinical importance in the management of musculoskeletal disorders. Hypermobility is common in young patients and in general is associated with an increased incidence of musculoskeletal injuries.[8] Ankle sprains, knee ligament injuries, shoulder instabilities, and osteoarthritis of the hand have been implicated in joint hypermobility.[8] Patients with hypermobility often complain of diffuse musculoskeletal pain and injuries with no specific inciting event. Orthopedic surgeons and other healthcare providers should be aware of the underlying relationship between hypermobility and musculoskeletal disorders to avoid unnecessary diagnostic tests and inappropriate

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management. Prolonged therapy and general conditioning are typically required, with special emphasis on improving muscle strength and proprioception to address symptoms and prevent future injury.[8] An effective management program may include medications including nonsteroidal anti-inflammatory drugs, acetaminophens, tri-cyclic antidepressants, serotonin/norepinephrine receptor inhibitors, physical therapy, cognitive-behavioral therapy and lifestyle modifications for relieving pain.[9]

Generalized joint hypermobility has been proposed as a risk factor for injuries to the ankle, knee, and shoulder joints.[10] Although the relationship between generalized joint hypermobility and injury to the ligamentous structures in the ankle and knee joints has been examined, less is known about the effect on joint instability. Several authors have suggested that generalized joint hypermobility may be related to joint instability, but this relationship has not been adequately investigated.[8,10,11] Generalized joint hypermobility is implicated in joint instability, but its relationship has not been yet established.[11-13] Individuals with generalized joint hypermobility may be at increased risk of physical activities-related injuries, and one of the high-risk groups for these injuries is military population.[14]

There are few studies about joint hypermobility and its related disorders in military population.[11-14] Hence, this study evaluated the prevalence of BJHS among the active-duty soldiers and the effect of training courses on the related joint instabilities such as the ankle sprain, temporomandibular joint (TMJ) and shoulder dislocations.

MATERIALS AND METHODS

The study was a prospective cohort study conducted on Iranian Army soldiers of training periods in one of the military bases of Isfahan in 2013. Inclusion criteria were: Soldiers of the training period deployed to the military service during 2013 and not affected by any rheumatologic and connective tissue disorders leading to joint laxity with participant consent. Exclusion criteria were: Patients with any mental or physical disorders or any history of drug dependency causing joint weakness or severe disability that would have disrupted the examination and may leading to exemption from combat. This study was reviewed and approved in the Ethics Committee of the AJA University of Medical Sciences and after being justified on the study objectives and consent, soldiers were consciously enrolled in the study.

The active-duty soldiers were first examined by a physician and their Beighton scores (BS) were obtained. Soldiers divided in two groups of healthy and suffered based on their scores. The prevalence of ankle sprain, shoulder and TMJ dislocations identified before beginning service by history-taking and reviewing paraclinical documents (such as radiographs, magnetic resonance imaging and surgical report sheets, previous history of ankle sprain, shoulder dislocation and TMJ clicks or dislocation). After passing 3 months of military training (including endurance exercises, physical strength practices and specific military educations), soldiers in two groups of healthy and suffered of BJHS were reevaluated in terms of recent occurrence of mentioned diseases. Patients suspected to any dislocations were reexamined by the cooperative orthopedist to make a definite diagnosis and control radiographies were taken for ruling out of possible fractures in shoulder or ankle joints.

The five criteria of BS[5] are:

1. Passive dorsiflexion of the fifth finger of the hands over 90°;
2. passive flexion of the thumbs to the flexor surface of the forearms;
3. passive hyperextension of the elbows over 10°;
4. passive knee hyperextension over 10°; and
5. forward trunk flexion as the knees fully extended and palmar surface of the hands resting on the floor.

For each hypermobile joint, one point is given with an additional point for positive trunk hyperflexion for a total score of 9. Although there is no universal agreement on the value needed to make a diagnosis for BJHS using the BS, most researchers use a score of 4/9.[15]

Based on the BS (achieving the minimum score of 4 from Beighton criteria), the studied soldiers were divided into two groups with BJHS and group of healthy soldiers. Furthermore, based on achieving minimum score of 5 and 6 from Beighton criteria, classification for suffering from the syndrome was done, and the studied variables were compared between groups.

The collected data were analyzed using IBM SPSS 20 software. The results obtained from analyzing variables have been reported as mean ± standard deviation and frequency (percentage) according to the type of variables. To compare the mean age and BS in individuals with BJHS with the healthy subjects and the frequency of ankle sprain, shoulder dislocation and TMJ dislocation, Independent-T and Chi-square tests were used, respectively. In all cases, the significance level for α has been considered as <0.05.

RESULTS

Out of 721 studied soldiers, two cases were excluded because of exemption and discharge from service before ending the training period and one case was excluded due to desertion from the service. Among from 718 soldiers, BJHS (achieving the minimum score of 4 from Beighton criteria) was diagnosed in 211 subjects (29.4%) before military training. Then, the

prevalence of mentioned musculoskeletal complaints before training and their incidence during the training period were studied and analyzed in soldiers with BJHS and healthy soldiers. The study flowchart is given in Figure 1.

In two groups, the mean age was similar, and there was no significant difference between them. The comparison of BS in soldiers with BJHS (achieving the minimum score of 4 from Beighton criteria) with the healthy soldiers shows that in the suffered soldiers, the mean BS was significantly higher than is in the healthy soldiers ($P > 0.001$) [Table 1].

The prevalence of ankle sprain, shoulder dislocation and TMJ dislocation compared in two groups of soldiers before military training, and there was no significant difference between the suffered and healthy groups [Table 2].

At the end of the training period, the incidence of ankle sprain, shoulder dislocation and TMJ dislocation in suffered soldiers (achieving the minimum score of 4 from Beighton criteria) is given compared with that of healthy soldiers. As it can be observed in Figure 2, there was no statistically significant difference between the studied groups in terms of the incidence of shoulder dislocation ($P = 0.34$) and TMJ dislocation ($P = 0.08$) during the training period. However, the incidence of ankle sprain at the end of the period, in the suffered group, was significantly higher than that in the healthy group ($P = 0.03$).

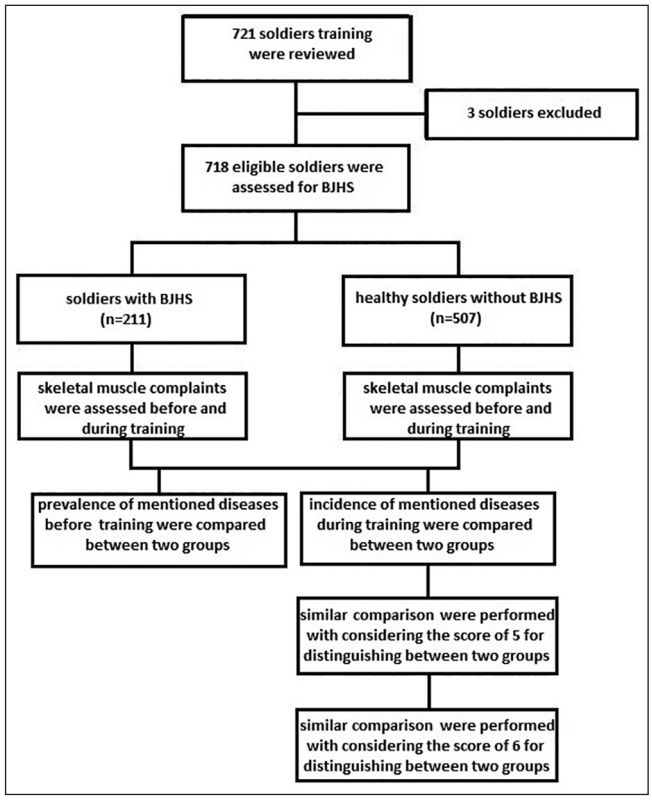

Figure 1: Study follow chart

Based on achieving the minimum score of 5 from Beighton criteria, the incidence of mentioned dislocations in the suffered soldiers (beigton score ≥5) compared to other soldiers (beigton score <5). During the training period, the incidence of ankle sprain ($P = 0.005$) and TMJ dislocation ($P = 0.03$) in the suffered soldiers was significantly greater than that in the healthy individuals. Whereas the incidence of shoulder dislocation between the two groups during the course was not significant again ($P = 0.18$) [Figure 3].

Moreover, when we considered beigton score ≥6, the incidence of ankle sprain, shoulder and TMJ dislocations in the suffered soldiers (score ≥6) compared to other soldiers (score <6) were not statistically significant. Difference between the incidence of shoulder dislocation at the end of the training period among studied groups was not significant ($P = 0.36$). While the incidence of ankle sprain ($P = 0.01$) and TMJ dislocation ($P = 0.03$) was significantly higher in the suffered soldiers in comparison to healthy ones [Figure 4].

Table 1: Comparison the age and BS between healthy soldiers and those with BJHS

Soldiers'	BJHS ($n = 211$)	Healthy ($n = 507$)	*P* value
Age (year)	19.58±1.53	19.64±1.86	0.69
BS	5.5±1.5	1.2±1.1	>0.001

Independent *t*-test was used to compare the means; BJHS = Benign joint hypermobility syndrome; BS = Beighton score

Table 2: Comparison the prevalence of ankle sprain, shoulder dislocation and TMJ dislocation in suffered and healthy soldiers before military training

Disease	BJHS ($n = 211$)	Healthy ($n = 507$)	*P* value
	Number (%)	Number (%)	
Ankle sprain	19 (9)	35 (6.9)	0.33
Shoulder dislocation	5 (2.4)	4 (0.8)	0.09
TMJ dislocation	11 (5.2)	17 (3.4)	0.24

Chi-square test was used to compare the means; BJHS = Benign joint hypermobility syndrome; TMJ = emporomandibular joint

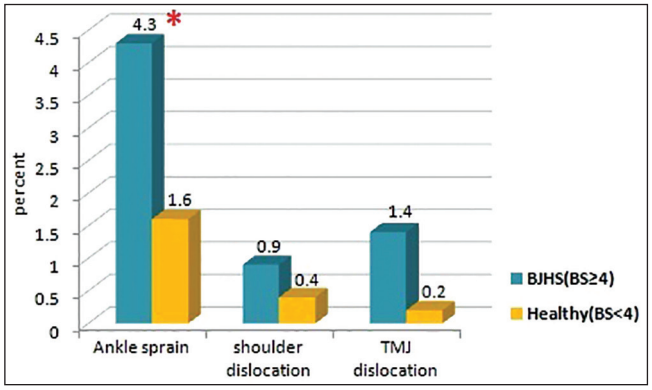

Figure 2: Comparison the incidence of dislocations after 3 months training period between healthy soldier (BS <4, $n = 507$) and those with BJHS (BS ≥4, $n = 211$). BJHS = Benign joint hypermobility syndrome; BS = Beighton score; *$P < 0.05$, *P* values calculated by Chi-square test

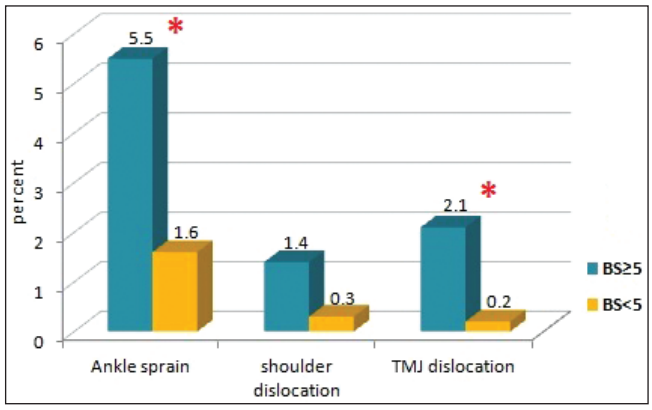

Figure 3: Comparison the incidence of dislocations after 3 months training period between all soldier with BS ≥5 (*n* = 145) and those with BS <5 (*n* = 573). BS = Beighton score; **P* < 0.05, *P* values calculated by Chi-square test

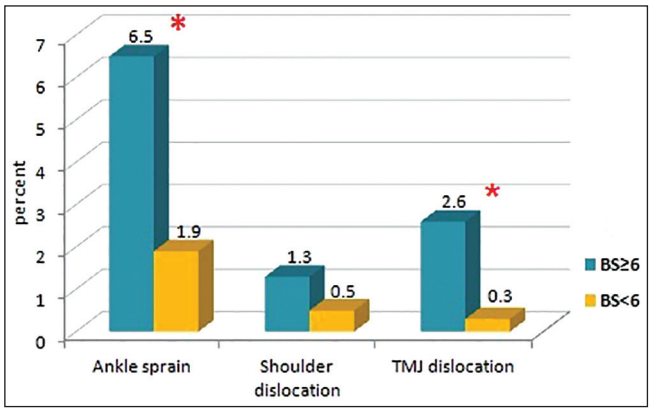

Figure 4: Comparison the incidence of dislocations after 3 months training period between all soldier with BS ≥6 (*n* = 77) and those with BS <6 (*n* = 641). BS = Beighton score; **P* < 0.05, *P* values calculated by Chi-square test

DISCUSSION

In this study, the prevalence of BJHS among the active-duty soldiers and the effect of the training period on the three common dislocations including ankle sprain, TMJ and shoulder dislocation has been investigated. The frequency of the BJHS found as 29.4% which is higher than what Scher *et al*. achieved in their study on the incidence of joint hypermobility syndrome (JHS) in the US military population as a raw incidence rate of 0.06/1000 person-years.[14] Current literature suggests JHS, defined as generalized hypermobility associated with musculoskeletal symptoms, occurs in approximately 5-6% of adults.[7,16] The lower incidence of JHS in the US military population may be secondary to a protective effect of the muscle strengthening and endurance training programs required by the US military personnel or selection of healthy persons in initial screening for employment.[17] In our small subpopulation in the Iranian military population, we found no differences in the prevalence of JHS by age group, this is perhaps because most of our soldiers are a subset of primarily young population without army or athletic training before that does not include either children or the elderly population. Previous studies of JHS suggest a trend toward decreasing prevalence of the disorder with increasing age.[9]

Several authors have speculated on the relationship between generalized joint hypermobility and joint instability; however, this relationship has not been examined empirically. Warner *et al*. observed generalized joint hypermobility in 25% of normal control participants and 22% of those with glenohumeral joint instability but did not examine the relationship between glenohumeral joint instability and measures of generalized joint hypermobility.[18] Cooper and Brems reported that 29 of 38 surgical patients (76%) with multidirectional glenohumeral joint instability demonstrated generalized joint hypermobility, but as in the previous study the relationship between these variables was not examined.[19]

In an epidemiologic study of traumatic shoulder dislocations, the estimated incidence rate of shoulder dislocations in the United States was reported as 23.9/100,000 person-years, which was approximately twice the previously reported value. A young age and male sex are risk factors for shoulder dislocation in the United States population.[20]

According to our knowledge there are a few studies on the incidence of hypermobility related dislocations among the military force in the world, but regarding the Owens *et al*. study, the overall incidence rate was 1.69 dislocations per 1000 person-years, and the significant demographic risk factors were male sex, the white race, service in the Army, junior enlisted rank, and age of <30 years.[21] In another studies by Owens *et al*. the incidence and characteristics of shoulder instability at the United States Military Academy was reported as a common injury in this population, with subluxations comprising 85% of instability events.[21,22]

In the present study, we have shown a relationship between increased joint hypermobility based on Beighton criteria and joint instability among active-duty soldiers during the training period. Participants with increased joint hypermobility, defined as a total BS of 4 or greater, reported a higher incidence of two common joint instabilities (ankle and TMJ) during the training. Moreover, by higher scores in the suffered patients, we observed higher incidence of dislocations in soldiers with joint hypermobility. In the case of shoulder dislocation although no statistically significant difference between two groups was obtained, the incidence of this joint instability in suffered group was higher than that in the control group. Thus, our results provide preliminary evidence to support the relationship between BJHS and joint instability when the influences of sex and race were controlled (female are exempt from military service in

Iran and because the sample population included the duty soldiers there were no significant difference in the age, and all of them were Iranian). Clinically, this investigation provides preliminary support for increased BJHS as a potential predisposing risk factor for joint instability or dislocation, especially ankle joint, in military force.

CONCLUSION

Military training can increase the incidence of ankle sprains and TMJ dislocations in hypermobility persons with higher BS during training course in comparison with healthy people, but it doesn't seem this course have a significant effect on the incidence of shoulder dislocations. Therefore, screening of generalized joint hypermobility may be useful in identifying individuals at increased risk for ankle, TMJ or even other joint instabilities, although more prospective researches with larger populations is needed to confirm this.

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AUTHORS' CONTRIBUTIONS

KA and PM carried out the design and coordinated the study, participated in most of the experiments and prepared the manuscript. ARH provides assistance in the design of the study, coordinated and carried out all the experiments and participated in manuscript preparation. HHA and MHN provided assistance for all experiments. All authors have read and approved the content of the manuscript.

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