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The Association of Generalized Joint Hyperlaxity and Occurrence of Musculoskeletal Injury

Betty Hestekin
University of North Dakota

THE ASSOCIATION OF GENERALIZED JOINT HYPERLAXITY AND OCCURRENCE OF MUSCULOSKELETAL INJURY

by

Betty Hestekin
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This Independent Study, submitted by Betty Hestekin in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)

PERMISSION

Title	The association of generalized joint hyperlaxity and occurrence of musculoskeletal injury.
Department	Physical Therapy
Degree	Master of Physical Therapy

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Signature Betty Hestekin

Date 12/16/99

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Finally, I thank God for allowing me the wonderful experiences I have encountered in physical therapy school and life.

ABSTRACT

Joint hyperlaxity is a condition characterized by excessive range of motion in joints. Generalized joint hyperlaxity has been associated with musculoskeletal pain. In addition, hyperlaxity has been linked to greater incidences of injury in the high level athlete. However, there is no published data available to assess if hyperlaxity places the general population at a greater risk of incurring musculoskeletal injury.

This study researched the association of generalized joint hyperlaxity and occurrence of musculoskeletal injury in the non-athlete. Subjects were 55 volunteers from a pool of physical therapy students. The subjects completed a survey indicating activity level and injury history. The Beighton test for generalized joint hyperlaxity was used to determine subject laxity status.

Results indicated a greater trend for the occurrence of musculoskeletal injury in hyperlax individuals (91%) as opposed to normal laxity individuals (79%). Implications of this finding are that an injury prevention program may be beneficial for the hyperlax individual in the general population.

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Joint hyperlaxity was of interest to Hippocrates in ancient Greece and continues to be a source of many unanswered questions to researchers of today. Hypermobility or hyperlaxity is described as the ability to move the joints in an excessive range of motion.[1] Joint mobility is dependent on several factors including muscle, connective tissue, and ligaments.[2] Beighton[1] noted the shape of the articulating bones, the individual's muscle tone, capsule shape, ligament and tendon strength, and extensibility of the skin and subcutaneous tissue to be important factors in a joint's range of motion. A joint must have a certain amount of laxity to allow normal, fluid movement of that joint.[3]

Generalized joint hyperlaxity associated with no other symptoms is reported in epidemiological studies as a normal variation throughout a population with an incidence of 4-7 %.[4,5] The differentiation of joint laxity and joint hypermobility is not reported with consistency in the existing literature. In fact, Beighton[1] states that hypermobility may be superimposed upon genetically determined laxity while many authors have used the terms interchangeably. Gustafson supported the differentiation of the terms in her study with the statement that her results "found that the majority of those with injuries were hypermobile, but they were also generally less lax than those who did not sustain an injury."[(6p19)] For the purpose of clarity in this study, the following designations were selected: 1) joint laxity refers to normal movement due to its presence in normal functions of the joint; 2) hyperlaxity indicates excessive movement of the joint; and 3) hypermobility refers to hypermobility syndrome as described below due to the association of inherent instability.

Information regarding the condition now called 'hypermobility syndrome' emerged in 1967 with the work of Kirk et al.[7] Joint laxity in addition to musculoskeletal complaints without a history of hereditary connective tissue disorders is called 'hypermobility syndrome'.[4] Hypermobility tends to coexist with varicose veins, piles, uterine prolapse, mitral defect, and neuropathies. Childhood hypermobility may present as osteoarthosis in middle age.[8] The most commonly affected joints are the carpometacarpal joint of the thumb, patellofemoral joint, and the midcervical spine. Hypermobility does not appear to correlate with the extent of hyperlaxity.[7,9] Conversely, in many studies, it has been found that those with the highest number of hyperlax joints have a higher incidence of musculoskeletal involvement. Inheritance of hypermobility is most likely an autosomal dominant, simple dominant, or recessive trait.[2]

There are several characteristics about joint hyperlaxity that have been described through observation and testing. It has been found that, in general, females have greater joint hyperlaxity than males.[10-13] There is also a difference between ethnicities as Iraqis, Africans, and Asian Indians have greater mobility than Caucasians.[11,14,15] It is generally accepted that range of motion decreases with age. Mobility falls rapidly in childhood and more slowly throughout adulthood.[11] Joint laxity is a common finding in connective tissue diseases including Ehlers-Danlos syndrome, Marfan syndrome, osteogenesis imperfecta, and psuedoxanthoma elasticum.[12,13]

Several theories have been proposed for the causation of hyperlaxity. The fact that collagen is the most abundant protein in the body, constituting a large portion of joint materials such as tendon, ligament, bone, and cartilage, has led much of the investigation to concentrate on this substance.[16] The structure of collagen has been implicated in the causation of hyperlaxity.[1] The collagen fibrils are coiled (crimped) in utero and gradually lengthen with age. The amount of collagen extensibility decreases with increased wavelength of the crimp, hence, decreasing laxity. The wavelength of the coils may differ between individuals allowing some to be more lax than others. Another theory states that an increased ratio of types III/III+I collagen may be a component in the hypermobility pathology.[17] Type I collagen fibrils are large and compose the dense connective tissues including tendon, bone, synovium, and adult skin. Type III collagen fibrils form a fine reticular network composing distensible connective tissue such as fetal skin. This type of collagen maintains tissue support while allowing extensibility and compliance. Therefore, a decrease in type I collagen may not provide adequate support in the joint tissues.[18] Child[2] suggests that new medications aimed at modifying collagen synthesis are needed to prevent hyperlaxity. She also offers an explanation regarding nerve impingement for the joint pain experienced by hypermobile individuals: "poorly supported nerve endings are unprotected from overstimulation in an already lax capsule. This may be why the majority of hypermobility syndrome patients do not respond to analgesics or nonsteroidal anti-inflammatory drugs."[(2p242)]

A plethora of studies have been conducted on various populations including different races, ages, gender, and types and levels of athletes to find if joint hyperlaxity is associated with musculoskeletal complaints. Joint hyperlaxity has been associated with congenital hip dislocation, rheumatic diseases, chondrocalcinosis, shoulder pain, arthralgic complaints, and osteoarthrosis.[9,11,19-21] Al-Rawi[22] found that individuals with hyperlaxity were more prone to bruising, joint complaints, ligament injury, and sciatica. Joint hyperlaxity has been linked with an increased injury rate in musicians and workers who use their joints for static jobs or as supportive structures.[23,24]

Not all findings about joint hyperlaxity have been negative as it is deemed an asset to ballet dancers, musicians, and workers who perform repetitive movements.[23-25] Another author found that joint dislocation was not associated with hyperlaxity.[22] Mikkelsson[26] reported that hyperlaxity is not a contributing factor to musculoskeletal pain in pre-adolescents. In developing an injury prediction index, no relationship was discovered between hyperlaxity and injury in West Point Cadets or football players and consequently a laxity factor would not be included.[27]

Methods used to measure joint hyperlaxity include goniometric measurement, fixed torque devices, the hyperextensometer, and clinical scoring systems.[28] As of yet, no one test has become the "gold standard". The global index measurement is a goniometric measurement of range of motion at most joints in the body. This method is comprehensive but very time consuming.[1] The hyperextensometer, a spring device, is used to measure extension of the second or fifth metacarpal phalangeal joint to a pre-set torque.[29] This device is an improvement over the fixed torque device. Scoring systems have been designed by Carter and Wilkinson,[19] Beighton and Horan,[16] Rotes,[28] and Diaz.[30] The first clinical scoring system was introduced by Carter and Wilkinson.[19] This method classifies generalized joint laxity on a five-point scale of unilateral tests as listed in Table 1. One point is awarded for the ability to perform each action. Beighton et al.

Table 1. Listing of criteria for the Carter and Wilkinson test for hyperlaxity.

CARTER AND WILKINSON TESTING CRITERIA
1) Passive apposition of the thumb to the flexor aspect of the forearm; 2) Passive hyperextension of the fingers so that they lie parallel with the extensor aspect of the forearm; 3) Ability to hyperextend the elbow more than 10 degrees; 4) Ability to hyperextend the knee more than 10 degrees; 5) An excess range of passive dorsiflexion of the ankle and eversion of the foot.
Adapted from Carter and Wilkinson. Persistent joint laxity and congenital dislocation of the hip. *J Bone Joint Surg Br*. 1964;46(1):9-10.

modified the Carter and Wilkinson model.[11] This system is based on a nine-point scale and measures the joints bilaterally. One point is given for the ability to perform each of the actions listed in Table 2. Currently, this is the most commonly used model.[28] Rotes' scoring system incorporates six additional joint measurements to Beighton's, rendering it less clinically efficient.[11] The additional criteria include external shoulder rotation, cervical rotation, cervical flexion, hip abduction, metatarsophalangeal extension, and lumbar lateral bend. This system has had widespread use in Spanish speaking countries. Diaz's system, a modification of Beighton's, assesses the fifth metacarpal, thumb, knee, elbow, and trunk on the non-dominant side only.[30] Inclusion of this method in the existing literature is sparse though reason is not provided.

Scoring these clinical methods has been a source of debate. Cutoff points for determining laxity/hyperlaxity have been arbitrarily chosen by the researcher. Factors influencing the researcher's decision on not only scoring cutoffs but also the method used include the population studied and difficulty of the procedure.[28] The cutoff score for the five point scales of Carter and Wilkinson and Diaz has generally been three. A score of four or five has been used for group delineation in the Rotes method. Cutoff scores for the Beighton method have ranged from three to six although Larsson[12] proposed a score of one would be appropriate for this scale.[11,13,21,26] An individual with a score at or above the cutoff is considered to have generalized joint hyperlaxity. Customarily, the higher cutoffs were used for children and ethnicities that are regarded as having greater joint mobility. The current trend for the Beighton method is a cutoff of four out of nine greatly due to ease of comparison with existing literature.[31] Bulbena[28] has proposed that separate criteria for males and females should be set to avoid false positives in females due to their

Table 2. Listing of criteria for the Beighton test for hyperlaxity.

BEIGHTON TESTING CRITERIA
1) Passive extension of the fifth fingers > 90 degrees; 2) Passive apposition of the thumbs to the flexor aspect of the forearms; 3) Hyperextension of the elbows > 10 degrees; 4) Hyperextension of the knees > 10 degrees; 5) Forward flexion of the trunk, with the knees straight, so the palms rest on the floor.
Adapted from Beighton P, Grahame R, Bird H. *Hypermobility of Joints.* Berlin; Springer–Verlag. 1983:31-32.

greater mobility. In an attempt to make the criterion more sensitive to each population studied, Cheng[32] has suggested delineating a positive score two standard deviations above the mean for the population studied. A similar idea using a geometric progression was designed by Larsson[12] based on occurrence of one, two, three, four, or five features of laxity.

Use of a particular method for testing laxity seems to be made more on historical use rather than because it has been proven valid. Tests of reliability and validity are scant or non-existent for hyperlaxity tests. As with any scientific testing, proving the validity and reliability of tests is important when making comparisons and conclusions about the results. Of the few studies published, it was found that the Carter and Wilkinson, Beighton, and Rotes methods had high correlation coefficients and predictive efficiencies.[28] Bulbena suggests that they, therefore, have high concurrent and predictive validity. Bird[33] found that the Carter and Wilkinson, Beighton, and hyperextensometer tests had high correlations. All were more accurate in more lax populations, making them better at studying hyperlaxity rather than normal laxity. Leeds et al.[1] compared the Beighton test, Leeds finger hyperextensometer, and the global index. He reported that the Beighton method correlated better with the global index than the hyperextensometer.

Once an individual has been classified as having generalized joint laxity, the prescription of care is variable. Historically, treatment of the hyperlax individual has not been a common occurrence in of itself. Child[2] offers some general ideas for a treatment plan including finding aggravating and relieving factors to modify the pattern of daily life, an analgesic or NSAID as needed, gentle manipulation, hydrotherapy, and education about hyperlaxity. Finsterbush[34] states that exercise, especially in weight bearing, should be encouraged in order to develop reflex reactions and to strengthen the surrounding joint structures. Discussion regarding exercise for hyperlax individuals varies in the literature. Moderate exercise programs, such as swimming, have been recommended by several authors.[2,23] The rationalization of this being that improving muscle and ligament support of the joint will ameliorate the hypermobility. Diaz[5] advises avoidance of high intensity exercise for individuals with hyperlax joints. McMaster[20] has used a strengthening protocol with symptomatic hyperlax swimmers with some success. The intention of the program was to balance muscle strength around the joint in order to decrease fatigue of the external rotators and scapular stabilizers, promote better alignment of the bony structures, and enhance normal movement. In addition to the exercise program, he states that any poor mechanical techniques performed by athletes should be altered, much as Child had suggested in non-athletes. The final choice of treatment, surgery, is reserved for patients with potential arthritic changes.[34]

Prevention of injury in individuals with generalized joint hyperlaxity seems an amenable option. One concept for the prevention of injury is counseling of the young athlete to choose a sport that would be beneficial to them regarding their hyperlaxity status.[27] In addition, encouraging a more sedentary occupation or modifying the work place for hyperlax individuals would be helpful.[2] Individuals should avoid overhead heavy-resistance training and passive shoulder stretches of joints that have been indicated as hyperlax due to a chance of forced joint subluxation.[20] Suggestions to avoid injury on the job include frequent changing of body posture jobs and strengthening spinal flexor and extensor muscles.[24]

Problem Statement: Hyperlaxity has been linked to joint pain and injury in various populations, curiously though, there is an absence of literature regarding musculoskeletal injury in the hyperlax non-athletic population.

Purpose of the Study: The purpose of this study was to determine the relationship of generalized joint hyperlaxity and incidence of injury in a non-athletic population.

Significance of Study: Hyperlaxity is a condition involving the structures that comprise the joints of the body. Due to the specialty of physical therapists in treating musculoskeletal disorders, they may be the first line of care in treating hyperlax individuals. Physical therapists may be able to develop an injury prediction profile and provide preventative intervention for hyperlax individuals, athletes and non-athletes alike, if needed.

Research Question:

1. Is hyperlaxity associated with musculoskeletal injury in the non-athletic population?

Hypotheses:

Null Hypothesis: There is no association between joint hyperlaxity and musculoskeletal injury in the non-athletic population.

Alternate Hypothesis: There is an association between joint hyperlaxity and musculoskeletal injury in the non-athletic population.

CHAPTER II

METHODS

Subjects

Seventy-two subjects from the University of North Dakota physical therapy school volunteered for participation in this study. A final sample of 55 subjects (45 females and ten males) was studied. Seventeen subjects were excluded based on study criteria and non-completion of tests. Subjects were excluded from the study if they were more than 30 years old or had participated in an athletic activity on a national level. This allowed a homogenous age group and ensured that highly trained athletes were not included in the sample population. Guidelines were established and the Institutional Review Board at the University of North Dakota, Grand Forks, ND, approved the study, project number IRB-9904-218 (Appendix A).

Instrumentation

Participant Survey

A participant survey (Appendix B) was developed to ascertain the subject's injury history, age, gender, and activity level. Injury was defined to the subjects as a musculoskeletal injury for which the individual sought medical attention.

Beighton Test

The Beighton test for hyperlaxity was used to determine the laxity status of individuals for grouping purposes. This particular clinical test was chosen because it has reported good intertester reliability and high correlation with the global index method as well as other clinical hyperlaxity systems.[28] Intertester reliability will be important for planned follow-up studies with larger populations. It is also the most commonly used test for determining hyperlaxity in non-athletic populations, therefore allowing easy comparison with existing literature. Testing maneuvers (Figures 1-5) include passive fifth finger extension, passive apposition of the thumb toward the flexor aspect of the forearm, elbow extension, knee extension, and trunk flexion. All tests involving extremities are performed bilaterally.

Intratester Reliability

The tester had been instructed in and had extensive practical experience with goniometric measurement prior to this study. Goniometric measurement for knee and elbow extension has been found to have high intratester reliability.[35] Intratester reliability for this study was determined through a pilot study of elbow extension measurements. Reliability was found to be good (ICC = .802).[36]

Procedure

Each subject completed the participant survey and consent form (Appendix C). The Beighton test for generalized joint hyperlaxity was then performed on each subject.[1] All testing was completed by one investigator. Tests requiring a quantified measurement were recorded with a standard goniometer. The standard scoring system was followed awarding one point for hyperlaxity for the ability to perform each test and a zero if the test criterion was not met. The criteria to meet were passive hyperextension of the fifth finger greater than 90 degrees, passive apposition of the thumb to the flexor aspect of the forearm, hyperextension of the elbow greater than 10 degrees, hyperextension of the knee

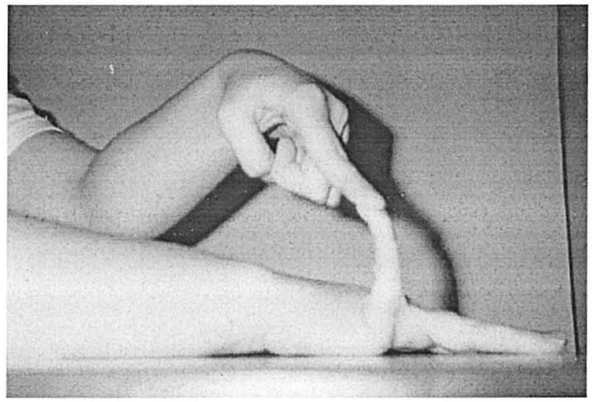

Figure 1. Hyperextension of the fifth finger.

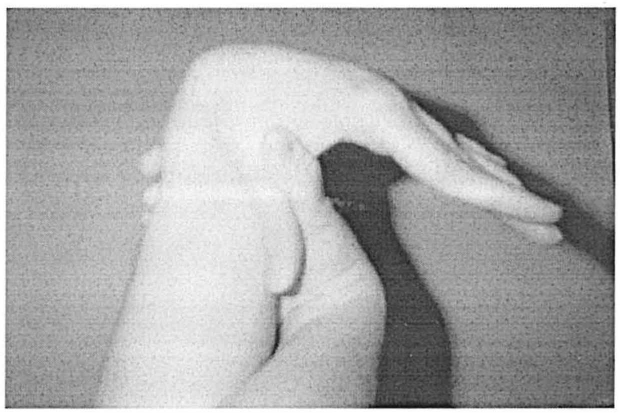

Figure 2. Apposition of the thumb to the flexor aspect of the forearm.

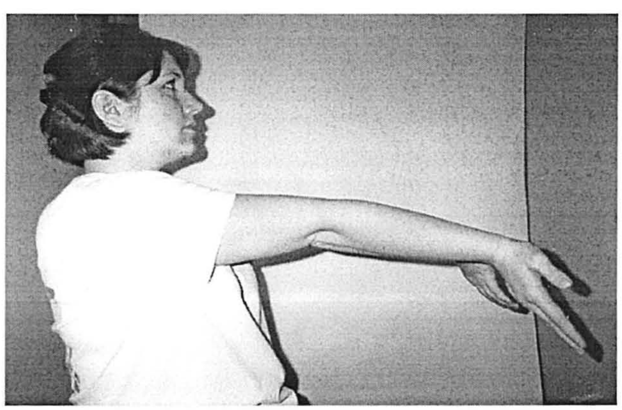

Figure 3. Hyperextension of the elbow.

Figure 4. Hyperextension of the knee.

Figure 5. Forward flexion of the trunk with palms resting on floor.

greater than 10 degrees, and flexion of the trunk, with the knees straight, so the palms rest easily on the floor.[28] Scores ranged from zero to nine. A subject was considered to have generalized hyperlaxity if four or more of the nine joints tested positive. Therefore, the sample population was divided into two groups based on laxity. Those who had a Beighton score of three or less were classified as normal laxity. Those with scores of four or greater were classified as hyperlax. This cutoff point was determined to be most applicable due to the relatively young age of the sample and the ease of comparability with existing literature.[21,22,31]

Data Analysis

Data analysis was completed using SPSS 8.0* computer software. An independent t-test was initially used with $\propto = .05$ significance to determine the association of laxity and injury occurrence. Due to the presence of kurtosis and skewness factors, the t-test was not appropriate. Rather, the Mann-Whitney U test and chi-square test of independence, non-parametric tests, were then run to find the correlation of laxity and injury occurrence. These statistics are reported but are also not reliable due to assumptions not being met by the test data.[37] Therefore, trends are reported to provide the reader with a concept of the results obtained.

*SPSS Inc. Headquarters, 233 S. Wacker Drive, 11th floor, Chicago, IL 60606.

CHAPTER III

RESULTS

Statistical analysis of the test data was difficult to apply due to the small sample group. The original scores, measured in number of injuries, were rank ordered and a Mann-Whitney *U*- test was used to compare the ranks for the n = 43 lax individuals versus the n = 12 hyperlax individuals. The results indicated no significant difference between groups, $U = 238.5$, $p > .05$, with the sum of the ranks equal to 28.5 and 26.4, respectively. This statistical finding is unreliable due to the number of tied values in the sample groups. The data was then analyzed using the chi-square test of independence. The groups showed no significant difference in numbers of injuries incurred, $X^2(7, n = 55) = 9.859$, $p > .05$. However, the findings of the chi-square are also not reliable due to the low number of individuals in the hyperlax group. It is probably most useful to look at trends of injury occurrence for the two groups. Percentages of injured individuals calculated for the two groups in Table 3 indicate a general trend for the hyperlax group to incur injuries more often than the lax group. Within the lax group, 79% sustained injury compared to 92% of the hyperlax group (Figure 6). However, the lax group had a slightly greater number of injuries per person with a mean injury rate of 1.86 (± 1.66) as compared to 1.75 (± 1.64) for the hyperlax group. A listing of mean injury rates is found in Table 4 with graphical representations in Figures 7 and 8. The maximum number of injuries incurred by one individual was seven. Interestingly, this individual was not hyperlax.

The mean number of injuries between genders was quite different (Table 5). The males had a two-fold injury rate over the female subjects, regardless of laxity status, as seen in Figure 9. Mean injury rates were as follows: lax males 2.88 (± 2.10), lax females 1.63 (± 1.52), hyperlax males 3.0 (± 4.24), and hyperlax females 1.5 (± 1.08).

The results of the hyperlaxity scores for the two groups are listed in Table 6 and a graphical representation can be found in Figure 10. Twelve out of the 55 (22%) subjects had a score of four or greater, classifying them as hyperlax. The greatest number of individuals, comprising one third of the sample, is found in the category of zero hyperlax joints. The frequency of individuals tends to decrease as scores rise. No males had a score greater than seven where as two females had scores of eight and nine. The distribution of hyperlax individuals was fairly symmetrical between genders with females having a slightly higher rate of 22% compared to 20% of the males as seen in Figure 11. A table of this data can be found in Table 7.

CHAPTER IV

DISCUSSION AND CONCLUSION

Discussion

The results of this study indicate a positive trend between joint hyperlaxity and musculoskeletal injury in a non-athletic population. This is similar to Diaz's[5] findings that joint hyperlaxity is correlated with musculoskeletal injury in an athletic population. It is also in accordance with the many studies that have linked hyperlaxity with musculoskeletal pain and osteoarthrosis.[1,9,20,21,24] It is the fine line between excessive movement versus excessive movement and pain that moves the individual into the category of hypermobility syndrome as described by Kirk et al.[7] The factor that places the hyperlax individual at greater risk of injury is yet to be determined. McMaster[20] suggests that as hyperlaxity increases, joint translation may increase and cause present joint instability to transition into a pathological state. This may lead the individual to self-limit themselves from activities based on their apprehension and avoidance of end range of motion. Therefore, the hyperlax individual may independently forego aggressive activities for more sedentary hobbies and occupations.

The mean injury rates, however, revealed a slight increase in the lax group. A speculative reason for this may be related to the previous statement. Once an individual is injured during an activity, they may avoid that and other similar activities, thereby avoiding further injury.

Gender differences were minimal in injury/no-injury status but males had approximately twice as many injuries as females. The reasons for this are beyond the scope of this study. It is interesting to note that the mean injury rate between the lax and hyperlax groups was rather consistent for both genders.

Descriptive features regarding hyperlaxity were generally in accordance with previous literature reports. This study's results did have a higher percentage (22%) of hyperlax individuals than is usually reported in epidemiological studies. But apparently, the percentage is similar to that of the study by Larsson[24] concerning industrial workers. The percentage of hyperlax individuals is not reported in that specific text but the numbers of cases reported reveal a 24% portion of hyperlax individuals. Larsson gives no explanation for the high number of hyperlax cases. The large amount of hyperlax individuals in the present study may be due to the predominance of female subjects or the subjects' relatively young age. In concerns with gender differences in this study, outcomes were consistent with the existing literature. It is generally accepted that females are normally more lax than males. This study supported this as a slightly greater percentage of females were hyperlax than were males. Along with females being more commonly hyperlax, the greatest degree of hyperlaxity is apparent in females. Pountain[10] reported that only females had extreme scores in the population he studied. This particular feature was also present in this study. The value of this finding, however, is somewhat questionable due to the shortage of male subjects.

The findings of this study were similar to studies of a like nature. However, being that non-athletic musculoskeletal injury has not been studied in depth, it would have been advantageous to have statistical data to strengthen the results. A statistical relationship was not able to be determined due to the fairly small sample size and inherent homogeneity of the subjects regarding laxity status. A larger sample size would satisfy test criteria and allow the application of a statistical analysis, such as the χ^2-test. This situation is demonstrated in the large epidemiological studies of 240 or more individuals that were tested in studies that use statistical analysis. The statistical tests, though unreliable, that were applied on the present test data pointed to no significant difference between the lax and hyperlax groups in relation to injury. Considering the difference between the statistical test data and the positive trends, it would be interesting to see how this outcome would be affected by a larger sample size that is more varied.

In addition to including a more diverse and larger sample, a few clarifications on the subject survey would lead to a better study outcome. Excluding only national competitors may not be sufficient in assuring that a non-athletic population is obtained. Collecting the number of days, intensity of activities, and type of activity the subject engages in would make this a more controlled factor. Defining an injury as being seen only by a doctor would also limit the injury reply to serious injuries as opposed to minor injuries. This would rule out the injuries treated by sports trainers during sporting activities that may not be a concern worthy of medical treatment for the non-athletic individual.

A long term study testing individuals at a young age and then again in their later twenties may prove to be helpful in determining if hyperlaxity is indeed a risk factor for musculoskeletal injury. Dividing the group into athletic and non-athletic groups would further elucidate the difference or consistency between the two populations.

Conclusion

This research study indicated that there is a positive trend between joint hyperlaxity and musculoskeletal injury. The presence of hyperlaxity in the human population has been documented and is becoming accepted as an independent entity apart from other connective tissue disorders. It is also being documented as having a relation to increased risk of injury, osteoarthritis, and joint pain. Due to this risk, there is a need to gather more concrete information on the types of activities that a hyperlax individual incurs injury. This information will be helpful in clearly defining the amount and type of exercise and activities in which a hyperlax individual can safely participate. Information could then be weighed, realizing that the goal of physical therapists is to promote the overall physical well-being of an individual. Restricting an individual from engaging in activities that may be safe for them may be just as detrimental as letting them participate in more precarious activities without education about the risks.

More research is also needed to discover why a hyperlax joint is more prone to injury. With the knowledge of the cause of injury, more directed intervention can be devised to prevent injury in the hyperlax individual.

APPENDIX A

_X_ EXPEDITED REVIEW REQUESTED UNDER ITEM _3_ (NUMBER[S]) OF HHS REGULATIONS
___ EXEMPT REVIEW REQUESTED UNDER ITEM ____ (NUMBER[S]) OF HHS REGULATIONS

UNIVERSITY OF NORTH DAKOTA HUMAN SUBJECTS REVIEW FORM FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED PROJECTS INVOLVING HUMAN SUBJECTS

PRINCIPAL INVESTIGATOR: Betty Hestekin and Sue Jeno **TELEPHONE:** (701) 780-9747 **DATE:** 03/31/99
ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: Box 9037

SCHOOL/COLLEGE: School of Medicine **DEPARTMENT:** Physical therapy **PROPOSED PROJECT DATES:** 04/25/99 – 05/08/00

PROJECT TITLE: The association of generalized joint hypermobility and occurrence of musculoskeletal injury

FUNDING AGENCIES (IF APPLICABLE):
TYPE OF PROJECT (Check ALL that apply):

_X_ NEW PROJECT ___ CONTINUATION ___ RENEWAL ___ DISSERTATION OR THESIS RESEARCH _X_ STUDENT RESEARCH PROJI

___ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Sue Jeno PhD, PT

PROPOSED PROJECT: ___ INVOLVES NEW DRUGS (IND) ___ INVOLVES NON-APPROVED USE OF DRUG ___ INVOLVES A COOPERATING INSTITUT

IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATIONS, PLEASE INDICATE THE CLASSIFICATION(S)

___ MINORS (<18 YEARS) ___ PREGNANT WOMEN ___ MENTALLY DISABLED ___ FETUSES ___ MENTALLY RETARC

___ PRISONERS ___ ABORTUSES _X_ UND STUDENTS (>18 YEARS)

IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE

IF YOUR PROJECT HAS BEEN\WILL BE SUBMITTED TO ANOTHER INSTITUTIONAL REVIEW BOARD(S),PLEASE LIST NAME OF BOARD(S):

Status: ___ Submitted; Date ________ ___ Approved; Date ________ ________Pending

1. ABSTRACT: (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS.

Diaz et al. reported that individuals with joint hypermobility participat: in a high level of activity have an increased prevalence of injury.[1] The purpo: of this project is to study the relation of generalized joint hypermobility and incidence of injury in the non-athletic population. It is expected that hypermobile individuals will be at a greater risk of injury in normal daily activities.

The study will involve one hundred physical therapy students. The subjects' joint mobility will be assessed using the Beighton method of joint hypermobility testing.[2] The subjects will also complete a survey indicating injury history, activity level, and demographic information.

The use of human subjects is necessary for the direct application of inju prediction and prevention in the general population.

Reference:

1. Diaz M, Estevez E, Guijo P. *Joint hyperlaxity and musculoligamentous lesions: Study a population of homogeneous age, sex and physical exertion.* Br J Rheum. 1993;32:120-12:
2. Beighton P, Solomon L, Soskolne CL. *Articular mobility in an African population.* Ani Rheum Dis. 1973;32:413-418

PLEASE NOTE: Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

2. PROTOCOL: (Describe procedures to which humans will be subjected. Use additional pages if necessary.)

Participation of the one hundred physical therapy students is on a volunteer basis. The subjects will be tested within the University of North Dakota physical therapy department. Subject consent will be obtain prior to participation in the study.

Beighton's method of testing joint laxity and criteria will be used. Subjects are assessed on their ability to do the following tests: Hyperextend the little finger beyond 90°, hyperextend the elbows beyond 10°, hyperextend the knees beyond 10°, apposition of the thumb to the flexor aspect of the forearm, and forward flex the trunk so the palms easily touch the floor with the knees fully extended. A scoring system o zero to nine is utilized with one point given for each extremity bilaterally and one point for the trunk if the test is positive for the aforementioned criteria. A subject with a score of 3 or more will be considered hypermobile.

Each subject will be asked to complete a questionnaire pertaining to demographic data, athletic activity, and injury history.

The results obtained will be analyzed statistically using an independent *t* test.

3. BENEFITS: (Describe the benefits to the individual or society.)

By assessing if individuals with generalized joint hypermobility are at a greater risk of injury during normal daily activities compared to individuals who are not hypermobile, therapeutic methods can be develope to prevent injury. With this knowledge hypermobile individuals may be al to avoid injury. The subjects in this study will be made aware if they have generalized joint hypermobility or not. Following the study, the results will be made available to the subjects to allow them to assess whether a preventative program would be beneficial to them. The finding of this study will be directly applicable to injury prediction and need preventative intervention in the general public.

4. RISKS: (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physic risk and includes risks to the subject's dignity and self-respect, as well as psycho-logical, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to insure the confidentiality of data obtained, including plans for final disposition or destruction, debriefing procedures, etc.)

The risks to the subject are anticipated to be minimal and unlikel in this study. The only risk the subject may experience is a momentary slight discomfort if excessive force is used to move their joir into position on for the tests. The subjects will be asked to move their joints only within their available range. If injury should occur, medical treatment will be available, including first aid, emergency treatment, and follow-up care as it is to a member of the general public similar situations. Payment for such treatment must be provided by the subject and their third party payer, if any.

5. **CONSENT FORM:** A copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringen upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for what period of time.

All resulting data and consent forms will be kept on file at the University of North Dakota Physical Therapy Department at Grand Forks foı three years, after completion of this research study, then destroyed.

6. For **FULL IRB REVIEW** forward a signed original and thirteen (13) copies of this completed form, and where applicable, thirteen (13) cc of the proposed consent form, questionnaires, etc. and any supporting documentation to:

Office of Research & Program Development
University of North Dakota
Grand Forks, North Dakota 58202-7134

On campus, mail to: Office of Research & Program Development, Box 7134, or drop it off at Room 105 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original and a copy of the consent form, questionnaires, etc. and any supportir documentation to one of the addresses above.

The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Sut performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior reviev approval as prescribed by the University's policies and procedures governing the use of human subjects.

SIGNATURES:

Principal Investigator	Date
Project Director or Student Adviser	Date
Training or Center Grant Director	Date

(Revised 3

APPENDIX B

ID #: ____________

Participant Survey

Birth date: ______________ Height (in ft. and in.): ________
Gender: M or F   Dominant hand: L or R   Weight (in pounds): ________

Athletic Activity
Circle all that apply.
Did/do you compete in: high school, college, intramural, or non-organized (independent) athletics?

If yes, what sport(s)? Star the activity if it was on a national level.

Football	Volleyball	Basketball	Cross Country
Softball	Gymnastics	Bowling	Wrestling
Baseball	Swimming	Bike Racing	Tae Kwon Do
Hockey	Cross Country Skiing	Figure Skating	Downhill Skiing
Golf	Track – event? ____________		
Other ____________			

How many days/wk. do you participate in athletic activities in a week?
0   1-3   4-7
What type of activity do you participate in? List all that apply. ____________
____

Injury History
Have you had to seek medical attention for any type of muscle, bone, or joint injury?
Yes or No

If yes, for what type of injury? List all that apply.
Sprain   Contusion   Dislocation
Strain   Fracture   Other ____________

What part of your body was injured?
Arm   Wrist   Fingers   Elbow   Shoulder
Leg   Ankle   Toes   Knee   Hip
Back   Neck   Other ____________

What side of your body was injured? Left or Right

How were you injured? (Sports, work, daily activities) ____________
____

Approximately what age were you at time of injury(ies)?____________
____

Did you require surgery? Yes or No
If yes, what type? ____________

Have you had any lasting disability due to an injury? Yes or No
If yes, what type of disability? ____________
____

APPENDIX C

Consent to Participate in Research

The association of generalized joint hypermobility and musculoskeletal injury.

You are invited to participate in a study conducted to determine if individuals identified with generalized joint hypermobility (excessive joint mobility) are at a higher risk of incurring musculoskeletal injury. The findings of this study will help determine if preventative steps need to be taken to prevent injury in hypermobile individuals in the general population. You will be made aware if you are identified as being hypermobile. Results of the study will be available to you to assess the need of a preventative program.

As a participant in the study you will complete a survey indicating demographic data such as age and gender, your level of athletic participation, and past injury history. Having an injury will not exclude you from this study. The Beighton test to determine hypermobility will be used. You will move your joints to the end of the available joint range. The amount of motion will then be assessed and scored by the researcher. Although there is a risk of injury involved in any experimental study such as this, the test poses minimal risk to you other than a possible temporary feeling of discomfort. The time to complete the survey and hypermobility test will be approximately 20 minutes.

Participation in this study is entirely voluntary. You are free to discontinue participation in the study at any time without prejudice to future or present association with the University of North Dakota. The final general results of this study will become a public document and access to this document will be provided to you. Your identity and all personal data will be carefully protected by using coded ID numbers. This information will be viewed solely by the examiner and members of the physical therapy staff at the University of North Dakota. Copies of resulting data and consent forms will be kept at the University of North Dakota Physical Therapy Department at Grand Forks for three years, after completion of the study, then destroyed.

If you have any questions or concerns about this project please contact Betty Hestekin at 780-9474 or Sue Jeno at 777-2831. You are encouraged to ask questions at any time. A copy of this consent is available upon request.

In the event that this research study results in injury, medical treatment will be available, including first aid, emergency treatment, and follow-up care as it is to a member of the general public in similar situations. Payment for such treatment must be provided by you and your third party payer, if any.

I have read and understand all of the above and willingly agree to participate in this study as explained in the above consent form.

____

Participant's Signature Date

____

Witness' Signature Date

APPENDIX D

ID #: ____________________

Data Collection Form

JOINT TESTED	YES	NO
5th FINGER -LEFT		
-RIGHT		
THUMB -LEFT		
-RIGHT		
ELBOW -LEFT		
-RIGHT		
KNEE -LEFT		
-RIGHT		
TRUNK		
TOTAL SCORE		

APPENDIX E

Table 3. Comparison of percentage of individuals injured in the normal laxity and hyperlax groups.

	N	# WITH INJURY	% INJURED
NORMAL LAXITY	43	34	79%
HYPERLAX	12	11	91%

Table 4. Comparison of mean injury rates between the normal laxity and hyperlax groups.

	N	MEAN INJURY RATE	SD
NORMAL LAXITY	43	1.86	1.66
HYPERLAX	12	1.75	1.64

Table 5. Comparison of male and female mean injury rates in the normal laxity and hyperlax groups.

	MALE MEAN INJURIES	FEMALE MEAN INJURIES
NORMAL LAXITY	2.88 (±2.10)	1.63 (±1.52)
HYPERLAX	3.00 (±4.24)	1.50 (±1.08)
TOTAL	2.94	1.57

Table 6. Laxity scoring distribution.

	SCORE	FREQUENCY
NORMAL LAXITY	0	17
	1	9
	2	10
	3	7
HYPERLAX	4	5
	5	2
	6	0
	7	3
	8	1
	9	1

Table 7. Percentages of hyperlax males and females.

	N	# OF LAX SUBJECTS	% OF SUBJECTS LAX	# OF HYPERLAX SUBJECTS	% OF SUBJECTS HYPERLAX
MALES	10	8	80%	2	20%
FEMALES	45	35	77%	10	22%
TOTAL	55	43	78%	12	21%

APPENDIX F

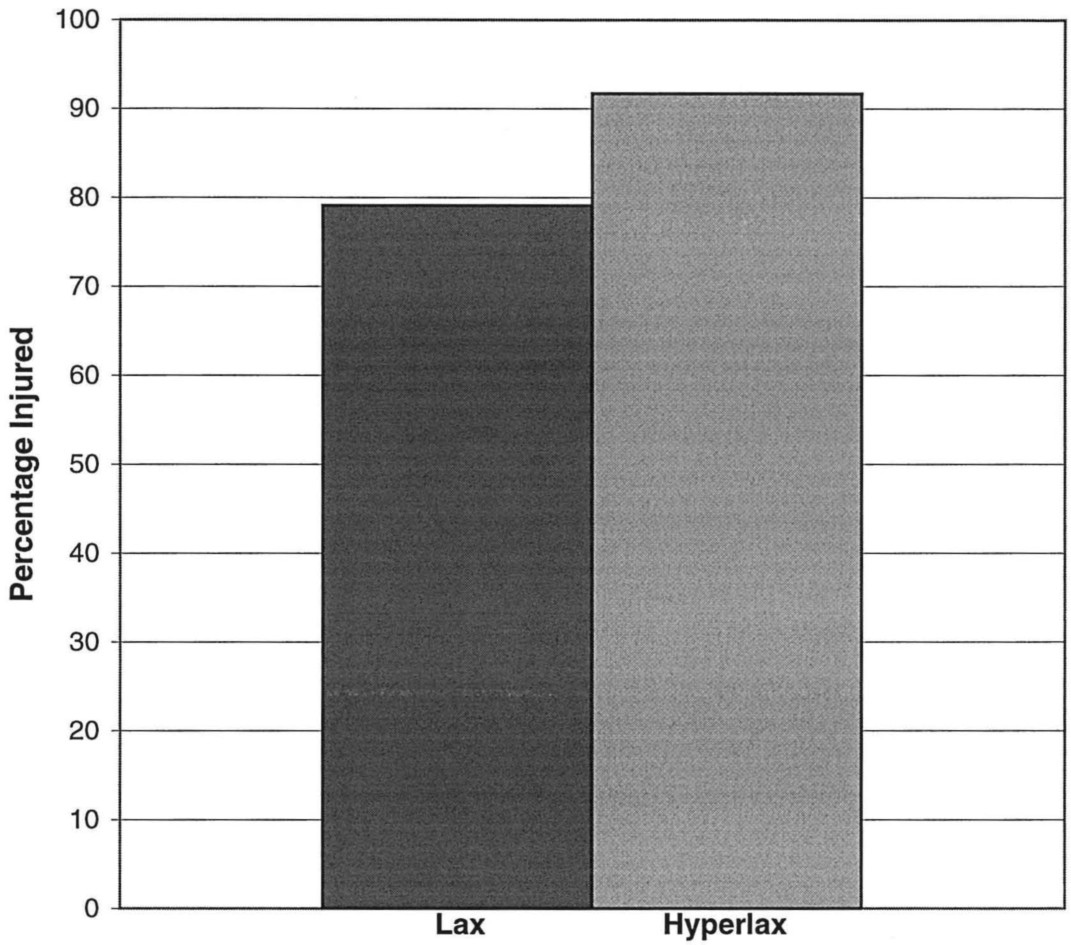

Figure 6. Comparison of percentage of subjects injured in the lax and hyperlax groups.

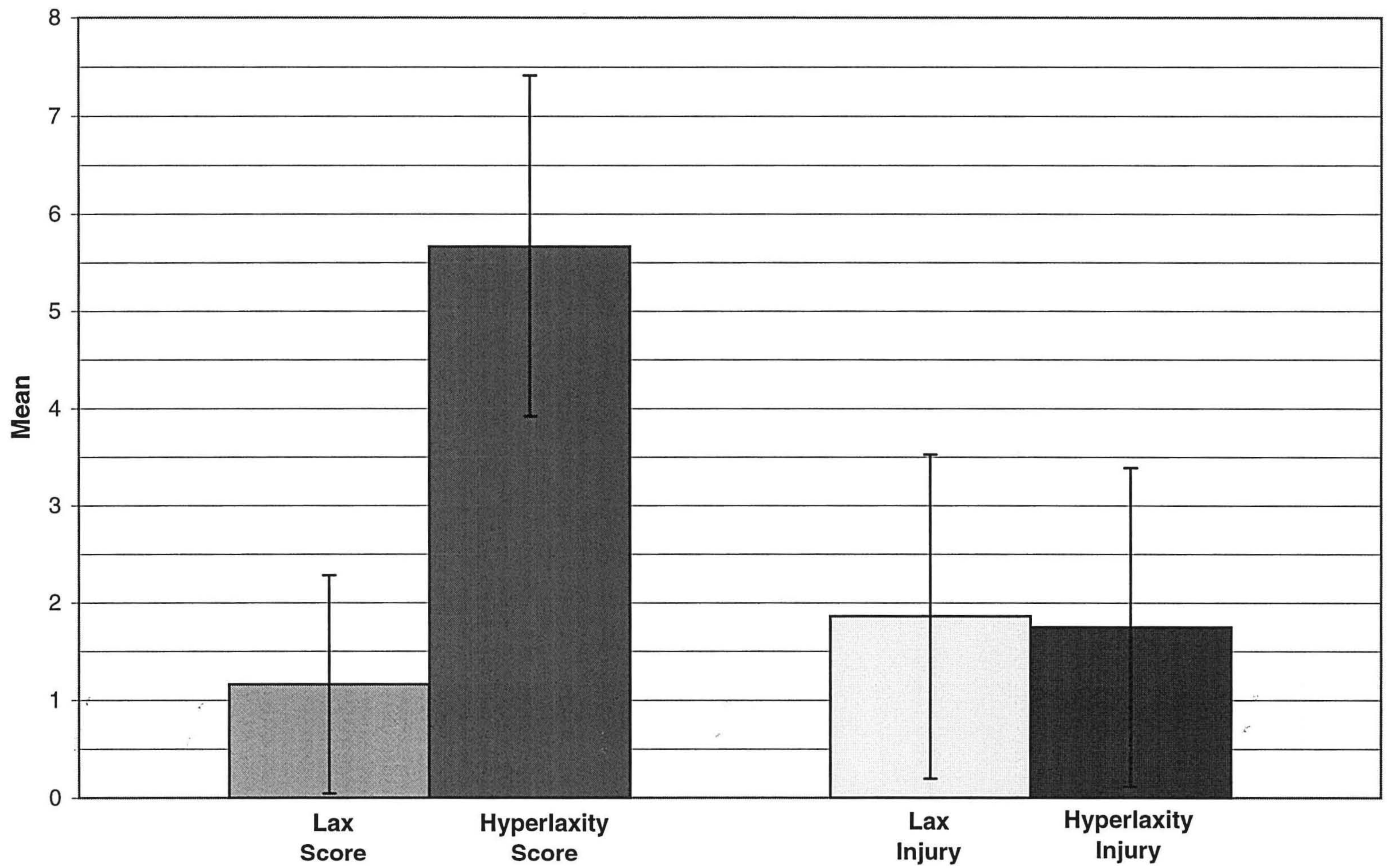

Figure 7. Group score means compared along with mean injury rates.

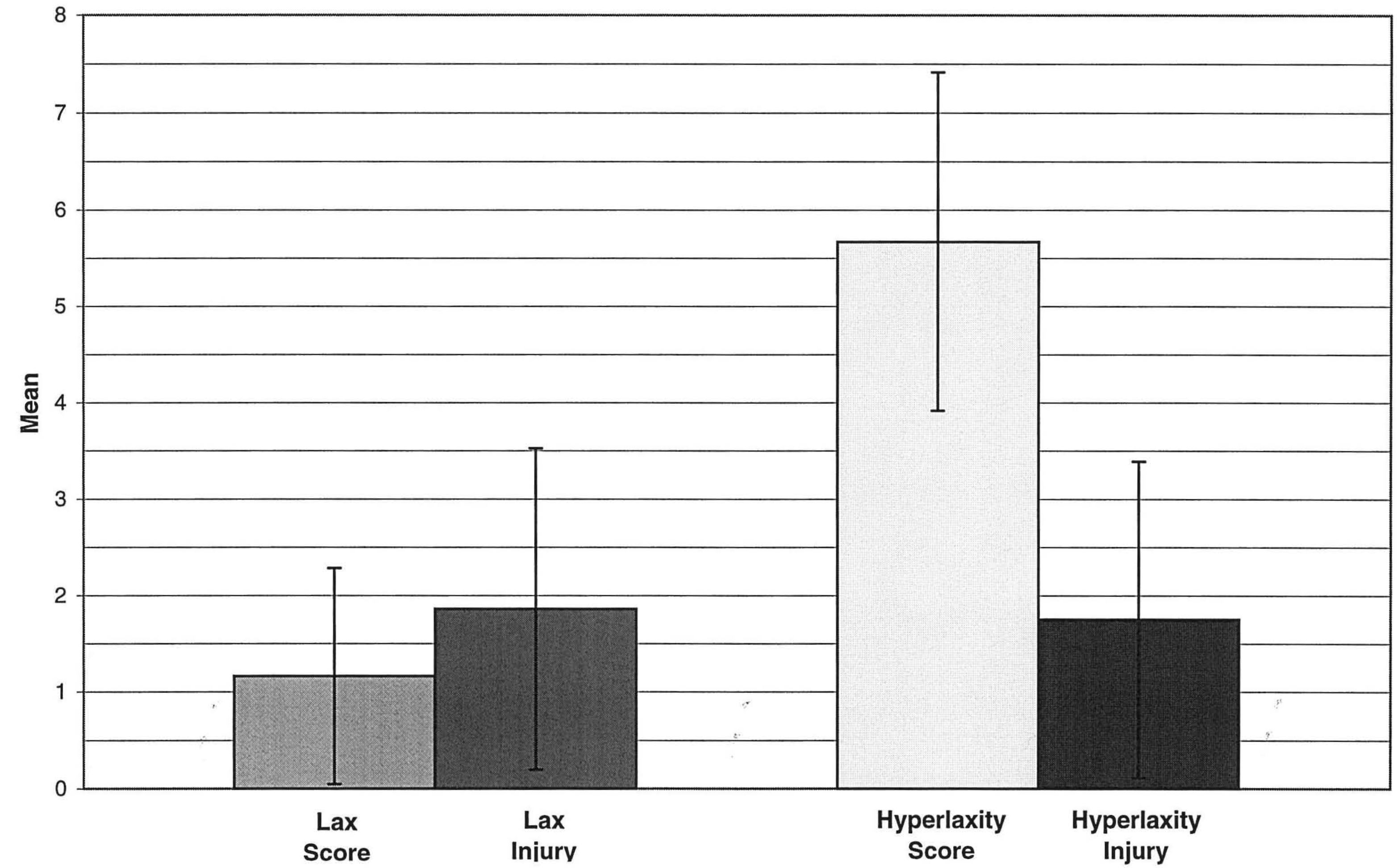

Figure 8. Mean group scores compared with their mean injury rates.

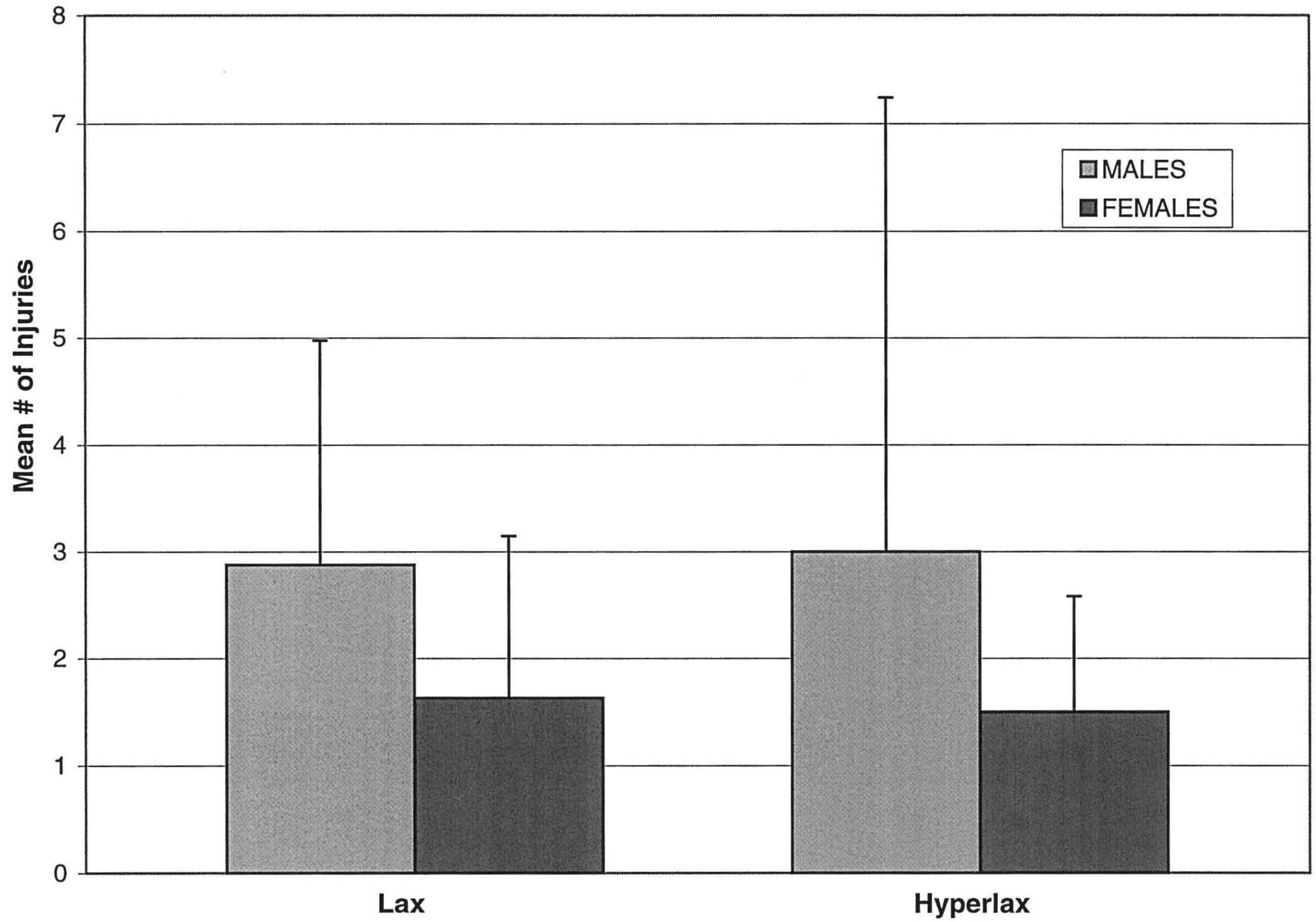

Figure 9. Male and female injury rates compared within the lax and hyperlax group.

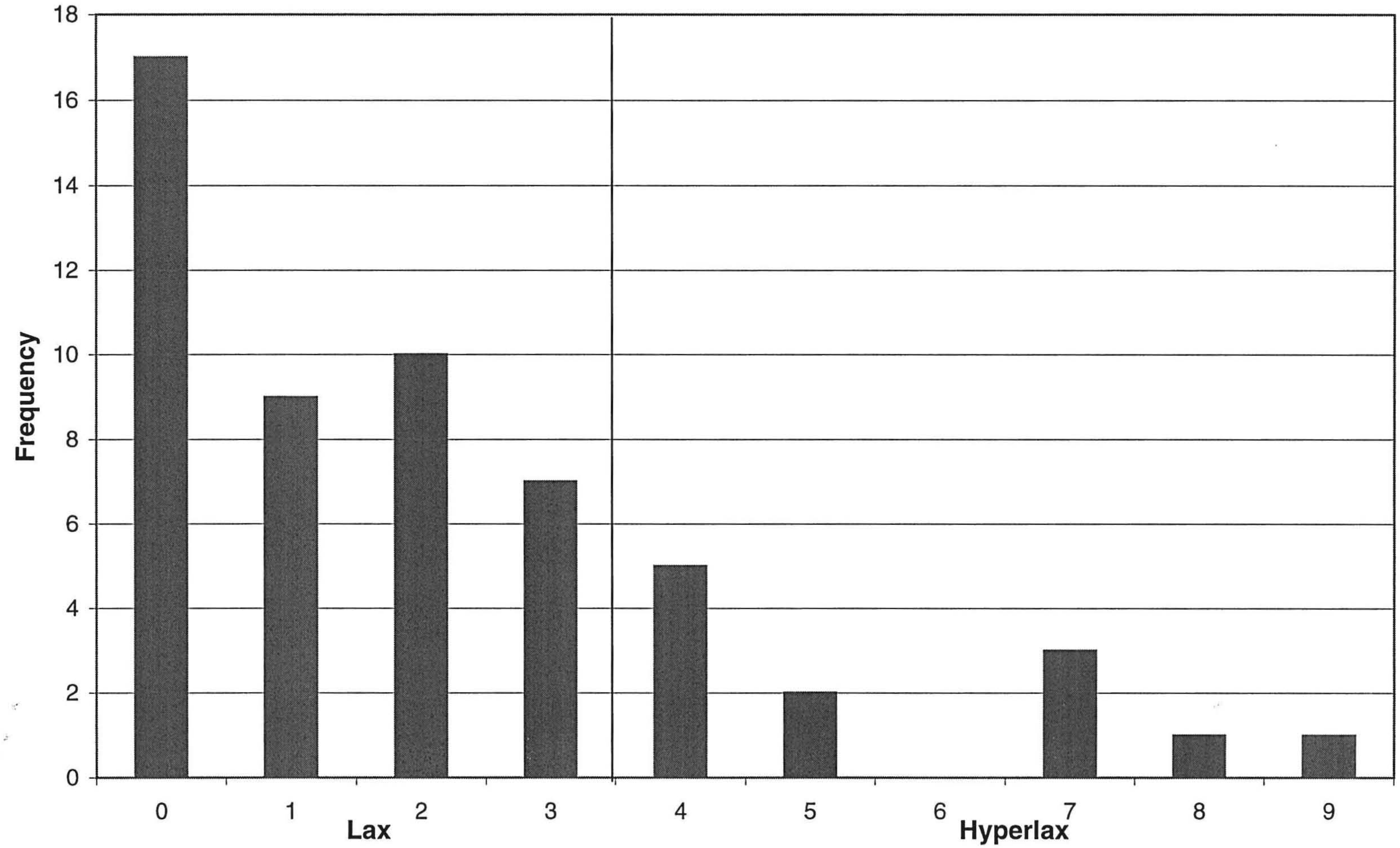

Figure 10. Frequency of individuals as categorized by laxity score. Vertical line indicates cut-off point between lax and hyperlax groups.

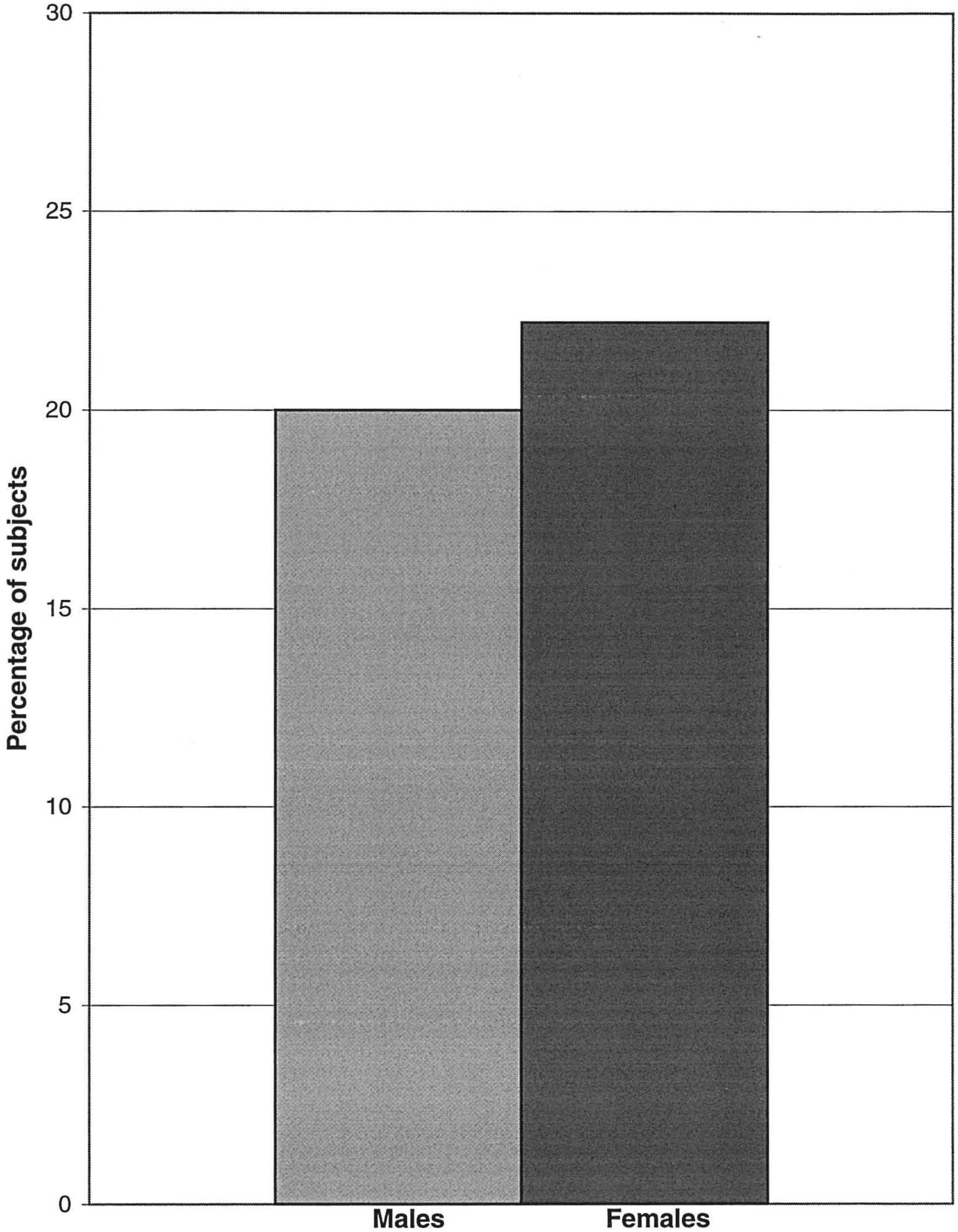

Figure 11. Comparison of percentage of hyperlax males and females.

APPENDIX G

Consent for Taking and Publication of Photographs

Name: Jacquelyn Knodle

Location: University of North Dakota School of Medicine and Health Science

Date: November 9, 1999

In connection with Betty Hestekin's independent study project entitled, The Association of Generalized Joint Hyperlaxity and Occurrence of Musculoskeletal Injury, I consent that photographs may be taken of me and may be published under the following conditions:

1) The photographs shall be used if the researcher, Betty Hestekin deems that medical research, education, or science will be benefited by their use. Such photographs may be published and republished, either separately or in connection with each other, in professional journals or medical books; provided that it is specifically understood that in any such publication or use I shall not be identified by name.

2) The aforementioned photographs may be modified or retouched in any way that the researcher, Betty Hestekin may consider desirable.

Signed Jacquelyn Knodle
Jacquelyn Knodle

Witness Maril McCord

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REFERENCES CITED

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