



2001

The Association of Generalized Joint Hyperlaxity and Occurrence of Musculoskeletal Injury

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THE ASSOCIATION OF GENERALIZED JOINT HYPERLAXITY AND
OCCURRENCE OF MUSCULOSKELETAL INJURY

By

Beth Klancher
Bachelor of Science in Physical Therapy
University of North Dakota, 2000

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

In partial fulfillment of the requirements

for the degree of

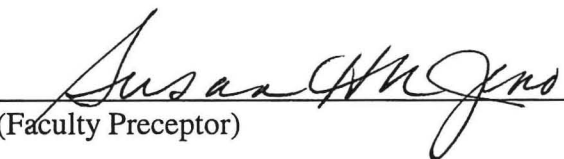
Master of Physical Therapy

Grand Forks, North Dakota


May
2001



This Independent Study, submitted by Beth Klancher 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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ACKNOWLEDGEMENTS

It is the Lord who gives wisdom; from him come knowledge and understanding.

Proverbs 2:6

My deepest appreciation to Dr. Sue Jenö for her guidance, encouragement, and assistance throughout this project. A special thank you to my research partner Jocelyn Hagen for her collaboration, support, and patience. I would also like to thank my classmates and other University of North Dakota students who volunteered to take part in this study.

ABSTRACT

Generalized joint hyperlaxity is characterized by excess range of motion in most joints, which surpasses accepted normal range of motion values for the population. Hyperlaxity is present in 4-7% of the general population. Literature is inconclusive regarding the significance of joint laxity as a predisposing factor to injury in non-athletic populations.

The purpose of this study was to determine if there is a significant correlation between joint laxity and previous musculoskeletal injuries. In addition, the data was evaluated to compare laxity rates by gender, choice of collegiate major, type of injuries, and weekly activity level.

Two-hundred and thirty-nine students, age 18 to 30 years old, on the University of North Dakota campus were voluntarily recruited to participate in this study. Subjects were excluded if they fell outside the age category or had competed in a sport on a national or collegiate level. A participant survey was given to each subject. The survey gathered demographic data regarding the subject's age, gender, major of study, activity level, frequency and intensity of exercise activity, and injuries which required medical attention from a physician. The Beighton test of hyperlaxity was used to determine the laxity status of individuals for classification purposes. Students with generalized joint hyperlaxity did not demonstrate significantly higher rates of previous musculoskeletal injuries. Trends showed individuals with hyperlaxity were more likely to sustain injuries

involving sprains and dislocations, whereas individuals with normal laxity were more likely to display ligamentous injuries and bone fractures. When gender was compared, females exhibited significantly greater systemic joint hyperlaxity. A significant difference in hyperlaxity rates was found between students in physical and occupational therapy programs compared to those in other majors. Research showed no correlation between high frequencies of physical activity and increased generalized joint hyperlaxity.

The high incidence of hyperlaxity in therapy students may create challenges in their careers as clinicians. Future studies of practicing physical and occupational therapists are warranted to determine if therapists with generalized joint hyperlaxity have a greater incidence of work-related musculoskeletal disorders in their career. Regular exercise is an integral part of maintaining a healthy lifestyle. Individuals with hyperlaxity should not be deterred from a daily exercise routine. All patients, regardless of their laxity status, should be taught to exercise in a safe and effective manner.

CHAPTER I
INTRODUCTION AND LITERATURE REVIEW

Definition

Hippocrates is attributed with the first clinical description of hyperlaxity. In the fourth century B.C., he described a race of people, the Scythians, who demonstrated so much hyperlaxity in their elbows and shoulders that they could not effectively draw their bows.¹ The general public may refer to this phenomena as “double jointedness”. However, today, generalized joint hyperlaxity has been defined by Kirk et al.², as a condition in which joints are overly lax and the range of motion is in excess of the accepted normal value in most of the joints examined. Laxity in this form is associated with musculoskeletal complaints and lacks the signs and symptoms of other systemic rheumatic diseases that present with hyperlaxity.

Prevalence

The amount of excess joint range of motion varies among individuals depending on age, sex, race and athletic training.^{3,4} Discrepancies exist regarding the prevalence of generalized joint hyperlaxity in the general population because studies have been performed on non-homogenous populations. Laxity, the amount of motion available in the connective tissue surrounding joints, has been shown to decrease with age.^{5,6,7,8} Children tend to have higher rates of laxity than adults (7%⁹ to 28%⁵) depending on the population and criteria used for evaluation. A study at a New York music school

showed that women demonstrate a decline in laxity at approximately age 40-45, while men show loss of laxity earlier, around 25 years of age.⁷ Generalized joint hyperlaxity has been established to be more prevalent among females than males.^{6,7,10,11,12} Reports indicate laxity may be from two¹¹ to five⁷ times more prevalent among females than males. It is possible that the difference between the sexes is due to the female sex hormones estrogen, progesterone and relaxin that fluctuate during the menstrual cycle and increase ligamentous laxity.¹³ These hormones have been shown to increase generalized joint laxity in women in areas such as, the anterior cruciate ligament¹³, temporomandibular joint¹⁶, and pelvic floor¹⁵.

Ethnic differences also play a role in the prevalence of hyperlaxity. Those of Asian descent have been shown to demonstrate a higher incidence of hyperlaxity than Africans⁵, and Africans a higher incidence than Caucasians.¹² An epidemiological study by Beighton et al.¹⁶ yielded incidences of generalized joint hyperlaxity in one percent of African males ages 20-44 and seven percent of African females in the same age category. Diaz et al.¹⁷ found hyperlaxity in 7.6% of 675 seventeen year-old male Spanish Air Force soldiers. Male Iraqi students ages 20-24 demonstrated a 25.4% prevalence of hyperlaxity as compared to 38.5% of females.³²

Activity level may have an effect on hyperlaxity. High-level athletes have demonstrated an increased incidence of functional, acquired laxity due to recurrent stress at one or two joints rather than presenting with structural generalized joint hyperlaxity throughout the body. For example, gymnasts have shown specific increased lumbar hyperlaxity, while swimmers have commonly had a higher incidence hyperlaxity in their

shoulders.^{1,18} Uninjured, professional baseball pitchers were found to have increased medial elbow laxity in their dominant arm.¹⁹

Diagnostic Criteria

Joint hyperlaxity is measured using a variety of methods. Researchers choose a method of determining generalized joint hyperlaxity depending upon equipment options, operator experience, time availability, and level of test sensitivity required to answer their research question.

Carter and Wilkinson⁹ were the first to develop a five-point scale to diagnose generalized joint hyperlaxity. Points were given if the patient could do the following: 1) passive apposition of the thumb to the flexor aspect of the forearm, 2) passive hyperextension of the fingers and wrist so that the fingers lie parallel to extensor aspect of the forearm, 3) hyperextension of the elbow past 10 degrees, 4) hyperextension of the knee past 10 degrees, and 5) excess dorsiflexion and eversion of the foot. A total of five points was possible, with one point given for each motion that met the test criteria. A score of three or higher was indicative of hyperlaxity.

Beighton et al.¹⁶ modified the five point scale proposed by Carter and Wilkinson. The Beighton method measures five characteristics: 1) passive extension of the little fingers beyond 90 degrees, 2) passive apposition of the thumbs to the flexor aspect of the forearm, 3) hyperextension of the elbows past 10 degrees, 4) hyperextension of the knees past 10 degrees, and 5) forward flexion of the trunk with the knees straight so that the palms of the hands rest easily on the floor. Each limb was scored separately in the first four categories, with one point possible for the final category. This method generated a possible high score of nine. The Beighton test for hyperlaxity has demonstrated a high

correlation coefficient and reliability between measurements assessed over time.^{20,21}

However, there is disagreement on the cut off point used to determine hyperlaxity on this scale. Some researchers use 4/9¹², 5/9¹¹, or 6/9⁵ as a cut off point. There is also a modified version of the Beighton scale that is frequently used. The modified version awards the patient one point for each of the first four categories only if the criteria are met for both extremities bilaterally, and one point for the trunk extension. There is a total of five points possible. Generally, a score of 3/5 is used to determine hyperlaxity on the Modified Beighton Scale.²²

Bulbena et al.²³ compared the Carter and Wilkenson⁹ scale, the modified scale of Beighton et al.¹⁶ and an 11-point scale by Rotes. Bulbena et al.²³ found that both the correlation coefficients and predictive efficiencies between the three hyperlaxity test criteria were uniformly high, suggesting high concurrent and predictive validity. The study by Bulbena et al.²³ also proposed a different cut off point to determine hyperlaxity for men (3/4) and women (4/5) due to the fact that women tend to have more positive signs of laxity. The scale was proposed to help avoid false negatives.

Although the Beighton test is the most widely used test by researchers, other laxity tests can be found in the literature. A global index of joint laxity is determined by measuring 34 different arcs of movement with a goniometer and dividing the end result by one hundred. Although it offers a more comprehensive look at generalized joint hyperlaxity, it is complicated, time consuming, and involves specific operator training.²⁴

Finger hyperextensometers have also been used to find a faster, more precise way to assess hyperlaxity. The hyperextensometer is a simple spring device that measures the extension of the metacarpophalangeal (MCP) joint of the little finger. Bird et al.²⁰

compared the finger hyperextensometer and Beighton Method to the global index of joint laxity. They found that a system that measured several joints (Beighton) correlated better with the global index method than a system that measured movement at just one joint (hyperextensometer). Numerous joints throughout the body were affected by generalized joint hyperlaxity, which made it difficult to use the hyperextensometer and assess laxity by measuring only one joint.

Pathophysiology

Generalized joint hyperlaxity appears to be inherited as a gender influenced dominant trait.² Laboratory tests are used to distinguish between benign hyperlaxity and hereditary connective tissue disorders in which hyperlaxity is a feature, such as Marfan's, Ehlers-Danlos and Osteogenesis Imperfecta.¹¹ Generalized joint hyperlaxity is probably due to an abnormality in type I collagen. Type I collagen is found in tendons, ligaments, joint capsules and skin. Type II collagen is found primarily in hyaline cartilage. Type III collagen is found mostly in the vascular system, skin and lungs. People with generalized joint hyperlaxity have a greater ratio of type III to type I collagen throughout their body which contributes to decreased tissue stiffness.²⁵ In a study performed by Child¹⁰, electron microscopy of the skin of 22 females with hyperlaxity showed a markedly decreased proportion of thick collagen fibers and an increased proportion of fine collagen fibers, ground substance, elastin and fibrocytes in the reticular layer. Individuals with hyperlaxity may be subject to premature osteoarthritis due to the production of abnormal biochemical forces on the joint and a basic collagen abnormality in both the joint's supporting structures and on the joint surfaces.^{10,26}

Consequences of Generalized Joint Laxity

In a study performed by Scott et al.²⁷, there was a significant increase in joint laxity in a group of patients who presented with symptomatic osteoarthritis compared to a control population of similar age and sex with no evidence of joint disease. It is suggested that the natural history of hyperlaxity may lead to traumatic synovitis and later to osteoarthritis in the fourth or fifth decades.² An arthroscopic study by Bird et al.⁴ showed a high incidence of chondrocalcinosis in the synovium of hyperlax patients with synovitis of the knees. These studies indicated that individuals with hyperlaxity may be predisposed to developing osteoarthritis during their lifetime.

Increased joint laxity may also be a factor in work-related musculoskeletal injuries. Industrial workers with spinal hypermobility, those who could place their palms flat on the floor keeping their knees straight, were found to have a significantly higher incidence of musculoskeletal problems in the neck and shoulders.²⁸ Interestingly, an increase in back pain was seen in those hyperlax patients who had stationary jobs that required prolonged sitting or standing, compared to other hyperlax patients with more mobile jobs. In the non-lax group, there was significantly more back pain reported with tasks that required frequent changes in body posture. It is possible that hyperlaxity of a joint is good if the joint is needed for repetitive motion, but detrimental if the prime role of the joint is to provide support. Larrson et al.²⁹ found that among musicians who played instruments requiring repetitive motion, hyperlaxity was an asset in the wrist and hands, whereas hyperlaxity of the less frequently moved joints like the knees and spine were a liability. Patients with hyperlaxity did better with tasks that required frequent changes in body position in order to avoid pain and musculoskeletal problems.²⁸

There is a disagreement in the literature on whether generalized joint hyperlaxity is associated with an increased injury occurrence. Studies have often compared laxity status and injury rate in young, highly active, athletic populations. A study of 675 seventeen year old well-conditioned soldiers by Diaz et al.¹⁷ found that the occurrence of musculoligamentous lesions, particularly those of the ankle and knee, were significantly more frequent in hyperlax individuals than in those with normal joint mobility. Professional ballet dancers have been found to have significantly higher hyperlaxity than the general population. Those who were hyperlax most commonly incurred ligamentous lesions of the knee, ankle and foot.¹ In a study of 2,300 West Point cadets representing a group of young males of above average athletic ability and physical fitness, no statistical relationship was found between increased joint laxity and injuries. Also, no relationship was found between laxity and the need for surgical intervention resulting from injuries sustained in general athletic competition.¹⁸ In college age athletes, Krivickas and Feinberg³⁰ found lower extremity injuries were unrelated to general ligamentous laxity in female athletes. Among men, lower extremity injuries were associated with lower ligamentous laxity scores, which indicated that tight ligaments caused more injury than lax ligaments. No significant difference between hyperlaxity and musculoskeletal pain has been shown in grade school children.^{3,29}

A pilot study at the University of North Dakota was performed to determine if hyperlaxity placed the general, non-athletic, college age population at a greater risk of incurring previous musculoskeletal injury.³¹ A trend was found suggesting non-athletic, college age students who met hyperlaxity test criteria had an increased rate of musculoskeletal injury.³¹ Similarly, Al-Rawi et al.³² completed a study on 20-24 year old

Iraqi university students and found ligamentous injury to be significantly more common in the subjects with hyperlaxity.

There is an absence of literature determining the relationship between generalized joint hyperlaxity and musculoskeletal injury in non-athletic populations. The purpose of this study was to determine the relationship between joint hyperlaxity and musculoskeletal injury in a non-athletic, college age population.

This study was significant to physical therapists due to the high volume of patients they treat for musculoskeletal injuries. The results of this study concerning generalized joint hyperlaxity and injury, gender, and activity level, will influence how therapists evaluate, screen, and treat patients. This study was also significant for the future of physical therapy education. If therapists, as a group, tend to show high incidences of hyperlaxity, joint saving techniques may be increasingly important in their educational curriculum.

This study was performed to answer the following research questions: 1) Is there a significant difference between joint laxity and previous injuries in non-athletic, college age students? Null hypothesis: There is a significant difference between joint laxity and previous injury in non-athletic, college age students. 2) Is there a significant difference in laxity scores between males and females? Null hypothesis: There is a significant difference in laxity scores between males and females. 3) Is there a significant difference between laxity score and choice of major? Null hypothesis: There is a significant difference between laxity score and choice of major. 4) Is there a significant difference between laxity score and type of injury? Null hypothesis: There is a significant difference between laxity score and type of injury. 5) Is there a significant difference

between laxity score and weekly activity level? Null hypothesis: There is a significant difference between laxity score and weekly activity level.

CHAPTER II

METHODS

Subjects

Two-hundred thirty nine subjects from the University of North Dakota volunteered to participate in this study. The study included 129 females and 110 males. Of the 129 females, 45 were physical therapy students, 40 were occupational therapy students, and 44 were in various non-therapy related majors. Of the 110 males studied, 19 were physical therapy students, 9 were occupational therapy students, and 82 were in various non-therapy related majors. Participants were excluded if they were greater than 30 years of age, or less than 18 years of age. Subjects were also excluded if they had participated in an athletic activity on a collegiate or national level. This allowed for a homogeneous 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 obtain demographic data including: the subject's age, gender, academic major, physical activity level, frequency

and intensity of activities, and number and type of injuries requiring medical attention from a physician.

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.^{20,21} The Beighton test is easy to administer, and is the most commonly used test in the literature.^{20,21} Testing maneuvers (Figures 1-5) included 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 that involved the extremities were performed bilaterally.

Reliability

The testers had previous practical experience with goniometric measurement before the start of this study. Goniometric measurement for knee and elbow extension has been found to have high reliability.³³ Intratester and intertester reliability for this study was established through a pilot study of elbow extension measurements. Reliability was found to be good for intertester reliability (ICC=.94) and intratester reliability was also classified as good, for tester one (ICC=.97) and tester two (ICC=.88).³⁴

Procedure

Each subject completed a survey and consent form (Appendix C) prior to being tested. The Beighton test for generalized joint hyperlaxity was then performed on each subject. Subjects were randomly assigned to one of the two testers for examination.

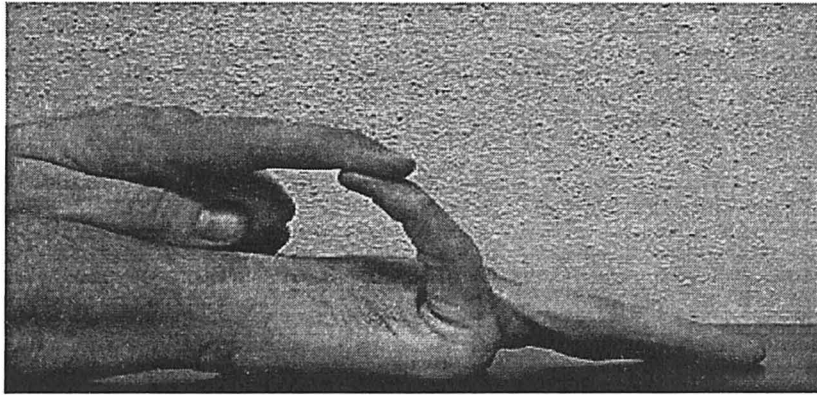


Figure 1. Hyperextension of the fifth finger

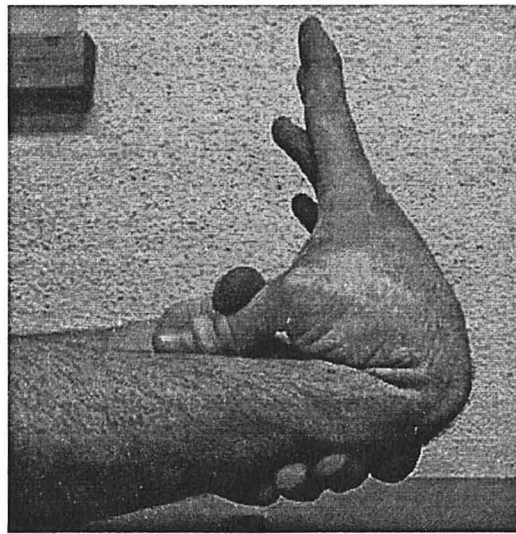


Figure 2. Apposition of the thumb to the flexor aspect of the forearm

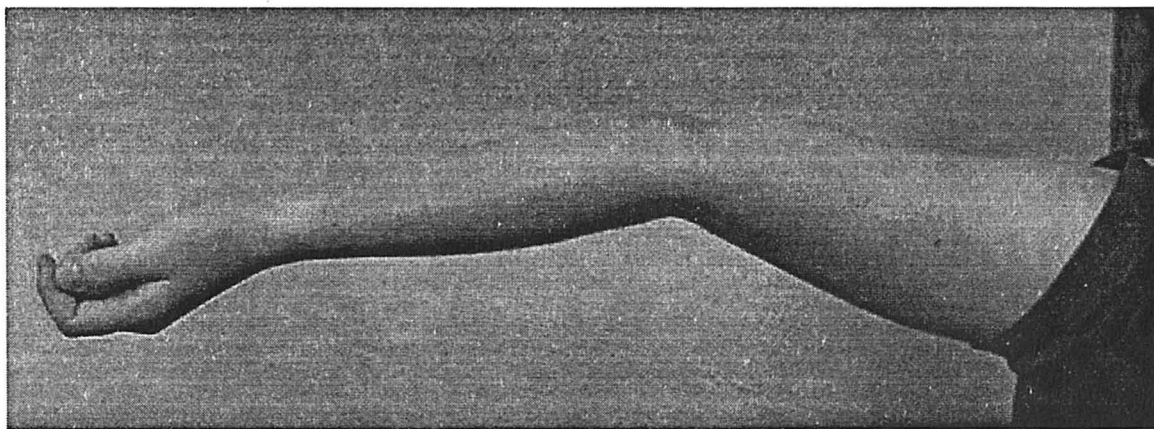


Figure 3. Hyperextension of the elbow

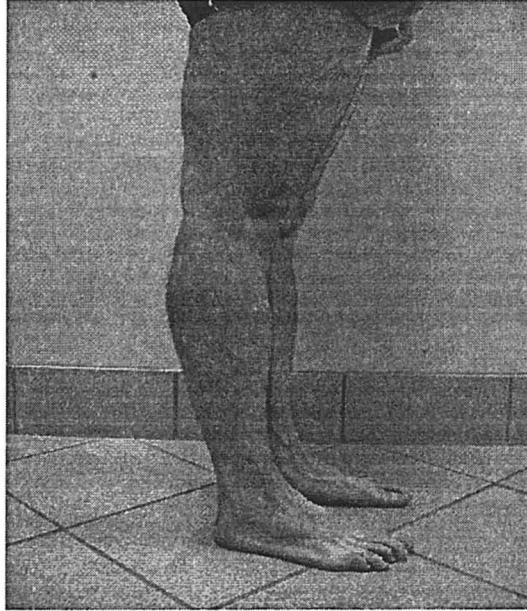


Figure 4. Hyperextension of the knee



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

Tests requiring range of motion measurements were recorded with a standard goniometer. The standard scoring system was used, awarding one point for meeting the test criteria, and zero points if the test criteria were not met. The standards to meet were passive extension of the fifth finger past 90 degrees with the palm of the hand resting on a flat surface, hyperextension of the elbows and knees greater than ten degrees, and flexion of the trunk with the knees straight, so the palms rest comfortably on the floor.¹⁶ Subjects could score zero to nine points. A score of zero to three represented normal laxity, while a score of four or greater constituted hyperlaxity. The cutoff point was chosen due to standards in the existing literature.¹⁶

Data Analysis

Data analysis was completed using SPSS 10.0* computer software. A chi square test was used with $\alpha=.05$ significance to determine the association between laxity and injury occurrence, gender, choice of academic major, type of injury and weekly activity level. Spearman Rho test of correlation was also performed to analyze activity level and hyperlaxity status. Statistics were reliable due to assumptions being met for test criteria in four of the five research questions. Trends were reported for the data that did not meet the chi square test criteria.

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

CHAPTER III

RESULTS

Results were tabulated after participants filled out the questionnaire and hyperlaxity scores were compiled for the 239 subjects. For these subjects, no significant difference was found between joint laxity and history of injury, $\chi^2(1, n=239)=.101$, $p=.751$. Only a slight difference was noted in percentage of injuries between the non-lax and hyperlax group (Table 1). Seventy percent of the non-lax group had previously sustained musculoskeletal injuries, compared to 72% of the hyperlax group (Figure 6).

A significant difference was found when evaluating laxity and gender, $\chi^2(1, n=239)=11.007$, $p=.001$. Females were found to have the highest percentage of hyperlaxity at 18.6%, while only 4.5% of males were classified as hyperlax (Figure 7, Table 2). Next, a comparison of laxity score and choice of major also yielded significant results, $\chi^2(2, n=239)=8.057$, $p=.018$. Of the therapy majors, 14% of physical therapy students and 22% of the occupational therapy majors displayed hyperlaxity. However, only 7% of students studying other majors offered at the University of North Dakota demonstrated hyperlaxity. Hyperlaxity scores for the three groups are listed in Table 3 and graphic representation can be found in Figure 8. These results are similar to those found in the pilot study conducted at the University of North Dakota.

Trends were reported in instances where criteria were not met for the chi-square test of independence. Therefore, significance was unable to be reported between

hyperlaxity and type of injury. $\chi^2(8, n=239)=4.562, p=.803$. However, trends show sprains were more common in the hyperlax population at 34.5%, whereas sprains only accounted for 23.8% of injuries in the non-lax population. In the hyperlax group, dislocations had a 10.3% occurrence, versus 6.2 % in the non-lax group. Ligamentous injuries were reported in 3.4% of hyperlax subjects as compared to 4.8% of those with no laxity. Bone fractures occurred in 17.2 % of the hyperlax group and 23.3% of the non-lax group. Figure 9 represents percentages of injury occurrence for all injury categories.

No significant correlation was found between laxity score and weekly activity level when compared using Spearman's rho test for correlation $r_s=.060, n=239, p=.359, 2$ tails³⁵ (Figure 10). Therefore, increased activity level did not increase overall generalized joint laxity in this population.

CHAPTER IV

DISCUSSION AND CONCLUSION

Discussion

The results of this study indicated that in non-athletic, college-age students increased generalized joint laxity did not correlate with a greater rate of previous musculoskeletal injury. Trends however, showed that those with hyperlaxity were more likely to have injuries involving, sprains, dislocations, contusions and arthroscopic surgery. Diaz et al.¹⁷ found ankle sprains and knee pain to be significantly more frequent in individuals with hyperlaxity. An increase in sprains and dislocations may be due to an abnormal ratio of type III to type I collagen seen in people with generalized joint hyperlaxity. The amount of tissue damage caused by injuries sustained in subjects with hyperlaxity may be decreased due to increased laxity of the joint structures. Stanitski³⁶ found patients with hyperlaxity and acute patellar dislocation to have an incidence of chondral injury and avulsion fracture only 33% of the time, as compared to patients without hyperlaxity who had an 80% incidence of avulsion fracture. The normal laxity group showed trends of increased injuries involving fractures and ligamentous tears. One theory may be that because structures break at their weakest point, more fractures were seen in people with normal laxity due to increased tissue stiffness of their ligaments. The ligaments of people with normal laxity may tend to tear when highly stressed instead of stretch as they would

in people with generalized joint hyperlaxity. This type of hyperlaxity varies between males and females.

In this study, females demonstrated increased hyperlaxity compared to men as anticipated by previous research.^{6,7,10,11,12} The higher rates of hyperlaxity in woman may be due to the influence female hormones, estrogen, progesterone, and relaxin, have on increasing ligamentous laxity.¹³ In pre-adolescent children, no clinically significant difference has been found between laxity scores and gender.^{9,5} After puberty, females show increased laxity scores when compared to males of the same age. In both sexes, hyperlaxity decreases with age.^{5,6,7,8} Women show the greatest decline in hyperlaxity between ages forty and forty-five,⁷ which coincides with menopause and the decline of female hormones. Investigative studies may be performed in the future to assess the effect of hormone replacement on laxity and the incidence of falls and fractures in elderly woman.

When comparing majors, the physical and occupational therapy students had significantly higher percentages of students with hyperlaxity than those students involved in other majors on campus. Based on the results of this study, it is postulated that many therapy students chose their major based on past experiences with injury rehabilitation. If therapy students had experienced more severe injuries requiring medical attention in the past, such as sprains and dislocations, they may have been more likely to receive therapy than their peers with normal laxity. It is possible that participation in the rehabilitation process piqued their interest in the therapy field leading to the higher than average number of students who demonstrate hyperlaxity. A significant number of athletes with hyperlaxity may be drawn to the field of physical therapy due to their experiences with

athletic injuries. It is probable that the reported number of therapy students with hyperlaxity would have been higher if athletes had not been excluded from this study.

The high incidence of hyperlaxity in therapy students may create challenges in their careers. Cromie et al.³⁷ found work-related musculoskeletal disorders to cause one in six physical therapists to change their specialty area or leave the profession. They also found a significant relationship between thumb symptoms and the use of mobilization techniques in practicing physical therapists. Those therapists with hyperlaxity in their thumbs may be predisposed to injury while performing manual therapy due to increased forces on their pliable ligaments. The high laxity scores in the therapy majors may have implications on the content of their educational curriculum. Future studies of practicing physical therapists is warranted to determine if therapists with generalized joint hyperlaxity have a greater number of work-related musculoskeletal disorders during their career. If so, it will be important that therapists are made aware of their laxity status and know how to prevent work-related musculoskeletal disorders through use of proper joint protection techniques.

Males in the therapy majors had a much higher percentage of laxity when compared to males in other majors. This was a novel finding. There may be biological, environmental or psychological explanations for this phenomenon. Martin-Santos et al.³⁸ studied the psychological implications of hyperlaxity and found joint laxity to be highly prevalent in patients with panic disorder, agoraphobia or both. This suggested a possible psychological component to joint hyperlaxity. Bridges et al.²⁶ analyzed the genetic component of hyperlaxity and found most patients with hyperlaxity to have a first-degree family member with a history of joint laxity. More research is needed to determine if the

high rate of hyperlaxity in male therapy majors was an isolated event or if these findings can be seen in other male health care workers. Future studies may also focus on determining the influence biology, environment, psychology and genetics have on generalized joint hyperlaxity.

Subjects who participated in an athletic activity at a collegiate or national level were excluded from this study. The group of remaining college-age students was considered to have physical activity levels that were closer to “normal” for their age. Increased activity levels did not correlate to an increase in the number of hyperlax joints. Based on this study, the health benefits from regular exercise outweigh the risks of increased joint laxity. The data from this study suggests that exercise should not affect the level of generalized joint laxity a person already demonstrates. Likewise, Mikkelsen et al.³ found no significant difference in frequency of physical activity between children with hyperlaxity and those with normal laxity.

Limitations

The exclusion of athletes from this study may have altered the percentage of subjects with hyperlaxity. However, our results are consistent with those found by other researchers. The use of two testers to assess hyperlaxity may have introduced test bias. An attempt was made to decrease bias by testing intra and inter-tester reliability prior to the start of the study. Due to the limited number of students with hyperlaxity in the population, it was difficult to test a large enough sample to meet all test criteria. It was felt the sample used in this study was realistic due to time and personnel restrictions. Another limitation of this study was the classifications used to quantify the types of injuries sustained by subjects. Besides the therapy majors, most subjects did not have

prior education concerning common types of musculoskeletal injuries and may have reported their injuries incorrectly. However, the testers were available while subjects filled out their questionnaire, to clarify the categories for those who questioned the type of injury they had sustained.

Conclusion

Students with generalized joint hyperlaxity did not demonstrate significantly higher rates of previous musculoskeletal injuries. However, trends showed individuals with hyperlaxity were more likely to have sustained injuries involving sprains and dislocations, whereas ligamentous injuries and bone fractures were more likely in individuals with normal laxity. When gender was compared, females exhibited significantly greater generalized joint hyperlaxity than their male counterparts. A significant increase in hyperlaxity scores was found between students in physical and occupational therapy programs compared to those in other majors. Research showed no correlation between high frequencies of physical activity and increased generalized joint hyperlaxity.

Individuals with hyperlaxity tend to have injuries involving sprains and dislocations which may be due to an abnormal collagen ratio. This may merit increased patient awareness of their laxity status and education regarding ways to avoid future injury.

The high incidence of hyperlaxity in therapy students may create challenges in their careers as clinicians. Future studies of practicing physical and occupational therapists are warranted to determine if therapists with generalized joint hyperlaxity have a greater incidence of work-related musculoskeletal disorders in their career.

Regular exercise is an integral part of maintaining a healthy lifestyle. Individuals with hyperlaxity should not be deterred from a daily exercise routine. All patients, regardless of their laxity status, should be taught to exercise in a safe and effective manner.

APPENDIX A

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: Dr. Sue Jenö, Jocelyn Hagen, Beth Klancher TELEPHONE: (701)-772-8752 DATE: 02-21-00

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: Box 9037

SCHOOL/COLLEGE: School of Medicine DEPARTMENT: Physical Therapy
PROPOSED PROJECT DATES: 3/1/00-5/13/01

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

FUNDING AGENCIES (IF APPLICABLE):

TYPE OF PROJECT (Check ALL that apply):

NEW PROJECT CONTINUATION RENEWAL DISSERTATION OR THESIS RESEARCH
 STUDENT RESEARCH PROJECT

CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

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

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

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 RETARDED
 PRISONERS ABORTUSES 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 _____

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 participating in a high level of activity have an increased prevalence of injury.¹ The purpose 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 greater risk of injury in normal daily activities.

The study will involve 300 UND 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 injury prediction and prevention in the general population.

References:

1. Diaz M, Estevez E, Guijo P. *Joint hyperlaxity and musculoligamentous lesions: Study of a population of homogeneous age, sex and physical exertion.* Br J Rheum. 1993; 32:120-122.
2. Beighton P, Solomon L, Soskolne CL. *Articular mobility in an African population.* Ann 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 300 UND students is on a volunteer basis. The subjects will be tested on the campus of the University of North Dakota. Subject consent will be obtained 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 degrees, hyperextend the elbows beyond 10 degrees, hyperextend the knees beyond 10 degrees, 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 of 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 will be analyzed statistically using a χ^2 test.

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

By assessing if individuals with generalized joint hypermobility are at greater risk of injury during normal daily activities as compared to individuals who are not hypermobile, therapeutic methods can be developed to prevent injury. With this knowledge hypermobile individuals may be able to avoid injury. The subjects in this study will be made aware if they have generalized hypermobility or not. Following this 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 findings of this study will be directly applicable to injury prediction and need for 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 physical 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 unlikely in this study. The only risk the subjects may experience is momentary slight discomfort if excessive force is used to move their joints into positions for the test. The subjects will be asked to move their joints only within 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 in 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 infringement 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 Dept. at Grand Forks for 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) copies 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 supporting 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 Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

SIGNATURES:

_____Principal Investigator

_____Project Director or Student Adviser

_____Training or Center Grant Director

(Revised 3/1996)

APPENDIX B

ID#: _____

Participant Survey

Birth date: _____
Dominant hand: R or L

Height: _____
Weight: _____

Gender: M or F
Major: _____

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 collegiate or national level.

Football	Basketball	Cross Country
Gymnastics	Bowling	Wrestling
Baseball	Swimming	Softball
Bike Racing	Tae Kwon Do	Cross Country Skiing
Figure Skating	Downhill skiing	Golf
Dance	Hockey	Tennis
Weight Lifting	Volleyball	
Track- event? _____		

Other _____

How many days/week do you participate in athletic activities?

0 1-3 4-7

How long do you perform the activity (in minutes per day)?

0-30 30-60 60-90 90+

What activities do you currently participate in? List all that apply.

Injury History:

Have you ever had to seek medical attention **from a doctor** 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(Bruise)

Dislocation

Strain

Fracture

Other _____

What part of your body was injured?

What side of the body was injured?

Right or Left

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

How old were you at the time of injury(ies)? _____

Did you require surgery? If so what type? _____

Have you had any lasting disability due to an injury?

If so what type? _____

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. The results of the study will be made available to you to assess the need of a preventative program.

As a participant in this study you will complete a survey indicating demographic data such as age and gender, 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 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 the hypermobility test will be approximately 15 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 available to you. Your identity information will be used 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 Jocelyn Hagen at 772-8752, Beth Klancher at 777-8487, or Dr. Sue Jenö 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. You and your third party payer, if any must provide payment for such treatment.

I have read and understood 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
5 th FINGER -LEFT		
-RIGHT		
THUMB -LEFT		
-RIGHT		
ELBOW -LEFT		
-RIGHT		
KNEE -LEFT		
-RIGHT		
TRUNK		
TOTAL SCORE		

APPENDIX E

Table 1. Comparison of Laxity Status and Injury Status

	No Injury	Injury	Total
Normal Laxity	64	146	210
Hyperlaxity	8	21	29

Table 2. Comparison of Laxity Status and Gender

	Male	Female	Total
Normal Laxity	105	105	210
Hyperlaxity	5	24	29

Table 3. Comparison of Laxity Status and Choice of Major

	N	Physical Therapy	Occupational Therapy	Other
Normal laxity	210	86%	78%	93%
Hyperlaxity	29	14%	22%	7%

APPENDIX F

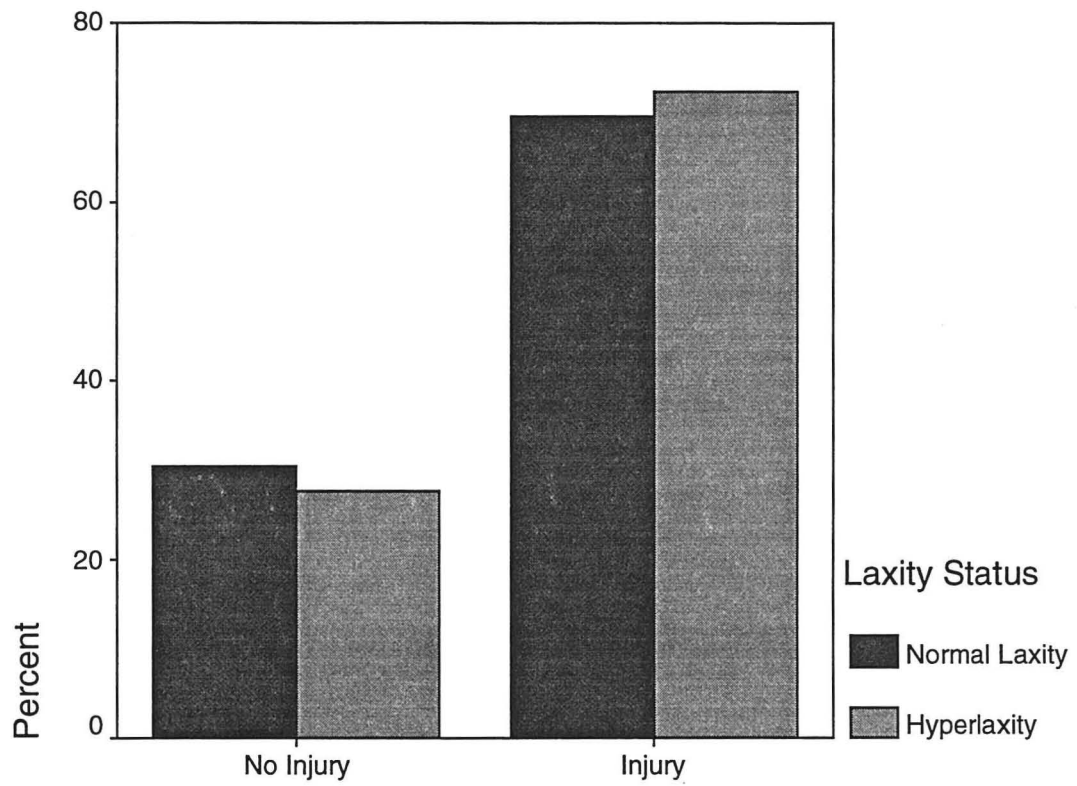


Figure 6. Comparison of laxity status and injury status

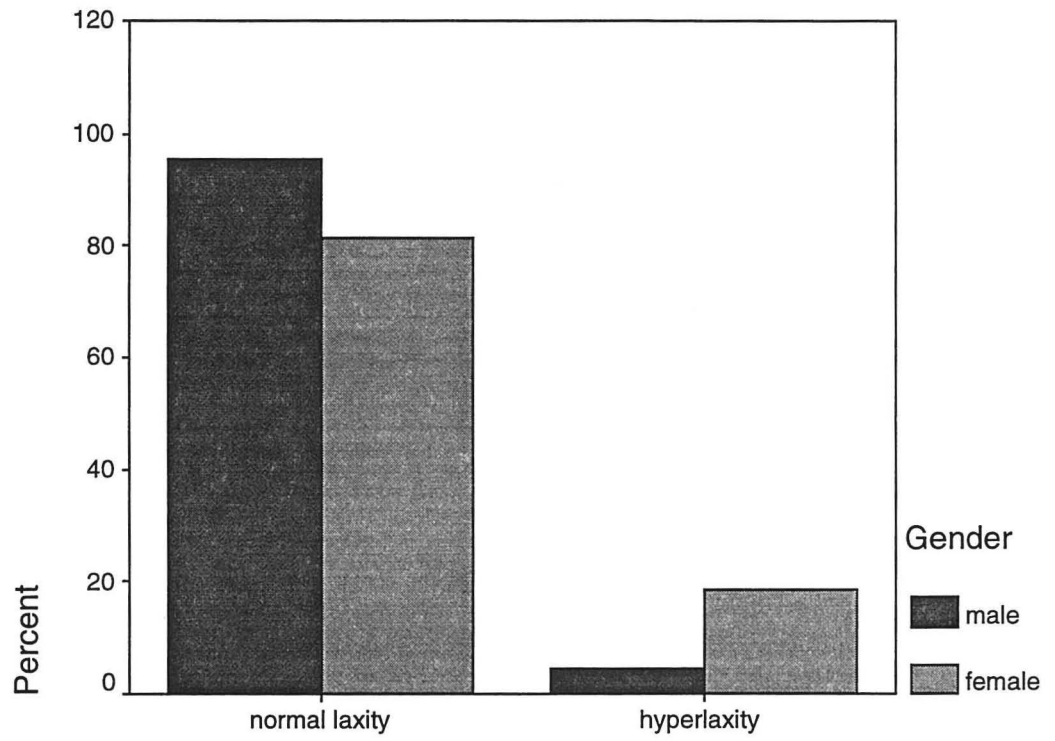


Figure 7. Comparison of gender and laxity status

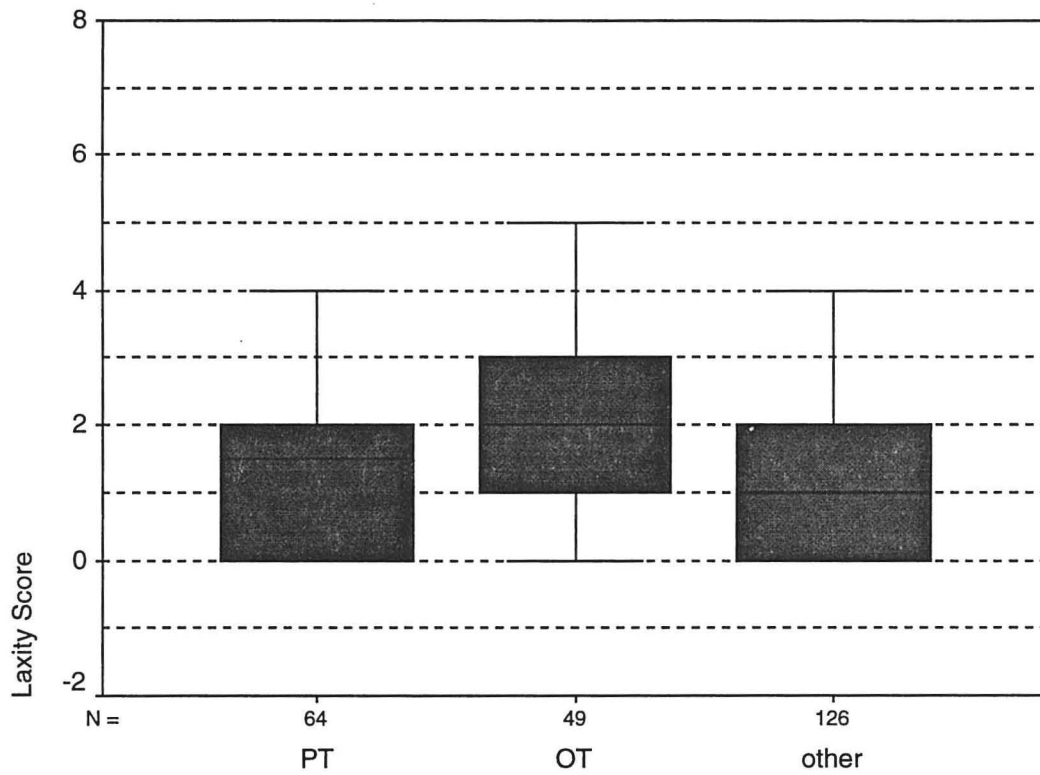


Figure 8. Comparison of Laxity Scores by Major: Means, Standard Deviations, High and Low Scores

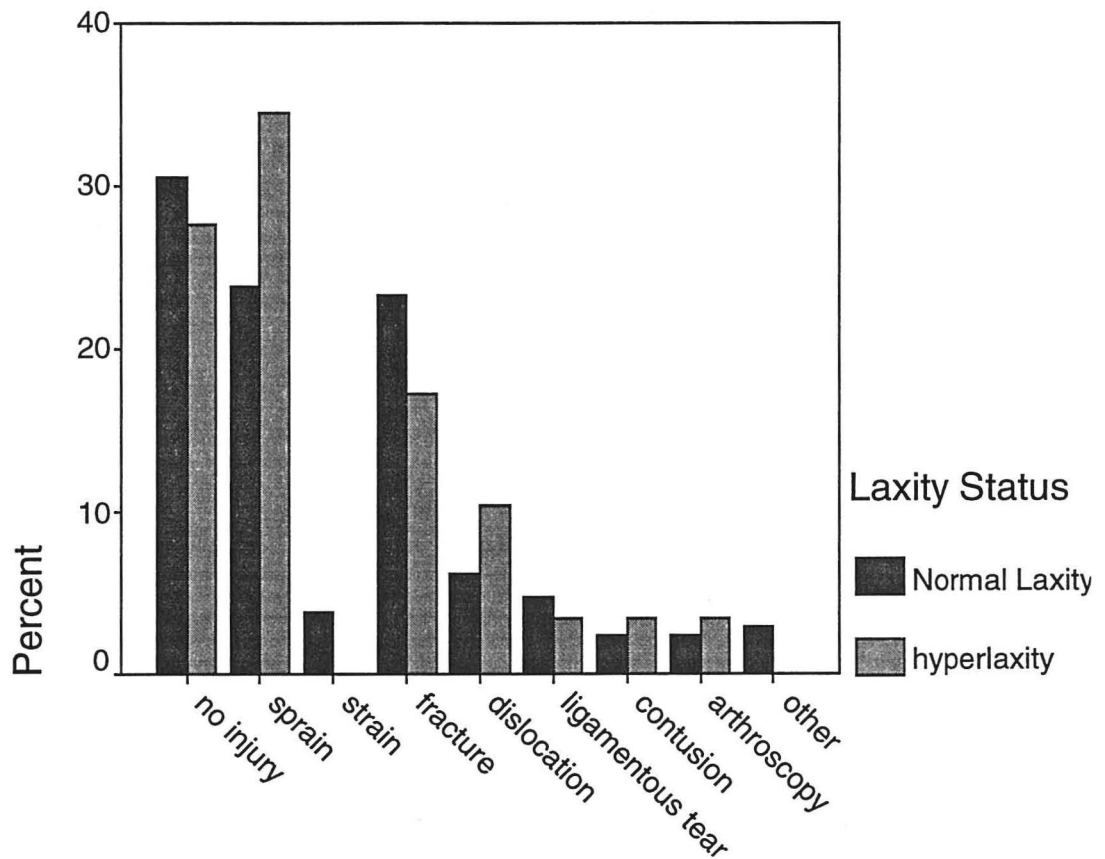


Figure 9. Comparison of laxity status and type of injury

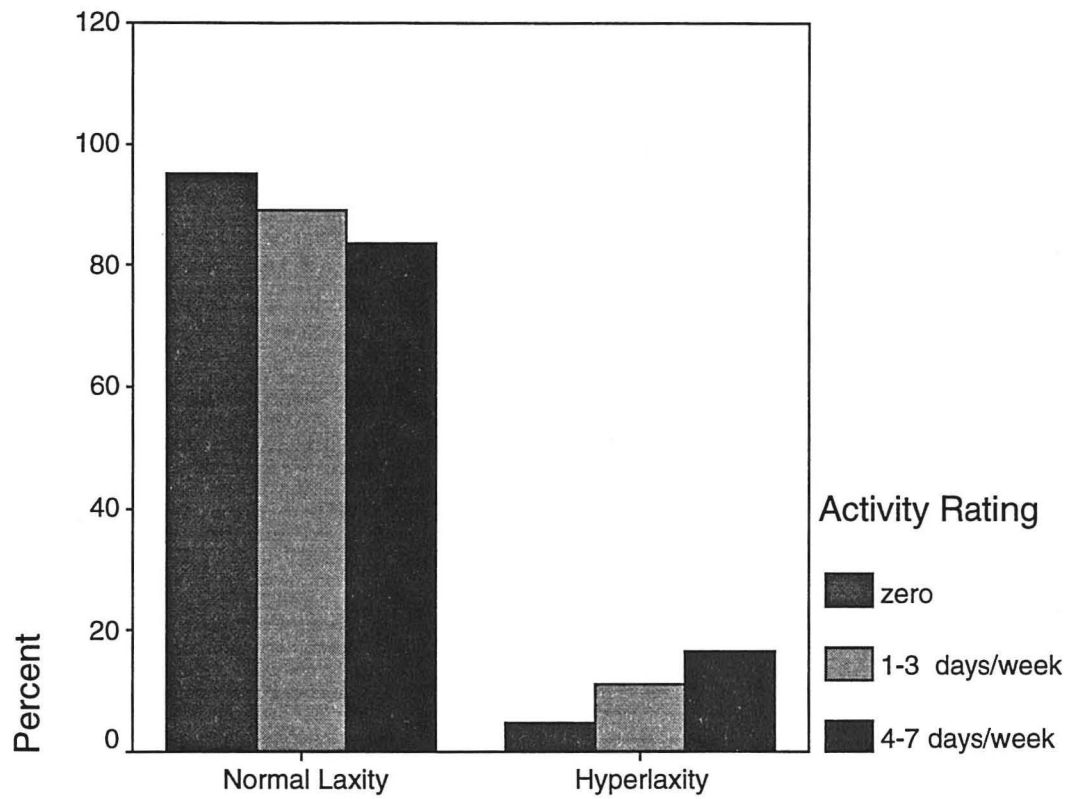


Figure 10. Comparison of activity rating and laxity status

APPENDIX G

Consent for Taking and Publication of Photographs

Name: Jay Armstrong

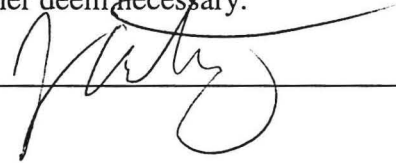
Location: University of North Dakota Medical School

Date: 10-25-00

In association with Jocelyn Hagen and Beth Klancher's study entitled The Association of Generalized Joint Hyperlaxity and Musculoskeletal Injury, I consent the researcher's may use photograph's of me and may be published under the following conditions:

- 1) The photographs shall be used if the researchers, Jocelyn Hagen and Beth Klancher deem that medical research, education, or science will be benefited from their use. These 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 the researchers, Jocelyn Hagen and Beth Klancher deem necessary.

Signed _____



Witness _____



Consent for Taking and Publication of Photographs

Name: Sarah Mannel

Location: University of North Dakota Medical School

Date: 10-25-00

In association with Jocelyn Hagen and Beth Klancher's study entitled The Association of Generalized Joint Hyperlaxity and Musculoskeletal Injury, I consent the researcher's may use photograph's of me and may be published under the following conditions:

- 2) The photographs shall be used if the researchers, Jocelyn Hagen and Beth Klancher deem that medical research, education, or science will be benefited from their use. These 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 the researchers, Jocelyn Hagen and Beth Klancher deem necessary.

Signed Sarah Mannel

Witness Andrea Palmer

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