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The Association of Generalized Joint Hyperlaxity and Occurrence of Musculoskeletal Injury

Jocelyn Hagen

University of North Dakota

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THE ASSOCIATION OF GENERALIZED JOINT HYPERLAXITY AND OCCURRENCE OF MUSCULOSKELETAL INJURY

By

Jocelyn Hagen
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 Jocelyn Hagen 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.

(Signatures)

(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)
**PERMISSION**

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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 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 than the males. 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 REVIEW OF LITERATURE

Generalized joint hyperlaxity is characterized by excess range of motion in most joints, surpassing accepted population norms for joint motion. 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 the non-athletic populations.

Joint hyperlaxity can be a source of pain, may cause greater risk for injuries, precipitate recurrent injuries, or predispose an individual to degenerative joint changes. Hyperlaxity is an asset for many occupations, for musicians and for some sports including gymnastics, and dancing. Hyperlaxity has been of special interest to various medical professionals for many years. Medical interest dates back to 1831 when a script was published regarding Paganini, a famous violinist, stating that a major factor in his accomplishments was his joint laxity.

Joint laxity is the amount of motion allowed by the ligaments, connective tissue, and the capsule surrounding a joint. When these tissues allow more motion than the accepted norm for the joint, the joint is classified as hyperlax. Hypermobility and hyperextensibility are synonymous terms to hyperlaxity and are used interchangeably throughout literature. If several joints throughout the body are hyperlax, the condition is termed generalized joint laxity. Some sources say a person must have laxity at four, five, or six joints out of nine to be considered generally lax, while other sources
say hyperlaxity at three or more joints constitutes generalized joint laxity.\textsuperscript{7,12-14} Due to
the variability reported in the literature, the cutoff point for the number of joints, which
constitute generalized joint laxity, is at the discretion of the researcher.

Several different methods can be used to measure joint hyperlaxity. The most
accepted and most widely used test is the Carter and Wilkinson method modified by
Beighton.\textsuperscript{14-16} To administer this test the examiner would ask the subject to do the
following actions bilaterally: 1) extend the fifth digit, 2) flex the thumb towards the
flexor aspect of the forearm, 3) extend the elbows, 4) extend the knees, and 5) place the
palms of the hands on the floor without flexing the knees. The subject receives one point
for each joint that tests positive for hyperlaxity, and zero points for each joint that does
not demonstrate hyperlaxity. Signs constituting hyperlaxity would be if the fifth digit
extends greater than 90 degrees, if the thumb touches the flexor aspect of the forearm, if
the elbows or knees hyperextend greater than ten degrees, or if the palms rest
comfortably on the ground with extended knees. A subject can score zero to nine points
with the Beighton test. According to the Beighton test, if a score of three or more is
received, the person is said to have generalized joint laxity.

Generalized joint laxity varies between genders, age groups, ethnic groups, and
genetic factors.\textsuperscript{1,2,6,7,10,13,16,18-20} In a study by Larsson et al.\textsuperscript{17} hyperlaxity was compared
between females and males. It was found that females showed hyperlaxity five times
more than males.\textsuperscript{17} Also, males decline in the amount of joint laxity in their mid-
twenties, and females demonstrate a decline in laxity levels in their mid-forties. As aging
occurs joints become less lax because the collagen content of a ligament remains fairly
constant through maturity, and then decreases slowly with aging due to the collagen
fibrils becoming more crosslinked and less soluble.\textsuperscript{18} Handler\textsuperscript{2} found increased collagen III to collagen I ratios in skin biopsies on hyperlax females, which also indicates hyperlaxity is due to a difference in collagen make up. The later decline of laxity levels in females can be attributed to hormones active until menopause.\textsuperscript{17} The female hormone relaxin has been targeted as one of the causative factors of joint hyperlaxity. Relaxin is always present, but released in higher amounts during pregnancy. The increased amount of relaxin in pregnancy effects ligaments throughout the body, which allows more joint laxity, and less joint stability.\textsuperscript{10} For example, multiparous women in Nigeria demonstrated high levels of laxity. Researchers speculated that increased number of births promoted an increase in joint hyperlaxity.\textsuperscript{10}

Age differences also exist with hyperlaxity. For instance, children have an overall higher incidence of joint hyperlaxity than adults.\textsuperscript{13} According to the data from a study done by Mikkelson et al.\textsuperscript{3} the cut off point of Beighton’s score of defining hyperlaxity, (greater than 3) is too low for preadolescents. If the Beighton method of defining hyperlaxity is used, one-third of all children measured in this study were classified as hyperlax.\textsuperscript{3} Cultural differences exist in children as well as adults. For example, Chinese children showed more laxity than their peers of other cultures.\textsuperscript{13}

Ethnic variation is evident in joint laxity. When West Africans were studied by Birrell et al.\textsuperscript{10} using the Beighton method, 54% of the population were classified as hyperlax at three or more sites, and 11% were positive at five sites. University students aged 20-24 in Iraq have an increased incidence for hyperlaxity. Of the students measured, 25.4% of males and 38.5% of females were lax, which was greater than the standard 4-7% of the population elsewhere. Also present in the university students in
Iraq were, increased presence of joint complaints, ligamentous sprains, flat feet, Raynaud's phenomenon, easy bruising, high palate and varicose veins.  

Hyperlaxity appears to predispose the individual to premature development of degenerative joint disease.  

Bird, et al. looked at the occurrence of joint hyperlaxity leading to osteoarthritis and chondrocalcinosis. "The clinical impression showed an onset of osteoarthrosis earlier in patients with hyperlaxity, but it was not possible to make an exact age comparison in this retrospective study." Synovial thickening was observed in most of the 21 patients with hyperlaxity observed in this study. It remained uncertain as to whether the hyperlaxity was acquired, or the patient had heredity hyperlaxity before the onset of the disease. Dr. J.S. Lawrence conducted a study of families with rheumatoid arthritis. He examined 600 first-degree relatives of patients with arthritis and found hyperlaxity present about two and one-half times as often as the relatives in the control study.

Generalized joint laxity is a feature of connective tissue disorders such as Marfan's syndrome, Ehlers-Danlos syndrome, and osteogenesis imperfecta. Hyperlaxity may be acquired in rheumatoid disorders, poliomyelitis, tabes dorsalis, and myotonia congenita. The link may be in collagen. Collagen is a component in skin, tendons, ligaments, joint capsules, demineralized bone, and blood vessels. In electron microscopy of the skin, Dr. Anne E. Child found a decreased proportion of thick collagen fibers and increased fine collagen fibers, ground substance, elastin and fibrocytes in the reticular layer of subjects with hyperlaxity. She felt that if prevention of hyperlaxity is attempted, then new medications would be required to modify collagen biosynthesis by normalizing synthesis or preventing degradation. Although this
hypothesis is plausible there is no consensus in the literature concerning the accuracy of Dr. Child’s hypothesis.

It appears to be uncertain whether sports or physical activity have an effect on joint laxity or injury rate. When studying a group of swimmers McMaster, et al.\textsuperscript{6} found competitive swimmers to have increased glenohumeral and generalized joint laxity as compared to recreational swimmers. It is yet to be determined whether there is a genetic component, or if sports induce a degree of laxity. What was found in this study was a statistically significant correlation between swimmers with glenohumeral joint laxity and increased pain. Laxity that allows excessive joint translations resulting in instability may be a key factor in causing shoulder pain. “In swimmers and water polo players, there is an increase in strength of the internal rotator and adductor muscles which may reinforce abnormal joint mechanics.”\textsuperscript{6}p84 As the muscles strengthen, they may pull the joint from a stable region to an unstable one and condition the joint to be more lax. When the researchers looked at reestablishing rotator cuff strength ratios, they reported promise for a decrease in excessive translation due to muscular imbalance.\textsuperscript{6}

Jackson et al.\textsuperscript{20} studied injury prediction in young hyperlax West Point Cadets. The Cadets presented with above average athletic ability and physical fitness. Athletes competed in either an intercollegiate or intramural sport during their time at West Point, and three orthopedic surgeons managed injuries for this study. The researchers measured five anatomical areas with a goniometer. The areas included were flexion of the spine, supination of the forearms, hyperextension of the elbow, external rotation of the hip, and hyperextension of the knees. It is interesting to report that the joint laxity of the cadets did not significantly predict injuries. This research utilized a different method of testing
joint hyperlaxity than the other studies discussed in this paper. If the Beighton method was used, it may have produced different results.

A study completed by Decoster, et al.\textsuperscript{16} looked at the prevalence of hyperlaxity in adolescent athletes. The study used the Carter-Wilkinson-Beighton method of measuring joint hyperlaxity. They also used an "injury allowance." If the athlete was positive for hyperlaxity on only one side of the body on a bilateral test, and had a history of injury (e.g., anterior cruciate ligament tear or reconstruction) to the corresponding side they were given an injury allowance point. The results showed 12.9\% of the athletes were hyperlax. There was a significant difference between the sexes, 22\% of the females were hyperlax, and only 6\% of the males. The study was unable to determine any differences in hyperlaxity based on sport.\textsuperscript{16} In different literature, it was suggested that hyperlax youth avoid strenuous physical activity due to increased risk for injury.\textsuperscript{2} Decoster's\textsuperscript{16} study stated otherwise. These researchers felt that making comparisons between an athletic and non-athletic population is difficult. Conclusions in literature are split as to whether hyperlax individuals actually run a higher risk of athletic injury. The researchers in Decoster's\textsuperscript{16} study recommended that the athlete be protected from risk with regular physical activity.

In more recent literature, multiple studies have looked the prevalence of joint hyperlaxity in an athletic population.\textsuperscript{6, 16, 20, 22} Hyperlaxity may be induced in an athlete due to the high level of training involved with their sport.\textsuperscript{6} For instance, a swimmer may strengthen one side of the joint with a repetitive stroke, therefore neglecting the opposing muscles. This imbalance in strength causes the stronger muscles to have a greater pull on the joint, allowing the ligament to stretch past the normal range. This type of laxity can
be influenced by a training effect, and is joint specific. In contrast, generalized hyperlaxity found in athletic and non-athletic populations is systemic in nature, affecting many joints of the body. Physical therapists (PT's) have shown interest in systemic hyperlaxity in a non-athletic population, because there is little research in this area. A research study by Kirk, et al. in 1967 speculated that hyperlax youth avoid athletics for fear of increased risk of injury. This speculation has never been verified in current literature, therefore, this study aimed to analyze a homogeneous sample of University students who were not involved in athletics at a collegiate or national level. Information was gathered regarding previous injuries, to determine whether the joint laxity predisposed an individual to injury.

PT's need proper education on the various implications of generalized joint hyperlaxity. Summaries of the implications discussed were, the potential for athletic injuries, early degenerative joint disease, and various medical conditions that may coexist with hyperlaxity. If the patient is known to have generalized hyperlaxity it will be important for the physical therapist (PT) to educate the individual on joint saving techniques and discuss prevention of early degenerative joint diseases. The patient will need education as to what physical activity level is safe for them, and if they are capable of participating in athletics. The PT should use caution when prescribing exercise to a patient with hyperlaxity. For instance, vigorous stretching to a patient with hyperlaxity should be avoided to prevent a further increase in motion. Results of this study showed that certain hyperlax individuals were more prone to musculoskeletal injuries, so it may be useful to incorporate screening for joint laxity in physicals for athletes.
The purpose of this study was to look at a non-athletic population aged 18-30 to examine various factors related to laxity. The study looked at whether joint hyperlaxity predisposed an individual to injury, the difference in hyperlaxity between males and females, laxity scores and choice of major, type of injury sustained, and weekly physical activity level of the subjects.

Purpose

The research study aimed to answer five research questions:

1) Is there a significant difference between joint hyperlaxity and previous injuries in college-aged students?
2) Is there a significant difference in laxity between males and females?
3) Is there a significant difference between laxity status and choice of major?
4) Is there a significant difference between the hyperlax population and ligamentous injuries?
5) Is there a significant difference between laxity score and weekly activity level?

Significance

The significance of this study was to determine if hyperlax individuals who are non-athletic, aged 18-30 years old, had a higher incidence of previous musculoskeletal injuries. If the research is significant, then physical therapists need to take an active role in assessing hyperlaxity, and educate individuals with hyperlaxity in how to prevent injuries caused by laxity.

Hypotheses

1) There is a significant difference between joint hyperlaxity and previous musculoskeletal injuries.
2) There is a significant difference between hyperlaxity in males and females.

3) There is a significant difference between hyperlaxity status and choice of major.

4) There is a significant difference in ligamentous injuries between the normal laxity group versus the hyperlax group.

5) There is a significant difference between laxity scores and weekly physical 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 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.\textsuperscript{22,23} The Beighton test is easy to administer, and is the most commonly used test in the literature.\textsuperscript{22,23} 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.\textsuperscript{24} 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).\textsuperscript{25}

**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. Tests requiring range of motion measurements were recorded with a standard goniometer.
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
The standard scoring system was used, awarding one point for meeting the test criteria, and a 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, flexion of the thumb to the flexor aspect of the forearm, 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. 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.

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 found 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 graphical 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, verses 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 \( r_s=.060, n=239, p=.359, 2 \text{ tails}. \) (Figure 10) Therefore, increased activity level did not increase overall generalized joint laxity in this population.
CHAPTER IV
DISCUSSION AND CONCLUSION

The results obtained in this study showed no statistically significant correlation between joint laxity and history of injury. This indicates that those individuals with systemic hyperlaxity reported a similar number of musculoskeletal injuries as their non-hyperlax counterparts. In fact, the group of students who were involved in the highest level of physical activity did not report an increase in number of injuries as compared to students who did not partake in any physical activity regardless of laxity status. This finding is a valuable tool for physical therapists because it will help them instruct their patients in the benefits of staying physically active despite laxity. Research by Decoster, et al.\textsuperscript{16} elicited the same findings and stated that it was beneficial for individuals with hyperlaxity to participate in physical activity while protecting the joints from undue risk. One drawback was that previous studies have shown a premature onset of osteoarthritis and degenerative joint disease in individuals with hyperlaxity.\textsuperscript{19} Physical therapists should be knowledgeable in instructing individuals with hyperlaxity in the proper types of exercise for their body. People with hyperlaxity should be discouraged from activities that would accelerate degeneration to their joints such as: running, gymnastics, or high impact aerobics. Rather, individuals with hyperlaxity should be encouraged to take part in recreational swimming, biking, rowing, or other activities where joints would not be jarred on a regular basis.
The results of this study also indicated that for the subjects tested, hyperlaxity differed significantly between males and females. Hyperlaxity was found eight times higher in females than males in this study, which is similar to findings in a study by Larsson, et al.\textsuperscript{17} where females showed hyperlaxity five times more than males.\textsuperscript{17} The difference in laxity may be due to certain female hormones, one of which is relaxin.\textsuperscript{10} The hormonal influence is especially important in females during the childbearing years to enable the pelvis to expand to accommodate the growing fetus. Therefore, hormones in females create more joint laxity and less joint stability.

Individuals with hyperlaxity may be more likely to receive therapy due to injury, so the rehabilitation experience may lead to a career interest for the individual. This hypothesis may explain why physical and occupational therapy students displayed hyperlaxity at a rate of two to three times greater than the general population. It was interesting to see a high degree of laxity in therapy students, which has not been addressed in previous studies. It could be speculated that the physical and occupational therapy students from this study were more lax because of the higher percentage of females in these fields. A novel finding was that a significant number of males in the therapies displayed greater hyperlaxity scores than was expected. Interestingly, the male influence increased the percentage of laxity for the total group of males and females in both of the therapy majors. Since this study showed significant laxity in both physical and occupational therapy students, future studies are warranted to study physical and occupational therapy programs at different educational institutions. If it is found that physical and occupational therapy students are consistently hyperlax, academic
curriculum should identify those at risk and aim to stress specific joint saving techniques to help avoid future work related injuries.

Although physical activity was not found to predispose a hyperlax individual to an increased risk of injury in this study, ligament sprains were commonly seen in this population. These injuries could occur in any aspect of daily living, not necessarily during physical activity. It could be that joint proprioceptors that are located in the ligament, allow the hyperlax joint to stretch further before sensing a change in position. For example, a person with joint hyperlaxity may roll their ankle while walking on irregular terrain. By the time the body senses that the ankle is in an abnormal position, corrective compensation may be too late. The ankle may continue moving in an abnormal direction, stretching beyond the physiologic limit of the tissue and resulting in a sprain of the ligament. On the other hand, bone fractures may be less likely to occur in people with hyperlaxity because a lax ligament would be more likely to give before the bone would fracture. A problem with ligamentous sprains is that they have the potential to decrease function more so than a fracture. Once stretched, a ligament generally will not return to a shortened length, thus placing the individual at greater risk for recurrence of sprains in the future. Repetitive injuries may necessitate the need for intervention by a physical therapist. Therefore, hyperlax individuals may have a greater chance of being referred to therapy and becoming familiar with the services.

A study was completed in 1997 by Dawn Liedholm, a graduate physical therapy student at the University of North Dakota, concerning musculoskeletal injuries encountered in the field of physical therapy. Surveys were mailed to 261 physical therapists that were alumni of the University of North Dakota’s physical therapy
program. The respondents answered questions regarding hours worked per week, type of employer, occupational injuries sustained on the job, potential risks for injury in the profession, and prior level of education on proper body mechanics. The results indicated 53.3% of physical therapists had experienced pain in one or more anatomical areas within the past 12 months. The highest injury rate occurred in therapists employed from four to seven years; and the rate of injury decreased with age. This finding was consistent with research by Molumphy et al. in that occupational injuries are most frequent in the newest and youngest employees, especially the first four years of employment.

The job demands placed on physical therapists are stressful to joints, and even more so if the joint is already hyperlax. From the previous study, it is interesting to note that the rate of injuries decreased with age. It is known that laxity also decreases with age. A possible explanation for the lower number of injuries in the older population would be that the joints are more stable, and not as susceptible to translate as excessively as joints of the younger therapists. Future studies are warranted to determine if physical and occupational therapists across the country are consistently hyperlax. If so, it would be necessary to educate students on the importance of joint saving techniques to prevent occupational injuries.

Future Studies

Future research could compare the laxity of other physical and occupational therapy students from various schools in the country. Comparison of other schools would determine if this study had an isolated finding, or if hyperlaxity in therapy students is universal throughout the country.
Since laxity in females is consistently higher than males, it would be interesting to do a future study looking at the hormonal influences in females. One could measure the laxity status of post-menopausal women who are not taking hormone replacements, and compare it to post-menopausal women taking hormone replacement therapy. Research may be able to study which hormones influence laxity.

It would be interesting to follow up with the hyperlax physical and occupational therapy students after their first five years of clinical practice to assess any occupational injuries that may have occurred in this time frame. Research could compare the hyperlax professionals to their non-lax peers to assess any differences.

Limitations

One limitation with the Beighton test of hyperlaxity was measurement of the spine. Testing of the spine was measured by the subject’s ability to place the hands flat on the floor without bending at the knees. This measurement may not have been a true measurement of the spine, because hamstring tightness could have been a limiting factor. The Beighton test was used due to ease of comparison with other research, and ease of administration.

A second limitation of the Beighton test was that it only tested five joints in the body. The Beighton test is not a global measure of systemic hyperlaxity, but again, was used for ease of comparison with other studies, and ease of administration.

This study utilized two researchers for testing the large sample size, so there may have been inconsistency in intratester measurements. An attempt at decreasing this error was done by testing intra- and intertester reliability before running subjects.
Conclusion

Students with generalized joint hyperlaxity did not demonstrate significantly higher rates of previous musculoskeletal injuries as compared to students who did not demonstrate hyperlaxity. 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 status 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. 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.
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: Dr. Sue Jeno, 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 x CONTINUATION ___ RENEWAL ___ THESIS RESEARCH x
STUDENT RESEARCH PROJECT

___ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

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

PROPOSED PROJECT: INVOLVES NEW DRUGS (IND) ___ 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 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 _____________

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. 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. 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:

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 $\chi^2$ 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
Participant Survey

ID#: ______

Birth date: ______ Height: ______ Gender: M or F
Dominant hand: R or L Weight: ______ 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 of 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.

________________________________________

________________________________________

________________________________________

28
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 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. 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
Data Collection Form

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<td></td>
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<td>-RIGHT</td>
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<td></td>
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<tr>
<td>TRUNK</td>
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<tr>
<td>TOTAL SCORE</td>
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APPENDIX E
Table 1. Comparison of Laxity Status and Injury Status

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<td>21</td>
<td>29</td>
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Table 2. Comparison of Laxity Status and Gender

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<td>Normal Laxity</td>
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<td>210</td>
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<tr>
<td>Hyperlaxity</td>
<td>5</td>
<td>24</td>
<td>29</td>
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Table 3. Comparison of Laxity Status and Choice of Major

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<th>Physical Therapy</th>
<th>Occupational Therapy</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal laxity</td>
<td>210</td>
<td>86%</td>
<td>78%</td>
<td>93%</td>
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<tr>
<td>Hyperlaxity</td>
<td>29</td>
<td>14%</td>
<td>22%</td>
<td>7%</td>
</tr>
</tbody>
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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

[Signature]

Witness Carrie Voeller
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:

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 [Signature]

Witness [Signature]
REFERENCES CITED
REFERENCES CITED


