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# The Effect of Various Shoulder and Elbow Positions on Grip Strength

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# THE EFFECT OF VARIOUS SHOULDER AND ELBOW POSITIONS ON GRIP STRENGTH

by

Melanie Dena Wentz
Bachelor of Science in Physical Therapy
University of North Dakota, 1997

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine and Health Sciences

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Physical Therapy

Grand Forks, North Dakota
May
1998

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This Independent Study, submitted by Melanie Dena Wentz 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 effect of various shoulder and elbow positions on grip strength.

Department Physical Therapy

Degree Master of Physical Therapy

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Signature Melanie Wentz

Date December 15, 1997

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ACKNOWLEDGEMENTS

I would like to thank Dave Relling, my preceptor, for his time, effort, and suggestions offered as I completed my independent study. I thank Renee Mabey for her statistical assistance and Sue Jeno for helping me get this project started. A special thank-you goes out to my classmates and the junior physical therapy students who volunteered for this study.

I thank God for his continual protection of the life he has given me to lead. To my parents, David and Brenda Opp, thank-you for the love and guidance you have given me throughout my life. My deepest appreciation to my husband, Jason, for the support you have given me over the years. Thanks for being my data recorder for the majority of this study, but most of all, thank-you for being my strength and my best friend.

# ABSTRACT

This study investigated the effect of various shoulder and elbow positions on grip strength in 42 subjects. Both dominant and non-dominant upper extremities were tested using the Jamar dynamometer. The subjects were tested in the following positions while standing: 1) 90 degrees shoulder flexion and 90 degrees elbow flexion, 2) 90 degrees shoulder flexion and full elbow extension, 3) 90 degrees shoulder abduction and 90 degrees elbow flexion, and 4) 90 degrees shoulder abduction and full elbow extension. A repeated-measures ANOVA showed that shoulder and elbow position does significantly ($p<.05$) affect grip strength. A significant difference between genders was found for each position and hand dominance was significant ($p<.05$) for position 2. Both males and females were strongest with their shoulder in 90 degrees of flexion. The findings suggest that 90 degrees of shoulder flexion may be more of a position of function than 90 degrees of abduction. When measuring grip strength, position of testing and gender are two important variables to consider when trying to help patients attain their highest grip strength score.

Chapter I
Introduction

Hand and upper extremity injuries are frequently seen in sports medicine.[1-11] In the sporting population, the incidence of wrist and hand injuries is approximately 25 percent.[1] Another source found that 80 percent of sports related orthopedic injuries involve the upper extremity.[3] Both the elite and recreational athlete populations are affected by these injuries. The upper extremity is at risk for injury in regular sports such as bicycling, swimming, fast-pitch softball, racquetball, and football.[3, 4, 8, 9] Also, participants in extreme sports such as rock climbing, in-line skating, snowboarding, and alpine skiing are at high risk for incurring an upper extremity injury.[5, 6, 10, 11]

Sports are not the only cause of hand and upper extremity injuries. Work-related injuries are also quite frequent.[12-14] According to Steinberg,[13] hand, finger, and wrist injuries as a whole are felt to be more occupationally disabling than any other type of injury. Brobak, et al[12] found that hand injuries have substantial socio-economic consequences. These injuries imply large costs to employers in medical benefits and loss of productivity.

**Problem Statement**

Grip strength is a test commonly performed in the clinic as a means of establishing a baseline for the treatment of upper extremity injuries and can also be used to assess the effectiveness of rehabilitation.[15] The measurement of grip strength is a way of determining the amount of lost work productivity when an upper extremity injury has occurred.[16] These measurements assist therapists in setting treatment goals and assessing the patient's readiness to return to work.[17] Although the standardized position of shoulder adduction with neutral rotation, 90 degrees of elbow flexion, and neutral forearm and wrist is recommended by the American Society of Hand Therapists and the manufacturers of the Jamar dynamometer, it may not be the optimal position for generating maximum mean grip strength.[15, 17, 18] The results of the studies relating to the effect of elbow position on grip strength show inconsistencies. To my knowledge, no previous studies have examined the effect of shoulder flexion and abduction along with elbow flexion of 90 degrees on grip strength. Also, studies that measure grip strength of the non-dominant upper extremity in various shoulder and elbow positions are lacking.

**Purpose of Study**

The purposes of this study are to: determine if grip strength is significantly affected by positions of shoulder flexion and abduction and positions of elbow flexion and extension; determine if grip strength varies significantly between genders when tested out of the standard position; and determine if hand dominance when related to shoulder and elbow position plays a significant role in grip strength.

**Significance of Study**

This study will establish research data on grip strength in various shoulder and elbow positions. The results of this study may assist physical therapists in the evaluation and treatment of patients with upper extremity injuries. By finding the position with the highest strength rating, patients with upper extremity involvement could benefit from this study as well. The results may also aid in setting up exercise protocols to increase grip strength. This study may stimulate further research on related rehabilitation topics.

**Research Questions**

- Research Question #1: "Is grip strength significantly affected by combinations of various shoulder and elbow positions?"
- Research Question #2: "Does grip strength in various shoulder and elbow positions vary significantly between genders?"
- Research Question #3: "Does hand dominance play a significant role in grip strength when related to shoulder and elbow position?"

**Hypotheses**

- Null Hypothesis #1: "Grip strength is not affected by combinations of various shoulder and elbow positions."
- Null Hypothesis #2: "Grip strength in various shoulder and elbow positions does not vary between genders."
- Null Hypothesis #3: "Hand dominance as related to shoulder and elbow position does not play a significant role in grip strength."

## Chapter II
## Literature Review

Various studies have discussed the effects of elbow position on grip strength. Mathiowetz et al[19] were the first to study this relationship. The grip strength of 29 female college students was tested in the seated position with the elbow in 90 degrees of flexion and another test with the elbow fully extended. It was found that significantly higher grip strength was generated when the elbow was positioned in 90 degrees of flexion. Conversely, another study found that grip strength was lowest in the sitting position with 90 degrees of elbow flexion.[20] This study measured the grip strength of 61 college students in the following positions: (1) sitting with 90 degrees of elbow flexion, (2) sitting with elbow in full extension, (3) standing with 90 degrees of elbow flexion, and (4) standing with the elbow fully extended. Kuzala and Vargo[21] measured the grip strength of 46 physical therapy students in 0, 45, 90, and 135 degrees of elbow flexion. According to their study, greater degrees of elbow flexion resulted in lower grip strength while full elbow extension allowed the highest mean grip strength to be generated.

Shoulder position is another variable that has been examined for its effects on grip strength. A study by Su et al[15] was the first to consider the effect of shoulder joint position on grip strength. They measured the grip strength of 160 subjects (80 men, 80 women) in the standing position with the shoulders adducted and neutrally rotated while keeping their forearm and wrist joints neutral. The following test positions were used: (1) 0 degrees shoulder flexion and 90 degrees elbow flexion, (2) 0 degrees shoulder flexion with full elbow extension, (3) 90 degrees shoulder flexion with full elbow extension, and (4) 180 degrees shoulder flexion and full elbow extension. It was found that grip strength decreased with lesser amounts of shoulder flexion. The highest mean grip strength score was recorded in the position of 180 degrees shoulder flexion with full elbow extension.

The role of body position and its effect on grip strength has also been studied. Grip strength measured in the standing position was about three percent higher when compared to sitting, according to Balogun and colleagues.[20] Similar findings were reported in a study by Teraoka.[22] He compared grip strength in standing, sitting, and supine positions. Grip strength was significantly higher in the standing position when compared to sitting and supine. In the sitting position, grip strength was also significantly higher than that measured in supine.

Hand dominance is another factor that has been considered in conjunction with grip strength measurements. Schmidt and Toews[23] tested the grip strength of 1,128 males and 80 females. It was found that among men, mean grip strength varied by only 3.5 pounds between the dominant and non-dominant hands. In fact, 22.6 percent of the men were discovered to be stronger in their non-dominant hand. The dominant and non-dominant hands of the women differed in grip strength by 5.9 pounds. Twenty percent of the women also demonstrated non-dominant hand strength that was equal or greater than that of their dominant hand. Comparable results were presented in a study that measured the grip strength of 57 female university students. This study found the average grip strength difference between dominant and non-dominant hands was 8 pounds. In twenty-four percent of the women, their dominant hand was weaker than or equal to the strength of their non-dominant hand.

More research is required to determine how grip strength is affected by a combination of shoulder and elbow positions along with hand dominance in both genders. Therefore, this study will examine grip strength in different shoulder and elbow positions. Gender and hand dominance will also be considered in this study.

## Chapter III
## Methodology

### Subjects

The subjects for this study were University of North Dakota students who volunteered to be a part of this study. Forty-two subjects (21 males and 21 females) participated in this study. Ages ranged from 20 years of age to 45 years of age, with 25.2 being the mean age. Seven (4 males, 3 females) subjects were left hand dominant. Subjects with current or chronic upper extremity pathology defined as any upper extremity problem requiring medical attention, were excluded from this study. Those who were ambidextrous by self report were also excluded. All participants in this study were informed of the purposes and possible benefits of this study, and then signed the appropriate human consent forms. Approval for this research project was given by the University of North Dakota Institutional Review Board under project number IRB-9705-270 (Appendix B).

### Instrumentation

An adjustable, hand held Jamar dynamometer (Asimow Engineering Co., Los Angeles, CA 90024) was used to measure grip strength (Figure 1). The dynamometer uses a hydraulic gauge along with a maximum reading hand to preserve the highest reading.[18] Of the instruments available to measure grip strength, the Jamar dynamometer has been accepted as the premiere tool for

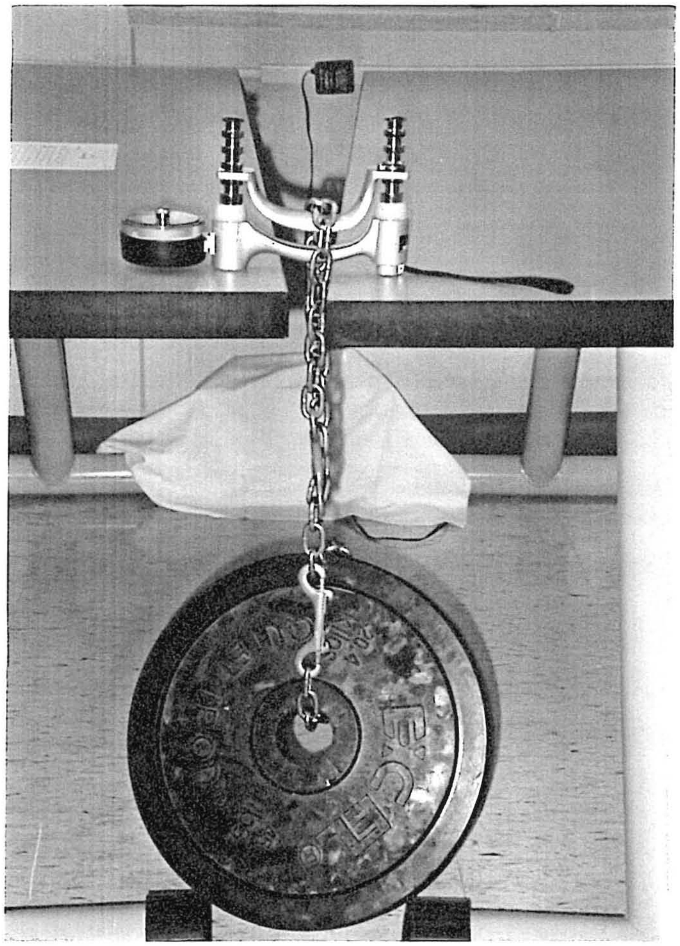

Figure 1. Checking calibration of the Jamar dynamometer by weight loading.

measuring grip strength.[25] Kirkpatrick[25] headed the California Medical Association committee study that compared: (1) a sealed hydraulic dynamometer that measured force in pounds; (2) a pneumatic device that measured the compression of a column of air by using a rubber bulb, similar to the type used on a blood pressure cuff; and (3) an instrument that registered compression of a steel spring. It was found that only the hydraulic dynamometer measured grip force, while the other devices measured grip pressure. This committee went on to study the Jamar dynamometer and felt it was "perfected to the extent that its sealed hydraulic system is as nearly leakproof as any mechanical appliance can be made."[25]

In a study by Hamilton, Balnave, and Adams,[26] it was found that test-retest reliability using the Jamar dynamometer was high (intraclass correlation coefficients above 0.9). Testing time and the elapsed time between re-tests varied in order to more closely reflect clinical conditions. The reliability and validity of the Jamar dynamometer was also tested by Mathiowetz et al[17]. Their research showed inter-rater reliability to be very high (0.97 or higher Pearson product-moment correlation coefficient). The highest correlations of the Pearson product-moment correlation coefficient for test-retest reliability were attained when the mean of three trials were utilized. The standard Jamar dynamometer was also found to be highly valid. By suspending a known amount of weight from the handle, Mathiowetz et al[17] found the instrument was accurate +/-3%.

To ensure accurate readings for this study, the calibration of the Jamar dynamometer was checked before each testing session. This was done by suspending a known amount of weight from the center of the handle (Figure 1).[17] Since the dynamometer registers pounds of force, the instrument was checked for accuracy by comparing the known amount of weight with the dial reading.

**Procedure**

Fifteen-minute testing times were established for each subject. The volunteers were randomly assigned to an appointment time. Upon entering the testing area, each subject was given an explanation of the purpose of the experiment, signed a consent form, and completed a demographic questionnaire (Appendix A). Each subject was assigned a code number to maintain confidentiality. Questionnaires were kept separate from the data collection form (Appendix A) and were not reviewed until after data collection was complete in order to limit tester bias. Prior to testing, the subject was asked to remove any jewelry and/or clothing that might interfere with the procedure. The subjects' height and weight were also measured at this time.

Each subject was positioned in standing and was instructed to maintain an erect posture throughout the entire testing procedure. The handle of the dynamometer was placed in the second position.[25] All subjects were given identical instructions regarding the procedure of the test (Appendix A). Measurements were recorded on the data collection form by a recorder after each trial. The test was repeated with the same instructions for the second and third trial and for the non-dominant side. The previous steps were repeated for the following positions: (1) full elbow extension, 90 degrees shoulder flexion; (2) 90 degrees elbow flexion, 90 degrees shoulder abduction; (3) full elbow extension, 90 degrees shoulder abduction. The testing was then complete. At that time, the dynamometer was taken and the subject was thanked for their participation.

**Data Analysis**

The mean value of the three trials for grip strength in each position was calculated using a standard calculator and rounded to the nearest tenth. The SPSSX statistical software was used to calculate the remainder of the data. A repeated-measures ANOVA was used to determine if a significant difference existed between positions. Tukey's HSD test was performed to find the positions that were significantly different from one another.[27] A repeated-measures ANOVA was also utilized to determine if a significant difference in grip strength existed for hand dominance or between genders for each treatment condition. The alpha cronbach reliability coefficient was performed to establish intrarater reliability. A value of $p<0.05$ was considered to be significant for all tests.

## Chapter IV
## Results

Table 1 summarizes the subjects' grip strength means and standard deviations for each shoulder and elbow position and for dominant and non-dominant hands between genders. Based on a repeated measures ANOVA, a significant difference between test positions was found ($F=8.5$, $p<.001$). The results of the repeated measures ANOVA are presented in Table 2. Tukey's HSD demonstrates that the significance for position lies between positions 1 and 4 and positions 2 and 4, with the largest difference between the former.

A significant difference between genders for each position and a significant difference for hand dominance for position 2 ($F=4.8$, $p<.05$) was also determined using a repeated-measures ANOVA. As evidenced in Table 2, two-way interactions were not present in these tests.

Grip strength was found to be greatest in the dominant hand for both men and women. Men were strongest in the position of 90 degrees shoulder flexion with full elbow extension (Position 2), while women were strongest in 90 degrees of shoulder flexion and 90 degrees of elbow flexion (Position 1). Both genders were weakest in 90 degrees of shoulder abduction and full elbow extension (Position 4). Males achieved significantly higher ($p<.001$) grip strength scores than females in all test positions.

Intrarater reliability was found to be high for this study. Twelve percent of the sample (5 subjects) were re-tested to determine intrarater reliability. Alpha cronbach reliability coefficient was 0.96.

Table 1. Comparison of Grip Strength for Gender and Hand Dominance

| | Male (n=21) | | | | | | Female (n=21) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dominant Hand | | Non-dominant Hand | | Both Hands | | Dominant Hand | | Non-dominant Hand | | Both Hands | |
| | Mean[e] | SD | Mean[e] | SD | Mean[e] | SD | Mean[e] | SD | Mean[e] | SD | Mean[e] | SD |
| **Position 1[a]** | 50.7 | 8.5 | 46.9 | 8.5 | 48.8 | 8.6 | 32.5 | 4.2 | 30.7 | 4.1 | 31.6 | 4.2 |
| **Position 2[b]** | 51.0 | 8.5 | 47.1 | 8.7 | ( )[f] | ( )[f] | 31.7 | 4.0 | 29.3 | 3.6 | ( )[f] | ( )[f] |
| **Position 3[c]** | 48.9 | 6.8 | 45.6 | 9.0 | 47.3 | 8.0 | 31.1 | 4.4 | 30.1 | 3.7 | 30.6 | 4.0 |
| **Position 4[d]** | 47.7 | 7.6 | 45.7 | 8.4 | 46.7 | 8.0 | 30.0 | 4.7 | 27.7 | 4.2 | 28.8 | 4.6 |

[a] 90 degrees shoulder flexion, 90 degrees elbow flexion
[b] 90 degrees shoulder flexion, full elbow extension
[c] 90 degrees shoulder abduction, 90 degrees elbow flexion
[d] 90 degrees shoulder abduction, full elbow extension
[e] Grip strength in kilograms
[f] Significant difference noted between dominant and non-dominant hands

Table 2. Repeated Measures ANOVA Determining Significance for Position, Gender, and Hand Dominance

| | df | SS | MS | F | *p* |
|---|---|---|---|---|---|
| **Total** | | | | | |
| Subject | 40 | 36638.77 | 915.97 | 79.33 | .000 |
| Position | 3 | 293.19 | 97.73 | 8.46 | .000 |
| Residual | 164 | 1893.62 | 11.55 | | |
| **Position 1** | | | | | |
| Gender | 1 | 6214.36 | 6214.36 | 138.58 | .000 |
| Dominant Hand | 1 | 162.69 | 162.69 | 3.63 | .060 |
| 2-Way Interactions | 1 | 21.50 | 21.50 | .480 | .491 |
| Residual | 80 | 3587.44 | 44.84 | | |
| **Position 2** | | | | | |
| Gender | 1 | 7176.15 | 7176.15 | 162.38 | .000 |
| Dominant Hand | 1 | 212.49 | 212.49 | 4.81 | .031 |
| 2-Way Interactions | 1 | 11.74 | 11.74 | .266 | .068 |
| Residual | 80 | 3535.54 | 44.19 | | |
| **Position 3** | | | | | |
| Gender | 1 | 5818.34 | 5818.34 | 145.88 | .000 |
| Dominant Hand | 1 | 95.36 | 95.36 | 2.39 | .126 |
| 2-Way Interactions | 1 | 27.77 | 27.77 | .696 | .407 |
| Residual | 80 | 3190.77 | 39.88 | | |
| **Position 4** | | | | | |
| Gender | 1 | 6683.93 | 6683.93 | 158.46 | .000 |
| Dominant Hand | 1 | 99.23 | 99.23 | 2.35 | .129 |
| 2-Way Interactions | 1 | .60 | .60 | .014 | .905 |
| Residual | 80 | 3374.46 | 42.18 | | |

## Chapter V
## Discussion

To my knowledge, this is the first study to investigate the effects of shoulder flexion and abduction in combination with elbow flexion and extension on grip strength. This study also compared grip strength between genders on both dominant and non-dominant hands. Since both males and females were stronger while the shoulder was in 90 degrees of flexion, this study seems to show that shoulder position has a greater effect on maximum grip strength than elbow position. This result differs from that found in the study by Su et al.[15] Su et al[15] showed that grip strength was greatest with the elbow fully extended, when compared to zero and 90 degrees of elbow flexion, regardless of shoulder position.

It is unexpected to find that shoulder position has a greater effect on grip strength than elbow position since the finger flexors cross the elbow joint, but do not cross the shoulder. Perhaps for most subjects, 90 degrees of shoulder flexion is a more functional gripping position than 90 degrees of shoulder abduction. It would seem reasonable to speculate that more daily gripping activities are performed in shoulder flexion than in shoulder abduction, therefore, specificity of training will affect grip strength in this position.

One exception to the trend of shoulder position having a greater effect on grip strength was found for the women's non-dominant hand. In this case, the two strongest grip strength scores were measured with the elbow in 90 degrees of flexion, regardless of shoulder position. A study by Mathiowetz et al[19] tested subjects in full elbow extension and 90 degrees elbow flexion each combined with the standard shoulder position of adduction and neutral rotation. Their results showed that greater grip strength was generated with the elbow flexed to 90 degrees. The grip strength scores for the women in my study were also strongest while the elbow was in 90 degrees of flexion, supporting this result of Mathiowetz's[19] study. Mathiowetz's[19] sample was entirely composed of females. This trend suggests that gender is a factor when considering which elbow position will yield the highest grip strength. The idea that women generate their highest grip strength in 90 degrees of elbow flexion, while men generate their highest grip strength in full elbow extension is not in agreement with Balogun and associates.[20] Balogun et al[20] found that having the elbow fully extended resulted in the highest grip strength scores, regardless of gender.

A significant difference in grip strength between genders, where males were stronger than females, was found in this study. This finding concurs with previous studies.[15, 20, 26, 28] It was shown that grip strength was significantly stronger in the dominant hand only for position 2. Strength differences between the dominant and non-dominant hands were greatest for position 2 in both males and females. It is unknown why hand dominance was only a factor in the position with the shoulder in 90 degrees of flexion and the elbow fully extended.

When comparing grip strength for the males in this study, their dominant hand ranged from 4.2 to 7.6 percent stronger than their non-dominant hand. The women in this study were 3.2 to 7.6 percent stronger in their dominant hand. These results are different than those found by Schmidt and Toews.[23] They found that there was a 3.1 percent difference in grip strength between dominant and non-dominant hands for the men, and an 8.4 percent difference between the dominant and non-dominant hands for the women. Lunde and associates[24] discovered a 13 percent grip strength difference between dominant and non-dominant hands for the women in their study. The percentage difference between dominant and non-dominant hands from Mathiowetz et al[28] was 4.2 percent for males and 1.2 percent for females. All of these studies are in opposition to the assumption made by the State of California's Industrial Accident Commission that the dominant hand is 10 percent stronger than the non-dominant hand.[25] This assumption is not an accurate one for my study or for the other studies mentioned.[23, 24, 28] In the past, few studies have considered the role of the non-dominant hand in grip strength. More grip strength studies that include data for the non-dominant hand need to be done.

It was difficult to obtain age-related grip strength data in this study because of the lack of subjects in the older age groups. Eighteen males and 19 females fell into the 20 to 29 year-old category. The males averaged 50.4 kg for their right hand and 47.3 kg for their left hand. The females averaged 31.1 kg in their right hand and 29.5 kg in their left. When comparing average grip strength scores in this study and those found by Mathiowetz and colleagues,[28] similarities were discovered for the 20 to 24 year-old and 25 to 29 year-old age groups. Both males and females in these age groups achieved higher grip strength scores in the Mathiowetz et al[28] study for their right hands, but both genders were able to generate similar or higher left hand scores in my study as compared to Matiowetz's[28] study. These differences can be attributed to the fact that this study did not test as many subjects as Mathiowetz et al[28] tested. Mathiowetz and associates[28] were able to obtain grip strength data from 29 males and 26 females in the 20 to 24 age group. They also tested 27 males and females in the 25 to 29 age group. In the 20 to 24 age category, I was only able to test 13 males and 16 females. In the 25 to 29 age group I tested 5 males and 3 females. Because the sample sizes in the various age groups were small, it is difficult to predict how grip strength testing in various shoulder and elbow positions will be affected by age.

**Limitations of Study**

One limitation of this study was that the order of the test positions was not randomized. Because of this, it is impossible to determine whether positions 3 and 4 were found to be the weakest due to the biomechanics of the position or due to fatigue factors.

Another factor in this study was slippage that occurred while holding the dynamometer. Many subjects reported losing their grip during testing and frequently adjusted their hand position in order to maintain a solid grip with the dynamometer.

Small sample size (n=42) was yet another limitation of this study. This became a factor especially when comparisons between genders were made (n=21 males, n=21 females). Sample size also became important when trying to determine age-related differences in grip strength scores.

**Ideas for Future Studies**

Further studies are recommended to examine the effects of the shoulder and elbow positions used in this study along with the standard grip strength testing position so that comparisons can be made between them. Grip strength measurements could also be taken in different shoulder angles (ie 0, 45, 135, and 180 degrees of flexion and/or abduction) combined with various elbow joint positions (ie 0, 45, 90, 110 degrees of flexion) to determine if shoulder position still has the greater effect on grip strength. Test positions should be randomized in order to decrease any influence of fatigue. Future studies should include a larger, more diverse sample.

## Chapter VI
## Conclusion

The results of this study show that grip strength is affected by shoulder and elbow position. A significant difference in grip strength between males and females was found to exist. Of the four positions tested, a significant difference for hand dominance was only found for position 2 (90 degrees shoulder flexion, full elbow extension). Although the position of greatest grip strength differed between genders, both men and women attained their greatest grip strength with the shoulder in 90 degrees of flexion. This finding suggests that 90 degrees of shoulder flexion may be a more functional position than 90 degrees of shoulder abduction. Because position testing was not performed randomly, fatigue could be the reason that both men and women were weaker with their shoulder in 90 degrees of abduction. In a clinical situation, random testing is an important technique to use in order to keep the effects of fatigue to a minimum.

Since positions 1 and 4 and positions 2 and 4 were found to have the greatest differences between them, measurements taken in the other combinations of positions should be quite similar. For example, positions 1 and 2 and positions 1 and 3 should have similar grip strength scores. To save time in the clinic, measurements could be taken in positions 1 and 4 only, since the greatest grip strength difference will be between these two positions.

All of the subjects in this study were 45 years old or younger and healthy, therefore, it is unknown if the same results can be expected for patients who may have upper extremity pathology or other underlying health problems.

# APPENDIX A

## SUBJECT'S QUESTIONNAIRE

Name:________________________ Code Number:___________________

Age:_______

Sex: M____ F____

Height:_______

Weight:_______

Hand Dominance: R____ L____

Any previous incident of upper extremity pathology? Yes____ No____
(Pathology is defined as any upper extremity problem requiring medical attention)

List any activity which requires repetitive gripping activity that you perform on a regular basis. (ie: racquet sports, carpentry)

Thank you for participating in this study.

## DATA COLLECTION FORM

Code#_________

| Position 1 | Trial 1 | Trial 2 | Trial 3 | Mean |
|---|---|---|---|---|
| | | | | |
| Dominant | | | | |
| Non-dominant | | | | |
| | | | | |
| Position 2 | | | | |
| | | | | |
| Dominant | | | | |
| Non-dominant | | | | |
| | | | | |
| Position 3 | | | | |
| | | | | |
| Dominant | | | | |
| Non-dominant | | | | |
| | | | | |
| Position 4 | | | | |
| | | | | |
| Dominant | | | | |
| Non-dominant | | | | |

## INFORMATION AND CONSENT FORM

**TITLE:** The Effect of Various Shoulder and Elbow Positions on Grip Strength

You are being invited to participate in a study conducted by Melanie Wentz, a physical therapy student at the University of North Dakota. The purpose of this study is to determine if grip strength is affected by various positions of the shoulder and elbow, whether hand dominance has a significant effect on grip strength, and whether grip strength in various shoulder and elbow positions varies significantly between genders. Only healthy subjects without upper extremity pathology and who are not ambidextrous will be asked to participate in this study. Pathology is defined as any upper extremity injury that required medical attention.

The study will take approximately a half-hour of your time. You will be asked to report to the University of North Dakota Physical Therapy Department lab at an assigned time. You will be asked to complete a questionnaire. Then you will be instructed on the process of grip strength testing.

A hand-held hydraulic device called a dynamometer will be used to measure your grip strength. You will be tested on both your dominant and non-dominant sides. Your grip strength will be tested in various elbow and shoulder positions. Three measurements will be taken for each of the four test positions. Measurements will be taken by alternating between the dominant and non-dominant sides. These measurements will then be recorded.

Although the process of physical performance testing always involves some degree of risk, the investigator in this study feels that the risk of injury or discomfort is minimal. Physical risks will be minimized by not allowing subjects with known upper extremity problems to participate in this study. Muscle fatigue will be minimized by allowing the subjects to rest their arm at their side after grip strength measurements in each position are taken, and by alternating between dominant and non-dominant sides. You will be given a practice trial before testing is begun. You will be asked to give a maximal effort for each grip strength test performed.

Your name will not be used in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The data will be identified by a number known only by the investigator. The investigator or participant may stop the experiment at any time if the participant is experiencing discomfort, pain, fatigue, or any other symptoms that may be detrimental to his/her health. Your decision whether or not to participate will not prejudice your future relationship with the Physical Therapy

Department or the University of North Dakota. If you decide to participate, you are free to discontinue participation at any time without prejudice.

The investigator involved is available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Melanie Wentz at (701) 777-9852. A copy of this consent form is available to all participants in the study.

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

**ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM ENCOURAGED TO ASK ANY QUESTIONS THAT I MAY HAVE CONCERNING THIS STUDY IN THE FUTURE. MY SIGNATURE INDICATES THAT, HAVING READ THE ABOVE INFORMATION, I HAVE DECIDED TO PARTICIPATE IN THE RESEARCH PROJECT.**

I have read all of the above and willingly agree to participate in this study explained to me by Melanie Wentz.

____________________________________________

Participant's Signature                    Date

____________________________________________

Witness (not the scientist)                    Date

## Testing Procedure:

- "Thank-you for participating in my research project."
- "The purpose of this study is to determine whether various shoulder and elbow positions, gender, and/or hand dominance have an effect on grip strength."
- "If you have any questions during the experiment, don't hesitate to ask."
- "This is a consent form which you must read, sign, and date."
- "Please complete this questionnaire to the best of your knowledge. I will measure your height and weight after you have completed this form. All data collected during this experiment will remain confidential."
- "Please remove any jewelry and clothing that may interfere with the experiment."
- "This is the dynamometer, which will measure your grip strength. For each test I want you to hold the handle like this and squeeze as hard as you can."
- The examiner demonstrates and then gives the dynamometer to the subject.
- "We will begin testing on your dominant side. You will be asked to complete three trials in each position on your dominant and non-dominant sides. Please maintain an erect posture throughout the entire testing procedure."
- "The first position will be 90 degrees elbow flexion with 90 degrees shoulder flexion. Please assume this position."
- Subjects will be assisted into this position by the examiner if necessary.
- "This is a practice trial. Are you ready? Squeeze the handle as hard as you can, then relax your arm at your side."
- "Now the testing will begin. You will have three trials in each position. After each trial, measurements will be recorded.
- "Assume the position of 90 degrees elbow and shoulder flexion on your dominant side. Squeeze as hard as you can. Harder, harder, relax."
- After the first trial score is recorded, the test is repeated with the same instructions for the second and third trial and then for the non-dominant side.

- The two previous steps will be repeated for the following positions: 1) Full elbow extension, shoulder 90 degrees flexion; 2) 90 degrees elbow flexion, 90 degrees shoulder abduction; and 3) Full elbow extension, 90 degrees shoulder abduction.

- "The experiment has now ended. Do you have any questions?"

- "Thank-you for participating in my research project."

# APPENDIX B

__EXPEDITED REVIEW REQUESTED UNDER ITEM ____ (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:** Melanie Opp **TELEPHONE:** (701) 777-8101 **DATE:** April 9, 1997

**ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT:** 313 Swanson Hall, Grand Forks, ND 58202-2014

**SCHOOL/COLLEGE:** Medicine **DEPARTMENT:** Physical Therapy **PROPOSED PROJECT DATES:** April 1997-December 1997

**PROJECT TITLE:** The Effect of Various Shoulder and Elbow Positions on Grip Strength

**FUNDING AGENCIES (IF APPLICABLE):** ____________________

**TYPE OF PROJECT:**

_X_ NEW PROJECT __ CONTINUATION __ RENEWAL __ DISSERTATION OR THESIS RESEARCH _X_ STUDENT RESEARCH PROJECT

__ CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT

**DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER:** Sue Jeno MA, PT

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

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

A large body of normative grip strength data has been obtained comparing gender, hand dominance, and age using hand held dynamometers. Much of this data has been collected with the subjects' shoulder adducted and neutrally rotated and the elbow flexed to 90 degrees. To date, little research has been conducted which studies the influence of shoulder position along with elbow position in the measurement of grip strength. The purposes of this study are to (1) Determine if grip strength is significantly affected by positions of shoulder flexion and abduction and positions of elbow flexion and extension, (2) Determine if grip strength in different shoulder and elbow positions varies significantly between genders, and (3) Determine if hand dominance plays a significant role in grip strength.

The results of this study will establish research data on grip strength in various shoulder and elbow positions. This information could prove to be important for physical therapists as they evaluate and treat patients with upper extremity injuries. This study could be beneficial for patients with upper extremity injuries by finding the optimal position for increasing grip their strength. Since grip strength is a routine test performed in the clinic, it is necessary to use human subjects for this study.

**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.)

**Subjects**

The sample will consist of 80 voluntarily recruited co-ed students from the University of North Dakota, ages 19-50 years. Subjects must be healthy and without upper extremity pathology. Subjects who are ambidextrous will be excluded from this study.

All participants will sign the appropriate human subject consent forms.

**Instrumentation**

An adjustable, hand held Jamar dynamometer will be used to measure grip strength. The dynamometer uses a hydraulic gauge along with a maximum reading hand to preserve the highest reading. The instrument is placed comfortably in the subject's hand and the subject is asked to squeeze the handle with maximum effort. Grip strength is measure in pounds and kilograms of force on a double scale. The dynamometer will automatically record the force exerted by the subject. The maximum reading hand will remain at the highest reading attained while gripping the dynamometer.

The reliability and validity of the Jamar dynamometer was tested by Mathiowetz, et al.[1] Their results showed that inter-rater reliability was very high. The Jamar dynamometer demonstrated the highest accuracy of the instruments tested and test-retest reliability was highest in tests when the mean of three trials was used.

**Procedure**

Upon entering the lab, the subjects will be asked to remove all jewelry and clothing that may interfere with the experiment and will be asked to complete the consent form. Then, the subjects will be given verbal instructions concerning the purpose and procedure of the experiments. The subjects will then be given a demographic questionnaire (See Appendix A).

The subject will be positioned in standing, and at that time, the dynamometer will be comfortably positioned in the subject's hand. The test positions used in this study will be: (1) 90 degrees elbow flexion with 90 degrees of shoulder flexion, (2) elbow fully extended with shoulder in 90 degrees of flexion, (3) 90 degrees of elbow flexion with 90 degrees of shoulder abduction, and (4) elbow in full extension with shoulder in 90 degrees of abduction. For each of the positions the subject will be asked to maintain their forearm and wrist in the neutral position. The subject will be asked to assume the first position and will be tested on both dominant and non-dominant sides. This procedure will be followed for each of the four positions. Before testing, each subject will be allowed a practice trial to orientate themselves to the dynamometer and testing procedure. This practice trial will consist of each subject performing one (1) repetition of grip strength in position 1 on the dominant side. Three grip measurements will be taken for each position. Testing will begin on the subject's dominant side. Fatigue will be minimized by alternating between dominant and non-dominant sides for each of the four test positions. The subjects will be asked to give maximal effort on every grip measurement for each position.

Data collection will consist of the measurements recorded of the subject's grip strength in each of the four positions on the dominant side for three (3) trials and on the non-dominant side for three (3) trials. The measurements will be recorded to the nearest pound. The mean of the three trials will be calculated. The measurements will be recorded on the pre-printed data collection form (See Appendix B).

1. Mathiowetz V, Weber K, Vollard G, Kashman N. Reliability and validity of grip and pinch strength evaluations. *J-Hand-Surg-Am.* 1984 Mar; 9(2): 222-6.

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

The possible benefits to the subjects include, but are not limited to, satisfaction gained from participating in a scientific study. Possible benefits to society are 1) research that may further the field of therapeutic rehabilitation and 2) stimulation of further research on related subjects. The results of this study may assist physical therapists when evaluating and treating patients with upper extremity injuries.

**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.)

Physical risks to the subjects in this study are minimal. The hand dynamometer is an assessment tool routinely used in the clinic for measuring grip strength. Muscle fatigue and stiffness may develop as a result of physical exertion. These risks will be minimized by excluding subjects with known upper extremity pathology. Fatigue will be minimized by allowing the subjects to rest their arms at their sides after grip strength measurements are taken in each position and by alternating between dominant and non-dominant sides.

Data will be collected in a confidential manner, and the collected data will be kept confidential. Names will not be used for any reason in this study and subjects will be assigned code numbers to ensure strict confidentiality. Participation in this study is voluntary and subjects are free to withdraw at any time and for any reason without fear of restitution.

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.

The signed consent forms will be kept by Sue Jeno in the University of North Dakota Physical Therapy Department for a period of two (2) years. A copy of the consent form is attached. (See Appendix C).

**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
Box 8138, University Station
Grand Forks, North Dakota 58202

On campus, mail to: Office of Research & Program Development, Box 134, or drop it off at Room 101 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.

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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:**

________________________________ **DATE:** ______________

Principal Investigator

________________________________ **DATE:** ______________

Project Director or Student Adviser

________________________________ **DATE:** ______________

Training or Center Grant Director

(Revised 8/1992)

## REPORT OF ACTION: EXEMPT/EXPEDITED REVIEW

**University of North Dakota Institutional Review Board**

**DATE:** April 11, 1997 **PROJECT NUMBER:** IRB-9705-270

**NAME:** Melanie Opp **DEPARTMENT/COLLEGE:** Physical Therapy

**PROJECT TITLE:** The Effect of Various Shoulder and Elbow Positions on Grip Strength

The above referenced project was reviewed by a designated member for the University's Institutional Review Board o May 13, 1997 and the following action was taken:

☑ Project approved. **EXPEDITED REVIEW** NO. 7.
Next scheduled review is on May 1998.

☐ Project approved. **EXEMPT CATEGORY** NO. ______. No periodic review scheduled unless so stated in the Remarks Section.

☐ Project approved **PENDING** receipt of corrections/additions. These corrections/additions should be submitted to ORPD for review and approval. **This study may NOT be started UNTIL final IRB approval has been received.** (See Remarks Section for further information.)

☐ Project approval **deferred. This study may not be started until final IRB approval has been received.** (See Remarks Section for further information.)

☐ Project **denied.** (See Remarks Section for further information.)

**REMARKS:** Any changes in protocol or adverse occurrences in the course of the research project must be reported immediately to the IRB Chairperson or ORPD.

cc: S. Jeno, Adviser
Dean, Medical School

[signature] 5/13/97

Signature of Designated IRB Member — Date
UND's Institutional Review Board

If the proposed project (clinical medical) is to be part of a research activity funded by a Federal Agency, a special assurance statement or a completed 310 Form may be required. Contact ORPD to obtain the required documents.

(3/9

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