

Utah State University

DigitalCommons@USU

All Graduate Theses and Dissertations

Graduate Studies

5-1975

Effect of Cryotherapy in Preventing Blistering and Tearing of Hands of Utah State University Male Gymnasts

Wayne E. Larson
Utah State University

Follow this and additional works at: <https://digitalcommons.usu.edu/etd>



Part of the [Medicine and Health Sciences Commons](#)

Recommended Citation

Larson, Wayne E., "Effect of Cryotherapy in Preventing Blistering and Tearing of Hands of Utah State University Male Gymnasts" (1975). *All Graduate Theses and Dissertations*. 3219.

<https://digitalcommons.usu.edu/etd/3219>

This Thesis is brought to you for free and open access by the Graduate Studies at DigitalCommons@USU. It has been accepted for inclusion in All Graduate Theses and Dissertations by an authorized administrator of DigitalCommons@USU. For more information, please contact digitalcommons@usu.edu.



EFFECT OF CRYOTHERAPY IN PREVENTING BLISTERING AND TEARING
OF HANDS OF UTAH STATE UNIVERSITY MALE GYMNASTS

by

Wayne E. Larson

A thesis submitted in partial fulfillment
of the requirements for the degree


of

MASTER OF SCIENCE

in

Health, Physical Education and Recreation

Approved:



UTAH STATE UNIVERSITY
Logan, Utah

1975

078.2
L329e
c.2

ACKNOWLEDGMENTS

I wish to express thanks to my committee, Dr. Lanny Nalder, Lucille Chase, and Leon Beutler.

The subjects are to be commended for their cooperation, with particular thanks to John Reid for his assistance.

Special thanks goes to my wife Linda for her patience and invaluable help, and to my children for their tolerance.

Wayne Larson

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	ii
ABSTRACT	iv
Chapter	
I INTRODUCTION	1
Justification of the Study	2
Statement of the Problem	3
Subproblems	3
Delimitations	4
Limitations of the Study	4
Definition of Terms	4
II REVIEW OF RELATED LITERATURE	6
Friction Blistering	6
Effects of Cold	8
Blisters and Cryotherapy	13
III METHOD OF PROCEDURE	14
Subjects	14
Experimental Design	14
Instructions	15
Activities	15
Experimental Period	16
Treatment	16
Ice Bath	17
Classification of Tears	17
IV ANALYSIS OF DATA, SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS	19
Analysis of Data	19
Areas of analysis	19
Test of significance	21

TABLE OF CONTENTS (Continued)

Chapter	Page
Summary	21
Findings and Conclusions	23
Recommendations	24
SELECTED BIBLIOGRAPHY	25
APPENDIX	28
Appendix A.	29
Appendix B.	30
VITA	32

ABSTRACT

Effect of Cryotherapy in Preventing Blistering and Tearing
of Hands of Utah State University Male Gymnasts

by

Wayne E. Larson

Utah State University, 1975

Major Professor: Dr. Lanny J. Nalder
Department: Health, Physical Education and Recreation

The purpose of this study was to compare the effectiveness of cryotherapy versus no treatment in preventing blistering and tearing of the hands of twenty-six male college age gymnastics students at Utah State University.

The subjects were tested with a hand dynamometer to determine differences in grip strength between right and left hands. Two groups of thirteen subjects each were formed to equalize the differences in grip strength.

During the experimental period of four class sessions totaling two hours, subjects participated in various activities on the horizontal bar, parallel bars, and rings which required simultaneous gripping by both hands. Whenever a subject experienced a burning sensation in the skin of his hands, he went immediately to an ice water bath (10° C) and soaked one hand for thirty seconds. One group treated only the stronger hand, while the other group treated only the weaker hand. After treatment, the hand was dried and workout continued.

When the skin tore on a subject's hand, he reported to the recorder and treated the tear by carefully trimming away all the loose skin. He was also encouraged to apply a disinfectant. The tear was measured and given a classification as to whether it was a 1st, 2nd, or 3rd degree tear, with a corresponding weighted value. Training continued unless the tear was serious.

The data was subjected to the t distribution test for significance to determine whether the cryotherapy was successful in preventing tearing of the skin on the treated hand. The results of the t test indicated a significant reduction in the amount of tearing that occurred on the treated hands of the subjects. Results of the t test for two sample means showed that there was no significant difference whether a subject treated the weaker hand or the stronger hand at the .05 level of significance.

(37 pages)

CHAPTER I

INTRODUCTION

Gymnasts depend on their hands. In four of the six Olympic gymnastics events for men, the only significant contact the gymnast has with the apparatus is through his hands. Well conditioned hands with tough, pliable calluses are perhaps as essential to the gymnast as well conditioned muscles.

A great amount of pressure and friction occur between the hands and the apparatus as the body goes through its movements and positions. These forces are repeated many times each day during the course of a workout. Blistering and subsequent tearing of the skin on the palms of the hands or fingers is nearly always the result when the gymnast makes a greater demand on his hands than what their conditioning will allow. Many individual and team goals have gone unattained when a gymnast was unable to practice adequately or had to forego some phase of competition because the pain or risk of further tearing of the skin was too great.

It is unfortunate that a sport as beautiful and expressive as gymnastics must be plagued by such a simple injury. Yet, for most gymnasts, it seems almost impossible to go through an entire season without having some problems with "rips." Those who escape this nuisance are either fortunate or lazy.

Cryotherapy, in various forms, is now widely used in certain medical practices, particularly the treatment of burns and some surgical procedures.

Cryotherapy and cryokinetic procedures are also commonly used to reduce swelling and pain of various athletic injuries, thereby promoting the healing process. Cooling the skin to prevent blistering is a relatively new concept in the prevention of athletic injuries. Few activities are concerned to any extent with blister formation. Fewer still lend themselves to preventive measures of the type in this study.

Justification of the Study

When a gymnast tears the skin on his hands, he is immediately faced with a number of problems that he would otherwise have avoided. The injury is often very painful and causes the gymnast to avoid placing any further pressure on the injury. When the pain is too severe, training on the apparatus is over until some healing has taken place. Some gymnasts try to reduce the pain by protecting the injury with tape while the workout continues. This is a clumsy procedure at best. The gymnast must also protect against further injury and infection, and must take care not to allow the exposed area to become dry and cracked as the new skin forms. These cracks can be very painful.

In spite of many different individual practices and preferences, gymnasts continue to get blisters and "rips." The ideal surface for the palm of the hand, tough, but pliable, comes only with continued practice and conditioning over several years.¹ The gymnast who fails to practice during the summer can

¹D. Williams and W. A. Crenshaw, "Gymnasts, Take Care of Those Hands," Athletic Journal, LII, (September, 1971), 42-44.

expect to begin the next season with soft hands. Well conditioned hands are hard to get and easy to lose. Hand guards provide some protection, but cover only part of the contact surface. Many gymnasts are careful to keep calluses trimmed so they do not catch on the apparatus and tear off. Some gymnasts use lotion or other skin conditioners to make dry skin more pliable.

All but the best conditioned hands will become hot and experience separation of the layers of the skin if subjected to a rigorous enough practice session on the apparatus. Beginning students may tear the skin with only a few swings. It is important to determine if external cooling of the skin with a readily available substance such as cold water will reduce the incidence of blisters and tears of the hands during a normal practice session on the apparatus.

Statement of the Problem

The purpose of this study was to compare the effectiveness of cryotherapy versus no treatment in preventing blistering and tearing of the hands of male college age gymnastics students at Utah State University.

Subproblems

The subproblems of this thesis were:

1. The selection of a procedure to identify the extent of injury to the hands of the subjects.
2. The selection of a representative group of subjects.

Delimitations

This study was delimited to male college age gymnastics students enrolled in beginning gymnastics classes at Utah State University. There were twenty-six subjects.

Limitations of the Study

The limitations of this study were:

1. The inherent physiological differences of the subjects.
2. The inability of the researcher to control activity of the subjects outside of class which may have affected the condition of the hands.
3. The limited number of subjects which were used.

Definition of Terms

Cryotherapy: cold treatment.

Cryokinetics: cold movement.

Hot hands: burning sensation caused by friction between the hands and the apparatus.

Tear or rip: ruptured blisters.

1st degree tear: average diameter of less than or equal to 8 mm. Determined by averaging the widest and narrowest midpoints of the tear after all the loose skin has been clipped away.

2nd degree tear: average diameter of less than or equal to 15 mm or a 1st degree tear with bleeding.

3rd degree tear: average diameter of greater than 15 mm or a 2nd degree tear with bleeding.

CHAPTER II

REVIEW OF RELATED LITERATURE

This study was to determine the effect of cryotherapy in preventing blistering and tearing of the hands of male gymnastic students.

Little research has been conducted dealing with the effect of cryotherapy on friction blisters. For this reason, literature will also be cited in the related areas of friction blistering (on which equally little research has been done) and physiological responses of the body to localized application of cold.

Friction Blistering

Sulzberger, Cortese, Fishman, and Wiley attempted to produce friction blisters on various parts of the human body in a clinical setting. This was done as extension and variation of the fundamental work of P. E. D. Naylor and used special rubbing apparatus in order to study the relationship between the amount of friction, number of strokes, duration of rubbing, and biologic response. Despite equal friction levels, the amount of time required to produce a blister on the palm of the hand using linear rubbing motion varied from three to four minutes to no blister produced in fifty minutes of rubbing. Use of the twisting eraser technique where an eraser is placed against the skin and then briskly rotated in clockwise-counter-clockwise directions produced blisters within a range or thirty seconds to three minutes on all subjects. Blisters began with a stinging or burning

sensation, and showed a pale collarette surrounding the reddened central area. With continued rubbing, the pale area enlarged toward the center and eventually raised to form the blister top. The blister top was composed of the stratum granulosum and stratum corneum as well as a portion of traumatically degenerated stratum spinosum. The separation occurred in the mid or upper malphigian layer and filled with clear free fluid. It was almost impossible to produce fluid-filled blisters on the less cornified areas of the body because of the difficulty of producing the right amount of friction needed for the deeper epidermal damage without also destroying the upper layers. Simple abrasion was the usual result. When local arterial pressure was reduced by holding the hand high above the head for a period of one hour, filling of the space by fluid was prevented until the hand was lowered. Three to four hours was required for complete filling. A control blister on the opposite hand held at normal position below the heart had fluid within the first hour, and was completely filled within two hours. Similar results were achieved when a pressure cuff was placed on the upper arm causing arterial occlusion. The cuff remained in place during blister formation and for thirty minutes following. Neither blister showed any filling during the first half hour, at which time the cuff was removed. At one hour, the previously occluded side showed little or no free fluid, but in the unoccluded side there was evidence of fluid. At four hours, both blisters appeared equal.²

²Marion B. Sulzberger, M. D., et al., "Studies on Blisters Produced by Friction: Results of Linear Rubbing and Twisting Technics," The Journal of Investigative Dermatology, XLVII, No. 5 (1966), 456-65.

Effects of Cold

Under the general topic of cold effects, it is important to consider body responses in light of three separate possibilities as related to this study. These could appropriately be described as initial effects (physiological responses within the first thirty to sixty seconds following cold application), secondary effects (subsequent responses different from initial responses), and overall effects.

The experimental design of this study was basically an attempt to employ some of the initial effects while minimizing certain secondary effects.

Olson and Stravino reviewed the work of several researchers concerning physiological responses of the body to cold.³ Relevant information from these studies is cited in the following material. Janssen and Waaler found that cold application to the skin of animals irritated with turpentine caused vasoconstriction, lowered metabolism and blocked release of histamine.⁴ Bierman and Friedlander applied ice bags to both sides of the gastrocnemius and found that skin temperature dropped immediately to 6° C. However, intramuscular temperature showed only a slight significant drop to slightly below 32.3° C after

³Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 840-53.

⁴C. W. Janssen and E. Waaler, "Body Temperature, Antibody Formation, and Inflammatory Response," Acta Pathologica et Microbiologica Scandinavica, LXIX, (1967), 557-66, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 841.

30 minutes.⁵ Studying cold analgesia, Fox concluded that there was an anesthetic effect by cold on the nerve fibers since conduction velocity slows, although conduction does not cease until the tissue temperature drops to 10 to 15⁰ C.⁶ Ellis as well as Travell propose the idea that cold analgesia occurs when the central pain receptors are literally overcome by the intensity of the cold impulses.^{7,8} Waylonis observed the physiological effects of ice massage, iced water, iced towels, and ethyl chloride spray; and found similar effects with all methods. However, it was noted that danger of frostbite was present when using ethyl chloride as it could produce skin temperatures of -4⁰ C.⁹ Horton, Brown

⁵W. Bierman and M. Friedlander, "The Penetrative Effect of Cold," Archives of Physical Medicine and Rehabilitation, XXI, (1940), 585-92, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 841.

⁶R. H. Fox, "Local Cooling in Man," British Medical Bulletin, XVII, (1961), 14-18, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 841.

⁷M. Ellis, "The Relief of Pain by Cooling of the Skin," British Medical Journal, I, (1961), 250-52, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 841.

⁸J. Travell, "Ethyl Chloride Spray for Painful Muscle Spasm," Archives of Physical Medicine and Rehabilitation, XXXIII, (1952), 291-98, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 841.

⁹G. W. Waylonis, "The Physiologic Effects of Ice Massage," Archives of Physical Medicine and Rehabilitation, XLVIII, (1967), 37-42, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 847.

and Roth discussed the release of an histamine-like substance, an accumulation of which may produce a systemic reaction in patients who would be considered hypersensitive to cold treatment. However, this condition has been noted in only a few patients.¹⁰

Downey, Darling, and Miller discuss the effects of cold as related to local and systemic reactions in the peripheral circulations.¹¹ The work of several researchers is cited as supporting material for the points presented. Pickering placed a hand in 15° C water and noted that within a latency period as short as one second, vasoconstriction occurred in the opposite limb.¹² Francois-Franck achieved the same reflex reaction by applying an ice cube to the skin.¹³

¹⁰ B. T. Horton, G. E. Brown, and G. M. Roth, "Hypersensitiveness to Cold with Local and Systemic Manifestations of a Histamine-Like Character: Its Amenability to Treatment," Journal of the American Medical Association, CVII, (1936), 1263-69, cited by Jane E. Olson, M. A. and Vincent D. Stravino, M. D., "A Review of Cryotherapy," Physical Therapy, LII, No. 8 (1972), 851.

¹¹ John A. Downey, M. D., Ph. D., Robert C. Darling, M. D., and John M. Miller, M. D., "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation," Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308-14.

¹² G. W. Pickering, "The Vasomotor Regulation of Heat Loss From the Human Skin in Relation to External Temperature," Heart, XVI, (July, 1932) 115-35, cited by John A. Downey, M. D., Ph. D., Robert C. Darling, M. D., and John M. Miller, M. D., "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation," Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308.

¹³ C. E. Francois-Franck, "Du volume des organes dans ses rapports avec la circulation du sang," Physiologie Experimentale, Travaux du Laboratoire de M. Marcy, II, (1876), 1-62, cited by John A. Downey, M. D. Ph. D., Robert C. Darling, M. D., and John M. Miller, M. D., "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation," Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308.

Lewis was the first to notice what has been called the "hunting reaction." He observed that when the skin is cooled below 10°C , alternating periods of vasodilation and vasoconstriction are set up, with corresponding warming and cooling of the affected part.¹⁴

Folkow, Fox, Krog, Odelram, and Thoren studied the reactions of the cutaneous vessels to intense cooling in both cats and man. Using the opposite hand as a control, the studies on man showed rapid vasoconstriction with blood flow being reduced from 15 ml/100 ml of tissue/min to about 1-2 ml/100 ml of tissue/min when 35°C water was replaced with 0°C water. Even though the water surrounding the control hand remained at 35°C , some vasoconstriction did take place in the hand showing the reflex response. The reflex disappeared in 3-4 minutes.¹⁵

Paik, Kang, Han, Rennie, and Hong investigated the vascular responses of eight Korean ama (women divers) and eight nondivers when one hand was placed in 6°C water for 30-60 minutes. Both groups showed slight initial

¹⁴T. Lewis, Observations Upon the Reactions of the Vessels of the Human Skin to Cold, "Heart, XV, (May, 1930), 177-208, cited by John A. Downey, M. D., Ph. D., Robert C. Darling, M. D., and John M. Miller, M. D., "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation," Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 310.

¹⁵B. Folkow, et al., "Studies on the Reaction of the Cutaneous Vessels to Cold Exposure," Acta Physiologica Scandinavica, LVIII, (August, 1963), 342-54.

increase in both systolic and diastolic blood pressure as recorded in the upper arm. The average increase was 10 mm Hg in 3 minutes. Skin temperature of both groups dropped immediately to 9° C, where it stayed for the ama. Finger temperature for the controls rose to 11° C and hunting reaction was evident.¹⁶

Petajan and Daube studied the conductive properties of the median nerve as affected by immersion of the arm and hand in 10° C water for 15 minutes. Skin temperature over the thenar eminence dropped to 18° C within 1 minute. Cooling did have gross effect on nerve function including action potential latency, action potential duration, conduction velocity, and rapid successive muscular contraction. However, since muscles controlling finger flexion and extension are in the arm, these functions would not be significantly impaired by severe cooling of the hand.¹⁷

Krog, Alvik, and Lund-Larsen used exposure of the hand to circulated ice water to investigate the time of onset and magnitude of cold induced vasodilation in Finnish Lapps. Skin temperature recorded on the pulp of the third finger dropped to 10° C at approximately 30 seconds. Mean time for the onset

¹⁶K. S. Paik, et al., "Vascular Responses of Korean Ama to Hand Immersion in Cold Water," Journal of Applied Physiology, XXXII, No. 4 (1972), 446-50.

¹⁷Jack H. Petajan and Jasper R. Daube, "Effects of Cooling the Hand and Arm," Journal of Applied Physiology, XX, No. 6 (1965), 1271-74.

of vasodilation for males was 5.5 minutes. Blood pressure rose immediately an average of 34 mm Hg for males and then returned slowly to former levels.¹⁸

Zacarian and Adham recorded temperatures of human skin following application of liquid nitrogen, and reported that the temperature needed for extra- and intracellular ice formation, increased hydrogen ion concentration, and protein denaturation of cellular and tissue damage is -18 to -20° C.¹⁹

Blisters and Cryotherapy

Brown and Johnson studied the effects of instant ice in preventing blistering and increasing the rate of cooling hotspots on the hands of eight subjects performing kips on the horizontal bar for a total of five minutes. Using control and experimental groups of four each, it was found that while there was no significant difference in the number of hotspots that developed in each group, the instant ice was effective in preventing the formation of blisters and increasing the number of kips performed and length of performance time of the experimental group.²⁰

¹⁸J. Krog, M. Ålvik, and K. Lund-Larsen, "Investigations of the Circulatory Effects of Submersion of the Hand in Ice Water in the Finnish Lapps, the 'Skolts,'" Federation Proceedings, XXVIII, No. 3 (1969), 1135-37.

¹⁹Setrag A. Zacarian, M. D. and Mustafa I. Adham, M. D., M.S., F. A. C. S., "Cryogenic Temperature Studies of Human Skin: Temperature Recordings at Two Millimeter Human Skin Depth Following Application with Liquid Nitrogen," The Journal of Investigative Dermatology, XLVIII, No. 1 (1967), 7.

²⁰Joe Brown and Bernard Johnson, "The Use of Instant Ice for Prevention of Blisters on the Hands," The Journal of the Association for Physical and Mental Rehabilitation, (July-August, 1966), cited by James S. Bosco, Ph.D., "Research and Fitness in Gymnastics," Modern Gymnast, IX, No. 6 and 7 (1967), 22.

CHAPTER III

METHOD OF PROCEDURE

Subjects

The subjects were twenty-six male college students enrolled in beginning gymnastics skills classes at Utah State University during the Spring Quarter of the 1973-74 school year. Ages of the subjects ranged from eighteen to twenty-seven with a mean age of 21.5. Of the group, six were Physical Education majors or minors. Twenty had majors in other fields and were taking the class either to fill general education requirements or other reasons related to general interest. Previous gymnastics experience of the subjects ranged from none to college physical education gymnastics instruction.

Experimental Design

During the two class periods of the week preceding the experimental period, each subject was tested with a hand dynamometer to determine grip strength. Each hand was tested twice on each day. The arm was held straight above the head on each testing occasion. The average grip strength of each hand was determined by averaging the four measurements taken. The average difference in grip strength between the right and left hands was then determined. The difference between the hands was divided by the average strength of the stronger hand to determine the percentage of difference in strength between the hands.

Groups A and B of thirteen subjects each were formed to equalize the above determined differences in grip strength between the hands. The Group A combined percentage differences of the subjects was a total of 90.87 percent. Group B had a total percentage difference of 91.35 percent.

Two separate controls were used. The first control was the opposite hand of the subject, since treatment was applied to only one hand. The other control was the opposite group, which had treatment applied to the stronger hand if Group A, or the weaker hand if Group B.

Instructions

Each subject was given a written list of instruction concerning his responsibility in the study. He was asked to read the instructions several times before the next class period. Any questions which arose were clarified by discussion with the instructor before the testing period began. A copy of the instructions may be found in the appendix.

Activities

All subjects participated in various activities on the horizontal bar, parallel bars, and rings which required simultaneous gripping by both hands. The activities were swinging, kips, and back uprisers on the horizontal bar; glides and kips on the parallel bars; swinging, back uprisers, and muscle ups on the rings. Hand guards were not worn by any of the subjects.

Experimental Period

The experimental period was a total of four one half hour class sessions during a two week period. Each subject participated in a normal rotation of activities each class session, such as ten minutes on the rings, five minutes on the parallel bars, and fifteen minutes on the horizontal bar. The session was terminated for a subject only if the skin of the hands became severely torn. Regular class sessions were Tuesdays and Thursdays at either the 8:30 or 10:30 A.M. periods. If a subject missed a regular class session, he attended a make-up session on the Tuesday following the established experimental period.

Treatment

During participation, the subjects experienced hot hands from the friction caused by gripping the apparatus. When this occurred, if the subject was in Group A, he would place his stronger hand, whether right or left, into a bath of cold water at a temperature of 10° C, plus or minus 2° C. Subjects in Group B treated the weaker hand.

The hand was kept in the water for thirty seconds. Then it was removed and completely dried with a towel before training continued.

Ice Bath

The bath was approximately three inches deep. The temperature was constantly monitored by an attendant with a thermometer. Ice was added to the water whenever necessary.

Classification of Tears

When the skin tore on a subject's hand, he immediately went to the recorder. The recorder permitted the subject to treat the tear by clipping away the excess skin with fingernail clippers and cuticle scissors to prevent further tearing of the skin when training continued. The subject was also encouraged to apply a disinfectant. Then the tear was measured across its widest and narrowest midpoints. The average of the two measurements was determined and recorded, as well as the hand on which it occurred. A determination was then made as to whether the tear was a 1st degree tear (average diameter less than or equal to 8 mm), 2nd degree tear (average diameter less than or equal to 15 mm, or 1st degree tear with bleeding), or 3rd degree tear (average diameter greater than 15 mm, or 2nd degree tear with bleeding).

The subject had the option of continuing training if the tear was a 1st or 2nd degree tear. For a 3rd degree tear, the subject was required to stop training for the rest of the session. He had the option of continuing training at future sessions.

Reopening or cracking of a previous tear was not considered to be a separate tear. When a new area of skin was torn adjacent to a previous tear, it was classified and recorded.

CHAPTER IV
ANALYSIS OF DATA, SUMMARY, FINDINGS,
CONCLUSIONS, AND RECOMMENDATIONS

Analysis of Data

The data was recorded on a form which listed the subjects' names and had a box for each class session. Exact size of each tear was reported and converted to a weighted value. A 1st degree tear had a weighted value of 1, a 2nd degree tear had a value of 2, and a 3rd degree tear was equal to 3. If the tear was on the hand which was being treated, the weighted value was negative. Tears on the hand which was not being treated were given positive weighted values.

At the end of the experimental period, the weighted values for each subject were totaled, and a final score was indicated. This final score was the figure used in the statistical computations.

Areas of analysis

The analysis of data was divided into two areas: (1) difference in tearing between the treated and non-treated hands; (2) difference in tearing based on whether the treated hand was the stronger or weaker hand.

Subject Group #	Tears in mm. Class Session #				Weighted Total Values	
	1	2	3	4	+	-
1 A						0
2 B						0
3 A						0
4 A	7.5			6.0	2	2
5 B						0
6 A						0
7 A						0
8 A		8.5	11.0(-)	8.5	4	2 2
9 B			19.5(B)		3	3
10 B						0
11 A		3.5, 5.0, 4.5(-)			2	1 1
12 A						0
13 B				11.5(B), 5.5(-)	3	1 2
14 B		9.5, 3.0			3	3
15 B						0
16 B						0
17 A						0
18 B		10.5(-)	6.5		1	2 -1
19 B						0
20 B						0
21 A		6.0, 8.0(-)	4.0, 3.0(-)		2	2 0
22 B		5.5	4.5		2	2
23 A		4.0, 10.5(-)			1	2 -1
24 A						0
25 A						0
26 B						0

Test of significance

The test for significance of the variables made use of the t distribution. Use of the t distribution allowed a statistical test for the mean of a small sample when the mean of the entire population was not known. Critical values for given levels and designated sample sizes are provided in table form.

Significance at the .05 level of confidence in relation to whether the treated hands experienced less tearing than the non-treated hands required a t score greater than 2.060. The computed t for this variable was 2.304 which indicated a significant difference in the amount of tearing on the treated and non-treated hands.

By using a t test for two sample means it was possible to determine if there was significance in the difference between the means of the experimental groups A and B. A significant difference at the .05 level of confidence using the group comparison t test would require a computed t greater than 2.064 or less than -2.064. The computed t for the groups was -.883. No significant difference in the amount of tearing based on whether the treated hand was the stronger or weaker hand was indicated by this result.

Summary

The purpose of this study was to compare the effectiveness of cryotherapy versus no treatment in preventing blistering and tearing of the hands of male college-age gymnastics students at Utah State University.

Subjects for this study were twenty-six students enrolled in two beginning gymnastics classes during the Spring Quarter of the 1973-74 school year. Subjects were tested with a hand dynamometer to determine differences in grip strength between right and left hands. Groups A and B of thirteen subjects each were formed to equalize the differences in grip strength.

During the experimental period of four class sessions totalling two hours, subjects participated in various activities on the horizontal bar, parallel bars, and rings which required simultaneous gripping by both hands. Whenever a subject experienced a burning sensation in the skin of his hands, he would go immediately to an ice water bath (10° C) and soak one of his hands for 30 seconds. Subjects in Group A treated only the stronger hand. Group B treated only the weaker hand. After treatment, the hand was dried and workout continued.

When the skin tore on a subject's hand, he would report to the recorder and treat the tear by carefully trimming away all the loose skin. He was also encouraged to apply a disinfectant. The tear was measured and given a classification as to whether it was a 1st, 2nd, or 3rd degree tear, with a corresponding weighted value. A 1st degree tear was the least severe. The subject continued his training unless the tear was serious. Only areas which had not been torn previously were classified as separate tears.

The data was compiled and subjected to the t distribution test for significance to determine whether the cryotherapy was successful in preventing tearing of the skin on the treated hand.

Findings and Conclusions

The t test for significance indicated a significant difference at the .05 level in the amount of tearing that occurred on the treated and non-treated hands of the subjects. The hands which were given the cryotherapy experienced significantly fewer tears than the hands which received no treatment. This is in agreement with the findings of Brown and Johnson in their work on blistering and gymnastic training.

Results of the t test for two sample means showed that there was no significant difference whether a subject treated the weaker hand or the stronger hand. The difference in tearing between the groups was not significant at the .05 level.

Of the 26 subjects involved in the study, 16 did not tear the skin on either hand during the experimental period. The workload for the relatively short class periods was not sufficient to cause blistering and tearing on the hands of these subjects.

Ten of the subjects experienced tears of varying degrees on one or both hands. These 10 subjects had a total of 23 separate tears. The weighted value of the tears was a total of 33, or an average value per tear of 1.43. The average tear had a diameter of 7.22 mm. Two of the tears also had some amount of bleeding.

Recommendations

The following recommendations for further studies were based on the findings and conclusions of this study:

1. A study comparing the relative effectiveness of cooling periods for cryotherapy.
2. A study comparing the effectiveness of different cooling agents.
3. A study comparing the effectiveness of varying temperature levels of cryotherapy.
4. A comparative study of the thickness of the skin at the middle of the tear and the size of the tear.

SELECTED BIBLIOGRAPHY

- Bierman, W. and Friedlander, M. "The Penetrative Effects of Cold." Archives of Physical Medicine and Rehabilitation, XXI, (1940), 585-92, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Brown, Joe and Johnson, Bernard. "The Use of Instant Ice for Prevention of Blisters on the Hands." The Journal of the Association for Physical and Mental Rehabilitation, (July-August, 1966), cited by Bosco, James S., Ph. D. "Research and Fitness in Gymnastics." Modern Gymnast, IX, No. 6 and 7 (1967), 22.
- Downey, John A., M. D., Ph. D., Darling, Robert C., M. D., and Miller, John M., M. D. "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation." Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308-14.
- Ellis, M. "The Relief of Pain by Cooling of the Skin." British Medical Journal, I, (1961), 250-52, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Folkow, B., et al. "Studies on the Reactions of the Cutaneous Vessels to Cold Exposure." Acta Physiologica Scandinavica, LVIII, (August, 1963), 342-54.
- Fox, R. H. "Local Cooling in Man." British Medical Bulletin, XVII, (1961), 14-18, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Francois-Franck, C. E. "Du volume des organes dans ses rapports avec la circulation du sang." Physiologie Experimentale, Travaux du Laboratoire de M. Marey, II, (1876), 1-62, cited by Downey, John A., M. D., Ph. D., Darling, Robert E., M. D., and Miller, John M., M. D. "The effects of Heat, Cold, and Exercise on the Peripheral Circulation." Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308-14.

- Horton, B. T., Brown, G. E., and Roth, G. M. "Hypersensitiveness to Cold with Local and Systemic Manifestations of a Histamine-Like Character; Its Amenability to Treatment." Journal of the American Medical Association, CVII, (1936), 1263-69, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." LII, No. 8 (1972) 840-53.
- Janssen, C. W. and Waaler, E. "Body Temperature, Antibody Formation, and Inflammatory Response." Acta Pathologica et Microbiologica Scandinavica, LXIX, (1967), 557-66, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Krog, J., Ålvik, M., and Lund-Larsen, K. "Investigations of the Circulatory Effects of Submersion of the Hand in Ice Water in the Finnish Lapps, the 'Skolts.'" Federation Proceedings, XXVIII, No. 3 (1969), 1135-37.
- Lewis, T. "Observations Upon the Reactions of the Vessels of the Human Skin to Cold." Heart, XV, (May, 1930), 177-208, cited by Downey, John A., M. D., Ph. D., Darling, Robert C., M. D., and Miller, John M., M. D. "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation." Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308-14.
- Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Paik, K. S., et al. "Vascular Responses of Korean Ama to Hand Immersion in Cold Water." Journal of Applied Physiology, XXXII, No. 4 (1972), 446-50.
- Petajan, Jack H. and Daube, Jasper R. "Effects of Cooling the Hand and Arm." Journal of Applied Physiology, XX, No. 6 (1965), 1271-74.
- Pickering, G. W. "The Vasomotor Regulation of Heat Loss From the Human Skin in Relation to External Temperature," Heart, XVI, (July, 1932), 115-35, cited by Downey, John A., M. D., Ph. D., Darling, Robert C., M. D., and Miller, John M., M. D. "The Effects of Heat, Cold, and Exercise on the Peripheral Circulation." Archives of Physical Medicine and Rehabilitation, XLIX, (June, 1968), 308-14.
- Sulzberger, Marion B., M. D., et al. "Studies on Blisters Produced by Friction: Results of Linear Rubbing and Twisting Technics." The Journal of Investigative Dermatology, XLVII, No. 5 (1966), 456-65.

- Travell, J. "Ethyl Chloride Spray for Painful Muscle Spasm." Archives of Physical Medicine and Rehabilitation, XXXIII, (1952), 291-98, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Waylonis, G. W. "The Physiologic Effects of Ice Massage." Archives of Physical Medicine and Rehabilitation, XLVIII, (1967), 37-42, cited by Olson, Jane E., M. A. and Stravino, Vincent D., M. D. "A Review of Cryotherapy." Physical Therapy, LII, No. 8 (1972), 840-53.
- Zacarian, Setrag A., M. D. and Adham, Mustafa I., M. D., M. S., F. A. C. S. "Cryogenic Temperature Studies of Human Skin: Temperature Recordings at Two Millimeters Human Skin Depth Following Application with Liquid Nitrogen." The Journal of Investigative Dermatology, XLVIII, No. 1 (1967), 7.

APPENDIXES

Appendix A

NAME

AGE

MAJOR

MINOR

Choose one of the following as the reason you are taking this class.

 General Education requirement Major requirement or option Minor requirement or option Other reason. If so, please state. _____.

Have you ever performed in any level of competitive gymnastics? _____.

If so, describe the highest level of competition you have been in.

If you have not competed, but have had any previous formal instruction
in gymnastics, describe the nature of the instruction. _____

Appendix B

READ THESE INSTRUCTIONS CAREFULLY! Keep this sheet for reference.

During the next two weeks, you are expected to be in class each scheduled period. If you miss class, see the instructor in Room 161 of this building as soon as possible to arrange a make-up session. You may also call University extension 7629 or home phone 752-0978.

Be sure the instructor places a check mark by your name on the roll sheet each time you attend class or a make-up session.

At 20 minutes before the hour, class instruction will begin. By that time you will have finished whatever loosening and stretching exercises you feel are necessary.

The instruction period will proceed as usual. Events covered will be horizontal bar, parallel bars, and rings. Do not go to any other apparatus to practice during the class period.

Anytime during class that you feel your hands getting hot, report to the ice water bath at the south end of the gym. Give your name to the attendant and he will tell you which hand to place in the ice water. He will also tell you when 30 seconds are up, and you will remove your hand. Thoroughly dry your hand on the towel provided and return to practice.

If the skin on either hand tears, report to the attendant at the south end of the gym. He will look at it and provide clippers for you to remove the loose skin. You should also apply disinfectant. If the tear is serious, you will not be allowed to continue practicing on the apparatus that day. Return to the apparatus and observe. If the tear is not serious, the attendant will tell you to return to the apparatus with the option of either participating or observing.

At 10 minutes after the hour, instruction and practice will stop, and you will leave the gym immediately.

Do not practice on the apparatus at any time except during the scheduled class period.

If you have a tear, you should keep vaseline on it continuously for a day or two. This will prevent it from drying and cracking.

It is important that you avoid any prolonged soaking of your hands outside of class. This would include such things as washing dishes, steam baths, or swimming, when such can be avoided. However, this should not be construed as an excuse to miss a swimming class.

VITA

Wayne E. Larson

Candidate for the Degree of

Master of Science

Thesis: Effect of Cryotherapy in Preventing Blistering and Tearing of
Hands of Utah State University Male Gymnasts

Major Field: Physical Education

Biographical Information:

Personal Data: Born August 28, 1946, in Phoenix, Arizona, to
Elliott G. and Clara B. Larson. Married Linda Gayle
Robinson of Phoenix, Arizona. Four children.

Education: Creighton Elementary School, 1952-60.
Phoenix Union High School, 1960-64.
Brigham Young University, 1964-65.
Phoenix College, 1968.
Brigham Young University, 1968-71.
Brigham Young University, 1973, B. S. Degree in
Physical Education, Minor in Driver Education.
Utah State University, 1973-74, M. S. Degree in
Physical Education. Supporting area,
Educational Administration.

Professional Experience: Graduate Assistant 1973-74 at Utah State
University; Instructor for Utah State University Conference
and Institute Division, 1973-74; Instructor for Logan, Utah,
Community School Program, 1973; Instructor for Brigham
Young University Special Courses and Conferences, 1968-69.

CREDITS

(This sheet to be completed and inserted as last page of thesis or dissertation, following Vita, not paginated.)

Typist Elsie Hansen

Address 439 East 4th South

Logan, Utah

Phone 753-3685

Printer Unique Printing Service

Address 374 N. Main

Logan, Utah 84321

Phone 752-0567 or 752-9935