



THE RELATIONSHIP BETWEEN KNEE EXTENSION
STRENGTH AND KNEE INJURY INCIDENCE AMONG
HIGH SCHOOL FOOTBALL PLAYERS

Thesis for the Degree of M. A.
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Randall P. Schrecengost
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**THE RELATIONSHIP BETWEEN KNEE EXTENSION STRENGTH
AND KNEE INJURY INCIDENCE AMONG
HIGH SCHOOL FOOTBALL PLAYERS**

By

RANDALL P. SCHRECENGOST

AN ABSTRACT OF A THESIS

**Submitted to the College of Education of Michigan
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1957

ABSTRACT

Title.

The relationship between knee extension strength and knee injury incidence among high school football players.

Statement of the Problem.

To determine the relationship of static knee extension strength and selected anthropometric measures to the knee injury incidence of high school football players.

More specifically, the problem was to compare the uninjured, previously injured, reinjured, and those players suffering initial knee injuries as to age, weight, year in school, thigh girth, raw static strength, strength per pound of body weight, strength per unit of crural index, and strength per unit of body surface area. In a rather general, survey type approach using these measures it was hoped that the factor or factors contributing to the cause or causes of the injuries could be isolated. It was considered to have merit in light of the rather general opinion that stronger knees have a lower injury incidence.

Methodology.

Five hundred ninety one high school football players from 20 high schools within a 25 mile radius of Lansing,

Michigan were measured. They were selected by their coach as his 30 best players. In schools where there was not 30 boys out for football all of the boys were measured.

The subjects were given a card on which they placed their name, date of birth, years they won football letters, position played, any previous injuries (not minor), year in school, and the name of the school. The testing team then collected the following information: weight, height, upper leg length, lower leg length, thigh girth, and knee extension strength as measured by the tensiometer.

The data was tabulated and punched into IBM cards. The sum of the X's and the sum of the X squares was calculated using the IBM technique. The statistic used was the t test of significance.

Conclusions.

No difference in age, year in school, raw static strength, strength per pound of body weight, strength per unit of crural index, strength per unit of body surface area, or thigh girth were found which could be attributed to factors other than chance which would differentiate the uninjured, those knees previously injured, and those with reinjured knees.

ACKNOWLEDGEMENTS

Appreciation is acknowledged to the author's advisor, Dr. Wayne D. Van Huss, for his constant encouragement and advice during the preparation of this study. Special consideration is given to Richard Berger, Earl Mahoney, and Douglas Stewart who were members of the testing team.

Appreciation is also extended to the subjects and the coaches who were very cooperative.

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August, 1957

DEDICATION

The author wishes to dedicate this thesis to his wife, Jackie and to his daughter, Randy Patricia.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

The problem of knee injuries has long been one of the major hazards of sport. This is particularly true among the high school and college football players of today.

Coaches, players, and trainers have attributed these injuries to such things as (1) newer cleats on the shoes, (2) the harder padding on the head, hips and shoulders which not only permits a player to hit another harder but does damage itself, (3) the change in the basic tactics which call for harder blocks, and more injurious blocks, particularly to the interior linemen, (4) the physical strength of the boys today not being what it was 20 years ago, (5) the use of the automobile to travel instead of walking as far as people did previously, and (6) less physical work done by the boys.

All of the above are broad general statements with little or no scientifically derived evidence to support or disprove them. A large number of these causes can be summed up as "strength" or "power". However, since we are primarily concerned with the knee it should be pointed out that we are dealing

with the muscles which support the knee, namely the quadriceps group. Nowhere in the human body is the functional integrity of a joint so dependent upon muscles for support as it is in the knee.¹

Statement of the Problem.

To determine the relationship of static knee extension strength and selected anthropometric measures to the knee injury incidence of high school football players.

More specifically, the problem was to compare the non-injured, previously injured, reinjured, and those players suffering initial knee injuries on age, year in school, body weight, thigh girth, raw static strength, strength per unit of crural index, strength per unit of body surface area, and strength per pound of body weight. In a rather general, survey type approach using these measures it was hoped that the factor or factors contributing to the cause or causes of the injuries could be determined. It was considered to have merit in light of the rather general opinion that stronger knees have a lower injury incidence.

¹DeLorze, T.L., Watkins, A.L., Progressive Resistance Exercise, New York, Appleton-Century-Crofts, Inc., 1951, p.125.

As Murphy² stated, "Among the injuries attributed to football the most common, especially among young boys, is the wrenched or sprained ankle....the most serious is the wrenched knee". For many years coaches, trainers, doctors, and players have been trying to find a way to cut down the number of knee injuries in football. They have tried many things all the way from the strapping of ankles to climbing stairs but the reasoning in most cases has been speculative.

Limitations.

1. Psychological factor. It is difficult to determine whether the subjects were adequately motivated to apply maximum tension during the strength testing.

2. The subjects were tested during different times of the day. Fatigue may have served to bias the results somewhat.

3. It is not possible to measure exposure to physical contact situations.

Definition of Terms.

Tensiometer³ An instrument used to determine the amount of tension applied to a cable.

²Murphy, M.C., Athletic Training, New York, Chas. Scribner's Sons, 1926, p. 168.

³Manufactured by the Pacific Scientific Company, Inc., 1430 Grand Vista Ave., Los Angeles, California.

Crural Index⁴ An index derived by dividing the upper leg length by the lower leg length.

Knee Injury. Any injury to the knee joint either in a game or at practice that prevented the individual from regular participation for 1 game or for 1 week.

The Sample.

The sample consisted of 591 high school football players from 20 high schools within a 25 mile radius of Lansing, Michigan. These boys measured were considered by the coach at the time to be the 30 best players on his squad or the players he expected to make up his first three teams. However, some of the smaller schools did not have 30 individuals out for football and in such schools, all players were measured.

⁴Cureton, T.K., Physical Fitness Appraisal and Guidance, St. Louis: C.V. Mosby Co. 1947.

CHAPTER II

REVIEW OF THE LITERATURE

To understand the conditions which underlie success in athletics or the accidents and injuries which often occur, a knowledge of the structures and functions of the joints is required. Bowen¹ presents detailed descriptions of the anatomical structures.

Robertson and Hawk² point out that the knee joint is not a simple hinge joint and that the quadriceps are the most active stabilizers of the joint.

Hawley³ states that all joints which permit extensive movements are reinforced by ligaments and muscle tendons. The ligaments may be thin, membranous tissues such as that of the intercostal ligaments; or they may be fibrous cords as in the case of the collateral ligaments in the knee joint. Sometimes they are extremely strong, as in the last example cited, preventing under

¹Bowen, W.P., Applied Anatomy and Kinesiology, The Mechanism of Muscular Movement, Phil., Lea and Febiger, 1950, pp. 175-187.

²Robertson, T.S., Hawk, J.M., "Corrective Therapy in the Surgical Knee", The Journal of the Association for Physical and Mental Rehabilitation, Vol.6, No.1, Sept.-Oct., 1952, p.7.

³Hawley, Gertrude, An Anatomical Analysis of Sports, New York, A.S. Barnes and Co., 1940, p.2.

all normal conditions, any lateral movements of the knee joint. Since ligaments are practically non-extensible they tear rather than stretch when movements which they are designed to check or limit are excessive. This results in a joint sprain. This sprain, along with a tear in the cartilage (usually medially), is quite common among football players. This presents quite a problem because of the severity of the injury and the length of time that the player is disabled.

Football, being a fall sport, presents special difficulties in the matter of pre-season training. Since most joint injuries apparently result from muscles which are too weak to withstand the shocks to the body inherent in the personal contact features of the game as is the opinion of Hawley⁴, the musculature must be specifically trained, "hardened" in preparation for the coming season.

According to the Athletic Accident Benefit Plan Annual Report for 1955-56 of the Michigan High School Athletic Association in which 799 schools were members

⁴Ibid., p.91.

showed that 2,862 allowed injury payments were made of which 88 of the paid claims were injuries to the knee, 54 of which required surgery.⁵

Along the area of things to do to prevent injuries, Warner⁶ states that strong knees are less susceptible to knee injuries and suggests that the boys should walk a distance of two miles every day of practice. Gallagher⁷ on the other hand states that if adolescents are to avoid knee, ankle, and lower back strains to which strenuous activities subject them, they would do well to supplement their games with exercises which are specifically designed to increase the size and power of those muscles which support knee joints and which help to protect the joints from injury. Klein⁸ states that the best protection for ligament strength is muscular strength and in order to accomplish this the muscle groups have to be placed under progressive stress.

⁵Forsythe, C.E., "Athletic Accident Benefit Plan Annual Report for 1955-56", Michigan High School Athletic Association Bulletin, Vol. 33, No. 1, Aug. 1956, pp. 41-55.

⁶Warner, Jack, "Sport Injuries Prevention", Scholastic Coach, Sept. 1954.

⁷Gallagher, J.R., as reported by DeLorme and Watkins, "Adolescents", Progressive Resistance Exercise, New York, Appleton-Century-Crofts, Inc., 1951, p.206.

⁸Klein, K.K., "A Preliminary Study of the Dynamics of Force as Applied to Knee Injuries in Athletics as Related to the Supporting Strength of the Involved Musculature," National Athletic Trainer's Journal, Vol.2, Dec. 1956.

DeLorme⁹ has pointed out that quadriceps muscles to become powerful enough to maintain the stability of the knee without the help of the ligament, must have greater than normal strength built in the involved extremity. Therefore, heavy resistance must be used in cases dependent on muscular support of the knee.

Riedman¹⁰ states that muscle girth is not always proportional to the work done by the muscle....The cause of hypertrophy is not only continuous use but the speed with which such muscle groups are contracted. According to McCloy¹¹ "The person who is markedly underdeveloped is working inefficiently and thus suffers greater fatigue, both locally and generally". Hellebrandt and others¹² have found hypertrophy related to the amount of work done in a unit of time.

⁹DeLorme, T.L., "Restoration of Muscle Power by Heavy Resistance Exercise", Journal of Bone and Joint Surgery, Vol. 27, Oct. 1954, pp. 645-647.

¹⁰Riedman, Sarah R., The Physiology of Work and Play, New York, Dryden Press, 1950, p. 487.

¹¹McCloy, C.H., "How About Some Muscle", Journal of Health and Physical Condition, Vol. 7, 1936, p. 301.

¹²Hellebrandt, F.A., S.J. Hatz, A.M. Parrish, "The Influence of the Unilateral Exercise on the Contralateral Limb", Archives of Physical Medicine, Vol. 27, 1947, p. 76.

In trying to find the effect of systematic weight training on power, strength, and endurance, Capen¹³ compared a weight training group to a required physical education class. The weight training group showed a greater general improvement in muscular strength, although there were no statistically significant differences between the two groups in muscular strength (McCloy's Revision), muscular endurance (chinning, push-ups, sit-ups, and squat jumps), and circulo-endurance (300 yard shuttle run), or in athletic power. The weight training group did, however, excel the required physical education group in all final scores, though not significantly due to the difference in initial scores. Capen concluded that the weight training group improved more in speed events than the required physical education group.

In another experiment, Riedman¹⁴ using rats found that hypertrophy was greater in those animals that ran faster. With the rats running at a moderate speed there was only slight hypertrophy. The important thing was that hypertrophy did not increase with the duration of the exercise, no matter how long the work was done.

¹³Capen, E.K., "The Effect of Systematic Weight Training on Power, Strength, and Endurance", Research Quarterly, Vol. 21, Oct. 1950, p.188.

¹⁴Riedman, Op. Cit., p.488.

She¹⁵ also found that exercise involving strength, speed, or great effort leads to hypertrophy of skeletal muscles and only a small increase in heart mass, whereas exercise for endurance leads to hypertrophy of the heart with a minimum of effect on the skeletal musculature.

Siebert¹⁶ in animal experiments found that the mere repetition of prevailing performance does not lead to the hypertrophy of skeletal muscles. Hypertrophy appears only when the rate of work is increased and power is the decisive factor, not the total amount of work done.

The Cramer Chemical Co.¹⁷ in their literature on the knee states, "There seems to be ample evidence in the literature, and in our own experience, to prove conclusively that the quadriceps muscle group forms the first line of defense against knee injury".

DeLorme¹⁸ found exercise to be essential in restoring function of muscles which were weakened as a result of injury or disease. Hoffman¹⁹ believes that maximum

¹⁵Riedman, Op. Cit., p.490.

¹⁶Siebert, W.W., "Investigations on Hypertrophy of the Skeletal Muscles", Zietschr. F. Klin. Med. 109, 1928, pp. 350-359.

¹⁷The Knee, Gardner, Kansas: The Cramer Chemical Co.

¹⁸DeLorme, Op. Cit., p.645.

¹⁹Hoffman, R., How to be Strong, Healthy, and Happy, York, Pa., Strength and Health Co., 1938, p.388.

strength, and muscular size can be acquired through the use of his method. He advocates three workouts per week using a specified set of exercises with progressively heavier weights to increase the capacity of the muscles to work. His method was empirically determined.

Concerning the use of progressive resistance exercises, DeLorme and Watkins²⁰ stated, "As a general rule, it may be stated that the longer the exercises are continued the smaller the gains in strength. It is not uncommon to double strength the first month or two of exercise and to show a comparatively small increase in the following months".

Gallagher and others²¹ note that the tendency of knee injuries to reoccur is known and that it is all important to combat atrophy and hypotonia of the extensor muscles of the thigh. It is further stated that progressive resistance exercise can restore muscle power lost, and can produce a much greater strength in the supporting muscles than they possessed prior to the incited injury. Along these same lines DeLorme and Watkins²² state that on an average of six weeks following surgery, the patient

²⁰ DeLorme, T.L., Watkins, A.L., Progressive Resistance Exercise, N.Y., Appleton-Century-Crofts, Inc., 1951. p. 27,

²¹ Gallagher, J.R., et.al., "The Use of the Techniques of Progressive Resistance Exercise in Adolescents", Journal of Bone and Joint Surgery, Vol. 31, Oct. '49, p. 847.

²² DeLorme and Watkins, Op. Cit., p. 134.

had recovered normal strength of the quadriceps femoris muscle. They also found that in the 80 patients tested it was by no means possible to restore thigh circumference to normal in such a short time as three weeks, indicating that increasing the efficiency of quadriceps contraction alone may increase strength to a normal level without proportional muscular hypertrophy.

Strength development by any strenuous activity is maintained indefinitely. Little or no reductions have occurred in athletes after stopping progressive resistance exercises for one year.²³ It is interesting to note also that athletes do not develop to maximum just from the strenuous exercises connected with their particular sport. Steinhaus²⁴ reports that a muscle develops in size and strength only as it is overloaded, that is as it is required to exert force against greater resistance than it normally does. DeLorme and Watkins²⁵ said that athletics, even of the most strenuous variety,

²³ DeLorme and Watkins, Op. Cit., p. 132.

²⁴ Steinhaus, A.H., "Some Selected Facts from Physiology to Illustrate Scientific Principles in Athletic Training", College Physical Education Proceedings, 1954, p. 3.

²⁵ DeLorme and Watkins, Op. Cit., p. 132.

do not produce muscular strength of the same degree as do focal progressive resistance exercises. This has been shown repeatedly in quadriceps redevelopment in young football players and trackmen. Even the fastest and most powerful lineman after several years of football have been able to increase quadriceps strength from 50 to 100 per cent in six to eight weeks. Steinhaus²⁶ reported that Bethe and Fisher found in Olympic athletes the greatest strength in those muscle groups which the athletes employed most strenuously in their athletic specialty.

²⁶ Steinhaus, A.H., "Chronic Effects of Exercise", Physiological Reviews, Vol. 13, No. 1, Jan. 1933, p. 104.

CHAPTER III

METHODOLOGY

Introduction

This study was conducted in an endeavor to evaluate the relationship of quadriceps strength to knee injury incidence in high school football players.

The subjects who participated in this experiment were the boys from 20 high schools within a 25 mile radius of Lansing, Michigan who coach thought would be one of the top 30 players on the team. In some cases where there was not 30 boys out for football, all the boys who were out were measured.

Due to the many measurements necessary, various instruments were employed. The measurements recorded and the instrument used were as follows: (1) scales for recording weight, (2) height in inches was measured by a meter stick attached to the wall, (3) a tape measure was used to measure thigh girth, (4) a tape measure was used to measure upper and lower leg length, (5) a table to which the cable for the tensiometer was attached was used to measure strength of the quadriceps.

Experimental Design

An appointment was set with the coach at each of the high schools and the coach was told that we were

interested in measuring the 30 football players whom he thought would play the most. The coach had the players together in some central location (in most cases it was the gymnasium) where the tests were conducted. All tests were conducted the first week of the football season.

The subjects were each given a card on which they placed the following information: name, date of birth, years they won letters in football, position played, any previous injuries (not minor), year in school, name of the high school. After they filled out this information on the card they were started through the testing routine.*

The boys were first weighed. The same calibrated scale was used throughout the testing. Height was measured in inches using a meter stick attached to the wall. A right angle from the meter stick across the top of the head determined the height. All heights were taken with the subjects heels together, standing as tall as possible with a full inhalation. Thigh girth was measured on the contracted thigh six inches above the patella. The upper and lower leg lengths were measured as described by Cureton.¹

¹Cureton, T.K., Physical Fitness Appraisal and Guidance, St. Louis: C.V. Mosby Co., 1947.

* A sample data card is presented in Appendix A

The individuals on the testing team computed the same measurements throughout the data collection.

Quadriceps strength was measured as described by Clarke using Richards'² modifications.^{2,3,4,5,6,7,8,9,10}

The author obtained a .91 coefficient of reliability on the test-retest method for the cable tensiometer.

²Richards, D.B., A Comparison of Cable Tensiometer Strength, 1-RM, and 10-RM Values Obtained in Knee Extension. Unpublished Master's Thesis, Michigan State University, 1955.

³Bovard, J.F., F.W. Cozens, E.P. Hagman, Tests and Measurements in Physical Education, (Third Edition) Philadelphia and London, W.B. Saunders Co., 1950, p. 317.

⁴Clarke, H. Harrison "A Comparison of Instruments for Recording Muscle Strength", Research Quarterly, Vol. 25, No. 4, Dec. 1954, p. 410.

⁵Clarke, H. H., "Improvement of Objective Strength Tests to Muscle Groups by Cable-tension Methods", The Research Quarterly, Vol. 21, No.4, Dec. 1950, pp. 399-419.

⁶Clarke, H. H., Cable Strength Tests, Chicoppe, Mass., Brown-Murphy Co., 1953, p.29.

⁷Clarke, H.H., E.C.Elkins, G.M. Martin, K.G. Wakim, "Relationship Between Body Position and the Application of Muscle Power to the Joints", Archives of Physical Medicine, Vol. 31, Feb. 1950, pp. 81-89.

⁸Carpenter, Aileen, "A Study of the Angles in the Measurement of the Leg Lift", Research Quarterly, Vol. 9, Oct. 1938, pp. 70-72.

⁹DeLorme, T.L., A.L. Watkins, Progressive Resistance Exercise: Technic of Medical Application, New York, Appleton-Century-Crofts, Inc., 1951, p.92.

¹⁰Darcus, H.D., "A Strain Gauge Dynamometer for Measuring the Strength of Muscle Contraction and for Re-educating Muscles", Annals of Physical Medicine, Jan. '53, p.183.

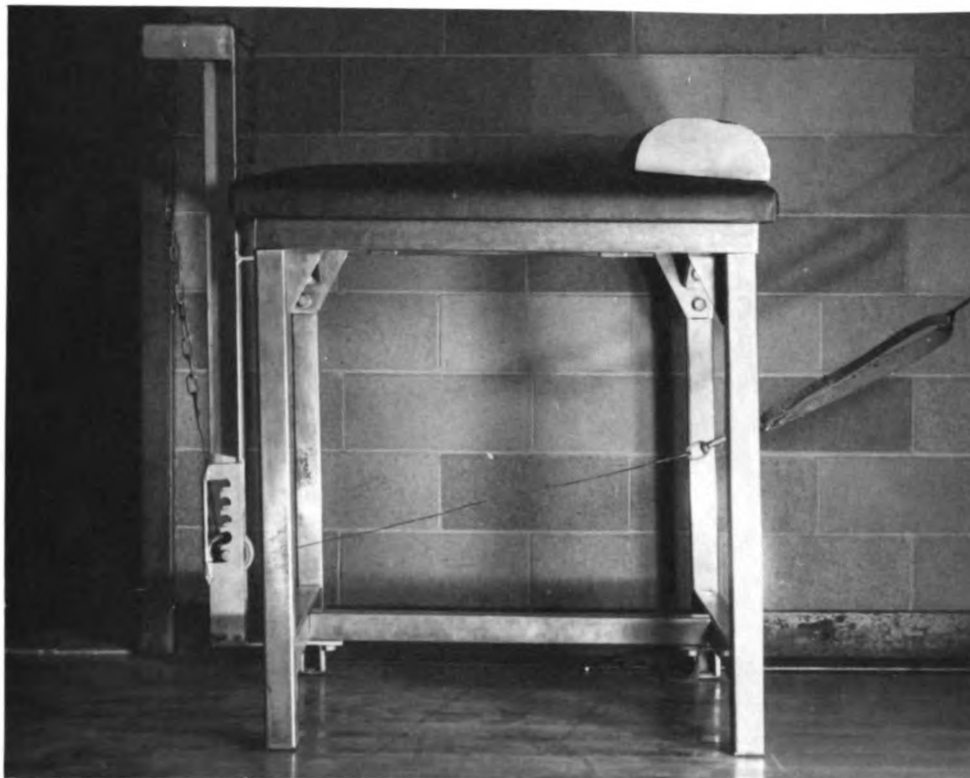


Figure 1. Table used in tensiometer test.

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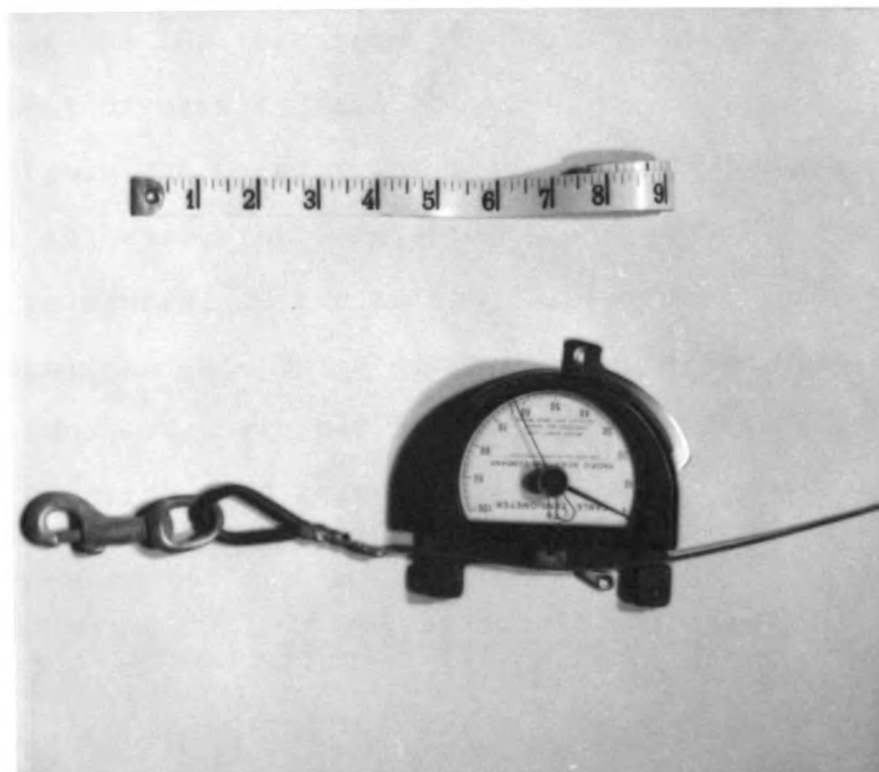


Figure 2. Tensiometer used in tensiometer test and tape measure used to measure thigh girth, upper and lower leg lengths.

Statistical Analysis

The data was tabulated and punched into IBM cards. The sum of the X's and the sum of the X squares was calculated using the IBM technique.¹¹ The statistic used was the t test of significance.¹²

It was possible using these techniques to compare the initial injuries, the uninjured, the previously injured, the reinjured, so far as age, experience, year in school, weight, height, thigh girth, strength per unit of crural index, strength per unit of body surface area, raw static strength, and strength per pound of body weight.

¹¹ Gruenberger, F., Computing Manual, Madison: University of Wisconsin Press. 1953. p. 14.

¹² McNemar, Quinn, Psychological Statistics, New York, John Wiley and Sons, 1949, pp. 223,225.

CHAPTER IV

ANALYSIS AND PRESENTATION OF THE DATA

This study was undertaken to determine the relationship of quadriceps strength to knee injury incidence in high school football players.

Aside from quadriceps strength (raw static strength) other measures such as age, year in school, body weight, strength per unit of crural index, strength per pound of body weight, strength per unit of body surface area, and thigh girth were considered.

A comparison was made between: (1) initial injuries vs. non-injured, (2) total previous injuries vs. non-injured, (3) total previous injuries vs. initial injuries, (4) previous injuries not reinjured vs. initial injuries, (5) previous injuries reinjured vs. initial injuries, and (6) previous injuries reinjured vs. previous injuries not reinjured.

The purpose of this analysis was to determine whether the measures listed above might possibly be related to injury incidence.

Analysis of the Data

Uninjured vs. Initial Injuries.

In the comparison of the 522 uninjured players to the 28 initially injured it was found that the uninjured

were slightly older, .38 of a year; and slightly behind the injured in school. For all practical purposes their body weight was the same. Comparing strength per unit of crural index, and strength per unit of body surface area it was found that the injured were slightly stronger in the previous while the uninjured were slightly stronger in the latter. Thigh girth, raw static strength, and strength per pound of body weight showed that both the injured and uninjured were practically the same so far as these measures were concerned. None of the differences were statistically significant.

TABLE I

A COMPARISON OF THE UNINJURED TO THOSE
INJURED FOR THE FIRST TIME

ITEM	UNINJURED		INITIAL INJURY		t
	Mean	σ	Mean	σ	
AGE	17.09		16.71		0.73
YR./SCH.	2.91		3.25		1.60
WEIGHT	154.5	22.0	153.2	18.2	0.30
ST/CI	187.2	54.1	188.2	40.2	0.09
ST/SA	111.8	43.5	110.0	20.0	0.21
TH. GIRTH	19.15	4.09	19.25	1.09	0.12
RAW ST.	203.5	53.1	204.2	40.7	0.06
ST/WT	1.32	0.29	1.35	0.26	0.47

The following are the abbreviations for the items in all of the tables: Raw St. is raw static strength, YR/SCH. is year in school (1 is Freshman and 4 is senior), ST/CI is strength per unit of crural index, ST/SA is strength per unit of body surface area, ST/WT is the strength per pound of body weight.

Previous Injuries vs. Uninjured.

In the comparison of the 41 previous injuries to the 522 uninjured it was found that those who had been previously injured were slightly stronger so far as the mean scores of the raw static strength is concerned. The mean score of the strength per pound of body weight was the same for both groups. None of the differences were statistically significant.

TABLE II
A COMPARISON OF THE PREVIOUSLY INJURED
TO THOSE UNINJURED

ITEM	UNINJURED		PREV. INJURED		t
	Mean	σ	Mean	σ	
RAW ST.	203.5	53.1	207.5	46.5	0.46
ST/WT	1.32	0.29	1.32	0.25	0.04

Previous Injuries vs. Initial Injuries

In the comparison of the 41 previous injuries to the 28 injured for the first time it was found that those previously injured were slightly stronger so far as mean scores of raw static strength is concerned while the mean scores of strength per pound of body weight shows that the initial injuries occurred in subjects who were slightly stronger. No statistically significant differences were found between the two groups.

TABLE III

A COMPARISON OF THE PREVIOUSLY INJURED TO
THOSE INJURED FOR THE FIRST TIME

ITEM	INITIAL INJURED		PREV. INJURED		t
	Mean	σ	Mean	σ	
RAW ST.	204.2	40.7	207.5	46.5	0.29
ST/WT	1.35	0.26	1.32	0.25	0.45

Previous Injuries Not Reinjured vs. Initial Injuries

In the comparison of the 33 previously injured who were not reinjured to the 28 injured for the first time it was found that the subjects previously injured but not reinjured were slightly stronger so far as the mean score of raw static strength is concerned while a comparison of the mean scores of strength per pound of

body weight showed that there was practically no difference between the two groups. No statistically significant differences were found between the two groups.

TABLE IV

A COMPARISON OF THE PREVIOUSLY INJURED BUT
NOT REINJURED TO THOSE INJURED
FOR THE FIRST TIME

ITEM	INITIAL INJURY		PREV. INJ. NOR REINJ.		t
	Mean	σ	Mean	σ	
RAW ST.	204.2	40.7	209.0	47.4	0.41
ST/WT	1.35	0.26	1.34	0.26	0.10

Reinjured vs. Initial Injuries

A comparison of the mean scores of these two groups shows that the initial injury group is slightly stronger in raw static strength and strength per pound of body weight. The mean scores also show that the initially injured are on the average somewhat lighter. None of the differences were statistically significant.

TABLE V

A COMPARISON OF THE PREVIOUSLY INJURED AND REINJURED TO
THOSE INJURED FOR THE FIRST TIME

ITEM	INITIAL INJURY		PREV. INJ. REINJ.		t
	Mean	σ	Mean	σ	
RAW ST	204.2	40.7	201.2	42.8	0.17
ST/WT	1.35	0.26	1.23	0.20	1.19
WEIGHT	153.2	18.2	161.2	12.3	1.13

Reinjured vs. Previously Injured Not Reinjured

A comparison of the mean scores of these two groups showed that the subjects who were previously injured but not reinjured were slightly stronger in all five of the comparisons involving weight and strength while those previously injured and not reinjured were slightly lower so far as crural index is concerned. No significant differences were found.

TABLE VI

A COMPARISON OF THE PREVIOUSLY INJURED AND REINJURED
TO THOSE PREVIOUSLY INJURED AND NOT REINJURED

ITEM	PREV. INJ. NOT REINJ.		PREV. INJ. REINJ.		t
	Mean	σ	Mean	σ	
RAW ST	209.0	47.4	201.2	42.8	0.41
ST/WT	1.34	0.26	1.23	0.20	1.12
TH. GIRTH	21.27	10.62	17.62	6.74	0.90
ST/SA	116.6	42.5	105.0	21.2	0.73
CRURAL IND.	1.09	0.08	1.10	0.06	0.19

Discussion.

In completing the statistical analysis of the data none of the variables were significant. In other words none of the variables were significantly sensitive to differentiate the groups as to injury incidence whether there had been a previous injury or not. The results obviously require limitation to the procedures used in the present study.

The reasons why the results are of this nature are not known. A possibility is that the number of injury situations in which any knee could have been injured were greater than the number in which the relative strength might have been a factor that only these differences were shown. This, however, can not be implied from the results as the circumstances are not known.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary.

Five hundred ninety one high school football players were tested and measured in order to get their age, height, weight, football experience, position played, upper leg length, lower leg length, thigh girth, and strength which was measured with the tensiometer.

They were then compared so far as uninjured, those injured for the first time, those injured previously, those injured previously who were reinjured, those injured previously who were not reinjured. These groups were compared in an attempt to isolate the factor or factors associated with knee injury incidence.

Conclusions.

1. No differences in age, year in school, thigh girth, raw static strength, strength per pound of body weight, strength per unit of body surface area, or strength per unit of crural index were found which could be attributed to factors other than chance which would differentiate the uninjured, those with knees previously injured, and those with reinjured knees.

Recommendations.

1. Further study should be conducted in which a record of exposure and a record of severity of injury

are included.

2. A similar study be conducted on the college level with the mentioned limitations removed and the exposure and severity included.

3. A long range study to be conducted with matched groups both control and experimental in which the legs of the control group would have no special progressive resistance exercise while the experimental group would be under a program to actually improve the strength of the quadriceps group and an extensive comparison made.

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APPENDIX

CARD FOR RECORDING DATA

Serial No.Last Name First Name M.I. SchoolDate of Birth Yrs. Exp. Yr. in schoolPosition Any Previous InjuriesWeight Height Tensiometer #1 #2Foreleg Length Upper Leg Length IndexSeason ResultsThigh Girth

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