THE EFFECT OF SELECTED DAILY ACTIVITIES ON THE KNEE EXTENSION STRENGTH AND INJURY INCIDENCE OF HIGH SCHOOL FOOTBALL PLAYERS

Thesis for the Degree of M. A.

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by

Johnny Mitchell Hinton

AN ABSTRACT

Submitted to the College of Education of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF ARTS

Department of Health, Physical Education, and Recreation

1957

Approved_____

ABSTRACT JOHNNY MITCHELL HINTON

Title. The Effect of Selected Daily Activities on the Knee Extension Strength and Injury Incidence of High School Football Players.

Statement of the Problem. To determine the effect of selected daily activities on knee extension strength and knee injury incidence.

Methodology. The static knee extension strength and body weight were measured on a sample of two hundred eleven high school football players from twelve high schools within a twenty-five mile radius of Lansing, Michigan prior to the 1955 football season. During the football season a record was made of all knee injuries. The players were also given a questionnaire on which they recorded daily activities, i.e., distance walked per day, ownership of car, et cetera. The quantitative strength results and injury data for the subjects' responses on the questionnaire were then statistically analyzed using analysis of variance and the chi square techniques.

Conclusion. No statistically significant differences were found in questionnaire response on knee extension strength or knee injury incidence. These results would tend to refute the prevailing concept of "automobile knees" being the cause of the high knee injury incidence.

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CHAPTER I

INTRODUCTION OF THE PROBLEM

Football is probably the outstanding sport in the United States at both the college and high school levels. Forsythe states that 799 high schools of Michigan play football at the varsity or intramural levels.[1]

Since the frequency of participation is high in this particular sport, it is of major concern that it also produces the greatest number of knee injuries.

There were seventy knee injuries for which athletic insurance claims were paid among Michigan high school football players during the season of 1956. Fourteen of these injuries required surgery.[2]

Logan believes that knee injuries present the most difficult problem in athletic training.[3] The prevalence of knee injuries in football, basketball, baseball, and hockey, indicates the seriousness of the problem and places unusual responsibilities on the coach.

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[1]Charles E. Forsythe, "Athletic Accidents," Michigan High School Athletic Association Bulletin, XXXIII (August, 1956), 48.

[2]Ibid., p. 25.

[3]Gene A. Logan and Ronald F. Logan, Techniques of Athletic Training (Los Angeles: Franklin-Adam Press, 1952), p. 4.

If some means of preventing or minimizing knee injuries could be found, it might be helpful to both the participants and the coaches. It was primarily for this reason the present research project was carried out.

The Problem

Statement of the Problem. To determine the effect of selected daily activities on static knee extension strength and knee injury incidence.

The Need for This Study. Methods are needed to prevent the high incidence of knee injuries and to understand factors contributing to this high incidence.

Source of Data. Two hundred and eleven varsity football players from twelve Michigan high school located within a radius of twenty-five miles of Lansing, Michigan, served as subjects for this investigation.

Definition of Terms Used

Knee Injuries. Any knee injury which kept players out of action for two weeks or more.

Selected Daily Activities. The activities about which information is sought on the questionnaire.

Static Knee Extension Strength. The ability of the extensor muscles of the leg to apply tension at 110° of extension.[4]

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[4]H. H. Clarke, Cable Tension Strength Tests (Chicopee, Massachusetts: Brown Murphy Co., 1953), pp. 12-15.

Procedure Used in Carrying Out This Study

Prior to the 1955 football season, two hundred eleven subjects' static knee extension strength and weight were measured. Following these measurements, it was considered information regarding the players' daily activities would be of interest. From the review of related literature and contact with coaches, doctors, and trainers, a questionnaire was then prepared. A copy of the questionnaire is included in Appendix A.

The questionnaires were taken to the respondents at each school at the completion of football season. After collecting the questionnaires, an analysis of the data was begun. The data obtained were organized, tabulated, and statistically analyzed.

Limitations. The limitations of this study are as follows:

1. The results are limited to static strength only.
2. Restriction of the sample to one geographical location.

CHAPTER II

A REVIEW OF RELATED LITERATURE

The literature reported has been organized into the following sections:

1. Prevention of knee injuries.
2. Exercise and procedures for strengthening and rehabilitating players.

In searching the literature, no quantitative evidence was found relating activities or strength of football players to knee injuries. Some opinionated material is available, but very little quantitative evidence can be found. As an example Warner states that strong knees are less susceptible to knee injury. He further indicates the boys should engage in activities of walking a distance of two miles or more every day during the first week of practice and, if the boys seem to be progressing well, the distance may be increased.[1]

Prevention of Knee Injuries

Ochsenhirt thinks that it is important to give proper attention to the young athlete. When he calls attention to the susceptibility of adolescents to injuries, Ochsenhirt states:

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[1]Lt. Jack Warner, "Sport Injuries Prevention," Scholastic Coach, September, 1954, p. 39.

> The adolescent years are fruitful, yet dangerous for the athlete. The structure of his body is developing, but has not reached physical maturity. For example, long bones are more susceptible to fractures, epiphyseal separations, dislocations, etc. The judgment of a qualified roentgenologist is necessary too in X-ray evaluations. Frequently, young tissues although fresh, virile and flexible, have neither matured, nor have they been trained sufficiently to develop tensile strength so necessary for the stresses they must withstand.[2]

Gallagher[3] states that if adolescents are to avoid knee, ankle, and low 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 joints and help to protect the joints from injury.

Bilik states that pre-season conditioning is fundamental in the prevention of subsequent mishaps.[4] He observes that men who will not take time to get "in condition" will be "out of condition," will grow stale, or may be easily injured.

Gallagher further points out that conditioning exercises, attention to the proper fitting of shoes, and the proper use of adhesive strapping are a few of the important matters

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[2]N. C. Ochsenhirt, "Prevention and Management of Athletic Disabilities," Archive of Physical Medicine, XXXIV (March, 1953), 158.

[3]Roswell Gallagher, Adolescents' Progressive Resistance Exercise, in Thomas L. Delorme & Arthur L. Watkins ed. (New York: Appleton-Century Crofts, Inc., 1951), p. 206.

[4]S. E. Bilik, "Athletic Training and the Treatment of Athletic Injuries," Illinois Medical Publication, 31, (December, 1930), 79, Archives Physical Medicine and Rehabilitation, 34 (March, 1953), 158.

to consider in the attempt to control the knee injuries connected with such a game as football.[5]

Thorndike states that special exercises divised by Raycroft and Crisler at Princeton for increasing the strength of the knee and ankle joints are distinctly beneficial and good prophylaxis for any squad in early season training.[6]

McCloy believes that sport injuries to joints, such as the knee are caused by strains which are placed on the ligaments of the joints, and are, consequently, too much to be borne by the ligaments, and hence give way with a rupture of the ligament, either partial or complete.[7] In the case of the knee, these injuries may be to the medial or lateral collateral ligaments, to the posterior cruciate ligament, or tears of the meniaci between the femur and tibia.

McCloy lists two types of procedures that can help to prevent such injuries. The first procedure is to greatly strengthen the muscles passing the joints. For example, in the knee one needs to strengthen the quadriceps and the hamstrings.[8]

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[5]Gallagher, op. cit., p. 222.

[6]Augustus Thorndike, Athletic Injuries (Philadelphia: Lea and Febiger, 1956), p. 58.

[7]H. C. McCloy, "Knee Injuries," Exercise Program to Strengthen Ligaments of Knees and Ankles (Iowa City: State University of Iowa Press, January, 1957), pp. 1-2.

[8]Ibid., p. 1

The second type of procedure is to strengthen the ligaments directly. McCloy further states:

> To strengthen (and hypertrophy) ligaments progressive strains should be put on them. One illustration is found in the operation used by orthopedists; this purpose is to compensate partially for the disability of children in whom there is total paralysis of the abdominal muscles due to poliomyelitis but in whom the thigh flexor muscles are intact. Here, a strip of fascia latae is often removed from each thigh and implanted under the skin of the abdomen, attached from the lower ribs to the pubis. After several months, these strips of fasciae latae hypertrophy and unite after treatment and are fifty per cent wider and several hundred per cent thicker than they were when implanted. This same thing can happen to ligaments of knee and ankle when progressively greater and greater stresses are systematically applied.[9]

McCloy states further:

> In addition to the support given to the knee joint, by the strengthening of the muscles passing the knee joint, another phenomenon is noted. . . . The vastus medalis and the vastus lateralis insert not only on the patella with the rest of the quadriceps, they insert also in retinaculum patella, associated with the capsular ligament of the knee, and blending posteriorly into the collateral ligaments; hence, when the quadriceps muscles are greatly strengthened these ligaments of the knee are also strengthening.[10]

Regarding the techniques for strengthening the ligament of the knee and ankle, McCloy states:

> One of the best techniques is to use "iron boots" with attached weights. Here the subject first sits on a bench with a pad under the knee of the foot to which the iron boot is attached. The weight should at first be about one-half of what the subject can lift ten times by extending the lower leg fully. He should lift this weight ten times, then increase the weight as many times as possible. After a further rest of about two minutes, he should again lift this weight a maximum number of times. When the subject can lift it from twelve to fourteen times,

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[9] Ibid., p. 1

[10] Ibid., p. 3.

> the weight should be increased until he can lift it only eight to ten times. The second technique is to pair the subjects off, and have each offer resistance to the other of the pair.[11]

McCloy has found:

> Exercises such as these not only result in the strengthening of the ligaments of the knee, but also add from 50 to 90 per cent to the strength of the muscles of the leg--a factor not entirely useless to football.[12]

Delorme and Watkins as reported by Klein state that numerous authors concur in the values of specific exercises for injury prevention, but few have outlined specific procedures for accomplishing the desired goals for massive muscular strength, and power for reducing the effect of medial and lateral hinging which is highly responsible for the medial and lateral ligament and cartilage problems.[13] There is also an apparent lack of emphasis on related literature on the importance of muscular flexibility relative to its value as an important phase of the conditioning efforts.

Klein further points out:

> In order for the exercise technique to have the relative value as applied in progressive resistive exercise, some of the following points should be considered:
>
> 1. The muscle groups have to be placed under progressive stress.
> 2. The exercise should have some semblance of individual prescription.

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[11] Ibid., p. 2.

[12] Ibid., p. 3.

[13] Karl K. Klein, "A Preliminary Study of the Dynamics of Force As Applied to Knee Injury in Athletics as Related to the Supporting Strength of the Involved Musculature," National Athletic Trainers' Journal (December, 1956), passim.

3. The exercise should be resistive enough to work in the strength power areas of development as well as to consider endurance qualities.

4. The exercise should be able to develop desired qualities of strength and power at a rapid rate so the protective qualities may be developed early in, or previous to, the competitive season.[14]

Colthard sums up the problem by emphasizing strong musculature for injury prevention in that the joint is more firmly bound together and lateral movement is reduced.[15] He states further that good muscle tone will tend to lessen injury when a player who is relaxed is hit on the field.[16]

Exercises and Procedures for Strengthening and Rehabilitating Players

Gallagher states that the tendency of knee injuries to recur if well known and hence the need for combating the atrophy and hypotonia of the extensor muscles of the thigh which accompany these injuries is most important.[17] Gallagher further observed that whether or not the ligaments are torn, whether or not the cartilage is damaged or removed, the most important

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[14] Ibid., pp. 3-4

[15] A. L. Coulthard, "Football Conditioning," Athletic Journal, XXXIII, No. 9 (May, 1953), 4.

[16] Ibid., p. 4.

[17] Thomas L. DeLorme and J. Roswell Gallagher, "The Use and Techniques of Progressive-Resistance Exercise in Adolescence," Journal of Bone and Joint Surgery, A: 847, 1949, p. 31.

part of the after-care of knee injuries is the development of strength in the quadriceps.[18] Recommended exercises, such as quadriceps setting, straight-leg raising, and walking are valuable in the early after-care of knee injuries and will gradually improve the power of the quadriceps; however, to prevent a recurrence of injuries, it seems logical to us to strive for more than a return to former strength. In regard to the importance of exercises in the restoring of strength to muscles, Gallagher further states that:

> Progressive-resistance exercises can restore the power lost and can produce a much greater strength in the supporting muscles than they possessed prior to the initial injury.[19]

Watkins[20] points out that exercises which are regular, systematic, and have natural rhythm will tend to thicken and toughen the sarcolemma of muscle fibers. These exercises will also increase the amount of connective tissues within the muscle. It is observed, however, that there is an increase in muscle size, but not an increase in the number of muscle fibers. The merits of stretching muscles in a strengthening program is expressed by Delorme when he states that:

> The loads to be overcome when performing progressive resistance exercise may stretch the muscles concerned beyond their normal resting length. This is advantageous.

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[18] DeLorme and Watkins, op. cit., p. 208.

[19] Ibid., p. 208.

[20] K. G. Watkins, "The Physiological Aspect of Therapeutic Physical Exercise," Journal of American Medical Association, 142 (January 14, 1950), 104-106.

> It has long been recognized that skeletal muscles develop greater force after they are previously stretched. Their elasticity appears to be sufficiently high to resist tearing by loads and are capable of being lifted under the conditions specified in the technic of application. Trauma of this type is never observed in properly administered progressive resistance exercise.[21]

West observes that experiences with 34 knee instability patients supports Watson Jones in his claim that following severe ligamentor injury, the patient may even return to strenuous athletics if the quadriceps muscle power has been completely restored.[22]

West expresses further that protection of an unstable knee by a brace is indicated only after surgery and maximum redevelopment of the quadriceps femoris muscle has failed to yield a serviceable knee.[23]

Thorndike has found that until the quadriceps return to their usual strength, the affected knee is not stable.[24]

West reports that no mechanical device could possibly stabilize the knee as effectively as powerful quadricep muscles.[25]

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[21]Thomas L. DeLorme and Arthur L. Watkins, Progressive Resistance Exercise (New York: Appleton-Century Crofts, Inc., 1951), p. 10.

[22]Francis E. West, reported by Thomas L. DeLorme and Arthur L. Watkins, "The Knee," Progressive Resistance Exercise (New York: Appleton-Century Crofts, Inc., 1951), p. 125.

[23]Ibid., p. 125.

[24]Augustus Thorndike, "Injuries to the Knee," Athletic Injuries (Philadelphia: Lea and Febiger Company, 1956), p. 206.

[25]West, op. cit., p. 125.

DeLorme observes that no joint ever completely recovers from a severe injury.[26] The least one can do is to attempt to protect it by developing the supporting muscles to their maximum. With regard to the effect of progressive resistance exercise technique, DeLorme reports that:

> In observing 47 boys at Phillips Academy who were taking progressive resistance exercise in an attempt to increase the power of their quadriceps only 3 of the 47 boys had a recurrence of knee injury, despite the fact that most of them were very active individuals in athletics.[27]

DeLorme further observed that one can be sure that the probability of a second injury is materially reduced when a high degree of quadriceps strength is achieved.[28]

Klein states that the use of progressive resistance exercise as a post injury technique is a scientific method of approach in establishing maximum muscular function.[29] Klein further thinks that the problem of rebuilding the muscles to their normal strength after injury does not particularly need specific technique of application, but once this normal level is reached systematic progressive resistance exercise is needed to build toward maximum muscular strength. It is further believed by Klein that due to the known characteristics of muscles, atrophy of the quadriceps and the hamstring muscles

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[26] DeLorme and Watkins, op. cit., p. 209.

[27] Ibid., p. 217 [28] Ibid., p. 217.

[29] K. K. Klein, "A Preliminary Study of the Dynamics of Force as Applied to Knee Injury in Athletics as Related to the Supporting Strength of the Involved Musculature," Athletic Journal, 1, No. 1 (December, 1956), 3.

groups, the application of progressive resistive exercise from the early restoration phase to completion of the program will produce maximum strength.[30] These results may be anticipated within a period of four to eight weeks of exercise on a basis of three exercise periods per week.

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[30] Ibid., p. 3.

CHAPTER III

METHODOLOGY

Development of the Questionnaire

Following the literature review on knee injuries, individual conferences were held with coaches, doctors, and trainers, and a number of possible causes of knee injuries were listed. The questionnaire was then prepared to obtain information regarding these possibilities (Appendix A).

Contacting Respondents

The list of schools contacted was a part of the sample used by Schrecengost.[1] This list made it possible to compose the qualitative questionnaire data to the more precise quantitative strength data. The subjects' static knee extension strength was measured preseason as described by Clarke[2] and modified by Richards. The weight was also measured. The purpose of the study was explained in detail to the school

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[1]Randall P. Schrecengost, "The Relationship Between Knee Extension Strength and Knee Injury Incidence Among High School Football Players" (unpublished Master's thesis, Michigan State University, East Lansing, 1957).

[2]H. H. Clarke, Cable Tension Strength Tests (Chicopee, Massachusetts: Brown Murphy Co., 1953), pp. 12-15.

authorities and permission granted in each case to make the investigation.

Distribution of Questionnaire

The questionnaires were taken to the schools participating in the investigation. They were explained in detail to the subjects prior to filling them out. The questions were explained as to meaning. Aid was given when needed in completing the questionnaire. Two hundred and eleven players were contacted and their completed questionnaires provided the qualitative data for this study.

Tabulation of Data

The questionnaires were numbered and the data tabulated on I.B.M. sheets and checked for accuracy. The data were then punched into I.B.M. cards and verified.

Statistical Analysis

The data were then sorted according to question. For each of the responses the necessary data were recorded or calculated for analysis of variance[4] of the quantitative data or chi square[5] analysis of the qualitative data. For the latter,

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[4]G. W. Snedecor, Statistical Methods (Ames, Iowa: The Iowa State College Press, 1956), pp. 240, 242.

[5]Quinn, McNemar, Psychological Statistics (New York: John Wiley and Sons, Inc., 1949), pp. 207-210.

the total injuries and knee injuries were merely counted. For the analysis of variance, the sum of the X's and sum of the X squares were calculated. The remaining portions of the analysis were completed using a hand calculator.

CHAPTER IV

ANALYSIS AND PRESENTATION OF THE DATA

Introduction

This study was undertaken to determine the effect of selected daily activities on knee extension strength and knee injury incidence of high school football players. Raw static strength, strength per pound of body weight, total injuries, and knee injuries were considered.

A comparison was made between the four items listed above and (1) place of residence, (2) distance of residence from school, (3) means of transportation to school, (4) distance walked per day, (6) frequency of bicycle riding, (7) personal ownership of car, (8) frequency using parents' car, (9) after school job, (10) hours devoted to after school job, (12) types of after school jobs, (13) special job assigned around home, (14) summer job, (15) hours devoted to summer job per week, (16) types of summer jobs, (17) the distance which can be swum, (18) frequency of swimming during summer, (19) farm work, (20) participating in other sports, and (35) wearing of knee brace or wraps.

Analysis of the Data

Prior to the football season static knee extension strength[1] and weight measures were made on two hundred eleven football players from twelve high schools within a 25 mile radius of Lansing, Michigan. Following the football season, the same subjects were given the questionnaire being investigated in this study.

The data were sorted according to questionnaire responses, and the quantitative raw static strength and strength per pound of body weight data were statistically analyzed by the analysis of variance technique.[2] The quantitative total injury and knee injury data were statistically analyzed using the chi square techniques.[3]

Presentation of Data

The data are presented in Tables 1 to 19 arranged according to questionnaire responses. Where statistical significance exists, the "F" value or chi square value is asterisked. The probability level desired for significance was the five per cent level. In other respects, the tables are self-explanatory in nature. There were no responses to questions 5 and 11.

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[1]H. H. Clarke, Cable Tension Strength Tests (Chicopee, Massachusetts: Brown Murphy Co., 1953), pp. 12-15.

[2]G. W. Snedecor, Statistical Methods (Ames, Iowa: The Iowa State College Press, 1956), pp. 240, 242.

[3]Quinn McNemar, Psychological Statistics (New York: John Wiley and Sons, Inc., 1949), pp. 207-210.

TABLE I

PLACE OF RESIDENCE

	City	Small Town	Country	Farm	"F" Value
Strength Data					
Raw Strength (M)	208	198	208	206	Within variance greater than between
St/Lb Body Wt. (M)	1.33	1.28	1.34	1.34	Within variance greater than between
Injury Data					Chi Square Values
Total Injuries	16	10	10	15	2.10
Knee Injuries	9	9	4	9	.33
	N=69	N=56	N=30	N=56	

TABLE II

DISTANCE OF RESIDENCE FROM SCHOOL

	0-1/4 Mile	1/4-1/2 Mile	1/2-3/4 Mile	3/4-1 Mile	Over 1 Mile	"F" Value
Strength Data						
Raw Strength (M)	196	202	216	192	210	1.28
St/Lb Body Wt. (M)	1.27	1.32	1.36	1.26	1.35	1.10
Injury Data						Chi Square Values
Total Injuries	5	7	5	6	28	3.73
Knee Injuries	4	5	3	4	15	1.55
	N=42	N=24	N=22	N=23	N=100	

TABLE III

MEANS OF TRANSPORTATION TO SCHOOL

	Walk	Bike	Bus	Car	"F" Value
Strength Data					
Raw Strength (M)	196	210	202	215	2.30
St/Lb Body Wt. (M)	1.28	1.40	1.29	1.38	2.04
Injury Data					Chi Square Values
Total Injuries	18	0	13	20	2.26
Knee Injuries	11	0	6	14	1.12
	N=90	N=1	N=38	N=82	

TABLE IV

DISTANCE WALKED PER DAY

	1 Mile	2 Miles	3 Miles	4 Miles	Over 5 Miles	"F" Value
Strength Data						
Raw Strength (M)	204	208	201	202	192	Within variance greater than between
St/Lb Body Wt. (M)	1.31	1.34	1.31	1.35	1.24	Within variance greater than between
Injury Data						Chi Square Values
Total Injuries	10	19	6	6	5	1.98
Knee Injuries	5	14	3	5	3	4.23
	N=59	N=71	N=30	N=21	N=17	

TABLE VI

FREQUENCY OF BICYCLE RIDING

	Every Day	3-4 Times Per Week	1-2 Times Per Week	Less Than Once Per Week	When Car Unavail-able	"F" Value
Strength Data						
Raw Strength (M)	214	168	189	200	217	1.47
St/Lb Body Wt. (M)	1.30	1.15	1.29	1.31	1.38	Within variance greater than between
Injury Data						Chi Square Values
Total Injuries	0	0	3	12	7	.52
Knee Injuries	0	0	1	7	5	1.14
	N=8	N=4	N=15	N=43	N=25	

TABLE VII

PERSONAL OWNERSHIP OF CAR

	Yes	No	"F" Value
Strength Data			
Raw Strength (M)	215	199	5.14
St/lb. Body Wt. (M)	1.36	1.26	3.98
Injury Data			Chi Square Values
Total Injuries	15	35	1.63
Knee Injuries	9	22	1.22
	N=81	N=128	

TABLE VIII

FREQUENCY OF USING PARENT'S CAR

	Week Ends	Several Times Per Week	Special Occasions	Any Time	Never	"F" Value
Strength Data						
Raw Strength (M)	200	200	207	215	192	1.50
St/Lb BodyWt. (M)	1.27	1.30	1.36	1.37	1.24	1.63
Injury Data						Chi Square Values
Total Injuries	10	7	10	15	8	.67
Knee Injuries	5	6	6	9	5	.10
	N=34	N=35	N=36	N=59	N=32	

TABLE IX

AFTER SCHOOL JOB

	Yes	No	"F" Value
Strength Data			
Raw Strength (M)	202	207	Within variance greater than between
St/Lb Body Wt. (M)	1.31	1.34	Within variance greater than between
Injury Data			Chi Square Values
Total Injuries	24	26	.10
Knee Injuries	17	14	.25
	N=104	N=103	

TABLE X

HOURS DEVOTED PER WEEK TO AFTER SCHOOL JOB

	1-3	4-6	7-10	10-15	More Than 15	"F" Value
Strength Data						
Raw Strength (M)	181	201	215	194	123	3.95
St/Lb Body Wt. (M)	1.27	1.34	1.35	1.30	1.26	Within variance greater than between
Injury Data						Chi Square Values
Total Injuries	0	6	5	6	14	1.67
Knee Injuries	0	3	1	5	10	3.28
	N=11	N=15	N=26	N=25	N=48	

TABLE XII

TYPE OF AFTER SCHOOL JOB

	Heavy Lifting	Running Errands	Mild Work	"F" Value
Strength Data				
Raw Strength (M)	206	187	196	1.24
St/Lb Body Wt. (M)	1.33	1.20	1.28	1.14
Injury Data				Chi Square Values
Total Injuries	18	1	13	1.97
Knee Injuries	13	1	6	3.43
	N=62	N=9	N=68	

TABLE XIII

SPECIAL JOBS ASSIGNED AROUND HOME

	Yes	No	"F" Value
Strength Data			
Raw Strength (M)	204	206	Within variance greater than between
St/Lb Body Wt. (M)	1.31	1.33	Within variance greater than between
Injury Data			Chi Square Values
Total Injuries	36	14	.05
Knee Injuries	22	8	.10
	N=147	N=61	

TABLE XIV

SUMMER JOB

	Yes	No	"F" Value
Strength Data			
Raw Strength (M)	204	288	Within variance greater than between
St/Lb Body Wt. (M)	1.32	1.38	1.09
Injury Data			Chi Square Values
Total Injuries	42	9	1.84
Knee Injuries	25	6	1.81
	N=185	N=24	

TABLE XV

HOURS DEVOTED PER WEEK TO SUMMER JOBS

	0-5	6-10	11-20	21-30	31-40	Over 40	"F" Value
Strength Data							
Raw Strength (M)	190	210	177	198	205	212	1.57
St/Lb Body Wt. (M)	1.35	1.33	1.19	1.27	1.33	1.35	1.13
Injury Data							Chi Square Value
Total Injuries	0	0	0	3	10	31	4.28
Knee Injuries	0	0	0	2	6	18	2.13
	N=4	N=7	N=15	N=19	N=55	N=91	

TABLE XVI

TYPE OF SUMMER JOB

	Light	Medium	Heavy	"F" Value
Strength Data				
Raw Strength (M)	198	202	206	Within variance greater than between
St/Lb Body Wt. (M)	1.25	1.33	1.33	Within variance greater than between
Injury Data				Chi Square Values
Total Injuries	3	6	35	5.85
Knee Injuries	2	4	20	1.62
	N=22	N=45	N=126	

TABLE XVII

THE DISTANCE WHICH CAN BE SWUM

	25 Yards	25-50 Yards	50-75 Yards	75-100 Yards	Over 100 Yards	Can't Swim	"F" Value
Strength Data							
Raw Strength (M)	207	206	200	198	206	202	Within variance greater than between
St/Lb. Body Wt. (M)	1.37	1.32	1.29	1.32	1.32	1.32	Within variance greater than between
Injury Data							Chi Square Values
Total Injuries	1	5	1	8	32	4	3.00
Knee Injuries	0	3	1	5	19	3	1.57
	N=10	N=24	N=12	N=22	N=129	N=14	

TABLE XVIII

FREQUENCY OF SWIMMING DURING SUMMER

	Every Day	5-6 Days	3-4 Days	1-2 Days	0 Days	"F" Value
Strength Data						
Raw Strength (M)	200	182	210	207	222	1.66
St/Lb Body Wt. (M)	1.32	1.20	1.32	1.34	1.50	1.85
Injury Data						Chi Square Values
Total Injuries	8	7	10	22	3	4.62
Knee Injuries	5	4	5	12	2	4.08
	N=27	N=21	N=60	N=94	N=6	

TABLE XIX

FARM WORK IN SUMMER

	Yes	No	"F" Value
Strength Data			
Raw Strength (M)	210	200	1.93
St/Lb. Body Wt. (M)	1.34	1.30	Within variance greater than between
Injury Data			Chi Square Values
Total Injuries	27	22	1.31
Knee Injuries	15	15	.11
	N=97	N=109	

TABLE XX

PARTICIPATION IN OTHER SPORTS

	Base-ball	Basket-ball	Tennis	Golf	Track or X-Country	Wres-tling	Swim-ming	Multi-ple	"F" Value
Strength Data									
Raw Strength (M)	203	196	214	0	217	202	196	200	Within variance greater than between
St/Lb. Body Wt. (M)	1.36	1.25	1.26	0	1.38	1.38	1.26	1.30	Within variance greater than between
Injury Data									Chi Square Values
Total Injuries	5	3	1	0	14	0	2	19	2.89
Knee Injuries	2	2	0	0	5	0	2	15	1.30
	N=23	N=16	N=5	N=0	N=38	N=5	N=5	N=84	

TABLE XXI

WEARING OF KNEE BRACES OR WRAPS

	Yes	No	"F" Value
Strength Data			
Raw Strength (M)	202	206	Within variance greater than between
St/Lb. Body Wt. (M)	1.27	1.33	Within variance greater than between
Injury Data			Chi Square Values
Total Injuries	23	27	121.23 **
Knee Injuries	9	19	28.46 **
	N=13	N=181	

* = Significant at 5% level.

** = Significant at 1% level.

Discussion

Examination of the tables reveals no differences that are significant except the data presented in Table 19. The results presented in Table 19 in regard to the wearing of knee braces were not surprising. The fact that the greater number wearing braces were injured was expected, as the players in all probability knew a weakness existed or had been injured previously, or they would not have been wearing a brace.

Much has been said about "automobile knees, that the boys ride too much and don't work as hard as the boys did several decades ago. These statements are refuted insofar as this sample is concerned, both in regard to strength and injury incidence. The complete refuting of these statements, however, would be questionable on the basis of these data, only static strength was measured. It is possible that a dymanic strength measure might have yielded different results. Larson[4] questions the relationship of static and dynamic techniques and presents evidence which suggests this to be true. On this basis the inclusion of a dynamic strength measure might be fruitful in future studies.

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[4] L. Larson, "A Factor Analysis of Strength Variable and Tests with a Test Combination of Chinning, Dipping and Vertical Jump," Research Quarterly, 11: 82-92, December, 1955.

CHAPTER V

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The weight and static knee extension strength were measured prior to the 1955 season and a questionnaire based on daily activities and injury incidence was completed post season on two hundred eleven high school football players.

Raw static knee extension strength, static knee extension strength per pound of body weight, total injuries and knee injuries were individually statistically analyzed for responses to questions on the following subjects: place of residence, distance of residence from school, means of transportation to school, distance walked per day, frequency of bicycle riding, personal ownership of car, frequency of using parents' car, after school job, hours devoted per week to after school job, type of after school job, hours devoted per week to summer job, types of summer job, special jobs assigned around home, summer job, the distance which can be swum, frequency of swimming during summer, farm work in summer, participation in other sports, and wearing of knee braces or wraps.

Conclusion

Subject to the limitations in the sampling and data collection, the following conclusion is drawn:

1. In terms of static knee extension strength, the concept of "automobile knees" with the associated knee musculature weakness and high knee injury incidence is refuted. For this concept to be tenable, statistical significance would have to be present in the associated items and in this study no differences were found.

Recommendations

1. It is recommended that this study be repeated on subjects from a different, more diversified area with a greater variety of questions on the questionnaire.
2. A similar study should be made on all high school football players in the state of Michigan.
3. It is recommended that this study be repeated with a larger group of boys.
4. It is recommended that psychological factors should be considered in the future.

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APPENDIX

APPENDIX A

NAME_____ SCHOOL_____

_____ 1. Do you live (1) in the city, (2) in a small town, (3) in the country, (4) on a farm?

_____ 2. How far from school do you live? (1) Less than ¼ mile, (2) ¼ of a mile but less than ½, (3) ½ of a mile but less than 3/4, (4) 3/4 of a mile but less than a mile, (5) more than a mile.

_____ 3. How do you get to school? (1) Walk, (2) ride a bike, (3) ride the bus, (4) ride a car (either drive yourself or ride with someone).

_____ 4. How far do you walk each day? (1) 1 mile, (2) 2 miles, (3) 3 miles, (4) 4 miles, (5) more than 5 miles.

_____ 5. Do you have a bike? (1) Yes, (2) no.

_____ 6. How often do you ride your bike? (1) Every day, (2) 3 or 4 times a week, (3) once or twice a week, (4) less than once a week, (5) when you cannot get the car.

_____ 7. Do you have a car of your own? (1) Yes, (2) no.

_____ 8. How often do you get your father's car? (1) Only on weekends, (2) several times a week, (3) only on special occasions, such as a prom, (4) almost anytime you want it, (5) never.

_____ 9. Do you have a job in the evening after school? (1) Yes, (2) no.

_____10. How many hours a week does this job take? (1) 1-3 hours per week, (2) 4-6 hours per week, (3) 7-10 hours per week, (4) 10-15 hours per week, (5) more than 15 hours per week.

_____11. Where do you work on this job just mentioned in question 10? (1) Off jobs around the house, (2) in a store, (3) outside.

_____12. What type of job is it? (1) Heavy lifting, (2) running errands, (3) mild work.

_____13. Do you have special jobs assigned to you around the house? (1) Yes, (2) no.

_____14. Do you have a summer job? (1) Yes, (2) no.

_____15. How many hours a week do you work in the summer? (1) 0-5, (2) 6-10, (3) 11-20, (4) 21-30, (5) 31-40, (6) over 40.

_____ 16. What type of work do you do? (1) Light work, such as office work, stock boy, or newspaper boy, (2) average work where you sweep up; do odd jobs, (3) heavy work, such as laboring or lifting.

_____ 17. How far can you swim? (1) 25 yards, (2) 25-50 yards, (3) 50-75 yards, (4) 75-100 yards, (5) over 100 yards, (6) cannot swim.

_____ 18. In the summer how many times a week do you go swimming? (1) Every day, (2) 5-6 days a week, (3) 3-4 times a week, (4) 1-2 times, (5) 0.

_____ 19. Do you work on a farm in the summer? (1) Yes, (2) no.

_____ 20. Do you participate in other sports such as (1) baseball, (2) basketball, (3) tennis, (4) golf, (5) track or cross country, (6) wrestling, (7) swimming, (8) multiple.

_____ 21. Were you injured in football this year? (1) Yes, (2) no.

_____ 22. Were you injured this year in any other sport? (1) Yes, (2) no.

_____ 23. What were you doing when you were injured? (1) tackling, (blocking, (3) carrying the ball, (4) running but not tackling or blocking.

_____ 24. Were you injured in (1) practice, (2) game?

_____ 25. Were you injured in (1) scrimmaging, (2) the game, (3) when not contacting?

_____ 26. If injured in practice was it (1) early in the practice, (2) in the middle of the practice, (3) toward the end of practice?

_____ 27. If injured in a game was it in the (1) 1st, (2) 2nd, (3) 3rd, (4) 4th quarter?

_____ 28. In what part of the season were you injured? (1) 1st week, (2) 2nd week, (3) 3rd week, (4) 4th week, (5) 5th week, or later.

_____ 29. Do you tape your ankles for games? (1) Yes, (2) no.

_____ 30. Do you tape your ankles for practice? (1) Yes, (2) no.

_____ 31. Do you use ankle wraps for games? (1) Yes, (2) no.

_____ 32. Do you use ankle wraps for practice? (1) Yes, (2) no.

_____ 33. Do you play without any ankle supports? (1) Yes, no.

_____ 34. Do you wear low cut shoes? (1) Yes, (2) no.

_____ 35. Do you wear knee braces or wraps of any kind? (1) Yes, (2) no.

_____ 36. Did you have a knee injury in football last year? (1) Yes, (2) no.

_____ 37. If yes, was it a (1) sprained or torn ligament, (2) torn cartilage, (3) other, (explain).

_____ 38. Did it require surgery? (1) Yes, (2) no.

_____ 39. How long were you "off" because of it? (1) Less than a week, (2) one to two weeks, (3) more than three weeks or out for the season.

_____ 40. Was it a reoccurrence of an old injury? (1) Yes, (2) no.

J. M. Hinton. 1957.

M. A.