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The Effects of Heel Disks, Heel Bars and Conical Cleats on the Speed and Cutting Ability of University of North Dakota Football Players

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THE EFFECTS OF HEEL DISKS, HEEL BARS AND CONICAL CLEATS ON THE SPEED AND CUTTING ABILITY OF UNIVERSITY OF NORTH DAKOTA FOOTBALL PLAYERS

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Date July 24, 1969

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	vi
LIST OF ILLUSTRATIONS	vii
ABSTRACT	viii
Chapter	
I. INTRODUCTION	1
Definition of Terms	2
Limitations of the Study	3
Delimitations of the Study	3
Survey of Related Literature	3
II. METHODOLOGY	18
The Test	18
Testing Procedure	20
Subjects, Controls, and Variables	21
Experimental Design	22
Statistical Procedure	24
III. ANALYSIS OF DATA	26
Presentation of Results	26
IV. DISCUSSION	30
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	32
Summary	32
Conclusions	33
Recommendations	33
APPENDIX	34
BIBLIOGRAPHY	54

LIST OF TABLES

Table		Page
1.	Summary of Analysis of Variance (Treatment: Heel Structures)	27
2.	Summary of Analysis of Variance (Treatment: Trial Days - Heel Structure: Cleats)	28
3.	Summary of Analysis of Variance (Treatment: Trial Days - Heel Structure: Disks)	28
4.	Summary of Analysis of Variance (Treatment: Trial Days - Heel Structure: Bars)	29

LIST OF ILLUSTRATIONS

Illustration Page

Cozens' Dodging Test 18

ABSTRACT

The problem of this study was to measure the effects of three different types of heel structures on the agility and cutting ability of University of North Dakota football players. The three types of heel structures used were regular conical cleats, heel disks and heel bars.

The test used in the study was the Dodging Test from Frederick W. Cozens' General Athletic Ability Test for College Men. It consists of running and dodging or cutting in and out among five hurdles placed at strategic points on five 3-foot lanes.

The subjects tested were the total population of the University of North Dakota football team during the spring of 1969. These athletes served as their own control. Their test performance while wearing one of the three types of heel structures was the variable in the study.

A null hypothesis, that there is no difference in agility or cutting ability of UND football players while wearing any of the three specific types of heel structures, was tested and accepted at the .01 confidence level by use of a one-way analysis of variance.

The study results indicated that, for 36 UND football players, there was no significant difference in performance of a dodging test while wearing cleats, disks, or bars as heel structures on their shoes.

CHAPTER I

INTRODUCTION

A great responsibility to parents and spectators, but mostly to participant athletes, to provide the best possible prevention and care of athletic injuries, falls on the shoulders of athletic coaches, trainers, and administrators. The urgency of this responsibility is felt in the area of contact sports more eminently than in non-contact sports because of the obvious opportunities for a higher rate of incidence and even severity of injuries.

In recent years, the heel cleats on football shoes have been cited by people in the fields of medicine, training, and physical education as a contributing factor to the high rate of injuries occurring to the lower extremities of the body in the sport of football. Studies, cited later in this chapter, show that participants, wearing either shorter, soccer style cleats on their shoes, or substituting a heel type disk or bar in place of the heel cleats, have sustained fewer and less severe injuries to the ankle and knee than fellow participants wearing the regular conical heel cleats.

The problem of this study was to measure the effects of three different types of heel structures on the agility and cutting ability of University of North Dakota football players. The three types of heel structures used were regular conical cleats, heel disks, and heel bars.

A study of the effects of these various types of heel structures on the agility and cutting ability of football players was needed. This study was designed to evaluate the effects of conical cleats, heel disks, and heel bars on the agility and cutting ability of the UND football team.

Definition of Terms

Cleats - Conical shaped pieces of solid nylon, with steel tips, fastened to a football shoe for the purpose of securing footing.

Disk Style Heels - Solid, flat, circular shaped pieces of synthetic material that fit over the cleat posts of a conventional football shoe.

Bar Style Heels - Narrow pieces of synthetic material that fit over the cleat posts and across the back part of the heel of a conventional football shoe. The heel disks and bars used in the study were manufactured by the Tim McAuliffe Athletic Equipment Company.

Agility - The ability of a person to change direction or body position quickly and regain body control to continue with another movement.[1]

Cutting Ability - A person's capability to change directions by using the planted foot alternately as a brake to momentum in one direction and force for momentum in another.

Mental Practice - The act of going over the course in one's mind before it is actually attempted.

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[1] Evelyn L. Schurr, Movement Experiences For Children (New York: Meredith Publishing Co., 1967), p. 190.

Subjects - The freshman, sophomore, and junior candidates for the UND football team who were participating during the third week of spring practice, 1969.

Limitations of the Study

1. There was no way of controlling the subjects' outside activities such as sleeping, dieting and other factors that may have effected the subjects' performances from test to test in the study.

2. Weather conditions of rain, wind and temperature and their effects on test performance were uncontrollable.

3. Any psychological effects of a certain treatment on a subject were uncontrollable.

Delimitations of the Study

This study was delimited to:

1. The number of freshman, sophomore, and junior football players participating in spring football at UND in the spring of 1969.

2. The number (36) of football players able to participate in the testing. Thirteen initial members of the spring roster did not participate in the testing due to injuries or scheduled late classes or labs.

3. Testing on only one type of playing surface, grassy turf.

Survey of Related Literature

The literature available failed to reveal any studies dealing specifically with the effects of various heel structures on the performance abilities of football players. However, much has been written about the causes and effects of athletic injuries, the methods of prevention of injuries, and the effects of heel structures on the incidence and severity of football leg injuries. An attempt has been made to arrange the literature into these three categories.

Causes and Effects of Injuries to the Lower Extremities of the Body

Dr. Murle L. Rowe,[2] Chairman of a Sports Medicine Symposium in New York, showed by use of some convincing statistics that the problem area in terms of incidence and severity of athletic injury lies in football. A look at the number of days of participation lost per 1000 exposures to injury in the state of New York showed that football, with a 14.03 rating, is far ahead in severity of injury over soccer (3.09), wrestling (2.19), basketball (1.62), baseball (1.32), and track (0.62). When breaking down the areas of injuries to the head, hand, knee, ankle, and shoulder regions, the study indicated that the legs (knee and ankle) accounted for 27 per cent of the injuries.

Winslow,[3] speaking at the same symposium about time loss in participation due to some certain types of common knee injuries, stressed tears in cartilage and ligament. Ligament tears can be mild, moderate, or complete and one can expect a time loss of

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[2]New York High School Athletic Association, Association of Health, Physical Education and Recreation, and The Medical Society of New York, "A Sports Medicine Symposium," New York, 1967. (Mimeographed.)

[3]*Ibid.*

approximately, from three weeks, to a season, to permanently, depending on severity.

Tears of the cartilage, even minor ones, most often eventually result in the need for surgery and partial excision or removal. Repair of this structure is not feasible and the most successful results, by far, are with complete removal. Dr. Winslow felt that the minimum period of time loss with this surgery was four months. He said that knee injuries "are usually the result of twist or torsion strain to a foot fixed in the ground . . . such as with football cleats . . . commonly by a block from the side."

Several authors placed a major share of the blame on cleats. Upon receiving a blow, the leg must give with the force. When the cleats are anchored in the ground, sometimes the only part(s) of the leg to give are the ligaments or cartilage.

Larson[4] stated:

> The vulnerability of the knee to injury is because of its exposed position and its restriction of motion to flexion and extension with little medial or lateral give. The most frequent cause of injury is by contact from the opposing player. To sustain a ligamentous injury, the foot must be fixed to the ground so that the force of the blow levers the joint apart with the outer rim acting as a fulcrum.

Klafs and Arnheim[5] agreed that a direct blow in the lateral or medial aspect of the athlete's knee while his foot is firmly planted will tend to stretch or tear the supporting tissue. The

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[4]Robert L. Larson, M.D., Eugene, Oregon, "Bones, Joints, and Ligaments, and High School Athletics," Proceedings of the National Conferences on the Medical Aspects of Sports, Committee on the Medical Aspects of Sports, American Medical Association. (Mimeographed.)

[5]Carl E. Klafs and Daniel D. Arnheim, Modern Principles of Athletic Training, (St. Louis: C. V. Mosby Company, 1963), p. 296.

amount of damage depends on history of previous injuries, position of the knee when hit, and the readiness state of the athlete when injured.

Dr. Richard Thompson,[6] Detroit Lions team physician, cited the same problem as a cause of knee injuries, which he termed, "probably the most serious injury among professional athletes." He believed that any conditioning, training, or emphasis on protection was useless in preventing possible tears of the medial collateral ligament and of the anterior cruciate ligament and a protrusion of the medial meniscus if a man is blocked on the "lateral aspect of the knee, when the foot is fixed to the ground." A player with his foot in this circumstance is as vulnerable as the player who gets clipped.

A study by Dr. Daniel F. Hanley,[7] of Bowdoin College, showed that 77 per cent of injuries to the knee occurred when the following was true. "The foot was fixed to the ground with long conical cleats, the player was weight bearing on the injured extremity, the knee was flexed, and a torsion force was applied to the knee joint."

He stated that 32 per cent of knee injuries occurred while the player was being blocked, 11 per cent while tackling or being tackled, 10 per cent as a result of ball carrying, 23 per cent with no contact when in the act of cutting, and 23 per cent in

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[6] "Detroit Lions Team Doctor Stresses Prompt Treatment," Medical Tribune, Oct. 3, 1968, p. 28.

[7] "Proper Conditioning Called Key to Prevention of Injury," Medical Tribune, Nov. 28, 1968, p. 28.

pileups.

Injury to the knee is not the only unfavorable result of using heel cleats. New York Jets team physician, Dr. James A. Nicholos,[8] blamed the cleats for part of the cause of the formation of small spurs which occur in the anterior tibial edge, the opposite talor edge, or along the inferior lateral obliguity of the articular facet of the fibular malleolus. He said, "This is not an uncommon finding in athletes who must use a cleated heel and who have to drive off the heel with the foot in dorsiflexion from a set position."

He also said:

> While the pathologic process is found not only in the athlete, its treatment is most rewarding in the athlete. The lesions may occur as a result of forced dorsiflexion of the foot either/or in combination with inversion or eversion or rotation as well as in plantar flexion.
>
> It is seen, therefore, especially in sports where leg drives to generate stability and momentum are an integral part, as in jumping, climbing, hopping, charging, cutting, crossing over, and where there is violent push-off, especially from a dorsiflexed position. The football player in particular, with his cleated shoe fixed, his foot dorsiflexed, his body weight forward is especially vulnerable.

Isrow[9] cited the fit of a shoe as a serious consideration. "If a boy wears a shoe that is too long, the shoe will cause him shin problems, achilles, calf problems, possibly hamstring pulls, and also he could have pulled muscles going way up into the lower back. The improperly fitted shoe will contribute to many back injuries along with poor posture."

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[8]"Surgery Corrects Bone Spurs for Four N. Y. Jets Players," Medical Tribune, March 17, 1969, p. 29.

[9]Denis Isrow, "Proper Fitting Equipment" (paper presented at the 2nd Annual NDSU Trainers Clinic, 1967), p. 1.

Havach[10] attacked the flat heel-less football or baseball shoe on the basis that even while it "puts the foot in an everted position, a strain is exerted on the medial collateral ligament, which in turn pulls on the medial semi lunar."

Other factors obviously lend themselves to athletic injury. While agreeing that research on heel cleats has indicated that the long cleat causes injuries and that a heel disk can eliminate such injuries, Spackman[11] noted several other causes of knee injuries. Poor turf, poor conditioning, weak legs, and negligence of the athlete in reporting injuries to the trainer all contribute to the high injury rate of the knee.

The highly practiced prevention of taping ankles is blamed by Dr. Albert Ferguson.[12] He has claimed that taping is harmful to the knee because it "restricts inversion-eversion of the sub-talar joint, which acts as the safety valve for the knee when shoe cleats are stuck firmly in the ground."

Prevention of Injuries to the Lower Extremities of the Body

Preventive measures for injuries in sports center around areas of conditioning and technique, wrapping, equipment, and facilities.

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[10] Dr. Emila Havach, "The Short Heel Cord," Scholastic Coach, November, 1964, pp. 32-33.

[11] Robert Spackman, "Knee Injuries and Preventions," Scholastic Coach, June, 1967, pp. 18-19.

[12] "Taping of Ankles in Football Generally Useless, MD Says," Medical Tribune, Jan. 6, 1969, p. 28.

Dr. H. Collins,[13] while speaking at a post-graduate conference on Medical Aspects of Sports, cited a National Federation of State High School Athletic Associations study showing that 64 per cent of football injuries over a three year period occurred in the first four weeks of the season. He felt that the best way for an athlete to avoid injury is to be in the best possible physical condition the year around.

Larson[14] felt that the greatest problem in dealing with athletes was not the injuries that were produced, but proper conditioning of the athlete to aid in the reduction of the number of such injuries. Injuries, he claimed, are inevitable in any endeavor; but, in an organized athletic program, conditioning, training and equipment are the variables that allow differences not only in win-loss records, but also in injury rate. Training, conditioning and knowledge of game skills for development to a physical peak are participation demands which, in themselves, will afford protection against injury.

He also listed some acute orthopedic conditions of athletes that require restrictions in participation until healing occurs. These are:

1. Osteochondritis of any epiphysis as the tibial tubercle (Osgood-Schlatter disease) or of the vertebrae (Scheuermann's disease) may develop during the active growth phase of the teen years. Restrictions should be continued until the condition has healed and then reevaluation made for residual deformity.
2. Osteochondritis dissecans of any area of the knee, talus, or elbow makes the individual ineligible for sports until

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[13]"Proper Conditioning," Medical Tribune, op. cit.

[14]Larson, op. cit.

healing has occurred. If a loose body is produced in a joint, surgical removal will be necessary.

3. A slipped femoral epiphysis may occur in the teenage athlete often with little or no known trauma. Athletics are forbidden until treatment has been rendered, healing has occurred, and the joint reassessed.
4. Inherited defects may begin to be manifest with the high school age group and their more vigorous participation:
   a. Recurrent dislocation of the patella may occur from trauma although there is often some pre-existent anomaly as a shallow femoral condyle, knock knee or shallow patellar groove. Surgical treatment is necessary before vigorous sports activity can be allowed.
   b. Recurrent dislocation of the shoulder is usually due to a traumatic initial dislocation. The ease of dislocation may be enhanced by such inherent factors as redundant capsule, lax ligaments, or a shallow glenoid cavity. Generally, after three recurrences, surgical repair is recommended. As a temporizing measure, athletic participation can be prolonged by the use of a harness worn by the athlete to prevent marked abduction and external rotation of the shoulder. After surgical repair, athletics may be resumed.

Concerning the specific ligamentous knee injury caused by the fixation of the foot in the ground, Larson[15] stated that prevention depends on strong muscular support around the knee and proper coaching so that the player has complete body control at all times and constantly keeps his feet moving to avoid anything more than momentary contact with the ground. Prevention includes, "(1) a proper playing surface so that the foot doesn't catch in a hold, (2) again, proper body control and conditioning, and (3) the use of aluminum or plastic cleats which are less likely to 'hang up' in the turf."

In referring to the principle that reduction of fixation of foot to turf will prevent knee and ankle injuries, Dr. Hanley[16] said,

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[15] Ibid.

[16] "New Type Heel Cleats Advised to Cut Gridders Knee Trauma," Medical Tribune, March 20, 1969, p. 28.

"No matter what you use on the heel of a football shoe, those two rear posts (cleats) and the long conical front cleats have got to go. What device you use to permit the foot to rotate is of secondary importance, in my opinion."

In recommending the use of heels instead of rear cleats, he said, "I am personally convinced that the elimination of rear cleats and the use of short, broad soccer-type cleats on the front of the football shoe (nubble cleats and a heel are the best) will cut down the incidence and, more important, cut down the severity of knee injuries."

Newell[17] noted that many coaches and a medical team of athletic trainers and medical doctors believe the cleat arrangement, particularly of the heel, is a contributing factor to knee trauma. The Western Intercollegiate Athletic Conference team physicians' group has recommended the use of a heel for both practice and games.

It is significant that rules bodies are establishing legislation for a shorter cleat. The National High School Federation's football rule 1-5-3d states:

> Beginning with the 1971 season, the maximum length of cleats shall be one-half inch. During the interim, that is for the seasons 1969 and 1970, cleats no longer than 7/8 inch will be legal.
>
> The action to reduce the length of the cleat was taken in the interest of safety. There is ample evidence the longer cleat makes the wearer increasingly susceptible to knee injuries. There is absolutely no evidence that the reduction in cleat length will in any way adversely affect the game. The committee's action unquestionably tends to keep football acceptable at the interscholastic level and is commendable in every way. There may be resistance to the action of the committee, but any

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[17]Letter from William E. Newell, Head Athletic Trainer, Chief Physical Therapist, Purdue University, April 18, 1969.

reversion to the greater length is undesirable, not in the best interest of football, and unnecessary.[18]

Karl K. Klein,[19] Associate Professor of Physical Education at the University of Texas, recommended that, "(1) ligaments and supporting musculature of the joint be 'over-strengthened'; (2) proper mechanics of movement be taught with emphasis on pigeon-toed walking and running; (3) heel cleats be eliminated from use on shoes worn by football and soccer players; and (4) full-squat exercises be eliminated."

Keck[20] felt the cleatless heel or modified cleat would reduce injuries. He also contended that, because fatigue hinders coordination and thus is a factor in injury, scrimmage should be held at a time during practice other than the last part of practice.

He also stated, "Actual scrimmage for high school and possibly even college age athletes should be held off for at least 5 days even though a good pre-season conditioning program is conducted. I feel it takes this length of time to develop the neuromuscular coordination of the athletes to the stresses of contact sports."

In place of taping ankles, Ferguson[21] recommended the development of strong quadriceps, hamstrings, and gastrocnemius muscles through progressive resistive exercises.

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[18] "Information Given to Clarify Option Privilege," North Dakota High School Activities Bulletin, April, 1969, p. 3.

[19] "Two Contact Sports May Boost Ligament Integrity of Knees," Medical Tribune, June 17, 1968, p. 28.

[20] Letter from Arnie Keck, R.P.T., Assistant Physical Therapy Professor and Trainer, University of North Dakota, May 19, 1969.

[21] "Taping Ankles," Medical Tribune, op. cit.

Thompson[22] believed that the development of synthetic playing surfaces would prove a boon in reducing the number of knee and ankle injuries to football players. He said that Dr. James R. Whitehurst, of the University of Houston, has reported that in two seasons of play on Astroturf, not one serious ankle or knee injury occurred among members of the University of Houston team. He also reported that at the University of Seattle, where the outdoor field is covered by the imitation turf, not one serious ankle or knee injury was reported after 90 games had been played by the University team and a semi-pro team.

Specific Studies Related to the Use of Heel Disks and Bars

Various studies have been made on the effects of bars and disks on the incidence and severity of injuries.

Dr. Rowe[23] reported from a study of 1,325 varsity football players in 44 public high schools near Rochester, New York, that the use of a low-cut shoe with disk heel "would, on the average, save each team two knee and ankle injuries per season over the most dangerous equipment combination, the low-cut shoe with conventional cleats, and one knee or ankle injury per season over other commonly used equipment combinations."

In the study, data, including grade, position played, hours of practice and game participation, shoe and cleat type worn, and history of previous knee or ankle injury, were collected by coaches

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[22] "Detroit Lions Team Doctor," Medical Tribune, op. cit.

[23] "New Type Heel Cleats," Medical Tribune, op. cit.

of the teams. For players sustaining knee or ankle injuries, additional data, including date and circumstance of injury, diagnosis and time loss from participation, were recorded.

The players in the study sustained one-hundred (100) knee injuries and seventy-seven (77) ankle injuries. The over-all rate of knee and ankle injury was 69 per 100,000 practice hours and 657 per 100,000 game-hours of participation. Backs tended to have twice the risk of injury when compared to linemen. Rates of injury for players with each type of shoe were adjusted according to the degree of game exposure and the degree of backfield exposure.

Injury rates ranged from 90 per 100,000 participation hours for players wearing low-cut shoes with heel disks to 162 for players wearing low shoes with conventional cleats.

In the first year of another study[24] of 18,000 players in New York State, serious knee and ankle injuries showed a definite decrease among players who wore a disk heel as against those who wore conventional heels. Incidence of fractures was reduced almost 50 per cent and severe sprains more than 50 per cent.

Hanley[25] stated that, at Bowdoin College, where flat round heels were worn in practice and those with histories of knee injury wore them in games, there have been no surgical knee injuries on the varsity football team since 1962.

Newell[26] said that Purdue University has used heel disks

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[24]Ibid.

[25]"Proper Conditioning," Medical Tribune, op. cit.

[26]Newell, op. cit.

and bars for all players since spring practice, 1966. Since that time, Purdue has had no surgical knees from practice injuries.

Acocella[27] cited a survey by Dr. Hanley involving 5,530 players in 35 colleges, 37 high schools, and three professional teams. Of the 4,441 players wearing regular football shoes, 14 per cent suffered significant knee and ankle injuries. Of the 1,089 athletes wearing flat heels, only 6 per cent suffered knee and ankle injuries.

He also cited seperate studies at Colby, Brown, Tulane, and nine high schools in Rhode Island that produced similar results. The players wearing flat heels "suffered far, far fewer injuries than the players wearing regular cleats."

Rowe[28] cited yet another study centered in the suburban area of Pittsburgh. In this study, the players of eight high school teams were equipped with three types of shoes. Shoe A was a regular football shoe with heel cleats replaced by a disk or tapped-on heel. Shoe B was a football shoe using five-eighths inch soccer cleats. Shoe C was the conventional football shoe. The results showed that the wearers of shoe A suffered 6 knee or ankle injuries, shoe B - 11, and shoe C - 26 in one season. As to the severity of these injuries, not only were the knee and ankle injuries less frequent with the cleatless heel shoe, but also those that did occur tended to be less severe. The shoes were distributed to players

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[27] Frank G. Acocella, "Heel Disk Instead of Cleats?" <u>Scholastic Coach</u>, January, 1967, p. 28.

[28] New York High School Athletic Association, <u>op. cit.</u>

in different positions on each squad.

Tim McAuliffe[29] noted that, in New York in 1968, about 15,000 pairs of safety heels were sold and a medical survey showed a reduction in leg injuries of 45 per cent over 1967. He said that the University of Maryland, Georgia Tech, University of Oklahoma, University of Tennessee, and the University of Arkansas have purchased upwards of 400 pairs of heels.

Summary of Related Literature

From the foregoing review of literature in the areas of causes, effects and prevention of athletic injuries to the lower extremities, one can deduce the following points:

1. A problem area in athletic injuries, in terms of incidence and severity, is the lower extremity injuries to participants in football. The knee, especially, has caused concern and even alarm.

2. Of all the specific causes of leg injuries, the fact that cleats tend to anchor the foot in the ground has been blamed as the major cause of knee trauma.

3. Prevention of athletic injuries depends on many factors. Included among these are proper conditioning to increase endurance and muscle strength, proper coaching to develop awareness by the player of injury situations and how to avoid them, restriction of the injured or physically handicapped player who may be further

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[29] Letter from Tim McAuliffe, Manufacturer of heel disks and bars, to Walter Koenig, Department of Health and Physical Education, University of North Dakota, March 14, 1969.

injured because of lack of coordination, strength, or agility, and the use of footwear that lends itself to not fixing in the turf.

Many studies show that participants sustain fewer and less severe injuries while wearing either shorter, soccer style cleats on their shoes or when wearing a heel type disk or bar in place of heel cleats.

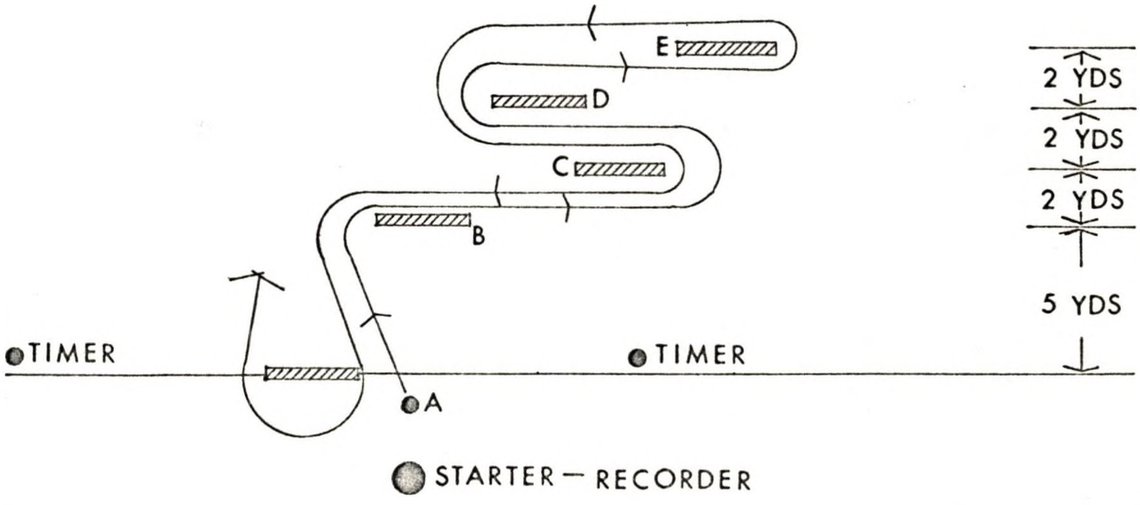
CHAPTER II

METHODOLOGY

The purpose of the study was to measure the effects of heel disks, heel bars and conical cleats on the agility and cutting ability of UND football players.

The Test

The test used in the study was the Dodging Test from Frederick W. Cozens' General Athletic Ability Test for College Men.[30] It consists of running and dodging or cutting in and out among five hurdles placed at strategic points on five 3-foot track lanes. The length of the course is 33 feet.



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[30]John F. Bovard and Frederick W. Cozens, Tests and Measurements in Physical Education (2nd ed.; Philadelphia and London: W. B. Saunders Company, 1938), p. 50.

Frederick Cozens' Dodging Test:

> The run may be described as follows:
> Starting from point A the runner goes straight ahead, turns right at hurdle B, left at hurdle C, right at D, and around E, coming to the far point of D, then following the same path back to A as was originally taken.
> Two complete round trips are made, starting at A and ending at A. Time is taken from the word "go" until the finish line is crossed. Only one trial is allowed unless a runner gets confused and runs incorrectly. The groups of 10 should jog over the course twice before any individual runs for time.[31]

The Dodging Test or Dodging Run is included in the American Association for Health, Physical Education and Recreation's Football Skills Test. The reliability coefficient for the test, as established by Cozens, is .850.

Validity for the test can be established by means of a subjective analysis of the test content. Because the subject is required to make four 90 degree cuts and ten 180 degree changes of direction, the Dodging Run is a test of cutting ability, leg speed and agility.

The test was administered with minimal expense of time and money. The following is a resumé of the equipment involved in administering the test:

1. One football field or other smooth grass field. (This was available on the practice football field at UND.)

2. Two Sportcraft stop watches, provided by Mr. Harold Kraft of the UND Athletic Department.

3. Five hurdles, made available by the UND track team.

4. Cleat wrenches and screw drivers.

5. One tape measure.

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[31] Ibid., p. 379.

6. One line marker.

The equipment involved in the experimental design of the test, the different kinds of heel structures, was provided for the subjects by the UND Athletic Department. Forty bar type and thirty disk type detachable safety football heels were purchased from the Tim McAuliffe Athletic Equipment Company. Regular nylon with steel tip conical cleats from Wilson were available. Each subject that was tested was dressed in full football uniform.

Testing Procedure

On the day before the first test day, the subjects were briefed as to reasons for the testing, the test procedure, and which heel structure to wear on their shoes and when to wear it. Directions for the three following test days were also posted in the football dressing rooms.

The 36 subjects had to be tested during their informal pre-practice session from 3:20 to 4:00 each day. One tester, a "clerk of course", had all the score cards in the random order for the day's trials. The card also contained information as to the correct treatment (heel structure) the individual subject was to wear that day. His job was to make sure the prescribed random order of testing was followed, and to be sure the correct heel structure was being worn by the subject. He also controlled the number of subjects at the testing station waiting to be tested. Because the subject did not report to the station until receiving his score card, a "mental practice" control as to the number of trials watched was introduced. He tried to keep the number waiting to be tested at 5.

Upon handing his score card to the second tester, the subject received a brief description of the test and was asked if he had any questions. At this time, he was again checked as to correct heel structure. The second tester then asked the timers if they were ready.

The starting procedure was simple. The subject stood in a standing start position with the starter a step behind him. The timers were at either end of the starting line to his right and left. The starter simply asked the question, "Ready?" and when he was assured that the subject and timers were (a few seconds pause), he gave the command, "Go!" It was the starter's responsibility to see that the correct test route was run.

The directions given to the timers regarding the methods to be used in timing became very important to insure high objectivity and reliability in measurement. The timers were required to hold the watch face upward with the crown of the watch away from the body. The clock was started and stopped by holding the watch as described with the thumbs of both hands at the base and the fore fingers of both hands at the top on the starter-stopper button. The stimuli for starting and stopping the watch were the command "go" for the former and the sight of the foot of the subject touching the ground after passing the finish line for the latter. Because the average of two times was recorded, the factor of reaction time to a stimulus in regard to reliability was somewhat diminished.

Subjects, Controls and Variables

The subjects tested were the total population of the UND football team during the spring of 1969. These 36 male athletes, ranging in age from 18-23 years, served as their own control, while their test performance was the variable in the study.

The testing was conducted in the third week of spring football practice, 1969. Test trials were run on Tuesday, Thursday, and Friday during the pre-practice warm up and learning period.

A control of any possible effects that various days and, thus, various weather or physical conditions had on the results was worked into the experimental design.

Three groups of twelve were tested each day. On the first trial day, the members of group I wore cleats, group II - disks, and group III - bars.

On the second trial day, group I changed to disks, group II to bars, and group III wore the cleats.

The last (third) trial was run with group I in bars, group II in cleats, and group III in disks.

This method of testing helped control the effects of weather and physical condition of the subjects. At least the variables (bars, cleats and disks) were exposed to the elements peculiar to a trial day, in terms of weather. As a concluding note on this subject, the weather and turf conditions were much the same on all three test days.

Experimental Design

The experimental design used to determine difference in cutting ability of UND football players while wearing different kinds of heel structures on their shoes was a single group, treatment X subject design (read "treatment by subject").

The treatments, wearing either cleats, disks, or bars on the heel of the subject's football shoe, were such that they were administered in sequence to the same subjects, 36 male athletes on the UND football team. Inter-subject differences, differences among the subjects resulting from physical ability or condition, health, or emotional or psychological readiness, were eliminated because the same subjects took all three treatments.[32]

Because the test was administered on three different days and because other chance errors of measurement may possibly have favored one treatment or another, some provisions were made to render negligible these effects.

The subjects were randomly assigned to three groups and the groups randomly assigned to treatment administered on each of the three trial days. The test was administered to the 36 subjects in random order each day. This randomness was used to eliminate any possible bias due to the possibility of subjects not being at performance peaks and any day to day practice effects.

The conditions or assumptions which underlie this experimental design were listed by Lindquist:

1. The experimental subjects were originally a simple random sample from a specified population.
2. The treatments X subjects interaction effects are normally and independently distributed in each treatment population.
3. The distribution of interaction effects has the same variance in each treatment population.
4. The means for the various treatment populations are identical.[33]

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[32] E. F. Lindquist, Design and Analysis of Experiments in Psychology and Education (Boston: Houghton Mifflin Co., 1956), p. 17.

[33] Ibid., pp. 157-158.

The first three assumptions are basic to the test of the significance of the treatment's effects that have been described in the following discussion of statistical procedure. The fourth assumption is actually the hypothesis to be tested.[34]

Statistical Procedure

After collecting the data (recording of the mean time of the two timers for each of 108 test runs, 3 by each of the 36 subjects), an analysis was made to determine the significance of the results.

The statistical tool used to analyze the data was a one-way analysis of variance. Because the study is concerned with more than two treatment means, the value of analysis of variance in testing the hypothesis is significant. A significant F result refutes the null hypothesis, but does not show where the difference occurs. At the same time, a non-significant F result leads to acceptance of the null hypothesis as none of the mean differences will be significant.

The null hypotheses, that there is no difference in agility or cutting ability of UND football players while wearing any of the three specific types of heel structures on their shoes (cleats, disks or bars) and that there was no difference in mean scores by trial day according to the style of treatment, were tested and accepted or rejected at the .01 level of confidence.

The F score is a ratio of the mean square for treatments divided by the mean square for with-in groups. This can be represented

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[34] *Ibid.*, p. 157.

by the formula:[35]

$$F = \frac{ms_A}{ms_W}$$

The formulas used to derive the mean square for treatments and for within-groups, along with an explanation, are listed below.[36]

$$ms_A = ss_A/(a-1)$$

$$ms_W = ss_W/(N-a)$$

$$ss_A = \sum_{j=1}^{a} \frac{T_j^2}{n_j} - \frac{T^2}{N}$$

$$ss_W = ss_T - ss_A$$

$$ss_T = \sum_{j=1}^{a} \sum^{n_j} X^2 - \frac{T^2}{N}$$

ss_A is the "sum of squares for treatments," which stands for "the sum of the weighted squared deviations of the individual treatment means from the general mean."

$a-1$ is the degrees of freedom for treatments when a represents the number of treatments.

ss_W is the "sum of squares for within-groups," which means "the sum of the squared deviations of the individual measures from their respective group means."

$N-a$ is the degrees of freedom for within-groups.

T_j is the sum of the scores for each treatment.

n_j is the number of scores for each treatment.

T is the "grand" sum of all scores for all treatments.

N is the "grand" number of scores for all treatments.

X is each individual score

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[35] Ibid., p. 55.

[36] Ibid., pp. 56-57.

CHAPTER III

ANALYSIS OF DATA

The purpose of this study was to measure the effects of three different kinds of heel structures on the agility and cutting ability of UND football players. The three types of heel structures used as treatments were regular conical cleats, heel disks, and heel bars.

An operational setting, the UND practice football field, with the subjects dressed in complete practice football gear, was used to simulate, as much as possible, a game or practice atmosphere for the subjects.

Presentation of Results

The 36 subjects had a "grand" mean time of 22.90 seconds for the 108 times the test was run. The mean time for the cleat treatment was 22.71 seconds. The same subjects ran the same test with disks on their heels in a mean time of 22.94 seconds. The bar treatment revealed the slowest of the three mean times at 23.03 seconds.

In the subject X treatment design, it was found that the null hypothesis, no difference in agility and cutting ability of subjects while wearing cleats, disks or bars on their heels was accepted. The results show an F value of 1.35. An F score of 4.82

is needed to have significant difference at the .01 confidence level.[37]

TABLE 1

SUMMARY OF ANALYSIS OF VARIANCE

(TREATMENT: HEEL STRUCTURES)

Source of Variation	df	Sum of Squares	Mean Square
Heel Structures (A)	2	1.95	.975
Within-groups (w)	105	75.94	.723
Total	107	77.89	

$$F = ms_A/ms_W = .975/.723 = 1.35$$

"F" at .01 level = 4.82

No significance at the .01 level

The same holds true in the tests of difference by trial days according to treatment style. There was no significant difference from trial day to trial day no matter what style of treatment was involved. The following tables summarize the results of the three F-tests for cleats, disks, and bars.[38]

[37]Henry E. Garrett, Statistics In Psychology and Education (New York, London, and Toronto: Longmans, Green & Co., 1958), p. 454.

[38]*Ibid.*, p. 453.

TABLE 2

SUMMARY OF ANALYSIS OF VARIANCE

(TREATMENT: TRIAL DAYS - HEEL STRUCTURE: CLEATS)

Source of Variation	df	Sum of Squares	Mean Square
Treatments (A)	2	1.80	.90
Within-groups (w)	33	23.40	.71
Total	35	25.20	

$F = ms_A/ms_W = .90/.71 = 1.27$

"F" at .01 level = 5.27

No significance at the .01 level

TABLE 3

SUMMARY OF ANALYSIS OF VARIANCE

(TREATMENT: TRIAL DAYS - HEEL STRUCTURE: DISKS)

Source of Variation	df	Sum of Squares	Mean Square
Treatments(A)	2	.37	.19
Within-groups (w)	33	24.40	.74
Total	35	24.77	

$F = ms_A/ms_W = .19/.74 = .26$

"F" at .01 level = 5.27

No significance at the .01 level

TABLE 4

SUMMARY OF ANALYSIS OF VARIANCE

(TREATMENT: TRIAL DAYS - HEEL STRUCTURE: BARS)

Source of Variation	df	Sum of Squares	Mean Square
Treatments (A)	2	2.14	1.07
Within-groups (w)	33	23.83	.72
Total	35	25.97	

$F = ms_A/ms_W = 1.07/.72 = 1.49$

"F" at .01 level = 5.27

No significance at the .01 level

CHAPTER IV

DISCUSSION

Football injuries have always been a great concern to people associated with athletics. Protective equipment and rules have been and are needed to help curb the incidence and severity of injuries. One aspect that must be considered in the making of safety devices or rules involves the problem of hindrance to an athlete's performance. This idea formed the basis for this investigation which was an attempt to discover whether certain heel structures hindered agility and cutting ability of UND football players.

It was observed and noticed that athletes differ somewhat in the actual mechanics of making a change in direction. Some cut off the front part of the foot, others off the whole foot, and others off the back or heel part. For this reason, some individuals may have to adapt to a certain style of heel structure.

The UND football players had some interesting comments during what might be considered their adaptation period to disks and bars. After being tested while wearing all three styles of heels, many players preferred the disk to the bar. The bar times were slower ($\overline{X}$ = 23.03 seconds) than either cleats ($\overline{X}$ = 22.71 seconds), or disks ($\overline{X}$ = 22.94 seconds). However, as mean measurements, these differences were not significant at the .01 level of confidence.

Receivers, especially split-ends and flankers, expressed some difficulty in making a specific "cut" involved in a "comeback" pass-pattern. This involved a sudden stop and a 180 degree change of direction.

The testing conditions of weather and turf remained relatively constant through the testing period. There was no significant difference in mean scores from test day to test day for any of the three styles of heel structures.

Thirty-six of the original 49 subjects finished all three test runs. Injuries or late class interferences were the reasons for this reduction in N. By chance, the random assignment to groups, which had resulted in 16 subjects in two groups and 17 in the third, reduced and evened out to 12 in each group.

As members of an inter-collegiate football team, the subjects were all highly motivated, especially in areas dealing with physical performance. A genuine interest in performance, their own as well as that of teammates, was noted. The players were also extremely interested in results of the comparison and most of them were not too surprised to find that there was no significant difference in mean scores. Many players stated that they had noticed little difference while wearing either disks or bars instead of cleats.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Many studies have shown that football players sustain fewer and less severe injuries while wearing either shorter, soccer style cleats on their shoes or when wearing a disk or bar in place of heel cleats.

In this study, thirty-six candidates for varsity football at the University of North Dakota served as subjects. They were tested three times, once while wearing cleats as heel structures, once with disks, and once with bars. The test was Cozens' Dodging Test and the performance was measured to the nearest tenth of a second. An analysis of variance was performed on the data to test the null hypothesis, that there is no difference in agility and cutting ability of the subjects while wearing cleats, disks, or bars as heel structures. The results indicated no significant difference at the .01 level of confidence.

Similarly insignificant results were found with variance tests of difference by trial days according to treatment style.

"F" values of 1.27 for cleats, .26 for disks, and 1.49 for bars were established when the "treatment" was trial days. An "F" of 5.27 was needed for .01 level significance.

Conclusion

The study results indicated that, for 36 UND football players, there were no significant differences in performances of a dodging test while wearing cleats, disks, or bars as heel structures on football shoes.

Recommendations

1. It is recommended that a study be conducted to determine the effects that the use of heel disks and bars have on the incidence and severity of knee and ankle injuries at the University of North Dakota.

2. It is recommended that similar studies be conducted on other groups of football players at different levels of competition, and different areas of the United States.

3. It is recommended a similar study be conducted with additional criteria such as jumping and running backwards included in the test.

4. It is recommended that studies be conducted under various turf conditions, dry, hard, soft, and wet. Also, a study should be conducted utilizing synthetic turf.

5. It is recommended that a study be done involving soccer shoes.

APPENDIX A

INDIVIDUAL SCORES AND SQUARES OF SCORES ON
COZENS' DODGING TEST WHILE WEARING
CLEATS AS HEEL STRUCTURES ON SHOES

Subject	Score	$(Score)^2$
1	21.75	473.06
2	22.85	522.12
3	21.65	468.72
4	23.45	549.90
5	22.70	515.29
6	22.10	488.41
7	21.50	462.25
8	21.80	475.24
9	21.90	479.61
10	23.85	568.82
11	23.10	533.61
12	23.15	535.92
13	22.00	484.00
14	22.50	506.25
15	23.80	566.44
16	22.10	488.41
17	22.75	517.56
18	21.55	464.40
19	23.70	561.69
20	21.85	477.42
21	24.05	578.40
22	22.65	513.02
23	22.55	508.50
24	22.15	490.62
25	22.30	497.29
26	23.25	540.56
27	23.40	547.56
28	22.40	501.76
29	25.20	635.04
30	21.90	479.61
31	22.45	504.00
32	22.65	513.02
33	23.15	535.92
34	23.35	545.22
35	23.95	573.60
36	22.20	492.84

INDIVIDUAL SCORES AND SQUARES OF SCORES ON COZENS' DODGING TEST WHILE WEARING DISKS AS HEEL STRUCTURES ON SHOES

Subject	Score	$(\text{Score})^2$
1	21.60	466.56
2	23.40	547.56
3	21.55	464.40
4	23.75	564.06
5	23.35	545.22
6	23.05	531.30
7	22.50	506.25
8	22.50	506.25
9	23.10	533.61
10	23.55	554.60
11	22.90	524.41
12	23.65	559.32
13	21.95	481.80
14	22.60	510.76
15	23.95	573.60
16	23.05	531.30
17	22.75	517.56
18	22.30	497.29
19	24.15	583.22
20	21.55	464.40
21	23.95	573.60
22	22.50	506.25
23	22.55	508.50
24	22.80	519.84
25	22.50	506.25
26	23.50	552.25
27	24.25	588.06
28	21.95	481.80
29	24.80	615.04
30	21.35	455.82
31	22.00	484.00
32	23.30	542.89
33	22.85	522.12
34	23.75	564.06
35	23.65	559.32
36	23.10	533.61

INDIVIDUAL SCORES AND SQUARES OF SCORES ON COZENS' DODGING TEST WHILE WEARING BARS AS HEEL STRUCTURES ON SHOES

Subject	Score	$(Score)^2$
1	21.55	464.40
2	22.85	522.12
3	22.05	486.20
4	23.40	547.56
5	23.25	540.56
6	21.90	479.61
7	22.55	508.50
8	23.45	549.90
9	21.60	466.56
10	23.25	540.56
11	23.60	556.96
12	23.40	547.56
13	22.35	499.52
14	23.30	542.89
15	24.55	602.70
16	23.50	552.25
17	23.65	559.32
18	22.60	510.76
19	24.20	585.64
20	22.45	504.00
21	24.05	578.40
22	23.55	554.60
23	23.85	568.82
24	21.95	481.80
25	22.45	504.00
26	23.60	556.96
27	23.35	545.22
28	21.95	481.80
29	24.70	610.09
30	21.70	470.89
31	22.30	497.29
32	22.90	524.41
33	22.70	515.29
34	23.60	556.96
35	24.50	600.25
36	22.50	506.25

COMPUTATION OF ANALYSIS OF VARIANCE
(TREATMENT: HEEL STRUCTURES)

	Cleats	Disks	Bars	(Grand)
n_j	36	36	36	N=108
T_j	817.65	826.00	829.10	T=2472.75
$\sum X^2$	18596.08	18976.88	19120.60	$\sum\sum X^2$=56693.56
$\bar{X}_j$	22.71	22.94	23.03	$\bar{X}$=22.90
T_j^2	668551.52	682276.00	687406.81	T^2=6114492.00
T_j^2/n_j	18570.88	18952.11	19094.63	$\sum T_j^2/n_j$=56617.62
				T^2/N=56615.67

$$ss_A = \sum_{j=1}^{a} T_j^2/n_j - T^2/N = 56617.62 - 56615.67 = 1.95$$

$$ss_T = \sum_{j=1}^{a}\sum^{n_j} X^2 - T^2/N = 56693.56 - 56615.67 = 77.89$$

$$ss_W = ss_T - ss_A = 77.89 - 1.95 = 75.94$$

APPENDIX B

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY I WHILE WEARING CLEATS

Subject	Score	$(\text{Score})^2$
1	21.75	473.06
2	22.85	522.12
3	21.65	468.72
4	23.45	549.90
5	22.70	515.29
6	22.10	488.41
7	21.50	462.25
8	21.80	475.24
9	21.90	479.61
10	23.85	568.82
11	23.10	533.61
12	23.15	535.92

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY II WHILE WEARING CLEATS

Subject	Score	$(\text{Score})^2$
25	22.30	497.29
26	23.25	540.56
27	23.40	547.56
28	22.40	501.76
29	25.20	635.04
30	21.90	479.61
31	22.45	504.00
32	22.65	513.02
33	23.15	535.92
34	23.35	545.22
35	23.95	573.60
36	22.20	492.84

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY III WHILE WEARING CLEATS

Subject	Score	$(\text{Score})^2$
13	22.00	484.00
14	22.50	506.25
15	23.80	566.44
16	22.10	488.41
17	22.75	517.56
18	21.55	464.40
19	23.70	561.69
20	21.85	477.42
21	24.05	578.40
22	22.65	513.02
23	22.55	508.50
24	22.15	490.62

COMPUTATION OF ANALYSIS OF VARIANCE
(TREATMENT: TRIAL DAYS - HEEL STRUCTURE: CLEATS)

	Day I	Day II	Day III	(Grand)
n_j	12	12	12	$N=36$
T_j	269.80	276.20	271.65	$T=817.65$
$\sum X^2$	6072.95	6366.42	6156.71	$\sum\sum X^2=18596.08$
$\bar{X}_j$	22.48	23.02	22.64	$\bar{X}=22.71$
T_j^2	72792.04	76286.44	73793.72	$T^2=668551.52$
T_j^2/n_j	6066.00	6357.20	6149.48	$\sum T_j^2/n_j=18570.88$
				$T^2/N=18572.68$

$$ss_A = \sum_{j=1}^{a} T_j^2/n_j - T^2/N = 18572.68 - 18570.88 = 1.80$$

$$ss_T = \sum_{j=1}^{a}\sum^{n_j} X^2 - T^2/N = 18596.08 - 18570.88 = 25.20$$

$$ss_W = ss_T - ss_A = 25.20 - 1.80 = 23.40$$

APPENDIX C

INDIVIDUAL SCORES AND SQUARES OF SCORES ON COZENS' DODGING TEST ON TRIAL DAY I WHILE WEARING DISKS

Subject	Score	$(\text{Score})^2$
13	21.95	481.80
14	22.60	510.76
15	23.95	573.60
16	23.05	531.30
17	22.75	517.56
18	22.30	497.29
19	24.15	583.22
20	21.55	464.40
21	23.95	573.60
22	22.50	506.25
23	22.55	508.50
24	22.80	519.84

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY II WHILE WEARING DISKS

Subject	Score	$(\text{Score})^2$
1	21.60	466.56
2	23.40	547.56
3	21.55	464.40
4	23.75	564.06
5	23.35	545.22
6	23.05	531.30
7	22.50	506.25
8	22.50	506.25
9	23.10	533.61
10	23.55	554.60
11	22.90	524.41
12	23.65	559.32

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY III WHILE WEARING DISKS

Subject	Score	$(\text{Score})^2$
25	22.50	506.25
26	23.50	552.25
27	24.25	588.06
28	21.95	481.80
29	24.80	615.04
30	21.35	455.82
31	22.00	484.00
32	23.30	542.89
33	22.85	522.12
34	23.75	564.06
35	23.65	559.32
36	23.10	533.61

COMPUTATION OF ANALYSIS OF VARIANCE
(TREATMENT: TRIAL DAYS - HEEL STRUCTURE: DISKS)

	Day I	Day II	Day III	(Grand)
n_j	12	12	12	$N=36$
T_j	274.10	274.90	277.00	$T=826.00$
$\sum X^2$	6268.12	6303.54	6405.22	$\sum\sum X^2=18976.88$
$\bar{X}_j$	22.84	22.91	23.08	$\bar{X}=22.94$
T_j^2	75130.81	75570.01	76729.00	$T^2=682276.00$
T_j^2/n_j	6260.90	6297.50	6394.08	$\sum T_j^2/n_j=18952.11$
				$T^2/N=18952.48$

$$ss_A = \sum_{j=1}^{a} T_j^2/n_j - T^2/N = 18952.48 - 18952.11 = .37$$

$$ss_T = \sum_{j=1}^{a}\sum^{n_j} X^2 - T^2/N = 18976.88 - 18952.11 = 24.77$$

$$ss_W = ss_T - ss_A = 24.77 - .37 = 24.40$$

APPENDIX D

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY I WHILE WEARING BARS

Subject	Score	$(Score)^2$
25	22.45	504.00
26	23.60	556.96
27	23.35	545.22
28	21.95	481.80
29	24.70	610.09
30	21.70	470.89
31	22.30	497.29
32	22.90	524.41
33	22.70	515.29
34	23.60	556.96
35	24.50	600.25
36	22.50	506.25

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY II WHILE WEARING BARS

Subject	Score	$(\text{Score})^2$
13	22.35	499.52
14	23.30	542.89
15	24.55	602.70
16	23.50	552.25
17	23.65	559.32
18	22.60	510.76
19	24.20	585.64
20	22.45	504.00
21	24.05	578.40
22	23.55	554.60
23	23.85	568.82
24	21.95	481.80

INDIVIDUAL SCORES AND SQUARES OF SCORES
ON COZENS' DODGING TEST ON TRIAL
DAY III WHILE WEARING BARS

Subject	Score	$(\text{Score})^2$
1	21.55	464.40
2	22.85	522.12
3	22.05	486.20
4	23.40	547.56
5	23.25	540.56
6	21.90	479.61
7	22.55	508.50
8	23.45	549.90
9	21.60	466.56
10	23.25	540.56
11	23.60	556.96
12	23.40	547.56

COMPUTATION OF ANALYSIS OF VARIANCE
(TREATMENT: TRIAL DAYS - HEEL STRUCTURE: BARS)

	Day I	Day II	Day III	(Grand)
n_j	12	12	12	N=36
T_j	276.25	280.00	272.85	T=829.10
$\sum X^2$	6369.41	6540.70	6210.49	$\sum\sum X^2$=19120.60
$\bar{X}_j$	23.02	23.33	22.74	$\bar{X}$=23.03
T_j^2	76314.06	78400.00	74447.12	T^2=687406.81
T_j^2/n_j	6359.51	6533.33	6203.93	$\sum T_j^2/n_j$=19094.63
				T^2/N=19096.77

$$ss_A = \sum_{j=1}^{a} T_j^2/n_j - T^2/N = 19096.77 - 19094.63 = 2.14$$

$$ss_T = \sum_{j=1}^{a}\sum^{n_j} X^2 - T^2/N = 19120.60 - 19094.63 = 25.97$$

$$ss_W = ss_T - ss_A = 25.97 - 2.14 = 23.83$$

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