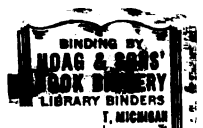
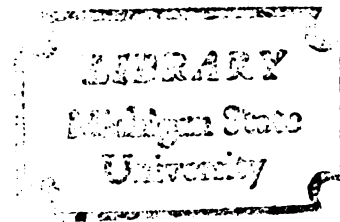


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ABSTRACT

RELATIONSHIP OF A SHOCK-ABSORBING SURFACE AND SELECTED PRECONDITIONING EXERCISES TO THE DEVELOPMENT OF SHIN SORENESS IN HIGH SCHOOL FEMALE SIDE-HORSE VAULTERS

By

Deeann Louise Cramer

The purpose of the study was to determine the effects of selected preventive measures on the development of shin soreness in high school female side-horse vaulters. Specifically, preconditioning exercises for the lower leg and a shock-absorbing running surface were studied.

Four regularly scheduled high school physical education classes were randomly assigned to four treatments: (a) Group A - the control group had no preconditioning and ran on a concrete floor; (b) Group B - an experimental group had no preconditioning but ran on a tumbling mat; (c) Group C - an experimental group received the preconditioning treatment but ran on the concrete floor, and (d) Group D - an experimental group received the preconditioning treatment and ran on the tumbling mat.

The preconditioning treatment was administered to groups C and D for a period of two weeks. All four groups then participated in daily vaulting activities for three weeks. Groups A and C ran on the concrete floor while groups B and D ran on the mat. At the conclusion

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of the five-week period, all subjects who had developed shin soreness were identified and interviewed. A 2 x 2 Chi-square contingency analysis was used to treat the data. The results showed that, within the limits of this study, neither a shock-absorbing running surface nor preconditioning of the lower leg are significantly related to the incidence of shin soreness.

RELATIONSHIP OF A SHOCK-ABSORBING SURFACE AND SELECTED
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By

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CHAPTER I

THE PROBLEM

"Shin splints" is a lay term commonly used to describe a condition of the lower leg which is characterized by pain in the tibial region following repeated bouts of walking, running, or jumping. This condition is relatively common in athletic activities where running and jumping are involved (e.g., track, cross country, tennis, basketball). The symptoms are relieved by rest and aggravated by continued activity. Although generally recognized as a minor injury, untreated cases of shin splints may reach a level of such intense pain that performance capacity is significantly reduced.

The literature dealing with the subject of shin splints or shin soreness in athletes has been focused primarily on attempts to identify the exact nature of the condition. Historically, these diagnostic efforts have been characterized by much disagreement and confusion which, until recently, has caused this condition to be regarded as a vague and generalized syndrome.

In a presentation to the American Medical Association in 1966, Paul and Soderberg (37) discussed numerous proposed explanations for shin soreness. Among the major theories considered were: stress fracture of the tibia and fibula, anterior tibial syndrome (partial to complete necrosis of the contents of the anterior tibial

compartment), and numerous types of inflammatory conditions affecting muscles, tendons, connective tissue and bone.

A questionnaire administered by Paul (37) in 1962 to a group of athletic trainers, physical education instructors, and orthopedic surgeons revealed that the anterior tibial syndrome theory was supported by a number of orthopedists while most athletic trainers were of the opinion that shin splints are caused by a strain of the tibialis anterior or posterior or by inflammation of the interosseous membrane. The majority of athletic trainers named hard surfaces and under-conditioning as the probable causes of this condition.

Another survey by Drake (18) was designed to "provide a collective opinion on shin splints which reflects the thinking of experienced trainers." The results of his questionnaire were similar to Paul's findings with most trainers attributing shin splints to strain or inflammation of the posterior tibialis, anterior tibialis, interosseous membrane, or a combination of these. Various treatment methods were suggested by respondents but moist heat and rest were recommended by most.

In 1966 the American Medical Association (A.M.A.) published the first restrictive definition of shin splints (43). This authoritative step changed its status from a nonspecific syndrome to that of a distinct clinical condition which could be distinguished as a separate entity from other non-traumatic conditions of the lower leg having similar symptoms. The A.M.A. definition described shin splints as

"pain and discomfort in the leg from repetitive running on hard surfaces or forcible, excessive use of foot flexors; diagnosis should be limited to musculotendinous inflammations, excluding fracture or ischemic disorder."

Slocum (39) attempted to clarify this condition further in light of the diverse theories previously suggested. Based on the A.M.A. definition, he listed several criteria for the correct diagnosis of shin splints: the lesion must lie within the plantar flexors or extensors of the foot; it must lie at the origin, belly or musculotendinous junction of these muscles (distal tendinous involvement excluded on the basis of anatomical location); there must be a history of aching pain following repetitive walking or running; classic signs of mild inflammation usually are present at the site of the lesion; pain may be elicited on either flexion or extension of the foot; and conditions resulting from direct trauma or recognized disease entities are excluded.

Slocum observed that the real problem in diagnosing shin splints arises from the great similarity, between its symptoms and those of certain other non-traumatic conditions brought on by overexertion. Several of these were specifically mentioned. In cases of stress fracture of the tibia or fibula (a disease process involving the cortex of the bone), Slocum noted that X-rays would reveal a stress fracture if sufficiently advanced. He advised that stress fracture should be suspected when normal treatment for shin splints fails to relieve the symptoms. Acute anterior tibial syndrome requires early diagnosis as it may develop rapidly to a point of surgical emergency. According to Slocum, its symptoms differ from those of shin splints in that pain covers the entire anterior tibial compartment and

intensifies over several hours despite rest and normal treatment. In the case of chronic anterior tibial syndrome, he pointed out that pain is recurrent throughout the entire season rather than only at the beginning, and pain and tenderness are felt over the entire anterior tibial compartment. Walking is not painful. Primary arterial occlusion and acute peroneal syndrome both have similar symptoms but are relatively rare in athletics. Slocum also noted that fascial hernias and tenosynovitis are somewhat similar but can usually be distinguished from shin splints without difficulty due to the location of the pain or other unique symptoms.

Relative to this more discriminating diagnosis, Slocum suggested several techniques for the treatment and prevention of shin splints. The purpose in treatment of this condition, according to Slocum, is to relieve the strain on the plantar flexors by supporting the arch and reducing the degree of dorsi-flexion. He recommended several methods: heel to forefoot taping of the arch; sponge rubber arch supports, heel lifts, or padding under the forefoot; providing adequate rest to the affected muscles; and application of physical therapy measures to increase circulation and eliminate edema.

Slocum's suggestions with respect to preventive techniques included: use of stretching exercises to attain normal flexibility of the calf muscles and plantar flexors; use of muscle strengthening exercises to prevent sudden overload to these muscles; correction of mechanical defects in gait; use of proper coaching techniques; avoiding hard running surfaces; and use of shock absorbing shoes.

Although shin soreness or "shin splints" continues to be a nagging problem for many athletes, some progress has been made in recent years in diagnosing and dealing effectively with it.

Need for the Study

As indicated in much of the literature, shin splints are found to occur frequently in a number of different athletic events. Although the condition is considered a minor injury, it has damaging potential for the athlete. If left untreated, shin splints eventually may become so painful that the performance level of the athlete is significantly reduced. The treatment recommended by the majority of physicians, trainers and coaches is rest. However, the application of this treatment creates two additional problems for the athlete and his coach: loss of participation in competition and a reduction in his level of conditioning. Although the importance of these subsequent effects will vary with respect to the length of rest required, they are undesirable side effects.

The most desirable approach to the problem of shin splints would appear to lie in the development of an effective preventive program. In reviewing the literature, no studies were found which dealt with this aspect of shin soreness in athletes. It was felt that such a study would be of definite value to coaches of athletes who participate in activities where shin splints commonly occur.

Statement of the Problem

The purpose of this study was to determine the effects of selected preventive measures on the development of shin soreness in

female side-horse vaulters. Specifically, the effects of a program of preconditioning exercises and the effects of a shock-absorbing surface were studied.

Research Hypotheses

This study was designed to test the following three research hypotheses: (a) preconditioning exercises can be used to reduce the incidence of shin soreness in inexperienced female side-horse vaulters at the high school level; (b) a shock-absorbing surface will reduce the incidence of shin soreness in inexperienced female side-horse vaulters at the high school level; and (c) the beneficial effects of preconditioning exercises and a shock-absorbing surface will be synergistic.

Research Plan

An available sample of 109 female high school physical education students was used for the study. The subjects were naive with respect to the specific experimental variables, and it was assumed that variations in fitness levels and inherent physical ability were randomly distributed.

Based on the review of literature, two frequently recommended preventive measures were chosen as independent variables: preconditioning of the lower leg and the use of a shock-absorbing running surface. Three exercises were selected to comprise the preconditioning treatment (see Appendix). These exercises were chosen on the basis of current diagnostic evaluations of shin splints and were designed to strengthen and increase the flexibility of the specific muscles most frequently involved. A 60' x 6' x 2" tumbling mat was

chosen as a suitable shock-absorbing running surface. The classroom floor was tile over concrete.

Four regularly scheduled physical education classes were assigned randomly to one of four treatments: (a) Group A - the control group had no preconditioning and ran on the regular classroom floor; (b) Group B - an experimental group had no preconditioning but ran on the tumbling mat; (c) Group C - an experimental group received the preconditioning treatment but ran on the regular classroom floor; and (d) Group D - an experimental group received the preconditioning treatment and ran on the tumbling mat. Careful attention was given to maintaining uniformity between groups with respect to the instructions given and the time of participation in various phases of the study. All subjects received basic vaulting instruction. No attempts were made to improve inherent running techniques. The subjects participated in bare feet or stocking feet and vaulted five times daily during the final three weeks of the study.

The study was conducted during a regularly scheduled five-week gymnastics unit and was administered by the investigator in her normal capacity as a physical education teacher. During the first two weeks, Groups C and D participated in a daily program of selected preconditioning exercises in addition to a general warm-up prior to work on other pieces of apparatus. Groups A and B were given only the general warm-up which included no exercises involving the lower leg.

During the final three weeks of the study, Groups C and D continued the daily conditioning treatment. All four groups

participated in daily vaulting practice with standardized instructions. Groups B and D used the mat for their approach runs, whereas Groups A and C ran on the bare floor.

Accurate attendance records were kept. Thirteen subjects who were absent more than 50% of the time were deleted from the study as were six subjects who had previous vaulting experience. The final sample consisted of 90 subjects with 23 in Group A, 28 in Group B, 13 in Group C, and 26 in Group D.

Although the subjects were unaware that a study was in progress, some volunteered complaints of shin soreness prior to the conclusion of the experiment. Records were kept of these complaints. In addition, private interviews were conducted after the final session to further identify any subjects who had experienced shin splints. The data were treated with a 2 x 2 Chi-square contingency analysis to determine if the incidence of shin splints was dependent upon the factors of preconditioning and running surface.

Limitations

1. Since the four research groups were available samples, they were of unequal size at the beginning of the study. The removal of previously trained and high absence subjects further contributed to the variance in size.

2. Because the investigator had no control over the activities of the subjects outside of the classroom, the possibility must be considered that some of the subjects may have received significant preconditioning due to various activities such as cheerleading, marching, skating, etc.

3. Close supervision of warm-up and preconditioning exercises by the investigator insured consistent participation by all subjects. However, the degree of effort put forth by each subject during these exercises and the vaulting activities could not be controlled.

4. Much variation in running and jumping technique was observed among the subjects; however, no effort was made to change these techniques beyond the normal vaulting instruction. Although the literature revealed that faulty mechanics may be an important factor in the development of shin splints, it was assumed that such cases were randomly distributed and no attempt was made to control this factor during the study.

5. Although cases of excessive absence were deleted from the study, it was recognized that the absences of retained subjects also carried limitations of varying degree.

6. Because of the inflexible structure of the physical education curriculum, the duration of the preconditioning treatment was limited to two weeks.

7. Although the selection of specific exercises used in the preconditioning treatment was based on investigative findings, the arbitrary nature of the choice must be regarded as restrictive.

8. The application of the results of this study are limited to similar groups of high school females.

CHAPTER II

REVIEW OF LITERATURE

In reviewing the literature, no studies could be found which dealt with preventive programs for shin soreness in athletes. However, several studies and articles by physicians, athletic trainers and other investigators regarding the nature of the "shin splint syndrome" served to provide information which was pertinent to this study.

An examination of the literature revealed that the term "shin splints" has been used rather loosely in reference to many conditions of pain or soreness in the lower leg following exertion where direct trauma was not involved. The condition was found to occur most frequently in sports which involve a great deal of repetitive running, walking, or jumping such as track, basketball, ballet dancing, cross country, gymnastics and tennis. Its symptoms generally have been recognized as a dull aching pain along the tibia which is most noticeable immediately following a workout. At first this pain is relieved by rest, but later it becomes almost continuous.

Suggested Diagnoses

Attempts to accurately diagnose shin soreness have resulted in a history of confusion and disagreement which has left the problem

of treatment and prevention in a state of some uncertainty. In 1962, Paul (37) distributed a limited questionnaire to orthopedic surgeons, athletic trainers and professional sports educators in an attempt to discover more about the causes and diagnosis of shin splints. His results showed that six orthopedists felt that shin splints are related in some way, either specifically or nonspecifically, to the anterior tibial syndrome; two thought it is caused by tenosynovitis; several attributed the symptoms to muscle strain and/or rupture; and one thought it is due to fracture. Most trainers gave multiple opinions which identified the tibialis posterior, tibialis anterior, interosseous membrane or a weak longitudinal arch as suspected locations of the injury. Since the middle 1950's numerous theories have been advanced in response to the mystery of shin soreness in athletes.

Stress Fracture

Devas (12) defined a stress fracture as "that fracture which occurs in the normal bone of a normal individual undergoing normal activity and with no injury." Based on his studies of numerous cases of stress fracture, he attempted to show that shin soreness or "shin splints" in athletes is caused by a particular type of stress fracture of the tibia involving only one cortex of the bone which is not apparent in X-rays until a later stage. This makes early diagnosis very difficult (13).

The symptoms begin slowly with a dull, aching pain usually at the end of a run. The intensity of the pain increases gradually over a period of time until it becomes so severe that running must

be discontinued. Early in its development, the pain is relieved by rest, but it returns with the resumption of activity. As the condition progresses, rest no longer relieves the pain and running must be stopped indefinitely. The pain usually is felt in the lower front part of the leg. Tenderness can be found on the medial tibial border but not necessarily where the pain is felt. It may be possible to reproduce the pain by "springing" the tibia, thus opening the fracture.

Devas (13) identified the usual sites of stress fracture in the tibia as the lower third in athletes, the middle third in ballet dancers and the upper third in military recruits. He further observed that, since stress fractures rarely develop into complete fractures, immobilization is not necessary as long as the individual ceases the precipitating activity and uses supportive strapping techniques.

In explaining the probable mechanism of stress fractures, Devas (13) referred to an earlier study by Devas and Sweetnam (14) on stress fracture of the fibula, a condition that is quite common in athletes. Fifty cases of stress fracture of the fibula were investigated. The symptoms included pain posterior to the fibula with tenderness and swelling just above the lateral malleolus. The onset of these symptoms was found to be gradual in most cases.

With the aid of radiographs, Devas and Sweetnam (14) studied the muscular actions of the lower leg in normal, healthy subjects. These showed that with the plantar flexors in strong contraction, there is a close approximation of the tibia and fibula. The point

of greatest stress appears to be near the inferior tibiofibular joint, which is the most frequent site for stress fracture.

In a very early study by Burrows (7) on fatigue (stress) fracture of the fibula, similar symptoms were observed. Burrows reported finding a high incidence of this condition among track men, most commonly in the lower third, and used the term "runners fracture" to describe it. He attributed this injury to activities involving repetitions of the same resisted movement.

In his work on various overuse syndromes in athletes, Corrigan (10) stated that stress fractures result from overuse and repeated strain. He cited the work of Armstrong and Tucker (2) in describing the mechanism of the fracture as a whipping action on the bone resulting from the repeated pull of large muscle groups. He noted that continued strain causes an extension of the crack, while rest permits healing and the formation of a callus at the site.

In his most recent article on the subject, Devas (12) identified two types of stress fracture: compression fracture and oblique fracture (caused by the bending or bowing out of the bone). He indicated that training helps in prevention because the bone will become stronger with use. Devas concluded that stress fracture is the cause of all shin soreness of the tibia in athletes with the sole exception of anterior tibial syndrome.

In reviewing Devas' theories, Paul and Soderberg (37) pointed out that their investigation of shin soreness in athletes at the University of Iowa failed to support his view. Over a period of several years, all University of Iowa athletes who complained of

pain in the tibial region were X-rayed two weeks to four months after the onset of pain. Stress fracture was found in only one case.

O'Donaghue (34) observed that stress fracture is a condition which may be easily mis-diagnosed as shin splints. Dolan (15) noted that ossification of the tibia is not complete until approximately 21 to 25 years of age and warned that epiphyseal fractures should be suspected, especially around the ankle and near the top and front of the shin, in young people.

Anterior Tibial Syndrome

This condition was first described in 1943 by Vogt (44) and numerous cases of anterior tibial syndrome (A.T.S.) have been studied by others since that time (25,31,33,36). Few of the reports have dealt with athletes, however. Craig (11) held that A.T.S. is a condition often mistaken for shin splints. He stated that A.T.S. usually results from a blow to the leg which causes swelling of the muscles in the anterior tibial compartment. This swelling causes a reduced blood supply to the area because of restriction of the anterior tibial artery.

A distinction was made by Mozes (33) between what he termed the "functional form" where no vascular lesions are found and the "anatomical form" where arterial lesions are present. He described eight cases which had vascular obstruction proximal to the anterior tibial artery. He further stated that A.T.S., which is begun by a sudden vascular obstruction, runs an acute clinical course leading to necrosis of the contents of the anterior tibial compartment. He found that most of the cases which he considered to be of the

functional form resulted from overexertion in young people who were untrained for sustained work such as army recruits.

In his discussion of the Overuse Syndrome in athletes, Corrigan (10) made reference to the possibility that overuse of muscles in the anterior tibial compartment may lead to A.T.S. and possible necrosis. A similar condition involving the peroneal compartment was reported by Lunceford (30) who stated that continuous and prolonged exertion on a hard floor produces edema of the muscles with accumulation of metabolites in a closed space. The result is diminished blood flow to the muscles.

In their review of this condition, Paul and Soderberg (37) indicated that the term A.T.S. had grown to include any condition in which the clinical picture is dominated by ischemia of the anterior tibial muscles. While posing the possibility that shin splints might represent a very mild form of ischemic necrosis, Paul and Soderberg made a clear distinction between the two syndromes.

"With athletes, the pain in shin splints may be relieved within a few minutes by rest or may continue as mild to moderately severe during exercise only. However, the pain from the A.T.S. persists despite rest and within a few hours becomes severe. This is followed by redness of the overlying skin and tenderness on pressure over the underlying muscles. The muscles feel firm, and slight local edema can be demonstrated. Constitutional signs are absent except for slight rise in temperature."

Slocum (39) noted that an acute case of A.T.S. had never been reported in a professional athlete. In his discussion of differential diagnosis he placed great emphasis on the serious nature of A.T.S. Slocum pointed out that while the occurrence of A.T.S. is quite rare in athletics, the rapid progression of symptoms to the point of irreparable damage makes early diagnosis essential.

Although the early symptoms are similar to those of shin splints, there are important differences. The pain appears early and extends over the entire anterior tibial compartment rather than being predominantly near the muscle attachment. The overlying fascia become stiff and hard and extremely tender. Glossiness of the overlying skin, fever, loss of muscle power, and partial loss of sensation in the toes indicate the beginning of necrosis.

In the chronic form, according to Slocum, the condition may be mistaken for recurring shin splints, although there are important distinctions in the symptoms. The symptoms are chronic rather than limited only to the beginning of the sports season, they occur at certain given levels of activity, pain and tenderness are present over the entire anterior tibial chamber, and walking is not painful. Slocum suggested that the probable cause of chronic A.T.S. is an anterior tibial compartment which is too small to permit the increased muscle bulk resulting from high levels of activity. Its correct diagnosis would be necessary to keep activity within a comfortable range. Mavor (31) also noted the similarity of symptoms in the case of chronic A.T.S. and stress fracture and indicated that X-rays may be necessary to confirm the diagnosis.

Muscle or Tendon Strain

A strain is an injury to a tendon or muscle resulting from trauma caused by excessive use or stress. No appreciable hemorrhage is present in the ordinary strain, and almost any muscle in the body can be affected. Lloyd's (29) study of 234 athletes who participated

in running events in the 1959 British Empire Games showed that approximately 28% suffered some form of muscle or tendon strain.

Paul and Soderberg (37) described two types of muscle strain:

"One is an injury to the muscle fibers themselves causing pain and localized tenderness. The major portion of the pain is produced by an active resisted isometric contraction. Far less pain is produced by passively putting the muscle on stretch. The other type of strain may involve any portion of the vast connective tissue framework of the entire muscle. The symptoms are pain and tenderness. The major portion of the pain is elicited by passively putting the muscle on a stretch. Far less pain is elicited by an active resisted isometric contraction."

In his text on athletic injuries, Litton (28) supported the theory that shin splints represent a "muscle strain, an avulsion of small groups of muscle fibers of the tibialis anterior from their origin on the tibia." His description of the antagonistic function of the tibialis anterior with respect to the gastrocnemius and soleus in normal gait provides support for this theory. He suggested that the tibialis anterior is strained while acting to check the strong contractions of the calf muscles. He further pointed out that

"It has been demonstrated that shin splints are relieved when the function of the gastrocnemius and soleus is restricted by strapping at the lower end of the calf muscle mass. Strapping reduces the effectiveness of muscular contraction thus reducing the force required to oppose it, therefore there is less strain on the tibialis anterior."

Paul and Soderberg (37) suggested that muscle soreness is an entirely different problem in that pain does not develop until some hours after exercise. If exercise is undertaken, the soreness will disappear only to return after completion of the exercise.

Craig (11) described two major conditions which could be authoritatively referred to as shin splints. In one instance, shin splints are attributed to the involvement of the anterior tibial muscle whose angular structure often imposes stress during contraction. If this stress is severe enough, the anterior tibial muscle may tear along its attachment to the tibia and may even cause a partial tearing of the interosseous membrane from the tibia and fibula. On the other hand, Craig reported that the symptoms may be due to involvement of the tibialis posterior. In this instance, it is suspected that an irritation of the osseous attachment occurs during plantar flexion. This muscle also undergoes a great amount of stretch during dorsiflexion in the landing phase of running and jumping. Craig concluded that partial separation of these muscles from their bony attachments is commonly manifested in shin splints.

Dolan (16) named the interosseous membrane between the tibia and fibula as the probable site of injury in cases of shin splints. His discussion of this membrane's structure and function lends some credibility to the theory. The interosseous membrane serves as a buffer or "elastic bone" to stabilize the structure of the lower leg. It also serves as an added source of attachment for the gastrocnemius, soleus and at least six of the anterior tibial muscles. The latter are pressed tightly between the skin and bone and tend to warm up slowly and cool off rapidly. Since the interosseous membrane receives only a limited blood supply, its nourishment and the removal of waste products are insufficient in view of the great amount of irritation created by strenuous use of these muscles. Dolan listed five possible causes of irritation to this area:

1. Isolated fibers of the tibialis anterior muscle that are abnormally attached to the shin bone may tear loose causing pain.
2. There may be separation of the tibiofibular ligament that lies between the tibia and fibula about an inch above the ankle joint.
3. A tough, non-yielding covering (sarcolemma) of the tibialis anterior muscle.
4. There may be a general displacement of the tissue that lies between the fibula and tibia.
5. Adhesions may form causing the calf muscles (gastrocnemius and soleus) to bind one another.

A similar theory was described by Morehouse (32), who suggested that constant muscle pull tears the origins away from the interosseous membrane or the periosteum away from the bone. He termed this an "irritative myositis." In his text on the treatment of athletic injuries, O'Donaghue (34) noted the tearing of the attachment of the posterior tibialis muscle along the tibia and irritation of the interosseous membrane among several conditions which are manifested in shin splints.

Inflammation

The symptoms commonly associated with shin splints also have been attributed to inflammation at various tissue sites.

Myositis. Inflammation of voluntary muscle, or myositis, is found only rarely in athletes, according to Paul and Soderberg (37), and is most common when traumatic injuries are involved. It is characterized by local pain and muscle spasm, followed by a period of

muscle atrophy and finally muscle repair. According to Brown and Moritz (6), a true inflammatory process is not present. Steindler (42) observed that the pain resulting from a myositic condition is of a more constant nature than that resulting from mechanical stress.

Fibrositis. Dorland (17) defined fibrositis as an "inflammatory hyperplasia of the white fibrous tissue of the body, especially of the muscle sheaths and fascial layers of the locomotor system; it is marked by pain and stiffness." In evaluating this condition as a possible explanation for the pain of shin splints, Paul and Soderberg (37) pointed out that while in shin splints the pain is brought on by activity and relieved by rest, the opposite is true in the case of fibrositis.

Enthesitis. The term enthesitis was first used by La Cava (24) in 1959 to describe a traumatic disease of muscular insertions. He suggested that the "continually recurring concentration of muscle stress at points of insertion of muscles provokes a reaction of inflammation with a strong tendency to the formation of fibrosis and calcification." He further noted that the condition is found in numerous occupations and frequently in sports. According to La Cava, the conditions commonly known as "glass arm", "tennis elbow", "shin splints" as well as periostitis of sprinters and achilles tendinitis in tennis players and skiers are some of the more frequent examples. He described the symptoms as a slight pain in the area of insertion which appears at first only toward the end of competition or in exaggerated movements, but which finally becomes constant to the point where all movement of the muscle is painful. While there is

tenderness in the area of insertion, it often is impossible to localize the pain exactly. Pain is not elicited by movement of the joint except when the affected muscle is used.

Periostitis. According to Dorland (17), "inflammation of the periosteum" or periostitis generally is chronic and is marked by tenderness and swelling of the bone and an aching pain. In their review of the shin splint syndrome, Paul and Soderberg (37) observed that very little could be found in the medical literature to support the periostitis theory.

O'Donoghue (34) listed several conditions which are commonly called "shin splints." Among them are two forms of periostitis: (a) irritation of the attachment of the posterior tibial muscle along the posterior face of the tibia with resulting periostitis, and (b) an ordinary periostitis along the posteromedial angle of the tibia.

In his discussion of sports injuries, Colson (9) denies the possibility that shin splints involve muscle attachments. His conclusion is based on the observation that there are no sites of muscle attachment on the lower third of the tibia where the pain is greatest. He suggests that the condition does bear strong resemblance to a traumatic periostitis, but he points out that frictional massage would be expected to aggravate a periostitic condition while in shin splint cases it often helps.

Liljedahl (26) briefly discussed shin splints and its symptoms in his article on physical training injuries and attributed them to "so-called periostitis", adding that it is "not yet established

whether this periostitis is a very early symptom of an insufficiency (stress) fracture." Corrigan (10) referred to shin soreness in a discussion of the "overuse syndrome." He suggested that while the pain may be due to minute muscle tears, it is more likely a periostitis caused by the constant overuse of the musculotendinous origin.

James and Brubaker (22) classified "runners injuries" into four groups: fatigue (stress) fractures, muscle strains, ligament sprains and tendinitis. Shin splints were mentioned exclusive of these categories which apparently indicated their belief that this condition is of a completely different nature.

Tenosynovitis. Inflammation of a tendon sheath, or tenosynovitis, is manifested by pain over the involved tendons which becomes severe on movement. There is localized swelling. A special form called crepitans is accompanied by a crackling sound in the soft tissue on movement.

Jagerink (35) reported the first case of tenosynovitis of the tibialis anterior tendon in 1929. He suggested that this condition could be expected to develop as a result of continued and prolonged irritation in any tendon sheath in which the tendon bends or moves in an angular direction.

Several studies (21,27) have shown that the tibialis anterior, tibialis posterior, and extensor hallicus longus tendons are all susceptible to tenosynovitis. According to Howard (21), it is a condition which results from fatigue of a definite muscle group and is not of infectious, rheumatoid or toxic origin.

While many theories have been offered in regard to its cause, Paul and Soderberg (37) observed that strain, rather than rapidity

of movement seems to favor the development of this condition. In attempting to verify their theory that shin splints are primarily tenosynovitis with occasional periostitis, muscle tears, and/or microscopic hemorrhage, Paul and Soderberg cited several pieces of symptomatic evidence. The most important symptom of shin splints is the pain which occurs over the tendon. Pain is intensified by movement and relieved by rest. Crepitus can at times be felt or heard. Atrophy or foot drop, which would result if a nerve were damaged, is seldom seen. No systemic symptoms are present and there occasionally is a slight increase in skin temperature over the involved area. Treatment of shin splints with rest and anti-inflammatory drugs relieves the pain and swelling rather promptly. This is the treatment used for patients with rheumatoid arthritis in whom tenosynovitis of varying degrees is a common occurrence.

Current Status

In 1966, the American Medical Association (A.M.A.) brought a measure of order to the longstanding confusion surrounding the shin splint syndrome when, based on extensive canvassing of professionals in athletic medicine and related fields, it published the first restrictive definition of this condition. In its first publication of the *Standard Nomenclature of Athletic Injuries* (43) the A.M.A. defined shin splints as

"pain and discomfort in the leg from repetitive running on hard surfaces or forcible, excessive use of foot flexors; diagnosis should be limited to musculo-tendinous inflammations, excluding fracture or ischemic disorder."

Slocum (39) pointed out that this authoritative step by the A.M.A. eliminated the use of the term "shin splints" as a "catchall" phrase and restricted its application "to a specific syndrome with a distinct anatomic location and typical clinical course." Based on the restricted A.M.A. definition, Slocum presented a detailed clarification of the shin splint syndrome. The lesion must lie within the plantar flexors of the foot (tibialis posticus, flexor hallicus longus, flexor digitorum longus) or within the extensors of the foot (tibialis anticus, extensor hallicus longus and extensor digitorum longus). It must lie at the origin, belly or musculo-tendinous junction of these muscles, for the diagnosis is restricted to conditions lying within the shin (tibial) area. Distal tendinous involvement is excluded on the basis of anatomical location since most of the tendons and tendon sheaths of these muscles lie at or below the ankle joint. There must be a history of aching pain of varying intensity which comes on following repeated rhythmic and repetitive exercises incurred while walking or running. Classic signs of mild inflammation are usually present at the site of the lesion: tenderness, mild swelling, slight rise in local skin temperature, and pain on movement. Conditions resulting from direct trauma or recognized disease entities are excluded.

The essential problem in the diagnosis of shin splints lies in differentiating this condition from other non-traumatic conditions causing pain in the lower leg due to overuse and overexertion (39). In the early stages, the onset and symptoms of other conditions may simulate those found in shin splints so closely that they are distinguished as separate entities only with great difficulty. Slocum

(39) included in this group stress fractures, acute anterior tibial syndrome, primary arterial occlusion, acute peroneal compartment syndrome, fascial hernias, tenosynovitis, acute sprains of the distal tibiofibular ligament, and strains of the interosseous membrane.

Symptoms

While the basic symptoms of shin splints are generally recognized, some variation has been observed in the location, intensity and onset of pain as described by different authors.

O'Donoghue (34) suggested that tenderness along the postero-medial angle of the tibia and pain on function of the posterior tibial muscle was a specific indication of irritation of the attachment of the posterior tibial muscle. In the case of involvement of the interosseous membrane, he observed that the symptoms were more posterior and seemed to be deeper in the muscles of the calf. Slocum (39) reported similar symptoms elicited by injury to the tibialis posterior and added that involvement of the tibialis anterior is manifested in tenderness at its attachments to the lateral border and crest of the tibia.

In cases of muscle tears or ruptures, Steindler (42) stated that "the pain will be most intense when rupture occurs at the tendon of origin or insertion, less if at the musculotendinous junction, and least if in the muscle belly. A minor degree of hemorrhage or edema may occur which may increase the intensity of the pain." An unusual symptom was reported by Brown (5), who described rough sand-like protrusions under the skin when running the fingers down the shin bone.

Responding to a questionnaire by Drake (18), one trainer noted that pain was not always noticeable when actually running hard, but there was pain immediately on stopping. Another respondent reported that pain was most noticeable on plantar or dorsiflexion of the foot. In most cases, with proper and immediate treatment, the athlete with shin splints is able to participate, although with some discomfort. Slocum (39) observed, however, that if the symptoms are not relieved, the intensity of pain increases to a point where running capacity for distance and speed are so greatly diminished that the sport must be discontinued.

Colson (9) noted that some athletes seem particularly susceptible and predisposed to shin splints, suffering frequent recurrences despite careful and progressive training. Dolan (16) also made such a distinction in classifying two types of shin splints:

(a) preseason - a transient condition that usually occurs in the first two weeks of the season, and (b) chronic - a condition that never responds to treatment and from which the athlete never fully recovers. In response to Paul's (37) questionnaire, one respondent explained this variation in symptoms by suggesting that "the simple shin splint is at one end of the spectrum and complete necrosis of the anterior tibial muscle at the opposite end--representing different degrees of the same entity."

Precipitating or Contributing Factors

A wide diversity of opinion was found to exist with respect to the cause of shin splints. Many authorities cite several possible factors or a combination of factors. Most theories fall into one

of three categories: conditioning of the athlete, external factors, and body structure and mechanics.

Slocum (39) stated that the type of strain which leads to shin splints is

"most likely to occur in muscle which is underdeveloped, untrained, weakened by fatigue, or when the tension within the muscle rises rapidly to an abnormally high peak as it does under the jarring strain encountered when running on hard ground or pavement."

He noted further, that shin splints are more likely to appear if there is improper warm-up, cold weather, uneven terrain, defective running technique, skeletal malalignment, or activity involving sudden direction changes or stop-and-go running. A change in footwear or a sudden change to a hard playing surface also were suggested by Slocum as possible precipitating factors.

Paul and Soderberg (37) observed that while shin splints commonly occur in track athletes, cross country and distance runners, tennis players, and basketball players, it is rarely seen in football players. They attributed this to the difference in footwear, noting that most athletes commonly affected by shin splints wear flat shoes with little or no heel while football players have cleats under both the heel and sole. Paul and Soderberg reported a consensus of opinion that shin splints would appear in football players as well if they wore tennis shoes. They ruled out the differences in playing surface as a factor noting that many practice football fields, especially in high school, have clay surfaces.

Various explanations were offered by authors of training texts. Litton (28) stated that shin splints occur "most frequently before

the athlete has become fully conditioned and usually are associated with running on hard surfaces."

Colson (9) and O'Donoghue (34) also attributed shin splints to continual pounding on a hard surface. Colson observed that cross country runners were much less likely to contract shin splints than sprinters because they run on grass.

According to Dolan (16), "most trainers look for a sprained or weak longitudinal arch" in cases of shin splints. He also mentioned tenseness in the lower back and structural defects such as uneven length of the legs as possible contributing factors. Cerney (8) stated categorically, "...in all cases of shin splints, a foot problem is present concurrently."

Brown (5) listed three major causes: dropped arches, running on the toes before being in condition, and running on hard surfaces. In their discussion of running mechanics, James and Brubaker (22) also blamed several factors for placing abnormal stresses on the foot: limiting anatomical features (such as foot deformity), gait which is not mechanically sound, certain types of shoes, and strenuous or prolonged effort by poorly conditioned athletes.

Klafs (23) noted that shin splints usually result from strenuous work on a hard surface or jumping activities. His theories included: falling arches, faulty posture alignment, muscle fatigue, and over-use stress. He also mentioned two theories not found elsewhere in the literature: body chemical imbalance and lack of proper reciprocal muscle coordination.

In his diagnosis of the syndrome, Craig (11) stated, "strain and prolonged irritation rather than rapidity of movement result in

shin splints." He listed hard and unyielding surfaces, weakness and lack of flexibility of the tibialis anterior and posterior, and awkward running mechanics as contributing factors.

The survey by Paul and Soderberg (37) showed that most athletic trainers were decidedly in support of underconditioned athletes and running on hard surfaces as the two major factors.

Treatment

Despite the diversity of opinion with respect to the diagnosis and cause of shin splints, the literature revealed consistent support for a program of rest and heat in treating the condition. Strapping also is a common recommendation, although the techniques suggested are as varied as the proposed causal factors.

O'Donoghue (34) noted that the syndrome involves many etiological factors and, therefore, requires various types of treatment in response. He recommended rest and local heat in all cases and added that the length of initial rest is directly related to the degree of recovery. When the athlete returns to work, careful supervision should be provided to see that function is kept below the level of pain.

Dolan (16) suggested the use of a hot whirlpool or analgesic pack to stimulate circulation in the legs and lower back. Craig (11) advised rest "to reduce strain and prevent swelling of inflamed muscles." Brown (5) called for a program of rest, constant heat, taping under the arches and strengthening. He also recommended the application of heat 30 minutes before play. Liljedahl (26) proposed that most overuse injuries are inflammatory conditions

and can be cured by heat and rest. Although pessimistic toward the value of all types of treatment, Colson (9) observed that relief often may be gained by the use of frictional massage which probably relieves congestion.

Drake's (18) survey indicated that most trainers use moist heat (such as packs and whirlpool) and recommend rest whenever possible. Although an adequate rest period undoubtedly is the most effective treatment, Drake observed that this method also results in a loss to the athlete's level of conditioning. Most authors advise the use of heat and strapping as a means of treatment while continuing the athlete's training at a normal or modified level when rest is not possible. Corrigan (10) observed that, in cases of minor injury, the athlete may be able to continue in this manner ignoring the pain for some time. However, in most cases the pain will eventually become so great that the athlete cannot continue.

Drake (18) reported that many trainers find the pain of shin splints to persist until a rest period is provided while others feel the symptoms may disappear with continued exercise. It would appear, as Drake observed, that the severity of the condition is of major importance in determining the course of treatment.

Assorted strapping methods and padding were suggested by many authors as a means of reducing strain on those muscles suspected as the source of pain. Litton (28) stated "it has been demonstrated that shin splints are relieved when the function of the gastrocnemius and soleus is restricted by strapping at the lower end of the calf muscle mass." Strapping reduces the effectiveness of muscle contraction and thus reduces the force required to oppose it.

Therefore, strapping of the lower calf results in less strain on the tibialis anterior.

Slocum (39) viewed adequate rest and supportive strapping as the most important factors in treatment and recommended physical therapy measures to aid circulation and reduce swelling. According to Dolan (16), the use of "high ankle strapping" is effective in supporting a weak longitudinal arch which may be the cause of shin splint symptoms. Morehouse (32) advised padding both heels and shins. From his survey of athletic trainers, Drake (18) reported that eight used arch taping, ten taped at the point of pain, and seven taped the tibialis anterior against the tibia. Cerney (8) expressed disapproval of the theory that strapping the shins will "squeeze" together the tibia and fibula, thus easing the strain on the interosseous membrane. He recommended strapping the feet with padding under the arch and stressed keeping the legs wrapped during warm-up. O'Donoghue (34), however, advised that padding under taping has little effect on a condition that is due basically to overuse of muscles. It is worthy of note that Devas (13) recommended a similar program of rest and/or strapping in cases of stress fracture.

Slocum (39) discussed running mechanics and their relationship to shin splints. He listed four factors to be considered in a treatment program: gravity, ground reaction, kinetic force effected by the forward moving body, and active muscle contraction. Following heel strike, the anterior tibial group absorbs the initial shock and is responsible for the smooth descent of the foot to the ground. It is during this time that these muscles are placed under the greatest tension and are likely to be strained. He observed that a

rubber heel pad would cushion the initial shock of weight bearing and also would reduce the range of plantar flexion through which the feet would pass.

Dolan (16) cautioned that "under absolutely no conditions can shin splints be 'run out'." This can result in development of scar tissue and a form of bone growth. The calcified material is never absorbed.

Prevention

Logically, the preventive techniques recommended for dealing with shin splints vary according to the individual's concept of the causes of the condition. Again, most theories fall into the categories of conditioning of the athlete, external factors, and body structure and mechanics. The strapping techniques described for treatment programs were recommended frequently as a preventive measure to be used in early season with athletes who appear to be shin-splint prone. These will not be repeated here.

Slocum (39) described a preventive program based on three goals: attaining normal flexibility of the calf muscles and plantar flexors through stretching exercises, correcting mechanical defects in the gait, and use of proper coaching techniques. He also observed that the "dynamic contractile overload which sometimes occurs as the result of forceful plantar flexion is best prevented by muscle strengthening exercises prior to participation." With respect to external factors, he recommended providing cushioned running surfaces when possible or a shock-absorbing shoe to eliminate the repeated sharp impact on the anterior and posterior muscle groups caused by hard surfaces.

Brown (5) urged that the athlete be given proper conditioning before running on hard surfaces, especially strengthening of the lower leg muscles. He also stressed the importance of immediate treatment of any soreness in the shin area. Cerney (8) and Craig (11) both recommended avoiding hard or unyielding surfaces. Craig's suggestions also included the use of exercises to develop both strength and flexibility of the anterior and posterior tibialis. He considered awkward running mechanics to be a source of tension which may be manifested in shin splints and advised that such defects be corrected as a preventive measure.

Liljedahl (26) stressed an adequate warm-up in preventing the development of inflammatory conditions. Static stretching was specifically recommended by Klafs (23) as an effective preventative.

Running Mechanics

A review of the mechanics of the normal running gait was helpful in understanding the stress sustained by the musculature of the lower leg and its possible effect on the development of shin splints.

There is general agreement that it is during the support phase rather than the recovery phase of the running stride that the stress occurs. James and Brubaker (22) divided this phase into three periods. First is the "foot strike" which may occur in one of three styles: (a) ball and toes (sprinter's style), (b) flat (heel and toe together), or (c) heel then toe. The second period or "mid-support" lasts until the heel begins to rise. The final period is the "take-off" which includes the time between the rising of the heel and the instant when the toes leave the ground.

Paul and Soderberg (37) clearly described the function of the muscles involved. The tibialis anterior serves to lift the forepart of the foot, straighten out the inner side of the main arch and turn the sole inward at the midtarsal joint. The tibialis posterior causes inversion of the foot and assists in plantar flexion. In the heel-then-toe running style, the tibialis anterior serves as an antagonistic restraint to the plantar flexors and acts to decelerate the dropping of the toes to the ground immediately after the heel strike. Craig (11) observed that this action creates a tremendous strain on the tibialis anterior muscle especially when running on a hard surface or when the muscles are not in condition. This period is followed by one of dorsiflexion during which the calf muscles increase their tension in preparation for take-off. At the point of take-off, the gastrocnemius-soleus group delivers a powerful contraction which lifts the heel from the ground. The common toe flexors and several accessory muscles assist in plantar flexion.

Corrigan (10) cited the initial foot strike as the point of abuse from which most overuse syndromes arise due to the sudden check of forward momentum by the counter pressure of the ground. He also noted that an unusual degree of pliometric dorsiflexion of the ankle occurs just prior to takeoff placing great strain on the inner arch of the foot.

Slocum (39) also indicated that during dorsiflexion the plantar flexors may be stretched beyond their normal working range of motion. This might be due to an unaccustomed degree of dorsiflexion, a shortened achilles tendon, or a flat-footed or out-toeing

gait. When overstretched, the elastic and tendinous elements of muscle are most likely to be involved (39). Thus, the musculo-tendinous junction, the fascial envelopes within the muscle belly, and the periosteal attachments of muscle to bone are all vulnerable. He further noted the particular susceptibility of periosteal attachments in the growing teenager and young adult.

CHAPTER III

RESEARCH METHODS

The purpose of this study was to determine the effects of a selected preconditioning program and a padded running surface on the development of shin splints in female side-horse vaulters.

Subjects

The subjects used in the study were female students at Everett High School, Lansing, Michigan. They ranged in age from 15 to 18 years. All subjects were untrained with respect to the specific factors involved in the study: physical conditioning of the lower leg and vaulting techniques.

Four regularly scheduled physical education classes were used for the study. Class sizes ranged from 19 to 32 students at the beginning of the program and were considered adequate for the successful completion of the investigation. Variations in current levels of fitness and physical skill were assumed to be randomly distributed throughout the comparison groups. It was recognized that the imbalance in class size between the four groups was less than ideal and that loss of subjects during the course of the study could not be controlled.

Independent Variables

Selection of a specific preventive program was based on the recommendations of coaches, trainers and physicians. A review of literature yielded two highly regarded preventive measures: pre-conditioning of the musculature of the lower leg and use of a shock-absorbing running surface.

Preconditioning Treatment

The preconditioning treatment was designed to meet four criteria: (a) to increase the flexibility of the foot plantar flexors, (b) to increase the strength of the foot plantar flexors, (c) to increase the functional endurance of the foot plantar flexors, and (d) to be compatible with the classroom setting in terms of time and equipment required. Three suitable exercises were selected: (a) the wall lean for flexibility, (b) heel raisers for strength and flexibility, and (c) speed runs for strength and endurance (see Appendix).

Surface Treatment

A 60' x 6' x 2" continuous tumbling mat was chosen as a suitable shock-absorbing running surface for the approach to the vaulting board. The classroom floor was tile over concrete.

Assignment of Treatments

The four physical education classes were assigned randomly to the four experimental treatments: (a) Group A - the control group had no preconditioning and ran on the regular classroom floor; (b) Group B - an experimental group had no preconditioning but ran

on the tumbling mat; (c) Group C - an experimental group received the preconditioning treatment but ran on the regular classroom floor, and (d) Group D - an experimental group received the preconditioning treatment and ran on the tumbling mat.

Administration

The study was conducted during a regularly scheduled five-week gymnastics unit with each class meeting for a standard 40-minute physical education period five days per week. No indication was given that an experimental study was in progress. All aspects of the research program were personally administered by the investigator in her normal capacity as the classroom instructor. Attention was given to maintaining uniformity between groups in instruction and in conducting the daily preconditioning exercises and vaulting activities. All groups used a carpeted reuther board and a 10" landing pad during the vaulting activities. The subjects participated in bare feet or stocking feet at all times.

All subjects were given basic group instruction in vaulting techniques. The instructions covered the correct use of the reuther board and methods of executing the basic squat vault in the bent hip, horizontal, and layout positions. Individual instruction was given as needed to correct errors in vaulting technique. No effort was made to alter natural running techniques, although all subjects were encouraged to increase the speed of their approach. Each subject vaulted five times daily.

Schedule of Treatments

The preconditioning treatment was administered to the appropriate groups during the first two weeks and was continued throughout the study. Daily vaulting instruction was given during the last three weeks with appropriate surface conditions maintained for each group (see Table 1).

Table 1. Schedule of Treatments

	1st week	2nd week	3rd week	4th week	5th week
Group A			VAULT Hard Surf.	VAULT Hard Surf.	VAULT Hard Surf.
Group B			VAULT Soft Surf.	VAULT Soft Surf.	VAULT Soft Surf.
Group C	Precond.	Precond.	Precond. VAULT Hard Surf.	Precond. VAULT Hard Surf.	Precond. VAULT Hard Surf.
Group D	Precond.	Precond.	Precond. VAULT Soft Surf.	Precond. VAULT Soft Surf.	Precond. VAULT Soft Surf.

Although each group met separately during the day, a uniform time schedule was maintained in all cases. The first five minutes of the period were devoted to a general warm-up. No exercises involving lower leg musculature were included. The warm-up period for Groups C and D was extended an additional five minutes to accommodate their special daily preconditioning exercises. All groups then were given approximately 15 minutes of vaulting instruction (five

repetitions). A shock-absorbing running surface was used for Groups B and D only. The remainder of the period was used for additional classroom activities involving other types of apparatus.

Daily Records

Accurate attendance records were maintained on all subjects. Absences from the preconditioning drills, the vaulting activity, or both were noted. Subjects who voluntarily complained of shin soreness prior to the conclusion of the study also were noted; however, no special attention was given and they continued on their assigned program.

Collection of Data

Identification of Positive Cases

At the conclusion of the five-week period, the subjects were asked if they had experienced shin soreness at any time during the unit. Each of these subjects then was interviewed privately. A history and description of the symptoms was obtained and determination was made as to whether the pain was of a traumatic or non-traumatic origin. All non-traumatic conditions were diagnosed as shin splints.

Adjustments

Prior to the analysis of data, two categories of subjects were eliminated from consideration:

1. One category included six varsity gymnasts who were in training several months prior to the study and, therefore, already were preconditioned or already had developed shin splints.

2. The second category included 13 subjects who were absent more than 50% of the time during either the preconditioning or vaulting portions of the study. It was felt that valid data could not be obtained on these subjects.

The elimination of 19 subjects affected the final composition of all four comparison groups since they had been randomly assigned to treatments at the beginning of the study. The final sample consisted of 90 girls with 23 in Group A, 28 in Group B, 13 in Group C, and 26 in Group D.

Data Analysis

A 2 x 2 Chi-square contingency analysis was used to determine if the incidence of shin splints was dependent upon the experimental factors of preconditioning and running surface.

CHAPTER IV

RESEARCH RESULTS

The purpose of this study was to determine the effects of two types of preventive measures on the development of shin soreness in female high school side-horse vaulters. The experimental factors were: (a) a selected program of preconditioning exercises, and (b) a shock-absorbing running surface. The data were gathered during a five-week high school gymnastics unit using an available sample of 109 female physical education students. The 2 x 2 Chi-square contingency analysis was used to test for independence of variables.

Findings of the Study

The Chi-square analysis yielded values of $\chi^2 = 0.07$ (N.S.) for the effect of the preconditioning factor and $\chi^2 = 0.00$ (N.S.) for the surface effect (see Tables 2 and 3).

Table 2. Effect of Preconditioning Treatment on the Development of Shin Splints

		Not Precond. (A & B)	Preconditioned (C & D)	Totals
Shin Splints	YES	9	6	15
	NO	42	33	75
	Totals	51	39	90

Table 3. Effect of Surface Treatment on the Development of Shin Splints

		Concrete (A & C)	Mat (B & D)	Totals
Shin Splints	YES	6	9	15
	NO	30	45	75
Totals		36	54	90

The results indicated that neither the preconditioning program nor the use of a cushioned running surface had a significant effect on the development of shin soreness in the subjects studied.

Discussion

Although the results of the study failed to support the two theories most widely accepted by trainers, coaches, physical educators, and physicians, it was felt that certain limitations of the study must be carefully examined.

A major limitation involved the length of the study. The time available for preconditioning of the subjects was limited to 10 sessions. It is possible that this period may have been insufficient for effective preparation of the lower leg musculature. In addition, the absences of a number of the retained subjects further reduced the preconditioning effect. The records showed that of the subjects in the preconditioned groups who developed shin splints, those whose symptoms appeared during the first week of vaulting were absent at least twice during the preconditioning period, while those whose symptoms appeared during the final three days of the study had

participated in all preconditioning sessions. This would suggest a possible delaying or preventive effect which might have been shown to be more pronounced if the preconditioning period had been extended.

Personal interviews with the subjects provided another interesting observation. The exercises selected for the preconditioning treatment (see Appendix) were focused on the posterior muscle groups. However, the results showed that, in 50% of the preconditioned subjects who developed shin splints, the symptoms indicated involvement of the anterior tibialis. It would appear that a preconditioning treatment designed for both muscle groups might have had a greater preventive effect.

During the vaulting portion of the study, a variety of running styles were noted among the subjects. Several authors have supported the belief that individuals with certain types of running styles may be more prone to the development of shin splints than others (10,11,22,39). Although no records were kept on this aspect of the activity, it is quite possible that the factor of running mechanics, which was not controlled in this study, may have had an appreciable effect on the results.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of the study was to determine the effects of selected preventive measures on the development of shin soreness (shin splints) in female side-horse vaulters of high school age. Two widely accepted preventive measures were chosen for the study: (a) preconditioning of the lower leg musculature, and (b) use of a shock-absorbing running surface. Three research hypotheses were tested: (a) preconditioning exercises can be used to reduce the incidence of shin soreness in inexperienced female side-horse vaulters at the high school level; (b) a shock-absorbing surface will reduce the incidence of shin soreness in inexperienced female side-horse vaulters at the high school level; and (c) the beneficial effects of preconditioning exercises and a shock-absorbing surface will be synergistic.

The study was conducted during a five-week high school gymnastics unit using an available sample of 109 female physical education students. Four regularly scheduled classes were randomly assigned to four treatments: (a) Group A - the control group had no preconditioning and ran on a concrete floor; (b) Group B - an experimental group had no preconditioning but ran on a 60' tumbling mat; (c) Group C - an experimental group received the preconditioning treatment but ran on the concrete floor; and (d) Group D - an

experimental group received the preconditioning treatment and ran on the tumbling mat.

Selected preconditioning exercises were administered to Groups C and D during the first two weeks of the study while Groups A and B received no preconditioning treatment. The vaulting activity was administered daily to all four groups during the final three weeks of the study. Groups B and D used the mat for their approach and Groups A and C ran on the concrete floor.

Two groups of subjects were deleted from the study prior to analysis of data: (a) six varsity gymnasts who were previously in training and already had attained a significant level of conditioning, and (b) 13 subjects who were absent for more than 50% of the preconditioning or vaulting sessions.

At the conclusion of the five-week period, those subjects who had developed shin soreness were identified and interviewed. A history and description of the symptoms were obtained from each.

A 2 x 2 Chi-square contingency analysis was used to test for independence of variables. The results yielded nonsignificant values for both experimental factors and failed to support the research hypotheses.

Conclusions

1. The results of the study failed to support the hypothesis that preconditioning exercises can be used to reduce the incidence of shin soreness in inexperienced female side-horse vaulters at the high school level.

2. The results of the study failed to support the hypothesis that use of a shock-absorbing running surface will reduce the incidence of shin soreness in inexperienced female side-horse vaulters at the high school level.

Recommendations

1. More meaningful results might be obtained by extending the length of the preconditioning period.

2. A longer study with an extended vaulting period might reduce the effect of subject absence and allow for the appearance of delayed cases of positive symptoms.

3. Numerous other preconditioning exercises could be explored for their effectiveness as a preventive measure. Inclusion of exercises focused on the anterior tibialis is suggested by this study.

4. The observation of various running styles during this study suggests a possible avenue for further investigation.

5. The similarity of many other extra-curricular activities to vaulting suggests that some effort should be made to identify subjects who are engaged in such activities at the time of the study.

APPENDIX

DESCRIPTION OF PRECONDITIONING EXERCISES

Wall Lean

Standing on tip-toe 3 to 5 feet from the wall, lean forward placing both hands against the wall and lower heels slowly until a stretching or pulling sensation is felt in the calf of the leg. Hold this position for a count of 10. Repeat 3 times.

Heel Raisers

Folded accordion type mats were placed under the high balance beam. Subjects stood with balls of the feet on the edge of the mat and held on to the beam for balance. Posterior portion of the foot protruded beyond the edge of the mat and could be raised and lowered without hindrance.

Begin on full tip-toe with straight legs. Gradually lower heels to maximum ankle flexion taking 6 slow counts. Raise heels gradually to full tip-toe position in 6 slow counts. Hold tip-toe position for 6 slow counts. Repeat 3 times.

Speed Runs

This exercise was done on a 2" mat to minimize the possibility of any causative effect on the development of shin soreness in the subjects.

Run rapidly in place with a high knee lift, keeping on the balls of the feet at all times. Run 15 seconds, rest 15 seconds, run 15 seconds, rest 15 seconds, run 15 seconds.

Subjects were instructed to count the number of strides during each repetition and were encouraged to improve their score each day.

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