A STUDY OF THE EFFECTS OF TRAINING AND INTERRUPTIONS IN TRAINING UPON CARDIORESPIRATORY AND ANTHROPOMETRIC MEASURES IN COLLEGIATE WRESTLERS

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ABSTRACT

Title of Thesis: A Study of the Effects of Training and Interruptions in Training Upon Cardiorespiratory and Anthropometric Measures in Collegiate Wrestlers.

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The purpose of this thesis was to examine group responses to training and interruptions in training upon cardiorespiratory and anthropometrical measures of collegiate wrestlers. The wrestlers (N=11) were members of the 1978-79 Lakehead University Wrestling Club. A repeated measures design was used during the 18 week training period on resting heart rate, blood pressure, pulmonary function and skinfold thickness which were measured five times at the beginning of each month. A one way analysis of variance was performed in an attempt to find a significant $\underline{F}$-ratio. In addition a Tukey Test was performed to determine during which portion of the season significant changes occurred. The results of this study indicated that interruptions in training, due to examinations and Christmas holidays, did not result in a significant change in any of the measured variables. However, significant changes ($p < .05$) occurred in percent body fat, resting heart rate, forced vital capacity and percentage of predicted vital capacity during the training program.

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Chapter 1

INTRODUCTION

Statement of the Problem

The purpose of this thesis was to examine group responses to training and interruptions in training upon cardiorespiratory and anthropometric measures on collegiate wrestlers during a four month training program.

Significance of the Study

All through history man has engaged in some form of wrestling for the purpose of self-defense or recreation. Wrestling was an important part of ancient sports programs, such as the Olympic Games, and is still a popular sport in the modern Olympic Games.

In more recent times in Canada, amateur wrestling has become increasingly popular in schools, colleges, and universities as a physical education activity, as well as an intramural, interscholastic and intercollegiate sport. With this rapidly growing national and international prominence of wrestling in Canada, it is important to understand the physiological, psychological and biomechanical characteristics of the sport. It is possible that studies could provide valuable insight for wrestling coaches about the preparation of their teams for competition.

To date, studies investigating wrestling have been large in number, but limited in scope. Pre-experimented designs have been frequently used with the investigators failing to consider extraneous variables (Shaver, 1974a, 1974b; Tomaras, 1948). Other investigators (Akgun & Ustun, 1960; Gale & Flynn, 1974; Nagle, Morgan, Hellickson, Serfass & Alexander, 1975; and Rasch & Brant, 1957) have tested individual champion athletes prior to, or immediately following a major wrestling competition. These measures have been proposed as being characteristic of successful training programs without any consideration as to the extent of the training program.

While a number of studies have suggested that certain physiological and anthropometric changes accompany wrestling training programs, there has been no attempt made to ascertain during which portion of the training program the changes actually occur. Also, the effects of interruptions in training, for example, examinations and vacations, have not been researched in collegiate wrestlers.

A comprehensive study monitoring bi-weekly physiological and anthropometric changes in a number of wrestlers during a wrestling training program with consideration to unavoidable interventions has yet to be completed. In this study, vital capacity, resting and maximal heart rate, blood pressure, percent body fat, lean body mass and weight changes which accompany a season of collegiate wrestling and its associated interruptions were monitored. This study contributes to the current literature as extraneous variables (interruptions in training), which accompany a season of varsity wrestling, were taken into consideration and reported. Also a bi-weekly testing schedule enabled the investigator to determine during which portion of the training program significant changes occurred.

Delimitations

1. A total of 11 members of the Lakehead University wrestling team, ranging from 18 to 24 years of age were used as subjects.

2. The scope of this study was delimited to tests of resting and maximum heart rates, resting blood pressure, vital capacity, and skinfold

thickness.

3. The period under observation was 18 weeks in duration commencing October 30th, 1978 and terminating March 3rd, 1979.

Limitations

1. It was assumed that the subjects were representative of collegiate wrestlers.

2. It was assumed that instructions were understood and the subjects performed as they were instructed.

3. The ability to control the effort exerted by the subjects in the training sessions was limited.

4. The ability to control the subjects habitual activity was limited.

5. A significance level of .05 was adopted for statistical analysis.

Definitions

Resting Heart Rate - the number of ventricular contractions per minute while the subject is at rest (Åstrand and Rodahl, 1970).

Diastolic Blood Pressure - the minimum pressure remaining in the arteries during the heart's resting period (Mathews and Fox, 1976).

Systolic Blood Pressure - the maximum pressure in the arteries caused by the contraction of the left ventricle of the heart (Mathews and Fox, 1976).

Percent Body Fat - total body fat of an individual expressed as a percentage.

Lean Body Mass - the body weight minus the weight of the body fat (Mathews and Fox, 1976).

Vital Capacity - maximum volume of air forcefully expired after maximum inspiration (Mathews and Fox, 1976).

Maximum Heart Rate - maximum number of ventricular contractions per minute the subject can achieve during heavy muscular work (Åstrand and Rodahl, 1970).

Unavoidable Interruptions - interruptions in the training schedule which the investigator has no control over e.g. examinations, Christmas holidays, injuries and illness.

Chapter II

REVIEW OF LITERATURE

The physiological effect of training programs on man at rest and at work has long been a concern of sport scientists. Specifically, wrestling training programs have been the subject of numerous researchers. The investigation of the effects of wrestling training programs adds to the scientific knowledge of the sport and is an aid to wrestling coaches in the development of amateur athletes (Rasch & Kroll, 1964).

There is a considerable amount of available literature dealing with physiological responses of wrestlers during varying stages of dehydration and rehydration. Studies by Herbert & Ribisl (1972) and Ribisl & Herbert (1970) indicated that physiological variables measured in wrestlers may fluctuate considerably depending on the time of day or day of the week the tests are administered in relation to an upcoming competition.

The effect of interruptions in training due to injuries, examinations, holidays, etc., would seem to be of paramount importance to the coach, as all collegiate wrestling teams are unavoidably affected by these interruptions. To date, there is no available literature concerning the effects of interruptions in training on cardiorespiratory and anthropometric responses on wrestlers.

Heart Rate

Heart rate responses to physical training programs have been the subject of numerous investigations. Low resting heart rates, as a result of endurance training, were reported by Åstrand & Rodahl (1977); Freedman, Snider, Brostoff, Kimelblot & Katz (1955); Fox, Bartels, Billings, O'Brien, Bason & Mathews (1975); Joseph (1974); Koeslag & Sloan (1976); Montgomery & Ismail (1977); Pollock, Cureton & Greninger (1969); Pollock, Miller, Janeway, Linnerud, Robertson & Valentino (1971); Reilly & Thomas (1977); Tabakin, Hanson & Levy (1965); and Wilmore, Royce, Girandola, Katch & Katch (1970b). A decrease in resting heart rate following wrestling training programs was reported by Akgun & Ustun (1960); Shaver (1974a) and Tomaras (1948). A non-significant decrease in resting heart rate following training was reported by Frick, Konttinen & Sarajas (1963) and Thomas & Reilly (1976). No change in resting heart rate following a moderate physical training program was reported by Frick, Sjögren, Peräsalo & Pajunen (1970).

Lamb (1978) indicated that resting heart rate is almost invariably reduced 5-10 beats per minute with at least a few weeks of aerobic endurance training. Scheuer & Tipton (1977) reported bradycardia is a biological adaptation resulting from chronic exercise. Mathews & Fox (1976) concluded that the resting bradycardia resulting from training is a) most evident when athletic and non-athletic subjects are compared; b) less evident but still clear cut when sedentary subjects undergo training; and c) least distinct when athletes are studied in the trained versus the untrained state.

An indication of an improvement in cardiovascular fitness is reflected in heart rate response to submaximal work loads following training. Numerous investigators have demonstrated a decrease in submaximal heart rate following training (Andrew, Guzman & Becklake, 1966; Davies, Tuxworth & Young, 1970; Douglas & Becklake, 1968; Durnin, Brockway & Whitcher, 1960; Ekblom, Åstrand, Saltin, Stenberg & Wallström, 1968; Ekblom, Kilblom & Soltysiak, 1973; Frick et al, 1963; Frick et al, 1970;

Fox et al, 1975; Hermansen & Andersen, 1965; Joseph, 1974; Montgomery & Ismail, 1977; Pollock et al, 1969; Reilly & Thomas, 1977; Siegel, Blomquist & Mitchell, 1970; and Tabakin et al, 1965).

In previously sedentary young adult males, about 50 percent of an increase in maximum oxygen uptake that occurs with endurance training has been associated with an increased maximal arteriovenous oxygen difference; whereas in fit young males all of the increase in maximum oxygen uptake has been attributed to a greater maximal cardiac output (Holloszy, 1973; Lamb 1978; and Rowell 1974). This training induced rise in maximal cardiac output is not a function of a greater maximum heart rate after training, as maximum heart rate has demonstrated a tendency to decrease with endurance training (Åstrand & Rodahl, 1977; Barnard, 1975; Cermak, Kuta & Pařízková, 1975; Pechar, McArdle, Katch, Magel & DeLuca, 1974; Pollock et al, 1969; Shaver, 1974a; Thomas & Reilly, 1976; and Wilmore et al, 1970b) or remain the same (Brynteson & Sinning, 1973; Douglas & Becklace 1968; Ekblom, Åstrand, Saltin, Stenberg & Wallström, 1968; Green & Houston, 1975; Pollock et al, 1971; Saltin, 1969; and Siegel, Blomquist & Mitchell, 1970). Consequently the greater maximal cardiac output after training must be the result of an increased stroke volume (Andrew et al, 1966; Åstrand & Rodahl, 1977; Ekblom et al, 1968; Frick et al, 1963; Hermansen & Anderson, 1965; Mathews & Fox, 1976; Rowell, 1969; Saltin, 1969; and Schneider & Crampton, 1940). An increase in stroke volume as an adaptation to aerobic training has been related to an increased heart volume (Åstrand & Rodahl, 1970; Barnard, 1975; Frick et al, 1963; and Mathews & Fox, 1976) or improvements in cardiac contractability (Barnard, 1975; Frick et al, 1963; Lamb, 1978; Mathews & Fox, 1976; and Scheuer, 1973).

Clausen (1977) concluded that an increase in maximal cardiac output as a result of training large muscle groups is due to a locally created ability to reduce the resistance to blood flow in the trained muscle and from improved myocardial performance. There is considerable uncertainty as to why training is associated with lower maximum heart rate or with lower heart rates at sub-maximal work loads. A change in stroke volume fails to explain whether the responsible mechanisms are intrinsic or extrinsic to the myocardium.

Although there is a lack of documented research regarding the effects of training on the mechanisms controlling heart rate, numerous investigators have offered theories in an attempt to explain bradycardia. Ekblom, Kilblom & Soltysiak (1973) suggested that, the training bradycardia in previously sedentary individuals after a short term physical training period, is due to both a reduced beta-adrenergic receptor activity and to an increased para-sympathetic activity. Lamb (1978) suggested that training bradycardia is probably caused by increased activity of the para-sympathetic (vagus) nerves to the heart or by greater stores of acetylcholine in the heart itself. Mathews & Fox (1976) attribute an increase in vagal tone with being responsible for bradycardia following training.

Scheuer & Tipton (1977) attempting to explain bradycardia suggested that training increased either the amount of acetylcholine in the heart or decreased sensitivity of the heart to atropine. They also mentioned an increase in para-sympathetic activity along with changes in the sympathetic system.

Barnard (1975) and Clausen (1977) stated that in man, training changes the balance between sympathetic and para-sympathetic activity in the heart toward greater dominance of the para-sympathetic system. During exercise, sympathetic stimulation of the heart is reduced and para-sympathetic inhibitory effect on the heart rate is decreased with increasing work loads resulting in a decreased heart rate.

Frick, Elovaino & Somer (1967) mentioned parasympathetic inhibition as being responsible for bradycardia at rest, whereas the slow heart rate upon exertion was due to a decreased sympathetic drive. Robinson, Epstein, Beiser & Braunwald (1966) suggested that the relative roles of the sympathetic and para-sympathetic systems were nearly equal concerning their influence on heart rate at rest. During exercise changes in sympathetic activity appeared to be the predominant mechanism by which speeding and slowing of the heart was achieved. Barnard (1975) suggested a decreased sensitivity of the heart to the sympathetic transmitters, adrenaline and noradrenaline, as being an important factor in training bradycardia.

Presently, the effects of training on the mechanisms of the heart are not fully understood. The majority of available literature tends to support the theory of a change in the balance between sympathetic and para-sympathetic stimulation of the heart.

Blood Pressure

The influence of training is not readily apparent in younger subjects and active individuals, but training does seem to lower blood pressure in older, less fit or hypertensive subjects (Choquette & Ferguson, 1973). This fact, along with the daily variability of an individual's resting blood pressure, has confounded experimental results and lead investigators to conclude that physical training programs have no effect on resting blood pressure (Akgun, Tartaroglu, Durusoy & Kocaturk, 1974; Åstrand

& Rodahl, 1977; Ekblom et al, 1968; Tabakin et al, 1965; and Wallin & Schendel, 1969).

On the other hand, Michael & Gallon (1960) reported significantly lower resting systolic blood pressure after sixteen weeks of basketball training. During de-training these measurements reversed and made significant changes again in ten weeks. Significant decreases in both systolic and diastolic blood pressure were reported by Montgomery & Ismail (1977); Reilly & Thomas (1977); Wilmore et al (1970b); and Young Ismail (1976), while Frick et al (1963), reported systolic and diastolic blood pressure increased in some subjects and decreased in others following training. Pollock et al (1971) reported a significant decrease in diastolic blood pressure following training.

In studies involving wrestlers, Shaver (1974a) reported significant decreases in resting systolic blood pressure and no change in resting diastolic blood pressure. Tomaras (1948) stated resting systolic pressure decreased and diastolic pressures were generally raised following wrestling training. Akgun & Ustun (1960) reported wrestlers had low arterial blood pressure (109 ± 2.5/73 ± 1.7 mm/Hg).

The mechanisms responsible for changes in blood pressure following training are not fully understood. Scheuer & Tipton (1977) offered two possible explanations; a) the possibility that a decrease in sympathetic tone might reduce total peripheral resistance, b) arterial baroreceptors are reset by training.

Three factors have been identified by Carlson & Johnson (1953) as having a major influence upon resting blood pressure. These three factors are a) cardiac output; b) peripheral resistance; and c) blood volume and viscosity. The autonomic nervous system also plays a major role in the control of circulation. It does this by influencing cardiac rate and contractability, arteriolar resistance and distensibility of the venous compartment.

The neural circulatory controls are pressure sensors (mechanoreceptors and baroreceptors). Two major centers are the carotid sinus and aortic arch. Of lesser importance for control of arterial pressure are those receptors in the artia, the left ventricle and lungs. These receptors, termed stretch receptors, are in a state of continuous activity and are activated by a stretching of the tissue due to high arterial pressure. Low pressure mechanoreceptors are located in the walls of the superior venae cavae at the junction with the right atruim, in the region of the tricuspid valve, in pulmonary arteries and veins along the posterior left atrial wall, in the ventricles and in the coronary arteries. The afferent nerves from these high and low pressure mechanoreceptors terminate on both the cardioaccelerator center and cardioinhibitory center (McClintic, 1975). Blood pressure therefore would be regulated by the cardiac output. Stegemann, Busert & Brock (1974) reported the control mechanisms regulating blood pressure have a stronger regulatory power against the fall of blood pressure than against its rise.

The sympathetic nervous system has been identified as being more important than the para-sympathetic system in controlling blood pressure (Carlson & Johnson, 1953; Frohlich, 1972; and Yamamoto & Brobeck, 1975). Both para-sympathetic and sympathetic efferent fibers go to the sinoatrial node and atrioventricular node and both atria whereas the sympathetic nerves are distributed to both ventricles and the peripheral vasculature. There are two types of receptors for sympathetic neurons; alpha and beta. The former influence the peripheral circulation primarily and determine the degree of arteriolar and venous tone; the latter primarily affect cardiac rate and contractability. DeCoursey (1961) has identified the sympathetic nervous system as being responsible for the rise in blood pressure that accompanies emotional states and the physical adjustments to exercise.

The literature concerning the effect of training upon man's resting systolic and diastolic blood pressure is conflicting and difficult to draw conclusions from. Lamb (1978) concluded that any reduction in resting arterial blood pressure in subjects with normal values within the normal range is minimal and unpredictable. One would not expect a significant change in blood pressure unless it was initially above the normal range.

Pulmonary Function

Of primary importance during aerobic work or recovery from anaerobic work, is increased ventilation and gas exchange in the lungs. An increased ventilatory capacity would be advantageous for wrestlers during a competitive match or the recovery period between rounds of a match.

To date, the available literature concerning wrestlers indicates that wrestling training programs significantly (Shaver, 1974b; Tomaras, 1948) and nonsignificantly (Bachman & Horvath, 1968) increased vital capacity. Rasch & Brant (1957) reported wrestlers' values exceeded predicted figures, but were not significantly greater than normal young men of equivalent size. Dening (1942) and Kroll (1954) reported the mean vital capacity of wrestlers exceeded the average vital capacity of American males.

In studies involving other athletes, Åstrand & Rodahl (1977), Thomas & Reilly (1976), and Wilmore & Norton (1975) reported slight increases in vital capacity as a result of training. Maksud, Wiley, Hamilton & Lockhart (1970), Reilly & Thomas (1977), and Smith & Byrd (1976) reported vital capacities that exceeded predicted values. Stuart & Collings (1959) reported athletes had a significantly higher vital capacity than non-athletes. On the other hand, Green & Houston (1975), Milesis, Pollock, Bah, Ayres, Ward & Linnerud (1976), and Saltin (1969) reported no significant change occurred in vital capacity following training.

While evidence tends to support the fact that athletes have a higher vital capacity than is predicted, post-training values do not always exceed the pre-training values. Saltin (1969) indicated that only swimmers and divers have an enlarged lung capacity as a result of training. This may be explained that vital capacity will increase only in athletes who specifically improve the strength of their breathing musculature (Lamb, 1978). The literature does not clearly support the theory that physical training programs increase vital capacity.

Skinfold Measurements

Of great concern to exercise physiologists is the effect of weight loss and dehydration amongst wrestlers. While numerous investigators have examined this variable in wrestlers there is a lack of available literature concerning changes in lean body mass and the effects of interruptions in training.

Kelly, Gorney & Kalm (1978) reported varsity wrestlers had a mean peak season percent body fat of 8.4 percent while no significant change was reported in body fat and lean body mass through the training season. However, Zambraski, Foster, Gross & Tipton (1976) reported a six percent decrease in body weight and also a decrease in skinfold thickness totals, following four months of wrestling training. Cermak et al (1975) studying canoeists during a yearly training program, reported that during the first three months of training body weight increased nine percent due to an increase in lean body mass and a decrease in body fat. During the next six months of training a decrease in total body weight was demonstrated which was due to a decrease in both lean body mass and body fat.

Taylor (1975) stated it would appear athletes in wrestling have less body fat due to their training program and the weight classifications necessary for the sport in the age group of 17 to 20 years. In contradiction, Rasch & Hunt (1959) concluded that wrestlers did not differ from non-wrestlers in respect to body composition. Contenders for the 1972 United States Olympic wrestling teams were observed and studied during the selection camp. Gale & Flynn (1974) reported a mean of 9.8 percent body fat for the successful freestyle and greco-roman wrestlers. Nagle, Morgan, Hellickson, Serfass & Alexander (1975) reported body fat of 8.26 percent for successful and 8.25 percent for unsuccessful candidates for the freestyle wrestling team. Fahey, Akka & Rolph (1975), while investigating body composition and oxygen uptake of exceptionally weight trained athletes, reported wrestlers to have an average percent body fat of 9.8 percent. Sinning (1974) reported an average percent fat of 8.81 percent for college wrestlers.

Pařízková (1963) reported that during periods of intense physical training in wrestlers, gymnasts, track and field competitors and hockey players, total body fat fell significantly while lean body mass increased and body weight remained constant. Interruptions of intense training resulted in a relative reduction in lean body mass and an accumulation of fat. Thompson (1959) reported similar decreases in body fat and an increase in body density during a season of college football. Pollock et al (1971) reported a significant decrease in weight and percent body fat as a result of training. Carter & Phillips (1969) demonstrated a significant decrease in weight, percent fat and a significant increase in specific gravity and percent lean body mass of middle aged males following 12 months training. The changes in these parameters were maintained throughout the remainder of the study.

Mathews & Fox (1976) indicated that changes in body composition induced by training are as follows; a) a decrease in total body fat; b) no change or slight increase in lean body weight; and c) a small decrease in total body weight. These changes are more pronounced for obese individuals than for already lean individuals.

Glick & Kaufman (1976) reported that changes in body fat, indicated by changes in skinfold thickness, were not, unidirectional and are related to the initial skinfold thickness. Pollock et al (1969) stated that changes in body fat are manifest in proportion to frequency of training. Dempsey (1964) reported initially overweight subjects experienced significant losses of body weight and total body fat with corresponding increases in muscular mass. Body fat and weight loss was not dependent upon the initial degree of obesity. On the other hand, gains in free fat weight showed some relation to the amount of excess fat as one very thin subject experienced a substantial weight gain which was almost entirely composed of non-fatty tissue.

In review, it is difficult for an individual investigator to generalize concerning body fat changes of a wrestling team, as these changes are related to frequency, duration and intensity of training as well as initial skinfold thickness of each individual. The effects of a wrestling training program may be reflected in changes in lean body mass.

In the present study, the investigator attempted to monitor the effects of training and interruptions in training on cardiorespiratory and anthropometric measures in collegiate wrestlers.

Chapter III

METHODOLOGY

Subjects

A total of 11 members of the Lakehead University varsity wrestling team, ranging from 18 to 24 years of age, were used as subjects.

Testing Location and Apparel

All tests were administered in the physiology laboratory at Lakehead University. The subjects were required to wear shorts, T-shirts and running shoes. Room temperature was maintained between 19 - 21^{o} Centigrade during all test sessions. All tests were administered between the hours of 3:30 p.m. and 5:00 p.m. to avoid a diurnal effect. All subjects were instructed to get eight hours sleep the night before the tests and to refrain from consuming food or beverages or engage in any physical activity within two hours of the tests.

Experimental Design

A repeated measures approach was used with test items being administered on a two week schedule. The maximum heart rate test was on a once-a-month schedule.

The initial tests were administered October 31st, November 1st, and November 2nd and the final test sessions were February 27th, 28th and March 1st. The final test sessions were during the week previous to the Canadian Intercollegiate Athletic Union Championship (CIAU). The total time period was 18 weeks and the total number of tests was nine. There was an extra week between test sessions during December 12th, 13th, 14th and January 2nd, 3rd and 4th when the subjects were writing examinations or were home for the holidays.

A total of four subjects were tested on every Tuesday and Thursday, with the remaining three subjects being tested on Wednesday. The order of the tests was height, weight, resting heart rate, blood pressure, pulmonary function and skinfold thickness.

Instrument and Technique

Height and weight of each subject was measured with the use of a Toledo Balance Scale, Model No. 101, and the attached height scale.

Resting Heart Rate

The subject's resting heart rate was monitored by a Cardiometer while the subjects were resting in the anatomical position. The lowest consistent heart rate occurring in the last five minutes of a 20 minute period was recorded as resting heart rate.

During the rest period all unnecessary lights were extinguished in the laboratory and the subjects were not allowed to converse with each other. Subjects were covered with a blanket to keep them warm.

Resting Blood Pressure

An indirect ausculatory method was used to measure blood pressure. After the subject has rested for 20 minutes, the sphygmomanometer cuff was placed firmly over the left arm. The stethoscope was placed over the brachial artery. The pressure was rapidly inflated until the blood flow through the artery was occluded. The pressure was released from the cuff until the force developed by the heart during systole was great enough to force the blood past the cuff. At this point a distinct sound was heard which was recorded as systolic blood pressure. The pressure in the cuff was lowered further allowing the sound to increase. When the point is reached where the pressure remaining in the artery at the end of diastole was still great enough to force the blood by the occluding cuff, another distinct sound change was heard. This was recorded as diastolic blood pressure.

Pulmonary Function

A Minato Medical Science Co. Autospirometer Model No. AS-700 was used to measure ventilatory capacity. Subjects were given a verbal explanation followed by a visual demonstration as to the proper method of expiring air into the mouthpiece. Subjects were then asked to take three deep breaths prior to maximal inhalation, followed by rapid and total exhalation. After each forced expiratory effort the following values were obtained: predicted vital capacity (V.C. pred.), forced vital capacity (FVC) and percentage of predicted vital capacity (%VC). Three trials were given each subject with the best trial value being recorded.

Skinfold Measurements

The instrument used was the Harpenden skinfold caliper which exerts a constant pressure of 10 gm/mm^2 at varying openings of the jaws. The width of the opening is read from a scale incorporated in the apparatus. The four sites measured were 1) bicep: over the mid-point of the muscle belly with the arm resting comfortably at the side, 2) tricep: over the mid-point of the muscle belly between the olecranon and the tip of the acromion with the arm resting comfortably at the side, 3) subscapular: just below the tip of the inferior angle of the scapula at an angle of 45 degrees to the vertical and 4) supra iliac: just above the iliac crest in the mid-axillary line.

A fold of skin and subcutaneous tissue was picked up between thumb and forefinger of the left hand and pinched clean away from the underlying muscle about one centimeter away from the spot being measured before applying the calipers (Brožek 1956; and Keys 1956). All measurements were taken with the skinfold vertical except where natural folding of the skin was in opposition. All skinfold measurements were completed by the same tester on the right hand side of the body while the subject was in a standing position.

Skinfold measurements were repeated at least twice to ensure skinfolds were measured to an accuracy of five percent (Glick & Kaufman 1976; and Sinning 1974). The four measurements were summated and percentage body fat was calculated using the norms established by Durnin & Rahaman (1967). From percent body fat, lean body mass and total fat weight was calculated.

Maximum Heart Rate

Subjects ran on a motor driven Quinton Treadmill, Model No. 18-60, to obtain maximum heart rate. The speed was set at six miles per hour and the grade increased two degrees every minute for the first five minutes. Subjects then ran for five minutes at a 10 percent grade. The grade was then increased two degrees every five minutes until the subject was unable to continue. Maximum heart rates were recorded from a Cardiometer when the subject had reached exhaustion or when there was no further increase in heart rate to correspond with an increase in work load.

Training Program

The training program was divided into three areas: the pre-season, Christmas season, and the competitive season. The pre-season extended from the beginning of formal practices to the end of classes on December 6, 1978. The practice sessions were one hour and a half in duration five times a week. Pre-season practices usually consisted of 15 minutes of warm-up exercises, 25 minutes of individual primary technique, 20 minutes of instruction and improvement in new technique, 10 minutes of scrimmage situations, 15 minutes of full scrimmage and 5 minutes of conditioning exercises. Warm-up exercises included jogging, front rolls, back rolls, duck walk, cart wheels, flexibility exercises and neck bridging. Conditioning exercises varied each night, but basically consisted of sprints, skipping or pyramids which are designed to increase the wrestler's tolerance to lactic acid. During this time period wrestlers were involved in competition on two occasions.

The Christmas season extended from the termination of formal classes in December until their resumption in January. Due to examinations and holidays, practice sessions were an hour in duration. Wrestlers were required to attend as many practices as possible during this time period. Allocation of practice time was as follows: 10 minutes of warm-up exercises, 30 minutes of individual primary technique, 10 minutes of scrimmaging and 10 minutes of conditioning exercises.

The competitive season extended from January 3, 1979 until the conclusion of the CIAU wrestling championships March 2nd and 3rd. During the competitive season there was a one hour practice in the morning and a one hour and a half practice in the evening. The morning work-out was primarily for the improvement of personal skills. The evening work-out consisted of 10 - 15 minutes of warm-up exercises, 10 - 15 minutes of technique followed by scrimmage situations, full scrimmages and conditioning exercises. Wrestlers were engaged in competition almost every weekend during this time period.

Analysis of Data

Following the analysis of variance, a Tukey test was carried out to determine the full extent of any differences which may have existed between the pre-break scores and the post-break scores.

Chapter IV

RESULTS

The characteristics of the subjects are shown in Table 1. The means, standard deviations, ranges and F-ratios for each variable on all nine tests are shown in Table 2. Mean differences, percentage differences and Tukey value for each test on all variables are shown in Tables 3 - 11.

A one way analysis of variance revealed a non-significant F-ratio on all test items. However, a Tukey test indicated that significant mean difference ($p < .05$) existed in Tables 5, 7, 10 and 11.

There was no significant difference between tests for weight and lean body mass. However, weight demonstrated a tendency to decrease due to training as all test values were lower than the pre-training value. The greatest difference existed between test one and nine (70.3-68.7) depicting a 2.3% decrease. Lean body mass tended to increase through the first six weeks of training then progressively decrease below the initial pre-training value.

Maximum heart rate and blood pressure also revealed no significant difference between means. Maximum heart rate progressively increased 2.2% from test one through to test three then it tended to decrease but remained 1.2% above the pre-training value at the final test session. Systolic and diastolic blood pressure values varied considerably during the course of the training program. The range amongst means was between 116.7 and 112.9 for systolic blood pressure and between 68.5 to 73.3 for diastolic blood pressure which represents a 3.3% decrease

TABLE 1

CHARACTERISTICS OF THE SUBJECTS

SUBJECT	AGE (yr)	HEIGHT (cm)	WEIGHT (kg)
DA	22	165	60.4
RB	23	177	77.5
NC	24	164	67.1
PC	22	175	76.5
AD	19	172	70.0
HL	20	176	70.7
SM	19	169	58.0
JP	18	171	65.3
RS	24	170	72.2
JT	19	178	78.0
MW	18	171	77.5
MEAN	20.3	171.6	70.3
RANGE	18-24	164-178	58.0-78.0

TABLE 2

MEANS, STANDARD DEVIATIONS, RANGES AND F-RATIOS FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION.

TEST NUMBER	STATISTICS / TEST ITEM	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	MEAN	70.3	62.5	10.9	191.2	51.2	114.4	68.5	4.33	99.7
	SD	7.0	5.6	1.9	10.4	6.0	8.9	7.6	0.63	14.1
	RANGE	58.1 - 77.9	53.9 - 68.6	7.3 - 13.1	175 - 209	42 - 66	98 - 130	56 - 80	3.18 - 5.18	77 - 122
2	MEAN	70.1	62.9	9.9		51.7	115.4	70.4	4.85	111.4
	SD	7.3	5.7	1.8	—	6.1	7.6	9.3	0.76	17.9
	RANGE	57.1 - 78.8	53.2 - 71.0	6.0 - 11.9		40 - 61	102 - 126	52 - 80	3.60 - 6.00	87 - 145
3	MEAN	69.8	63.1	9.6	192.0	51.0	113.9	72.0	4.79	108.1
	SD	7.1	5.9	1.7	11.0	5.7	3.4	6.3	0.54	11.9
	RANGE	56.7 - 78.1	53.6 - 70.6	5.5 - 11.7	180 - 214	41 - 60	100 - 126	62 - 82	3.72 - 5.80	90 - 129
4	MEAN	69.9	63.0	9.8		51.2	116.7	71.5	4.78	109.5
	SD	7.1	5.7	1.8	—	4.9	5.4	6.1	0.58	13.8
	RANGE	57.0 - 78.1	53.5 - 70.5	6.1 - 12.5		43 - 60	110 - 125	60 - 80	3.80 - 5.74	92 - 139
5	MEAN	69.9	62.4	10.9	195.5	52.5	114.5	73.3	4.51	103.5
	SD	7.5	6.5	1.3	12.9	4.0	6.8	7.5	0.48	10.5
	RANGE	54.9 - 78.7	49.5 - 70.0	8.3 - 12.7	177 - 218	45 - 60	106 - 127	64 - 86	3.47 - 5.07	84 - 117
6	MEAN	69.5	61.7	11.2		50.7	114.4	72.3	4.60	105.5
	SD	7.5	6.2	1.8	—	4.2	7.4	6.4	0.54	12.8
	RANGE	55.0 - 78.6	50.3 - 69.0	8.6 - 15.5		42 - 56	104 - 126	64 - 80	3.56 - 5.35	86 - 130
7	MEAN	69.6	61.4	11.7	194.4	50.8	114.7	68.7	4.54	104.4
	SD	7.2	5.7	1.5	13.6	4.9	5.8	8.0	0.54	11.9
	RANGE	56.3 - 78.7	51.0 - 69.0	5.4 - 14.3	177 - 222	42 - 57	106 - 124	56 - 78	3.46 - 5.55	83 - 124
8	MEAN	69.6	61.5	11.3		48.9	116.4	73.1	4.69	107.5
	SD	7.5	5.7	1.9	—	4.2	8.3	7.3	0.58	13.4
	RANGE	54.6 - 78.0	50.9 - 68.9	6.8 - 13.8		42 - 56	102 - 132	60 - 86	3.44 - 5.52	83 - 134
9	MEAN	68.7	61.2	10.8	193.4	47.5	112.9	71.4	4.62	106
	SD	8.2	6.6	2.0	9.8	3.5	8.2	5.9	0.55	12.4
	RANGE	51.4 - 78.6	48.4 - 64.3	5.9 - 13.8	167 - 205	42 - 51	100 - 122	60 - 78	3.42 - 5.42	83 - 123
	F-RATIO	0.044	0.182	1.98	1.071	0.251	0.268	0.620	0.879	0.743

and a 7.0% increase, respectively. The highest mean for systolic blood pressure occurred during the examination period and the lowest mean for systolic pressure was the post training value. The lowest mean for diastolic pressure was the pre-training value and the highest mean occurred during test five which followed the Christmas holidays.

As can be seen in Table 5 a significant increase ($\underline{p} < .05$) in percent body fat was demonstrated between tests two and six, seven and eight, between tests three and five, six, seven, and eight and between tests four and six, seven and eight. A significant decrease was also found between tests one and three. The range amongst means occurring between tests three and seven (9.6-11.7) demonstrated a 21.8% increase. The general trend between tests one and nine, the pre- and post-training values, was a decrease in percentage body fat until test five. After the Christmas holidays the subjects reported for test five with a mean of 10.9% body fat which was identical to the pre-training value. Tests six, seven, and eight demonstrated slight but non-significant increases in percent body fat from the pre-training value.

Table 7 indicates a significant decrease ($\underline{p} < .05$) in resting heart rate between tests nine and one, two, three, four, and five and between tests five and eight. The range amongst means was (52.5-47.5) occurring between tests five and nine depicting a 9.5% decrease. The highest mean for resting heart rate occurred during test five which was administered following the Christmas holidays and initiated the wrestlers into the competitive season. The lowest mean for resting heart rate of 47.5 occurred during the last week of training prior to the Canadian Intercollegiate Wrestling Championship.

Tables 10 and 11 demonstrate significant increases ($\underline{p} < .05$) for forced vital capacity (FVC) and percentage of predicted vital capacity (%VC). Forced vital capacity increased significantly between tests one and two, three, and four. The range amongst means was (4.33-4.85) demonstrating a 12% increase which occurred between tests one and two. There was a non-significant increase in forced vital capacity in tests five, six, seven, eight and nine from the pre-training value. Percentage of predicted vital capacity (%VC) increased significantly between tests one and two and between tests one and four. The range amongst means was (99.7-111.4) indicating an 11.7% increase between tests one and two. There was also a non-significant increase in %VC for tests three, five, six, seven, eight and nine above the pre-training value.

Test one demonstrated the lowest means for diastolic blood pressure, maximum heart rate, forced vital capacity, percentage of predicted vital capacity and the highest mean for weight. Test nine revealed the lowest values for weight, lean body mass, resting heart rate and resting systolic blood pressure.

TABLE 3

MEAN AND PERCENTAGE DIFFERENCES FOR WEIGHT

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	-0.3	-0.7	-0.6	-0.6	-1.1	-1.0	-1.0	-2.3
2	-0.2	—	-0.4	-0.3	-0.3	-0.9	-0.7	-0.7	-1.9
3	-0.5	-0.3	—	+0.1	+0.1	-0.4	-0.3	-0.3	-1.6
4	-0.4	-0.2	+0.1	—	0	-0.6	-0.4	-0.4	-1.7
5	-0.4	-0.2	+0.1	0	—	-0.6	-0.4	-0.4	-1.7
6	-0.8	-0.6	-0.3	-0.4	-0.4	—	+0.1	+0.1	-0.7
7	-0.7	-0.5	-0.2	-0.3	-0.3	+0.1	—	0	-1.3
8	-0.7	-0.5	-0.2	-0.3	-0.3	+0.1	0	—	-1.3
9	-1.6	-1.4	-1.1	-1.2	-1.2	-0.5	-0.9	-0.9	—

Tukey value at 0.05 level = 5.23

TABLE 4

LEAN BODY MASS

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	+0.6	+0.9	+0.8	-0.2	-1.3	-1.8	-1.6	-2.1
2	+0.4	—	+0.3	+0.2	-0.8	-1.9	-2.4	-2.2	-2.7
3	+0.6	+0.2	—	-0.2	-1.1	-2.2	-2.7	-2.5	-3.1
4	+0.5	+0.1	-0.1	—	-0.9	-2.1	-2.5	-2.4	-2.9
5	-0.1	-0.5	-0.7	-0.6	—	-1.1	-1.6	-1.4	-1.9
6	-0.8	-1.2	-1.4	-1.3	-0.7	—	-0.5	-0.3	-0.8
7	-1.1	-1.5	-1.7	-1.6	-1.0	-0.3	—	+1.6	-0.3
8	-1.0	-1.4	-1.6	-1.5	-0.9	-0.2	+0.1	—	-0.5
9	-1.3	-1.7	-1.9	-1.8	-1.2	-0.5	-0.2	-0.3	—

Tukey value at 0.05 level = 4.22

TABLE 5

PERCENT BODY FAT

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	- 0.9	-11.9	-10.1	0	+ 2.8	+ 7.3	+ 3.7	- 0.9
2	- 1.0	—	- 3.0	- 1.0	+10.1	+13.1	+18.2	+14.1	+ 9.1
3	- 1.3*	- 0.3	—	+ 2.1	+13.5	+16.7	+21.9	+17.7	+12.5
4	- 1.1	- 0.1	+ 0.2	—	+11.2	+14.3	+19.4	+15.3	+10.2
5	0	+ 1.0	+ 1.3*	+ 1.1	—	+ 2.8	+ 7.4	+ 3.7	- 0.9
6	+ 0.3	+ 1.3*	+ 1.6*	+ 1.4*	+ 0.3	—	+ 4.5	- 0.9	- 3.6
7	+ 0.8	+ 1.8*	+ 2.1*	+ 1.9*	+ 0.8	+ 0.5	—	- 3.4	- 7.7
8	+ 0.4	+ 1.4*	+ 1.7*	+ 1.5*	+ 0.4	- 0.1	- 0.4	—	- 4.4
9	- 0.1	+ 0.9	+ 1.2	+ 1.0	- 0.1	- 0.4	- 0.9	- 0.5	—

Tukey value at 0.05 level = 1.24

* denotes significance ($p < .05$)

TABLE 6

MAXIMUM HEART RATE

PERCENTAGE DIFFERENCE

	Test No.	1	2	3	4	5
MEAN DIFFERENCE	1	—	+0.4	+2.2	+1.7	+1.2
	2	+0.8	—	+1.8	+1.3	+0.7
	3	+4.3	+3.5	—	-0.6	-1.1
	4	+3.2	+2.4	-1.1	—	-0.5
	5	+2.2	+1.4	-2.1	-1.0	—

Tukey value at 0.05 level = 8.23

TABLE 7

RESTING HEART RATE

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	+0.9	-0.4	0	+2.5	-0.9	-0.8	-4.5	-7.2
2	+0.5	—	-1.4	-1.0	+1.5	-1.9	-1.7	-5.4	-8.1
3	-0.2	-0.7	—	+0.4	+2.9	-0.6	-0.4	-4.1	-6.7
4	0	-0.5	+0.2	—	+2.5	-1.0	-0.8	-4.5	-7.2
5	+1.3	+0.8	+1.5	+1.3	—	-3.4	-3.2	-6.9	-9.5
6	-0.5	-1.0	-0.3	-0.5	-1.8	—	+0.2	-3.6	-6.3
7	-0.4	-0.9	-0.2	-0.4	-1.7	+0.1	—	-3.7	-6.5
8	-2.3	-2.8	-2.1	-2.3	-3.6*	-1.8	-1.9	—	-2.9
9	-3.7*	-4.2*	-3.5*	-3.7*	-5.0*	-3.2	-3.3	-1.4	—

Tukey value at 0.05 level = 3.48

* denotes significance ($p < .05$)

TABLE 8

RESTING SYSTOLIC BLOOD PRESSURE

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	+0.9	-0.4	+2.0	+0.9	0	+0.3	+1.7	-1.3
2	+1.0	—	-1.3	+1.1	-0.8	-0.9	-0.6	-0.9	-2.2
3	-0.5	-1.5	—	+2.5	+0.5	+0.4	+0.7	+2.2	-0.9
4	+2.3	+1.3	+2.8	—	-1.9	-1.9	-1.7	-0.3	-3.3
5	+0.1	-0.9	+0.6	-2.2	—	-0.1	+0.2	+1.7	-1.4
6	0	-1.0	+0.5	-2.3	-0.1	—	+0.3	+1.8	-1.3
7	+0.3	-0.7	+0.8	-2.0	+0.2	+0.3	—	+1.5	-1.6
8	+2.0	+1.0	+2.5	-0.3	+1.9	+2.0	+1.7		-3.0
9	-1.5	-2.5	-1.0	-3.8	-1.6	-1.5	-1.8	-3.5	—

Tukey value at 0.05 level = 5.40

TABLE 9

RESTING DIASTOLIC BLOOD PRESSURE

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	+2.8	+5.1	+4.4	+7.0	+5.5	+0.3	+6.7	+4.2
2	+1.9	—	+2.3	+1.6	+4.1	+2.7	-2.4	+3.8	+1.4
3	+3.5	+1.6	—	-0.7	+1.8	+0.4	-4.6	+1.5	-0.8
4	+3.0	+1.1	-0.5	—	+2.5	+1.1	-3.9	+2.2	-0.1
5	+4.8	+2.9	+1.3	+1.8	—	-1.4	-6.3	-0.3	-2.6
6	+3.8	+1.9	+0.3	+0.8	-1.0	—	-4.9	-1.1	-1.2
7	+0.2	-1.7	-3.3	-2.8	-4.6	-3.6	—	+6.4	+3.9
8	+4.6	+2.7	+1.1	+1.6	-0.2	-0.8	+4.4	—	-2.3
9	+2.9	+1.0	-0.6	-0.1	-1.9	-0.9	+2.7	-1.7	—

Tukey value at 0.05 level = 5.12

TABLE 10

FORCED VITAL CAPACITY

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	+12.0	+10.6	+10.4	+ 4.2	+ 6.2	+ 4.8	+ 8.3	+ 6.7
2	+ 0.52*	—	- 1.2	- 1.4	- 7.0	- 5.2	- 6.4	- 3.3	- 4.7
3	+ 0.46*	- 0.06	—	- 0.2	- 5.8	- 3.9	- 5.2	- 2.1	- 3.5
4	+ 0.45*	- 0.07	- 0.01	—	- 5.6	- 3.8	- 5.0	- 1.9	- 3.3
5	+ 0.18	- 0.34	- 0.28	- 0.27	—	+ 1.9	+ 0.7	+ 3.9	+ 2.4
6	+ 0.27	- 0.25	- 0.19	- 0.18	+ 0.09	—	- 1.3	+ 1.9	+ 0.4
7	+ 0.21	- 0.31	- 0.25	- 0.24	+ 0.03	- 0.06	—	+ 3.3	+ 1.8
8	+ 0.36	- 0.16	- 0.10	- 0.09	+ 0.18	+ 0.09	+ 0.15	—	- 1.5
9	+ 0.29	- 0.23	- 0.17	- 0.16	- 0.11	+ 0.02	+ 0.08	- 0.07	—

Tukey value at 0.05 level = 0.41

* denotes significance ($\underline{p} < .05$)

TABLE 11

PERCENTAGE OF PREDICTED VITAL CAPACITY

PERCENTAGE DIFFERENCE

MEAN DIFFERENCE

Test No.	1	2	3	4	5	6	7	8	9
1	—	+11.7	+ 8.4	+ 9.8	+ 3.8	+ 5.8	+ 4.7	+ 7.8	+ 6.3
2	+11.7*	—	- 2.9	- 4.4	- 7.1	- 5.3	- 6.3	- 3.5	- 4.8
3	+ 8.4	- 3.3	—	+ 1.3	- 4.3	- 2.4	- 3.4	- 0.6	- 1.9
4	+ 9.8*	- 1.9	+ 1.4	—	- 5.5	- 3.7	- 4.7	- 1.8	- 3.2
5	+ 3.8	- 7.9	- 4.6	- 6.0	—	+ 1.9	+ 0.9	+ 3.9	+ 2.4
6	+ 5.8	- 5.9	- 2.6	- 4.0	+ 2.0	—	+ 1.0	+ 1.9	+ 0.5
7	+ 4.7	- 7.0	- 3.7	- 5.1	+ 0.9	+ 1.1	—	+ 2.9	+ 1.5
8	+ 7.8	- 3.9	- 0.6	- 2.0	+ 4.0	+ 2.0	+ 3.1	—	- 1.4
9	+ 6.3	- 5.4	- 2.1	- 3.5	+ 2.5	+ 0.5	+ 1.6	- 1.5	—

Tukey value at 0.05 level = 9.42

* denotes significance ($p < .05$)

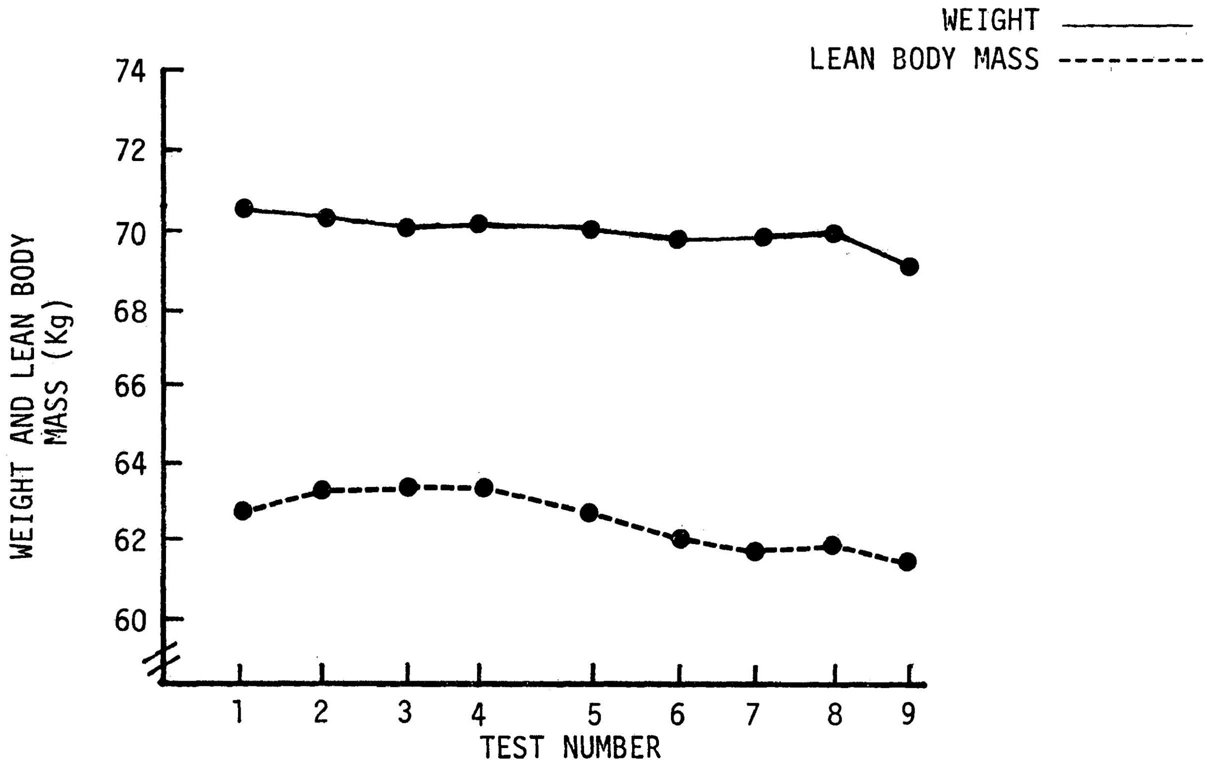

FIGURE 1. WEIGHT AND LEAN BODY MASS TESTED BI-WEEKLY.

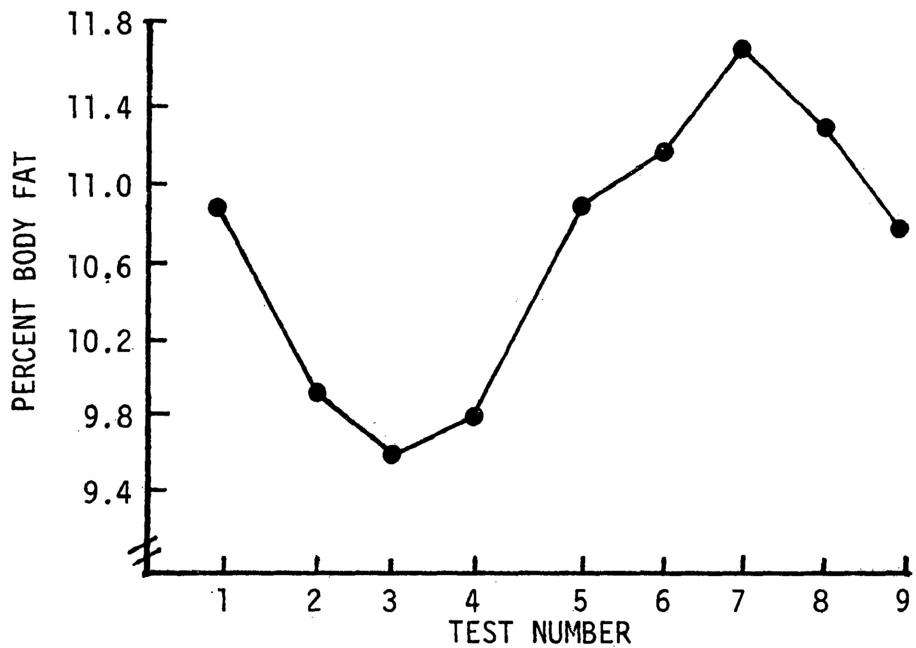

FIGURE 2. PERCENT BODY FAT TESTED BI-WEEKLY.

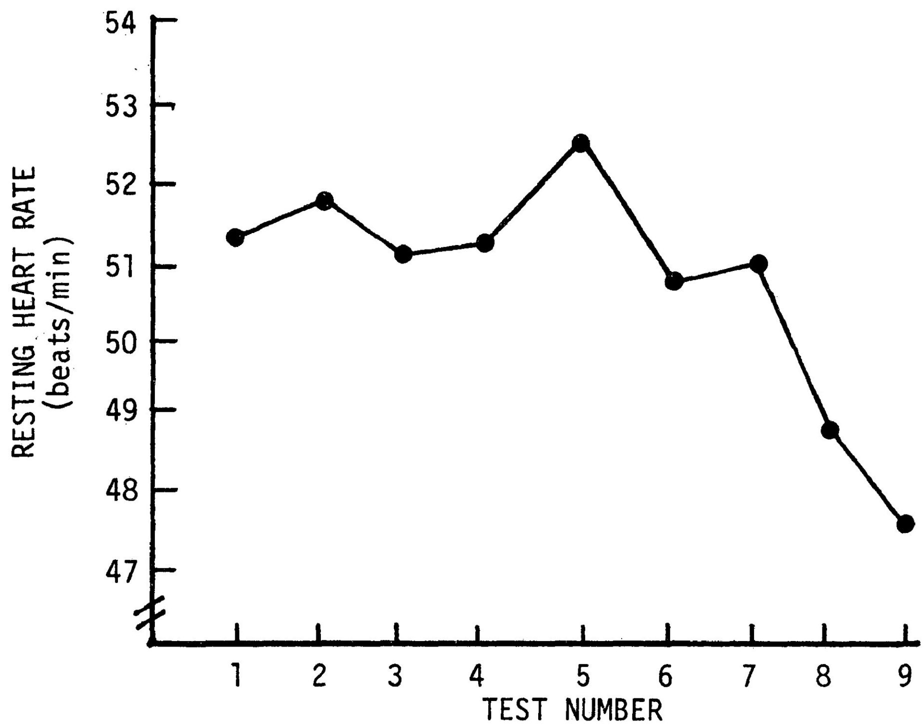

FIGURE 3. RESTING HEART RATE TESTED BI-WEEKLY.

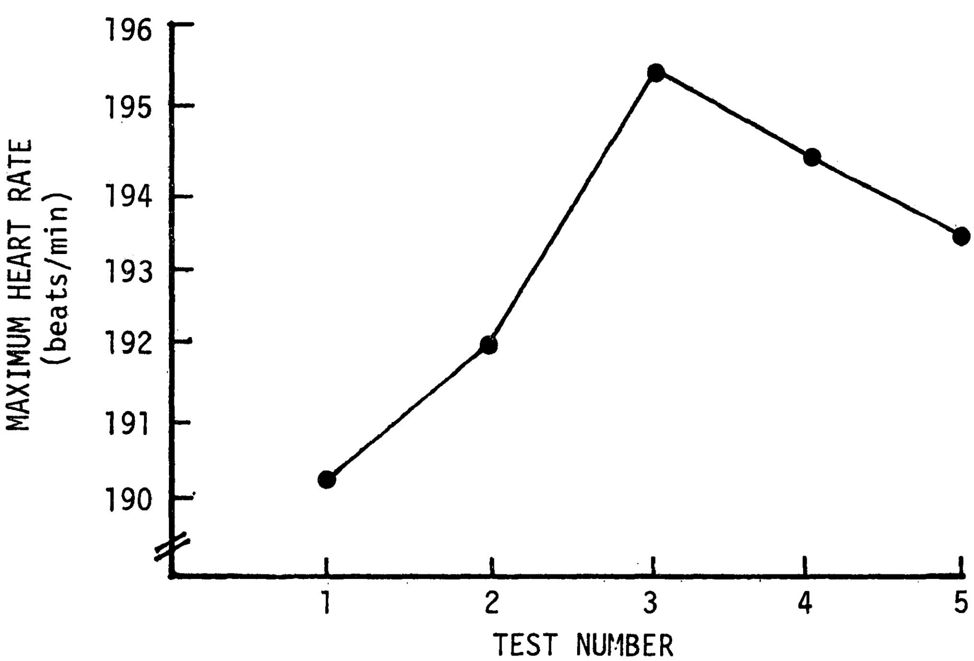

FIGURE 4. MAXIMUM HEART RATE TESTED MONTHLY.

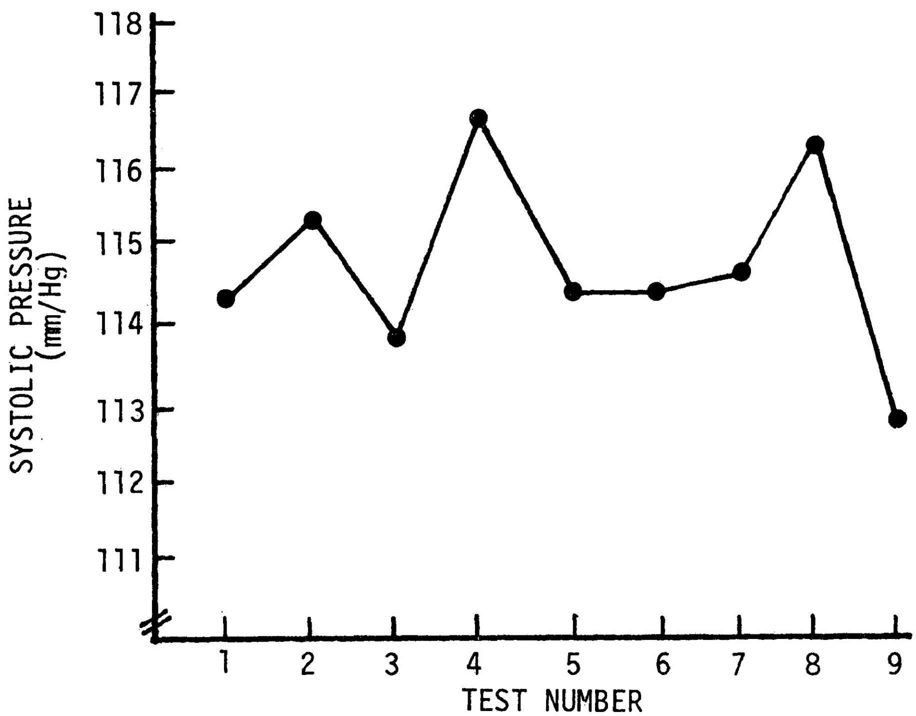

FIGURE 5. RESTING SYSTOLIC BLOOD PRESSURE TESTED BI-WEEKLY.

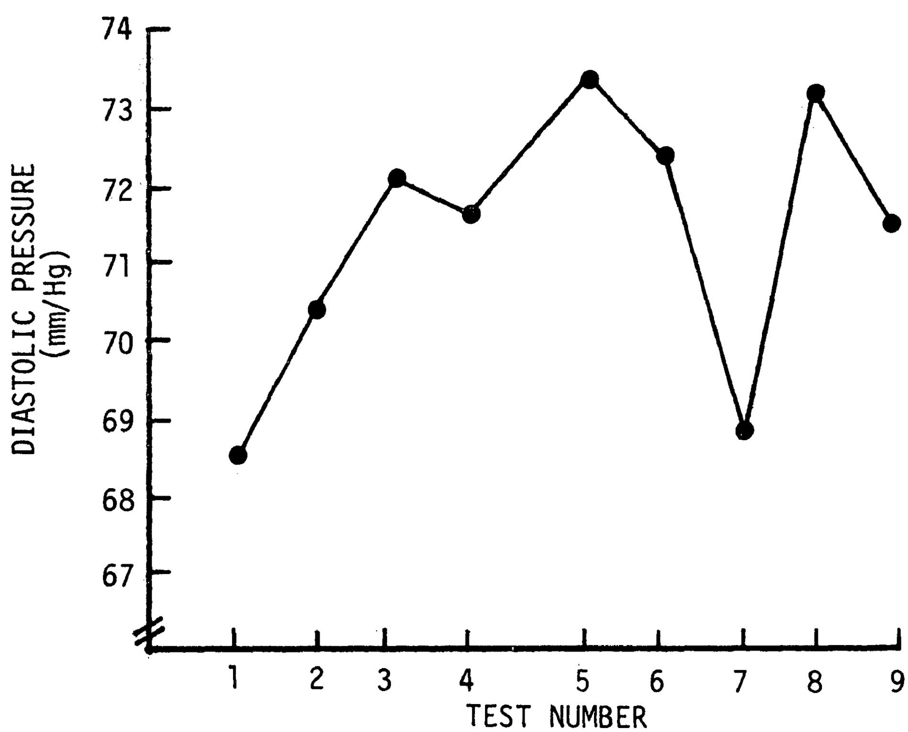

FIGURE 6. RESTING DIASTOLIC BLOOD PRESSURE TESTED.

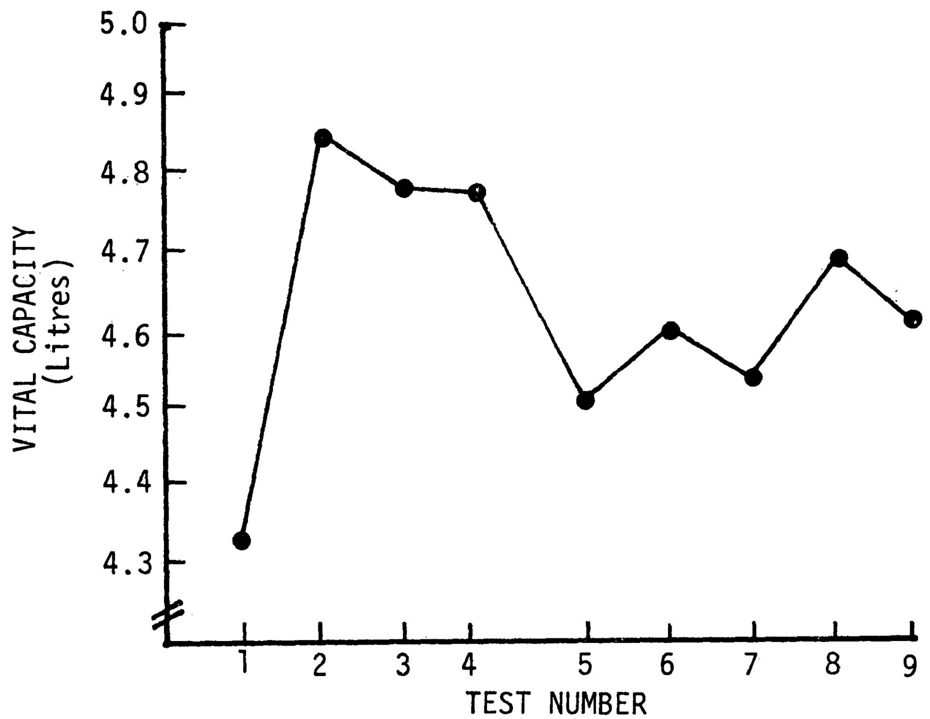

FIGURE 7. FORCED VITAL CAPACITY TESTED BI-WEEKLY.

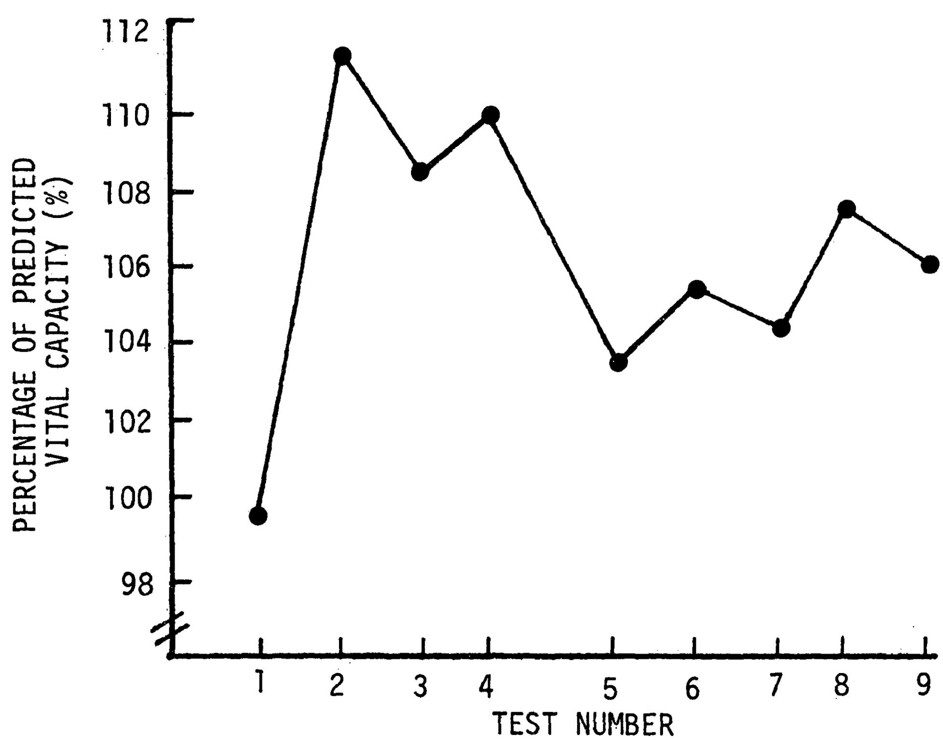

FIGURE 8. PERCENTAGE OF PREDICTED VITAL CAPACITY TESTED BI-WEEKLY.

Chapter V

Discussion

Anthropometrical Measures

The results of this study indicated that total body weight of collegiate wrestlers remains fairly stable during a season of varsity wrestling and its associated interruptions. The largest change in body weight was between tests one and nine, a non-significant decrease of 1.6 kilograms. Similar results were reported by Kelly et al (1978) who indicated that weight varied no more than 1.09 kilograms from September to March in another group of collegiate wrestlers. Other researchers have reported non-significant changes in weight following hockey and football training programs (Green & Houston, 1975; and Thompson, 1959). Skinner, Holloszy, & Cureton (1964) reported average weight remained constant during a six week training program but that there was some individual variation.

Numerous researchers have demonstrated significant decreases in body weight following at least 10 weeks training (Carter & Phillips, 1969; Pollock et al, 1969; Pollock et al, 1971; Milesis et al, 1976; and Wilmore et al, 1970b). Pollock (1973) concluded that changes tend to manifest themselves with months of training and that programs of less than 10 weeks duration result in less change. On the other hand, Glick & Kaufman (1976) and Thomas and Reilly (1976) reported significant and non-significant increases in body weight following six weeks and five months training, respectively.

During the 18 week period of the present study weight decreased gradually but this decrease was not significant. Interruptions in training due to examinations and Christmas holidays resulted in a 0.1% increase in weight above the mean for test three but it still remained 0.6% below the pre-training value. Kelly et al, (1978) attributed year round training with being responsible for weight remaining fairly constant through the investigative period. In the present study the gradual decrease in weight would seem to be a result of the training program. Upon termination of the training program all subjects would probably increase in weight to the pre-training value. This is supported by the results of Hassman (1961) who reported that wrestlers significantly gained weight upon cessation of training.

Table 4 indicates a non-significant increase in lean body mass during the pre-season training period and during the examination period. The following three week period between December 12th, 13th, 14th, and January 2nd, 3rd, and 4th, when the majority of subjects were home for Christmas holidays resulted in a 0.9% decrease in lean body mass. When the subjects reported for test five the mean for lean body mass was 0.1 kilogram below the pre-training value. The largest value for lean body mass occurred during test three which corresponds with the end of pre-season training and beginning of the Christmas season. The effect of pre-season training on lean body mass of wrestlers is in agreement with the results of Cermak et al, (1975) who reported increases in lean body mass during early season training. Dempsey (1964), Pollock et al, (1969) and Thompson (1959) have reported similar changes in body composition following training. Pařízková (1963) reported that during preparatory intensive training for competition body weight remained constant, the amount of body fat fell strikingly and lean body mass increased. During training periods of increased muscular activity lean body mass hypertrophies and fat decreases, with substantial reduction of muscular activity muscular mass decreases slightly in size and fat accumulates. Hanson (1975) and Kelly et al, (1978) reported no significant change in lean body mass of alpine skiers and wrestlers that they attributed to year round training.

In the present study, lean body mass progressively decreased during the remaining nine weeks of the competitive season. This non-significant decrease corresponds to similar decreases in total body weight. Similar results were reported by Cermak et al, (1975) who found decreases in lean body mass and total body weight during the last six months of a yearly canoeing program. The present results are also in partial agreement with Montgomery & Ismail (1977) who reported a non-significant decrease in weight and an increase in lean body mass whereas a high fit group demonstrated a non-significant decrease in weight without a change in lean body mass. It may be suggested that this group of wrestlers was a highly fit group prior to training and the effects of training may not be manifested in changes in lean body mass as they were already at their optimal level before the season started.

With the exception of test nine lean body mass varied inversely with percent body fat which were both estimated using a skinfold technique. Investigators have suggested that skinfold thickness may not be sufficiently sensitive enough to detect changes in body composition occurring as a result of training (Watson & O'Donovan, 1977; Wilmore, Girandola & Moody, 1970a and Zwiren, Skinner & Buskirk, 1973). The calculation of lean body mass was dependent upon measurement of skinfold thickness, therefore any variation in total skinfold thickness would explain the fluctuation in lean body mass. Test nine however, demonstrated the lowest value for both weight and lean body mass which was independent of skinfold thickness.

The use of a more sensitive measuring technique may have resulted in little or no fluctuation in lean body mass.

Numerous investigators have substantiated the fact that participation in physical training programs result in a decrease in percent body fat (Carter & Phillips, 1969; Milesis et al, 1976; Pollock et al, 1969; Pollock et al, 1971; and Thompson, 1959). In the present study there was a gradual decrease in percent body fat from the pre-training value which became significant at test three. During the Christmas examination period there was a slight increase in percent body fat. Following the Christmas holidays the wrestlers had 10.9% body fat identical to the pre-training value indicating a significant increase between tests three and five. Percent body fat increased 2.8% and 7.4% above the pre-training value for test six and seven, respectively. Test seven which revealed the highest mean was during a break in the competition schedule, January 30th, 31st and February 1st. It may be suggested that the decrease in training intensity and lack of dietary control at test seven may have had an effect in increasing percent body fat. Crews & Roberts (1976) reported a similar increase in mean percent body fat during a training program which they attributed to a lack of dietary control. Other investigators have reported increases in percent body fat of thin individuals during training (Dempsey, 1964; and Glick & Kaufman, 1976).

The wrestlers involved in the present study had a seasonal mean of 10.7% body fat which was slightly lower than the values which were presented by Kelly et al, (1978) who reported a mean pre-season, peak-season, and post-season percent body fat of 12.8, 10.4, and 12.6%, respectively for a group of collegiate wrestlers (N=13). The means from that group included a heavy weight which may have elevated the overall average. Other researchers have reported 6.9% (Katch & Michael, 1971) 8.81% (Sinning, 1974) 8.26%, 8.25%, (Nagle et al, 1975) and 9.8%, (Fahey et al, 1975; and Gale & Flynn, 1974) percent body fat for different groups of wrestlers.

Heart Rates

Maximum heart rate tended to increase slightly above the pre-training mean reaching the highest value at test three immediately following the Christmas holidays. It then tended to decrease slightly during the competitive season. This non-significant change in maximum heart rate is in agreement with other studies (Brynteson & Sinning, 1973; Davies et al, 1970; Douglas & Becklake, 1968; Green & Houston, 1975; Kelly et al, 1978; Montgomery & Ismail, 1977; Reilly & Thomas, 1977; Saltin, 1969; and Siegal et al, 1970). Although maximum heart rate did not change significantly all subjects were able to run a longer period of time at maximum heart rate and/or run at a higher work load to reach maximum heart rate. Montgomery & Ismail, (1977) reported a similar non-significant increase in maximum heart rate although the subjects were able to run longer on the treadmill after training.

The means for the maximum heart rate test of the present group of wrestlers are similar to the values presented by Kelly et al, (1978); 192.5 pre-season, 188.2 peak-season, 193.2 post-season and Fahey et al, (1975) who reported a mean of 192.2 for two wrestlers. The means for maximum heart rate of the present study were higher than the studies of Nagle et al, (1975) who reported 172.6 and 180.2 for successful and unsuccessful U.S. Olympic wrestling team candidates. The mean for maximum heart rate was also higher than the values presented by Maksud et al, (1970) and Saltin & Åstrand (1967) for U.S. Olympic speed skaters and Swedish National Team members, respectively.

Resting heart rate demonstrated a tendency to decrease with training. The post-training mean of 47.5 was the lowest mean and it was significantly lower than tests one to five. A significant decrease was also demonstrated between tests five and eight. These results are consistent with the results of Akgun et al (1974); Barnard (1975); Joseph (1974); Koeslag & Sloan (1976); Milesis et al (1976); Pollock et al (1969); Pollock et al (1971); Reilly & Thomas (1977); Shaver (1974a); Tabakin et al (1965); Wallin & Schendel (1969); and Wilmore et al (1970b), who reported significant decreases in resting heart rate following training. Pollock (1973) concluded resting heart rate is reduced with training, with the magnitude of change dependent on the initial level of fitness. The decrease in intensity, duration and frequency of training during the Chrismas holidays was reflected in resting heart rate as the highest mean of 52.5 occurred during test five immediately following the holidays. Similar increases in resting heart rate during de-training has been reported by Fringer & Stull (1974); Hassman (1961); and Penny & Wells (1975). The decrease in resting heart rate of the present group may be due to an increased stroke volume (Åstrand & Rodahl, 1977; Clausen, 1977; Ekblom et al, 1968; Frick et al, 1963; Hermansen & Andersen, 1965; Rowell, 1969; Saltin, 1969; Scheuer, 1973; Schneider & Crampton, 1940) or it may be due to intrinsic mechanisms (Barnard, 1975; Clausen, 1977; Ekblom et al, 1973; Mathews & Fox, 1976; and Scheuer & Tipton, 1977).

The average overall mean for resting heart rate was 50.6. This mean is considerably lower than the typical resting heart rate of well conditioned wrestlers who demonstrated an average of 60 to 65 beats per minute (Akgun & Ustun, 1960; Rasch, Faires, & Hunt, 1958; Rasch & Kroll, 1964; and Tomaras, 1948).

Blood Pressure

The resting systolic and diastolic blood pressure demonstrated bi-directional changes following four months of wrestling training. Although changes occurred in both systolic and diastolic blood pressure these changes were not significant. Both systolic and diastolic pressure failed to demonstrate a consistent trend as both fluctuated considerably. This fluctuation may be attributed to individual variability, individual anxiety, (DeCoursey, 1961) and possibly the consumption of food prior to the tests (Dagenais, Oriol, and McGregor, 1966).

The average overall mean for systolic blood pressure was 114.8 (mm/Hg). The means for pre-training, post-training and immediately following the Christmas holidays were all below the average overall mean. The highest individual mean for systolic pressure occurred during test four which may be attributed to the anxiety which accompanies the Christmas examinations. The average overall mean for diastolic pressure was 71.2 (mm/Hg) which was slightly higher than the pre-training mean and slightly lower than the post-training mean.

The results of the present study are in agreement with other investigators who have reported no change or slight reductions in blood pressure following training (Akgun et al, 1974; Åstrand & Rodahl, 1977; Clausen, 1977; Ekblom et al, 1968; Frick et al, 1963; Lamb, 1978; Pollock, 1973; Tabakin et al, 1965; and Wallin & Schendel, 1969).

Other investigators have reported significant changes that are conflicting with the present study. A significant decrease in both systolic and diastolic pressure was reported by Choquette & Ferguson, (1973); Michael & Gallon, (1960); Montgomery & Ismail, (1977); Reilly & Thomas, (1977); and Wilmore et al, (1970b). Tomaras (1948) concluded systolic pressure is lowered, diastolic pressure is raised, while Shaver (1974a) indicated systolic pressure decreases significantly while no change occurred in diastolic pressure following wrestling training. Penny & Wells (1975) reported that systolic blood pressure progressively increased during a de-training period indicating that training might have caused an initial reduction in systolic blood pressure in football players.

The literature concerning the effects of training on resting blood pressure remains conflicting and difficult to draw conclusions upon. The wrestlers in the present study revealed that the means for systolic and diastolic blood pressure of wrestlers were below the normal value for individuals of the same age group (120/80mm/Hg), and above the values presented by Akgun & Ustun (1960) (109±2.5/73±1.7mm/Hg).

Pulmonary Function

A significant increase ($p < 0.5$) in the forced vital capacity (FVC) was indicated in Table 10 between tests one and two, three, and four. Tests six, seven, eight and nine also revealed slight increases in FVC above the initial value but these increases were not significant. The lowest value for FVC occurring during the training program was demonstrated in test five immediately following the Christmas holidays. The test five value, however, remains 4.2% higher than the pre-training value.

The results of the present study are in partial agreement with other investigators. Shaver (1974b) and Tomaras (1948) reported significant increases in FVC following wrestling training while Bachman

& Horvath (1968) reported a significant increase in FVC of swimmers but only a slight non-significant increase in wrestlers. Wilmore et al (1970b) reported a significant increase in FVC following a 10 week jogging program.

The non-significant change during the competitive season is in agreement with numerous other researchers (Akgun et al, 1974; Freeman et al, 1955; Green & Houston, 1975; Hanson, 1975; Milesis et al, 1976; Montgomery & Ismail, 1977; Reilly & Thomas, 1977; and Thomas & Reilly, 1976).

Percentage of predicted vital capacity (%VC) followed a similar trend as forced vital capacity. A significant increase was demonstrated between tests one and two and between tests one and four. Brynteson & Sinning (1973) reported a similar increase in %VC following training. All tests values revealed a %VC higher than both the pre-training value and predicted value. Similar values on athletes has been reported by Dening (1942); Kroll (1954); Maksud, Hamilton, Coutts, & Wiley (1971); Maksud et al (1970); Reilly & Thomas (1977); Smith & Byrd (1976); Stuart & Collings (1959); and Thomas & Reilly (1976).

An increase in FVC following training and competition has been attributed to an increased development of the respiratory musculature (Shaver, 1974b; and Stuart & Collings, 1959). Brynteson & Sinning (1973) concluded that pulmonary function improvements are more readily retained during detraining due to this increased strength and endurance of the thoracic, abdominal and diaphragm muscles resulting from training. Saltin (1969) suggested that only swimmers and divers experience an increased FVC due to the fact that a large percentage of their vital capacity must be used in each breath. Other training programs may not supply a sufficient stimulus for an increase in the static dimensions of the lungs.

The content of the pre-season training program significantly increased both FVC and %VC whereas the examination and holidays periods resulted in a slight decrease. The content of the competitive season training differed from the pre-season as it was more sport orientated with more time spent scrimmaging.

During the competitive season the wrestlers were engaged in losing weight for the weekend competitions. Weight loss has been reported by Tuttle (1943) as having a tendency to reduce vital capacity. It may be postulated that the differences in FVC and %VC between the pre- and post-season may be attributed to different training procedures and possibly weight loss which accompanies preparation for tournaments.

Chapter VI

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to examine the effects of training and interruptions in training upon cardiorespiratory and anthropometric measures of collegiate wrestlers (N=11). The wrestlers participated in 18 weeks of training which was divided into the pre-season, Christmas season and competitive season.

The research design was a repeated measures technique with resting heart rate, blood pressure, pulmonary function and skinfold thickness administered on a bi-weekly schedule. Maximum heart rate was measured five times at the beginning of each month.

A one way analysis of variance was employed to determine if a significant *F*-ratio existed. In addition a Tukey Test was used to determine during which portion of the training program significant changes occurred.

Conclusions

In this study the author may conclude as follows:

That the interruptions associated with a collegiate wrestling training program had no significant effect upon any of the measured variables. An 18 week wrestling training program and its associated interventions had no significant effect upon weight, lean body mass, maximum heart rate and blood pressure.

Recommendations

1. This study should be replicated with the test items being

administered for a period of time prior to training to establish a consistent pre-training baseline for comparison.

2. A more sensitive method for determining percent body fat and lean body mass be utilized.

3. A case study approach be attempted which would enable the investigator to identify individual trends.

4. A similar study be attempted monitoring physical work capacity, aerobic power, anaerobic power and one minute recovery heart rate.

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APPENDIX A

TABLES CONTAINING RAW DATA

TABLE A. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT DA.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	60.4	54.8	9.3	184	42	114	76	3.18	77
2	60.0	54.7	8.9	—	40	108	78	3.60	87
3	60.6	55.1	9.0	187	47	108	72	3.72	90
4	60.7	55.2	9.0	—	47	110	72	3.80	92
5	60.5	54.1	10.5	188	45	108	68	3.47	84
6	59.8	53.8	10.1	—	42	126	68	3.56	86
7	60.0	53.6	10.7	185	42	110	68	3.46	83
8	60.7	54.1	10.9	—	46	120	64	3.44	83
9	59.7	53.7	10.1	194	43	112	76	3.42	83

TABLE B. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT RB.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	77.5	68.6	11.6	180	66	116	78	4.16	94
2	77.3	68.5	11.4	—	61	126	80	4.90	110
3	75.3	68.1	10.9	202	60	116	70	4.79	107
4	75.9	67.8	10.7	—	78	120	80	4.64	104
5	76.2	67.3	11.7	201	60	120	86	4.73	106
6	76.0	67.3	11.5	—	56	112	72	4.64	104
7	75.0	66.0	12.0	203	57	118	70	4.78	107
8	75.2	66.3	11.9	—	56	122	78	5.01	112
9	75.1	66.8	11.1	205	50	112	66	4.74	105

TABLE C. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT NC.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	67.1	59.9	10.8	191	50	130	80	5.00	122
2	66.8	61.0	8.7	—	53	125	80	6.00	145
3	66.5	60.8	8.6	190	50	125	80	5.17	125
4	67.0	61.2	8.7	—	51	125	80	5.74	139
5	66.7	60.0	10.0	189	52	127	80	4.80	117
6	66.1	58.8	11.1	—	54	110	70	5.34	130
7	66.3	59.8	9.8	197	52	124	78	4.85	118
8	66.2	59.8	9.6	—	49	122	78	5.52	134
9	65.2	58.1	11.0	194	43	122	78	49.2	120

TABLE D. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT PC.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	76.5	68.5	10.9	182	52	128	76	4.22	96
2	74.0	65.6	11.3	—	58	148	74	4.81	109
3	75.5	68.0	9.9	181	50	126	76	4.57	103
4	75.0	67.3	10.3	—	53	124	76	4.43	100
5	75.0	66.4	11.5	193	55	124	84	4.65	105
6	73.7	65.7	10.9	—	53	120	79	4.74	107
7	74.8	66.1	11.6	186	52	120	78	4.53	103
8	75.2	66.4	11.7	—	52	120	70	4.87	110
9	72.5	64.5	11.0	184	45	120	72	4.82	110

TABLE E. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT AD.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	70.0	62.4	10.8	—	52	98	64	4.68	107
2	70.0	62.1	11.3	—	51	110	52	4.10	90
3	69.3	61.7	10.9	189	52	108	62	4.98	114
4	69.0	61.6	10.8	—	53	118	68	4.98	114
5	69.5	60.7	12.7	200	51	106	66	4.83	110
6	69.5	61.4	11.7	—	50	104	64	4.70	107
7	70.0	60.4	12.4	200	52	118	58	4.70	107
8	69.0	60.7	12.0	—	48	102	68	4.68	107
9	67.5	59.7	11.5	200	50	106	56	4.62	106

TABLE F. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT HL.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	70.7	61.6	12.9	184	47	112	64	5.18	116
2	71.5	63.0	11.9	—	48	112	74	5.92	132
3	71.5	63.1	11.7	180	51	110	76	5.80	129
4	71.5	62.8	12.2	—	50	114	70	5.49	120
5	71.7	63.6	12.7	177	55	112	70	4.88	109
6	73.1	61.8	15.5	—	52	108	80	5.06	113
7	71.7	61.5	14.3	167	55	108	76	5.55	124
8	71.6	61.7	13.8	—	42	110	74	5.13	114
9	70.5	61.0	13.5	167	46	100	70	5.17	115

TABLE G. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT SM.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	58.1	53.9	7.3	190	54	110	56	4.13	95
2	57.1	53.7	6.0	—	58	116	68	4.55	105
3	56.7	53.6	5.5	214	60	112	64	4.56	105
4	57.0	53.5	6.1	—	57	110	60	—	—
5	54.7	49.5	9.4	—	—	—	—	—	—
6	55.0	50.3	8.6	—	56	110	70	4.46	103
7	56.3	51.0	9.4	222	57	106	66	4.39	101
8	53.6	50.0	6.8	—	45	116	78	4.44	102
9	52.8	49.7	5.9	205	44	100	64	4.57	105

NOTE: SUBJECT SM SUFFERED A DISLOCATED ELBOW AND WAS ABSENT FOR SOME TESTS.

TABLE H. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT JP.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	65.3	56.7	13.1	205	51	116	64	3.76	86
2	64.9	58.3	10.2	—	47	116	68	4.18	95
3	64.3	57.9	9.9	202	41	102	74	4.39	100
4	63.7	57.6	9.6	—	43	118	70	—	—
5	64.2	58.9	8.3	213	50	112	78	3.85	88
6	63.5	56.9	10.4	—	49	124	80	3.77	86
7	64.0	57.0	11.0	219	45	110	64	4.04	93
8	63.5	56.8	10.5	—	44	110	74	4.15	95
9	63.9	57.1	10.7	203	42	114	68	4.32	99

TABLE I. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT RS.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	72.2	66.0	8.6	175	46	108	64	3.86	91
2	71.5	65.6	8.2	—	47	116	64	4.73	111
3	72.0	66.0	8.3	181	45	100	68	4.60	108
4	73.5	66.9	9.0	—	65	124	70	4.75	111
5	74.0	66.0	10.9	177	50	110	70	4.42	104
6	73.0	65.3	10.7	—	47	114	64	4.72	111
7	72.5	64.2	11.5	178	45	116	56	4.55	107
8	73.5	64.7	11.9	—	50	108	60	4.64	109
9	73.3	65.7	10.3	180	51	116	70	4.80	113

TABLE J. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT JT.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	77.9	68.6	11.9	182	53	110	66	4.24	93
2	78.8	71.0	9.9	—	54	102	58	4.10	90
3	78.1	70.6	9.6	200	53	120	68	4.29	94
4	77.6	70.5	9.2	—	54	120	69	4.48	98
5	79.5	70.0	12.0	200	51	124	64	4.28	94
6	78.6	68.7	12.6	—	51	122	68	4.45	98
7	78.7	69.0	12.3	192	50	112	64	4.17	92
8	78.0	69.0	11.6	—	53	118	74	4.45	98
9	78.6	67.8	13.8	190	51	110	71	4.30	94

TABLE K. RAW DATA FOR WEIGHT, LEAN BODY MASS, PERCENT BODY FAT, MAXIMUM HEART RATE, RESTING HEART RATE, BLOOD PRESSURE AND PULMONARY FUNCTION OF SUBJECT MW.

TEST ITEM / NUMBER	WEIGHT (Kg)	LEAN BODY MASS (Kg)	PERCENT BODY FAT (%)	MAXIMUM HEART RATE (beats/min)	RESTING HEART RATE (beats/min)	SYSTOLIC PRESSURE (mm/Hg)	DIASTOLIC PRESSURE (mm/Hg)	PULMONARY FVC (L)	FUNCTION %VC
1	77.5	67.3	13.1	186	51	116	66	5.15	117
2	77.0	68.6	10.9	—	52	116	78	5.62	128
3	78.0	69.6	10.8	186	52	126	82	5.31	120
4	78.1	68.3	12.5	—	48	116	80	5.40	123
5	79.5	69.9	12.1	195	51	110	72	5.07	115
6	76.6	69.0	9.9	—	48	134	80	5.13	116
7	76.8	66.5	13.5	189	52	120	78	5.03	114
8	77.5	66.9	13.7	—	51	132	86	5.27	119
9	77.1	67.4	12.6	193	51	120	78	5.42	123