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Robert James Grindey

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THE EFFECTS OF TWO TRAINING PROGRAMS ON MIDDLE DISTANCE SWIMMING SPEED

By

Robert James Grindey

A Thesis

Submitted in Partial Fulfillment of the

Requirements for the Degree of

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CHAPTER I

INTRODUCTION

For a number of years there has been some discussion on the subject of what elements constitute the best type of training program for competitive swimmers. Each school of thought has advocated its type of program as the best, and each has turned out champion swimmers.

One of the largest areas of discussion and disagreement has centered around the question of whether or not competitive swimmers should include running or strenuous leg work, other than kicking laps in the pool, in their training programs.

Some coaches and physical educators believe that the competitive swimmer should not engage in running or strenuous leg work. They believe that activities such as running, skating, and skiing "tighten up" muscles and hamper swimming performance. Another group has used cross-country and endurance running in its training programs but has made no studies to determine the effect of these activities on the performance of swimmers. Studies that will help to settle this issue are needed.

I. THE PROBLEM

Statement of the problem. It was the purpose of this study to determine the effect of two different training programs upon the swimming speed of high school boys in the 200-yard crawl stroke event.

Importance of the study. We are constantly breaking records and bettering marks in many aspects of the athletic program. Most coaches and athletes believe that the athlete of today has more endurance, speed, strength, and power than his counterpart of the past because of advanced methods of training.

This study should be of importance to those coaches who are seeking scientific evidence on which to base their training programs and methods.

II. ORGANIZATION OF THE REMAINDER OF THE STUDY

The remainder of the subject matter of this study will be presented in five main divisions. Chapter II deals with a review of related literature. Chapter III presents the methods of research used in the study as well as the method of testing, the training programs and frequency of training, and the method of collecting data. The data are analyzed in Chapter IV. The final chapter contains the summary, conclusions and, recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

A review of literature related to the problem of this study is presented in this chapter. Thompson and Stull stated, "Except for opinions based upon empirical observations, little is known regarding the effects of various programs on speed in swimming."[1] There has been a great deal of research done in the general field of swimming, but very little of it has been in the area of evaluating training programs for swimmers. Personal experiences or heresay about the methods of others have been the usual bases for evaluation. The literature reviewed is presented in two sections. The first section deals with studies of various physiological factors and swimming speed and performance. The second section reviews literature directly related to the subject of training programs for swimmers.

Physiological Factors and Swimming Speed and Performance

Swegan and Thompson[2] compiled research done in the field of swimming in recent years. They citedaan unpub-

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1. Hugh Thompson, and G. Alan Stull, "Effects of Various Training Programs on Speed of Swimming," The Research Quarterly, 30:479, December, 1959.

2. D. Swegan, and H.Thompson, "Experimental Research in Swimming," Scholastic Coach, 28:24, April, 1959.

lished Masters Thesis by Robert Lueft, of Pennsylvania State University, on the subject of the effect of warming-up upon swimming speed of forty-nine subjects. The warm-up consisted of formal type exercises on land, and the fifty yard crawl stroke in the water. Lueft concluded that the mean times for the warm-up trials were slightly faster than the mean times for the non-warm-up trials. The difference in the mean times was significant up to the five percent level of confidence.

Fillipponi[3] studied the effect of warming-up on the swimming speed of twelve varsity swimmers. The subjects were directed to swim a distance of 100 yards, five times with a formal type warm-up and five times without warming-up. No statistically significant difference was found between these times.

Another study on the influence of body temperature on performance in swimming was done by Muido for Acta Physiologiea Scandinavica in 1946.[4] Muido exposed his subjects to preliminary jogging for ten minutes, heavy preliminary work on the bicycle ergometer for a ten minute period, hot

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3. Mervyn Fillipponi, "The Effect of Warming-up Upon Speed of Swimming 100 Yards," (unpublished Masters Thesis, Springfield College, Springfield, Massachusetts, 1951).

4. Leonid Muido, "The Influence of Body Temperature on Performance in Swimming," Acta Physiologiea Scandinavica, 12:102-109, 1946, citing Swegan and Thompson, loc.cit.

showers, turkish baths, radio diathermy, and cold baths at different intervals of time. He concluded:

1. A given distance could be swum in a shorter time when the organism was warmed previously.

2. Both-active warming by preliminary work and passive warming by hot baths, radio diathermy and turkish baths had the same beneficial effect.

3. The increased rectal, i.e., blood temperature, before swimming seemed to be more essential for improved results than the increased muscle temperature.

4. The deviation of the influence of warming was at least 60-80 minutes.

5. It is quite probable that the beneficial effect of higher body temperature is due to the increase in the velocity of reactions.

Carlile[5] conducted an experiment in swimming in which he used hot showers as a passive type warm-up for his subjects. He stated:

1. A subject showed an improvement in swimming performance in 220-yard swims of 1½% following 8-minute hot showers. The difference in swimming speed was statistically significant.

2. Ten swimmers in 230 trials with various strokes showed an improvement of 1% for 40-yard time trials when the swims were preceded by 8-minute hot showers. A statistical consideration of the group data showed the difference in swimming speed between control and pre-heated swims to be highly significant.

Carlile suggested that at least in temperate climates, some passive pre-race heating of the body, in addition to

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5. Forbes Carlile, "Effect of Preliminary Passive Warming on Swimming Performance," The Research Quarterly, 27:143, May, 1956.

some active work, constituted a valuable adjunct to the warming-up procedure.

Two groups of subjects were tested by Thompson[6] to determine if warm-up affected performance in speed and endurance in swimming. No evidence was found of improvement from informal warm-up immediately preceding testing in swimming. Formal warm-up did improve group performances in speed and endurance in swimming. Formal warm-up consisted of exercises which imitated the activity for which the performer was getting ready, and informal warm-up consisted of general, free-movement exercises.

DeVries,[7] in his study of the effects of various warm-up procedures on 100-yard times of competitive swimmers, found that swimmers reacted differently to different types of warm-up. Thirteen subjects swam five 100-yard trials with each of the different warm-up methods, including swimming warm-up, hot shower warm-up, calisthenics, and massage warm-up. His major findings were as follows:

1. Considering all swimmers in one group regardless of strokes swum, it was found that warming up by swimming 500-yards was effective in reducing the subsequent 100-yard time trials by a significantly mean difference.

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6. Hugh Thompson, "Effect of Warm-up Upon Physical Performance in Selected Activities," The Research Quarterly, 29:245 , May, 1958.

7. H.A. DeVries, "Effect of Various Warm-up Procedures on 100-Yard Times of Competitive Swimmers," The Research Quarterly, 30:18 , March, 1959.

2. Considering all swimmers in one group, regardless of style swum, it was found that warming up by six-minute hot showers, or by calisthenics, or by massage had no effects which were significantly different from those of the controls.

3. For a free-style swimmer, only the calisthenics warm-up had a significant effect upon the time trial. It slowed them down compared to the controlled group.

4. For the breast-strokers and dolphin swimmers, only the calisthenics warm-up increased swimming speed.

5. A distinct difference in reaction to warming-up by calisthenics was observed between the free-style swimmers and the breaststrokers and dolphin swimmers. Whereas the breaststrokers and dolphin men improved their 100-yard trials with this method, the free-stylers slowed down.

After analyzing these findings he concluded:

1. Swimming performance at the level of the highly skilled competitive swimmer can be improved by the proper warm-up procedure.

2. Swimming performance at the level of the highly skilled competitive swimmer can be impaired by the improper warm-up procedure.

3. There is an interaction between the warm-up procedure and the type of stroke swum, so that it may be well to vary the warm-up procedure according to the stroke swum.

There have been some studies in areas other than that of warming-up procedures.[8] Karpovich studied the effect of oxygen consumption on swimming performance of varsity swimmers at Springfield College. He reported that:

1. Oxygen inhalation immediately followed by swimming increased speed in the 100-yard sprint.

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8. P.V. Karpovich, "The Effect of Oxygen Inhalation on Swimming Performance," The Research Quarterly, 5: 151, May, 1934.

2. Inhalations four to five minutes before performance didn't improve speed.

3. Inhalation of oxygen for five minutes after a 100-yard swim had little effect upon recovery, as judged by a second 100-yard swim 20 minutes later.

4. Oxygen breathing immediately after severe exercise did give quicker relief from respiratory and circulatory embarrassment.

Haldi and Wynn reported a study regarding the effect of drugs on swimming performance.[9] They found that:

1. Ingestion of 100 milligrams of metrasol, 5 milligrams of benzedrine sulfate, 250 milligrams of caffeine alkaloid or 200 milligrams of sucrose approximately an hour and a half before swimming had little or no effect on sprint swims of 100-yards.

2. Blood sugar levels after swimming did not differ appreciably, regardless of the material ingested. Subjects did not know what material was being ingested prior to performance.

These same investigators studied the effect of diet on swimming performance. In experiments on twelve swimmers, they found that the time required to swim each of three laps in a 100-yard sprint was the same after a heavy meal as after a light meal eaten two-and-a-half to three hours before swimming. Supplementation of the light meal by the ingestion of 50 or 100 grams of sucrose one hour before swimming had no effect on swimming time.

The drop-off in the second and third laps, which is taken as an index of fatigue, was the same regardless of

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9. J. Haldi, and Winfrey Wynn, "Action of Drugs on Efficiency of Swimmers," The Research Quarterly, 17:100, May, 1946.

the amount of food intake before the swimming. The blood sugar concentration immediately after swimming was approximately the same in all the experiments regardless of the food intake.[10]

Ball[11] studied the effect of eating at various times upon performance in swimming. He found that of the six time intervals tested no one of the intervals had any more effect than any other on the time required to swim one-hundred yards in the free-style stroke.

Hawkins[12] conducted a study to determine the effect of training for swimming upon the morphological composition of the blood. Eight varsity swimmers were tested for blood composition before, during, and after a season of competitive swimming. An analysis of his data showed that:

> 1. At the beginning of training there was an immediate rise in the younger forms of the neutrophiles, which reached its maximum at the peak of training and returned to normal soon after the discontinuation of training.

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10. J. Haldi, and Winfrey Wynn, "Observations on Efficiency of Swimmers as Related to Some Changes in Pre-exercise Nutriment", Journal of Nutrition, 20:5, May, 1946.

11. Jerry R. Ball, "Effect of Eating at Various Times Upon Subsequent Performances in Swimming," The Research Quarterly, 33:166, May, 1962.

12. C.C.Hawkins, "Effect of Training in Swimming Upon the Morphological Composition of the Blood", The Research Quarterly, 6:59, May, 1935.

2. Training in swimming not only causes a re-distribution of the white corpuscles, but also increases the activities of the blood forming tissues.

Johnson and Wong[13] studied young, healthy, varsity swimmers over a fourteen month period to determine the effect of a typical training and competitive collegiate swimming program on plasma, cholesterol and, phospholipids. They found that the exercises used for conditioning varsity swimming athletes did not significantly lower blood cholesterol and phospholipids.

Rohter studied the effect of starting from a dry body state on swimming speed. He tested four different groups of college students in short speed swims. "Each subject was timed during two trials: when he started the race from a dry body state, and one when he entered the pool before the start of the time trial and remained submerged up to the neck for a designated period."[14]

The first group was timed both dry and after a thirty second submersion period. The dry body state times were significant over the times taken after submersion at the ten per cent level of significance. The other three

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13. T.P.Johnson, and Harry Wong, "Effects of Exercise on Plasma Cholesterol and Phospholipids in College Swimmers", The Research Quarterly, 32:514, December, 1961.

14. Frank D. Rohter, "Effects on Swimming Speed of Starting From a Dry Body State", The Research Quarterly, 33:142, March, 1962.

groups were tested both from the dry body state and after a two minute submersion in the water. In all three groups the subjects registered faster times when swimming from the dry body state. In two of the three groups the difference between the dry and submersion times was significant at the ten per cent level of significance, and in the third group the difference between the times was significant at the five per cent level of significance. All four groups averaged faster times when starting from a dry body state.

Training Programs for Swimmers

Thompson and Stull[15] reported a study on the effects of weight training on the speed of swimming. They studied the effects of six different training programs on the speed of swimming thirty yards. Their subjects, eighty-one male college students, were divided into the various groups:

1. Controlled group-participated in absolutely no vigorous exercise throughout the six-week training period.

2. Weight training group met for three forty-minute periods each week, and performed thirteen different weight training exercises, ten repetitions each.

3. Swimming group I-swam a distance and a sprint workout three times weekly.

4. Weight training and swimming group-swam three

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15. H.L. Thompson, and G.A. Stull, "Effects of Various Training Programs on Speed of Swimming", The Research Quarterly, 30:482, December, 1959.

times weekly using the same routine as swimming group I and employed the same exercises as the weight training group three times weekly.

5. Swimming group II-used the same routine as swimming group I, but swam six times a week.

6. Swimming group III-performed a routine of twelve 30-yard sprints and ten starts daily, six days a week.

After testing these six groups both before and after a six week training period in which the subjects trained in the above programs they concluded:

1. Students who participated in absolutely no exercise did not improve in speed in swimming 30 yards.

2. The weight-training program employed three times per week in this study did not significantly improve group performance in speed swimming.

3. Swimmers who practiced starts, kicking for 150 yards, arm stroking for 150 yards, two 60-yard sprints at three-quarters speed and three 30-yard sprints at full speed three times per week significantly improved their performances in speed of swimming 30 yards. (This t ratio was significant beyond the 1 per cent level of confidence.

4. Subjects who swam six times weekly the same routine as cited in conclusion 3, above, showed, a significant improvement in speed swimming.

5. Swimmers who practiced twelve 30-yard sprints and ten starts six times per week, improved significantly in speed in swimming 30 yards.

6. Swimmers who did specific exercises with weights three times weekly and swam three times weekly improved significantly their performances in swimming.16

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The findings of Davis contradicted the conclusions

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16. Ibid. p.485.

17. Jack F. Davis, "The Effect of Weight Training on Speed in Swimming", The Physical Educator, 12:28-29, March, 1955.

reached by Thompson and Stull. After testing them in sprint crawl swimming, Davis subjected seventeen male college students to a vigorous and comprehensive weight training program for nine weeks. During this period the subjects did not train with swimming work-outs, but were allowed to enter the water once a week. After the intensive weight training program, on the tenth week of the experiment, Davis retested all of the subjects in sprint crawl swimming. His findings revealed that all seventeen subjects increased their speed in swimming the crawl stroke. He concluded that weight training was not detrimental to swimming, but highly beneficial. Davis failed to mention whether or not the increases made by the subjects were statistically significant.

Davis[18] also studied the effects of training and conditioning for middle distance swimming upon various physical measures. Davis tested thirty male college students in the following factors: (1) cardiovascular condition, (2) general physical fitness, (3) gross stength, (4) motor fitness, (5) strength of the muscle groups primarily utilized in swimming the crawl stroke, and (6) the strength decrements of these involved muscles. He subjected them to seven weeks training for middle distance

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18. Jack F. Davis, "Effects of Training and Conditioning for Middle Distance Swimming Upon Various Physical Measures," The Research Quarterly, 30:411-412, December, 1959.

swimming, and retested them in these physical measures after this training program. His conclusions were as follows:

1. General physical fitness, motor fitness, gross strength, and swimming time all evidenced highly significant improvement.

2. All test items of the various test batteries, with the exceptions of grip strength, showed improvement well beyond the .01 level of confidence.

3. Significant improvement was obtained, in the cable-tension strength of the knee extensors, shoulder flexors, and shoulder extensors.

4. The highest significant relationships obtained between swimming time and all variables studied were lung capacity and various gross strength measures.

5. No significant differences were found for cardiovascular condition or the strength decrement indexes.

Nunney[19] studied the relationship between circuit training and the improvement of endurance, speed, weight, and strength of swimmers during a six week training period. The experimental group combined a circuit routine, which consisted of two arm curl with bar bell, bounce jumps with knee lift at stall bars, bent-over rowing motion with bar bell, leg press with bar bell, two arm press with barbell and squat thrusts, with swimming in their program, while the control group had swimming only. It was found in the retest at the end of six weeks that the experimental group made significant gains in swimming endurance, and speed, weight, and ability to perform chins and pushups.

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19. Derek N. Nunney, "Relation of Circuit Training to Swimming," The Research Quarterly, 31:197, May, 1960.

The control group made significant gains in swimming endurance and weight and tended to lose strength as measured by the ability to perform chins, vertical jump, and push-ups. There was no significant evidence to indicate that the circuit training was in any way detrimental to swimming performance.

Aside from these studies on the subject of training for swimming, there have been a number of magazine articles and chapters in books, written primarily by swimming instructors and coaches, that have dealt with this subject of training programs for swimmers.

The United States Naval Institute,[20] advocated the use of calisthenics and water games (water polo, water basketball, etc.) in the training program for swimmers.

Kiphuth,[21] explained that he used calisthenics in training his swimmers. He claimed that the muscles used in swimming could be developed more quickly by a routine of calisthenics than by trying to condition them through swimming alone. He particularly stressed the use of land drills and cross-country running in the pre-season and early season training periods.

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20. The United States Naval Institute. Swimming. (Annapolis, Md., The United States Naval Institute, 1944). p. 255.

21. Robert J. Kiphuth, Swimming (New York, Ronald Press Company, 1942). p. 37.

Armbruster, Allen, and Harlan,[22] stressed the usage of exercises and land drills in the development of strength for swimmers. They stated:

> For peak performance in swimming, the muscles, which are the sources of power, must be strong. As a rule the practice of the sport itself is not sufficient to develop the muscles to their greatest strength. The addition of strength-building exercises can be used to supplement this muscular development.

They listed two different exercise programs for swimmers and divers. The first group of exercises was designed particularly to develop flexibility. The second group were special body building exercises for swimmers. Among these were a number of bar-bell exercises to develop the fore-arm, and upper-arm, especially biceps and triceps muscles. They also explained exercises for the chest, back, legs, and abdominal muscles. In speaking about the pre-competition period they advocated the use of running outdoors to develop wind endurance.

Rajki[23] was particularly emphatic about the use of land exercises in the training program for competitive swimmers. In addition to this accent on gymnastics and running in the basic conditioning period he felt that

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22. Dave Armbruster, and others, Swimming and Diving. St. Louis; C.V.Mosby Co., 1958), p. 219.

23. Bela Rajki, The Technique of Competitive Swimming, (Budapest, Hungary: University Printing House, 1956.) p. 63.

every swimmer should have at least twenty minutes a day in gymnastic work, thru-out the year.

Davies,[24] made the following statement.

> I think we swimming coaches can take lessons from the track coaches. We should encourage all of our swimmers to go out for cross-country, for this sport builds up one's muscle fibers.

Ryan[25] was another coach who emphasized the use of land drills as an activity for training swimmers. He stated that they had a two-fold value for the team. First of all, they helped the swimmer to prepare his body and muscles for the strenuous activities that lay ahead in the coming competitive season. The second importance of these drill sessions was that they provided a method by which the team could start training as a unit. His program particularly stressed exercises that would add strength and flexibility to a swimmers' muscles.

In another article, Ryan[26] spoke about the pre-season training program that he used for training swimmers at the University of Florida. This program was done three days per week and consisted of a rugged period of calisthenics, which was designed to strengthen and condition the swimming

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24. James M. Davies, "The Soft American Swimming Coach", Swimming Pool Age, February, 1960, p.47.

25. Jack Ryan, "Calisthenics for Swimmers", Athletic Journal, 36:16, January, 1956.

26. Jack Ryan, "A Pre-Season Training Program for Swimmers", Athletic Journal, 40:21, November, 1959.

muscles, and the running of laps on the track to stengthen the leg muscles and increase the cardiac efficiency. The program continued through the month of October but during the latter part of the month the running was cancelled and in its place the team started kicking laps in the pool.

Lipovetz[27] felt that track work and gymnastics could be a beneficial part of the training programs for swimmers as long as these activities were not over indulged in, but that the best form of exercise for a good swimmer was swimming.

Counsilman recognized the similarity of a running workout to a swimming workout. Regarding principles of training he stated:

> When it is not possible to practice the specific activity for which the athlete is training, it is wise to prevent loss of conditioning, by engaging in an exercise program as similar to the regular training program as possible. Running has been substituted for swimming by swimmers who are traveling and are unable to find a pool available for practicing. We have used calisthenics and pulley weight exercises to prevent excessive loss of conditioning in swimmers who have had ear infections and are unable to enter the water. Calisthenics and running have been substituted for many other forms of training.28.

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27. F.J. Lipovetz, The Teaching and Coaching of Swimming, Diving, and Water Sports, (Minneapolis; Burgess Publishing Co., 1945, p.8.

28. James E. Counsilman, "Principles of Training", Athletic Journal, 35:42, March, 1955.

Gray[29] surveyed 127 swimming coaches for their ideas about training and conditioning competitive swimmers. He stated that modern swimming coaches agreed that a swimmer should be given a pre-season training program whether it be on land or in the water, in order to prepare him for the more vigorous work to follow during the competitive season. Of the coaches surveyed, fifty-seven per cent had a pre-season body building program, and the rest did not, either because of lack of equipment, or time. Fifty-nine per cent of the coaches did not use pulley-weights because the cost was prohibitive. Some sixty of the coaches had their swimmers do daily exercises to develop and strengthen the lower back, leg, and abdominal muscles, and to increase general flexibility. The time devoted to daily pre-season calisthenics ranged from ten to forty minutes daily. Most coaches indicated that they would like to spend more time on calisthenics. The number of weeks devoted to the pre-season body building program ranged from one to two weeks, to eleven to twelve weeks, the average program being three to four weeks long.

Hartlaub[30] was another coach who recognized the im-

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29. Norman Gray, "Training and Conditioning for Competitive Swimming", Athletic Journal, 32:14, February, 1952.

30. Paul Hartlaub, "Conditioning for Swimming", Athletic Journal, 39:30, October, 1958.

portance of land drills in conditioning for swimming. He advocated that both bar-bell exercises and calisthenics were important. He felt that the bar-bell exercises should be done more in the pre-season period and should always be followed by work in the water to keep the swimmers' muscles loose and pliable. He also felt that calisthenics which would stretch and strengthen the swimming muscles, should be done as part of the daily workout throughout the season.

Gardner[31] was another coach who used dry land exercises in training his swimmers. Gardner thought that a certain amount of calisthenics and weight lifting were beneficial for swimmers as long as this work was properly supervised by a qualified instructor. Gardner also believed that cross-country running on the grass was good to build up the leg muscles of swimmers. He felt that the running should be properly supervised.

Dawson[32] wrote an encyclopedia of swimming exercises which contained the swimming exercise philosophy of a number of famous swimming coaches. He noted that the exercises for swimmers were divided into three main groups, those which developed strength, those which developed suppleness

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31. "Gardner's Yankee Clipper Makes Them Run to Swim Well," Junior Swimmer-Swimming World, 2:14-15, October, 1961.

32. Buck Dawson, A Swimmer's Book of Dry Land Exercies. (Ann Arbor, Michigan, Swim Central, 1961). pp 1, 9.

and flexibility. Dawson was one of the coaches who advocated running to develop the stamina needed for swimming.

Dawson[33] wrote that Jim Counsilman of Indiana University besides using running to train his swimmers was also attaining amazing results by using isometric contractions in the exercise program for swimmers. Dawson[34] also wrote of an interview that he had with Earl Ziegler. Ziegler, a former swimming coach of Western Ontario University, who is presently on the physical education faculty at the University of Michigan, thought that running could be used as a substitute for kicking laps in the pool to develop the legs of swimmers, and also to develop the circulatory-respiratory efficiency needed for swimming.

In the next chapter the methods used in the gathering of the data are explained.

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33. Ibid., p.4

34. Ibid.

CHAPTER III

METHODOLOGY OF RESEARCH

This chapter will discuss the subjects and time division of the experiment, the testing procedures, and the training programs used.

The Subjects

The subjects selected for this study were forty-four male high school students enrolled at the Carl Sandburg Consolidated High School in Orland Park, Illinois. The subjects ranged in age from fourteen to eighteen years and all were candidates for the freshman-sophomore or varsity swimming teams of the school. The students were all volunteers who were acquainted with the purposes and requirements of the study. All of the subjects were told that the experiment would be strenuous and exhausting and that they would be expected to make "all-out" efforts in both the testing and training programs.

Medical examinations were given to the subjects before the beginning of the experiment to determine their health status. Although the diet, training, and sleeping habits of the subjects could not be completely controlled during the experimental period, all of the subjects were acquainted with desirable athletic training habits by means

of a lecture that was given prior to the beginning of the experiment. All of the subjects agreed to get a reasonable amount of sleep each night; to eat a well-balanced diet; and refrain from smoking or drinking alcholic beverages during the experimental period.

All subjects appeared to comply with the above requests and to cooperate fully.

There were two criteria for choosing the subjects for this experiment. First, the subjects were chosen for their ability to achieve a four point rating on their American crawl stroke on the following four point scale:

1 point - Poor
2 point - Below Average
3 point - Average
4 point - Good

The rating was done by two qualified American Red Cross Safety Instructors.

The second criterion was the ability to complete a 200 yard crawl stroke swim in three minutes and thirty seconds, or better.

The subjects were divided into matched groups in the following manner: On the basis of the best 200 yard test time done during the pre-training period, and according to the seeding method used for championship swimming meets. In this way the mean time for each group was equated thus facilitating measurement and evaluation of the groups. One subject in each group was appointed as the group leader.

These two group leaders were asked to pick two slips of paper from the top of a table. On the face-down side of each slip was the training program: either program A or program B (explained below). that his group would follow during the training experiment period. Thereafter the groups were referred to as Group A (Control) and Group B (Experimental).

Time Division

The total time required for this study was seven weeks, divided into three parts: the pre-training period of one week; the training period of approximately five and a half weeks; and the post-training or final testing period which was given on the last two days of the study.

The pre-training period. During the first week of training, two functions were performed. First, the subjects were given instructions and practice in stroke techniques, starts, and turns (the open turn was used by all subjects). Their ability in these skills was brought to a fairly stable level. Also, during this period the subjects became familiar with pacing in the 200-yard swim. Each subject swam three time trials in the 200-yard event. In each trial the subjects were asked to vary their pace in order that each might familiarize himself with the pace that enabled him to swim his fastest time trial. The fastest 200-yard test time done during this period was the one that was used for measurement purposes.

The training period. This period constituted the training and conditioning phase. The subjects met five times per week. The workout periods were each at least an hour in length. The sessions were held Monday through Friday leaving the week-end for rest.

The final testing period. The last two days of the experiment were devoted to administering the two final time trials. Since throughout the whole experiment the subjects worked on pacing this race, the fastest trial done during this period was deemed to be a reliable measure of the subjects ability in the event. This fastest post-training time trial was used to measure the amount of improvement brought about by the training programs.

Procedures for Testing

The test used for measurement in this experiment was the 200-yard crawl stroke swim. The test was evaluated in terms of time rather than style or form.

Prior to taking time trials each swimmer performed the following warm-up:

(A) Stretching, trunk, and shoulder rotation-five-ten minutes.

(B) Bobbing thirty times

(C) Fifty yards of easy kicking

(D) Fifty yards of easy pulling

(E) Fifty yards of easy swimming

Each subject swam his time trial alone. National Collegiate Athletic Association swimming rules were followed in all time trials in regard to starting, turning, and timing. The timing was done with the same stopwatch by the same timer who was thoroughly experienced in this skill.

All testing was done in an indoor swimming pool which was twenty five yards long. During the tests the air temperature was 84 degrees Fahrenheit and the water temperature was kept at 78 degrees Fahrenheit.

The Training Program

Listed below are the daily warm-up and workout programs employed by each group during the training period of this study.

Group A (Control)

This group did the following workouts in the swimming pool five days per week, warming up each day with ten push-ups, fifteen sit-ups, fifteen knee-bends, stretching exercises, bobbing twenty times, and a warm shower.

First Week

Monday - Warm-up, kick 100 yards, pull 100 yards, swim 220 yards(easy).

Tuesday - Warm-up, swim 100 yards,(easy), two 100 yard swims for pace.

Wednesday - Warm-up, kick 100 yards, pull 100 yards, swim 220 yards (easy),

Thursday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), two 125 yard swims for pace.

Friday - Warm-up, pull 100 yards, kick 100 yards, swim 100 yards (easy), swim two all out 50 yard swims, swim 220 yards (easy),

Second Week

Monday - Warm-up, overdistance swimming-swim 350 yards at ½ speed, swim 220 yards (easy), swim 100 yards (easy).

Tuesday - Warm-up, pull 50 yards; kick 50 yards, swim 100 yards (easy), swim 200 yards, pacing first 125 yards and finishing at ½ speed.

Wednesday - Warm-up, swim two 100 yards swims (easy), swim 200 yards at 3/4 speed, swim two 100 yards at ½ speed.

Thursday - Warm-up, pull 50 yards, kick 50 yards, swim pace 125 yards, swim 200 yards at 3/4 speed.

Friday - Warm-up, kick 50 yards, pull 50 yards, swim 220 yards (easy), sprint four 50 yard swims.

Third Week

Monday - Warm-up, overdistance swimming for 45 minutes (swim, rest, swim, etc.).

Tuesday - Warm-up, swim 100 yards (easy), pace two 150 yard swims.

Wednesday - Warm-up, swim 100 yards (easy), swim two 200 yard swims, swim two 100 yard swims (easy) at 3/4 speed.

Thursday - Warm-up, 100 yard swim (easy), swim 200 yards pacing first 150 yards, 100 yard swim (easy).

Friday - Warm-up, swim 100 yards (easy), swim five 50 yard sprints, swim 200 yards (easy).

Fourth Week

Monday - Warm-up, swim 100 yards (easy), swim 100 yards at 3/4 speed, swim two 300 yard swims at 3/4 speed, swim 200 yards (easy).

Tuesday - Warm-up, swim 100 yards (easy), swim pace 175 yards, swim two 100 yard swims at half speed.

Wednesday - Warm-up, overdistance swimming (swim at least 3/4 of a mile).

Thursday - swim-100 yards (easy), swim 200 yards, pacing first 175 yards, swim 200 yards (easy).

Friday - Warm-up, swim four 200 yard swims at half speed.

Fifth Week

Monday - Warm-up, swim 440 yards picking up and slowing down (above and below ½ speed) at 50 yard intervals, swim 220 yards at ½ speed, swim 100 yards (easy).

Tuesday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), swim 200 yards at race pace.

Wednesday - Warm-up, overdistance swimming (swim at least one mile).

Thursday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), swim 200 yards at race pace.

Friday - Warm-up, swim 100 yards (easy), swim 440 yards all out, swim 220 yards (easy), swim 100 yards all out.

Sixth Week

Monday - Warm-up, swim two 200 yard swims in an attempt to loosen up.

Tuesday - Warm-up (consisting of stretching, and trunk and shoulder rotation exercises; bobbing thirty times; 50 yards of easy kicking; 50 yards of easy pulling; 50 yards of easy swimming), all out 200 yard swim test.

Wednesday - Rest.

Thursday - Warm-up (same as above)all out 200 yard swim test.

Friday - Accumulate testing data, discuss workout and testing programs with participants.

Group B (Experimental)

This group ran three days per week and swam two. This group worked out on Monday, Wednesday, and Friday on the track, and Tuesday and Thursday they worked out with Group A in the swimming pool. On the days the subjects ran, their warm-up consisted of the following; ten push-ups, fifteen sit-ups, fifteen knee-bends, stretching exercises, and breathing exercises. On the days the subjects worked out in the swimming pool, they performed the same swimming warm-ups as Group A.

First Week

Monday - Warm-up, run two 440 yard runs (easy), run 880 yards (easy).

Tuesday - Warm-up, swim 100 yards (easy), pace two 100 yard swims.

Wednesday - Warm-up, run two 440 yard runs (easy), run 880 yards (easy).

Thursday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), pace two 125 yard swims.

Friday - Warm-up, run three 440 yard runs (easy), run two all out 220 yard sprints.

Second Week

Monday - Warm-up, overdistance running - run 1320 yards at ½ speed, walk 440 yards, run 880 yards (easy), run 440 yards (easy).

Tuesday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), swim 200 yards, pacing first 125 yards and finishing at ½ speed.

Wednesday - Warm-up, run two 440 yard runs, (easy), run 880 yards (easy), run four 220 yard sprints.

Thursday - Warm-up, pull 50 yards, kick 50 yards, swim pace 125 yards, swim 200 yards at 3/4 speed.

Friday - Warm-up, run 440 yard run (easy), run 880 yards (easy), run four 220 yard sprints.

Third Week

Monday - Warm-up, overdistance running for forty-five minutes (run, walk, rest, run, etc.).

Tuesday - Warm-up, swim 100 yards (easy), pace two 150 yard swims.

Wednesday - Warm-up, run 440 yards (easy), 3/4 speed, two 880 yard runs, two 440 yard runs, (easy).

Thursday - Warm-up, swim 100 yards (easy), swim 200 yards, pacing first 150 yards, 100 yard swim (easy).

Friday - Warm-up, run 440 yards (easy), run five 220 yards sprints, run 880 yards easy.

Fourth Week

Monday - Warm-up, run 440 yards (easy), run 440 at 3/4 speed, run two 1320 yard runs at 3/4 speed, run 880 yards (easy).

Tuesday - Warm-up, swim 100 yards (easy), swim pace 175 yards, swim ½ speed two 100 yard swims.

Wednesday - Warm-up, overdistance running (run at least 2½ miles).

Thursday - Warm-up, swim 100 yards (easy), swim 200 yards, pacing first 175 yards, swim 200 yards (easy).

Friday - Warm-up, run four 880 yard runs at above ½ speed.

Fifth Week

Monday - Warm-up, run one mile picking up and slowing down (above and below ½ speed) at 220 yard intervals, run 880 yards at ½ speed, run 440 yards (easy).

Tuesday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), swim 200 yards at race pace.

Wednesday - Warm-up, overdistance running (run at least three miles).

Thursday - Warm-up, pull 50 yards, kick 50 yards, swim 100 yards (easy), swim 200 yards at race pace.

Friday - Warm-up, run 440 yards (easy), run one mile all out, run 880 yards (easy), run 440 yards all out.

Sixth Week

Monday - Warm-up, run two 880 yard runs in an attempt to loosen up.

Tuesday - Warm-up (consisting of stretching, and trunk and shoulder rotation exercises; bobbing thirty times; 50 yards of easy kicking; 50 yards of easy pulling; 50 yards of easy swimming), all out 200 yard swim test.

Wednesday - Rest.

Thursday - Warm-up (same as above), all out 200 yard swim test.

Friday - Accumulate testing data, discuss workout and testing programs with participants.

CHAPTER IV

TREATMENT OF THE DATA

In this chapter the analysis of the data was undertaken to determine whether or not the results of the experiment were statistically significant.

Statistical Treatment

The difference between the pre-training tests and final tests for both the experimental and control groups was used both to evaluate the progress made within each group, and to compare the two groups in terms of progress.

In order to determine whether or not the two different groups improved their performance as a result of the training program that they followed, the data for both the experimental and control groups were treated in the following manner. The means of the pre-training test times and final test times were computed from the raw scores by using the formula $M = \frac{\text{scores}}{N}$ (see Table IV in the appendix). Then the standard deviations of both pre-training and final test times were found by using the formula $SD = \sqrt{\frac{X^2}{N}}$, in which X^2 stood for the deviation of the scores from the mean score squared, and N stood for the number of subjects. The standard error of the mean of both the pre-training and final test times was calculated by the use of the formula

$\sigma_M = \sqrt{\frac{SD}{N}}$ in which SD stood for the standard deviation. After finding these measures the difference between the mean times for the pre-training and final test times was found by subtracting $\sigma_{M_1} \sigma_{-M_2}$.

The next step was to find the coefficient of correlation between the test scores of pre-training and final tests. The r was found by using the formule $r = \frac{xy}{N - dx\ dy}$, in which $\sigma_x\ \sigma_y$ xy stood for the deviations from the mean of one group of scores multiplied by the deviations from the mean of the other group of scores. Then to find the standard error of the difference between the means obtained in the pre-training test and the final test the formula for correlated data which was $\sigma_{M_1} \sigma_{-M_2} = \sqrt{\sigma^2_{M_1} + \sigma^2_{M_2} - \sigma 2 r_{12} \sigma_{M_1} \sigma_{M_2}}$ was used. In this formula σ_{M_1} and σ_{M_2} were the standard errors of the pre-training and final test means and r_{12} was the coefficient of correlation between raw scores made on pre-training and final tests.

The r ratio was then computed to determine whether or not the difference between the pre-training and final test times were significant.

After determining whether or not significant improvement took place within the experimental and control groups these two groups were compared to determine whether or not the improvement made by the control group was significantly greater than that made by the experimental group.

In order to compare the groups the means, standard deviations, and standard errors of the means were found for the final tests of both groups. Then the mean difference was found by subtracting the mean of the experimental group's final times from the mean of the control group's final times. The reliability coefficient was then found between the final scores of both groups. With these data the standard error of the difference between the final test means was calculated and the t ratio was computed to determine whether or not the difference was significant.

Analysis of the Data

In the analysis of Group B, the Experimental Group, it was found that all but three of the subjects improved their time after the six week training period. The pre-training test times had a mean of 180.3 seconds, a standard deviation of 18.40, and the standard error of the pre-training test times was 3.92. The mean of the final test times was 170.5 seconds, while the standard deviation was 14.98 and the standard error of the final test times was 3.19. The difference between the pre-training and final test means was 9.8 seconds. The reliability coefficient between the pre-training and final test times was found to be +.80. The standard error of the difference between the pre-training and final test mean times was 2.36. The t ratio was

4.15. Since with twenty-one degrees of freedom a t of 2.83 is significant at the .01 level of confidence, it can be seen that the t of 4.06 is significant. Table I shows these facts in tabular form.

The above data show that the Experimental Group made significant gains in speed in swimming the 200 yard crawl stroke event after participating in a six week training program that consisted of three days per week of running and two days per week of swimming.

In analyzing Group A, or the Control Group, it was found that of the twenty-two subjects all but two had faster times after six weeks of training. The pre-training test times had a mean of 178.6 seconds and a standard deviation of 19.94. The standard error of the pre-training mean was 4.25. The mean of the final test times was 168.7 seconds, the standard deviation was 17.58 and the standard error of the final test mean was 3.75. The difference between the pre-training and final test mean times was 9.9 seconds and the coefficient of correlation between the pre-training and final test times was an r of +.88. The standard error of the difference between the pre-training and final test mean times was 2.02. The t ratio is 9.9/2.02 or 4.41. Since there were twenty-two subjects, there are twenty-two pairs of scores and twenty-two differences so that the df, or degrees of freedom becomes 22-1 or 21. Upon consulting the

TABLE I

COMPARISON OF THE PRE-TRAINING AND FINAL TEST TIMES
FOR GROUP B (EXPERIMENTAL GROUP)

Group B (Experimental)	Number of Scores	Mean Score (Seconds)	Standard Deviation	Standard Error of Mean	Difference Between Means			
					Difference	r	S.E. Difference	t
Pre-Training Test	22	180.3	18.40	3.92	9.8	+.80	2.36	*4.15
Final Test	22	170.5	14.98	3.19				

* significant at .01 level of confidence

t table it was found that with twenty-one degrees of freedom a t of 2.83 is significant at the .01 level of confidence. The obtained t is 4.41 and hence can be termed significant. Table II shows the preceeding data in tabular form.

The above data show that the Control Group made significant gains in speed in swimming the 200 yard crawl stroke event after participating in a six week training program that consisted of swimming workouts five days per week.

In comparing the final tests of the experimental and control groups, it was found that the reliability coefficient was +.76, and the difference between the final test means was 1.80 seconds. These two measures were combined with the mean, standard deviation, and standard error of the mean of each of the final groups to calculate the standard error of the difference between the final test means of the control and experimental groups. The standard error of the difference between these means was 2.46. The t ratio was then calculated and found to be .73 which was not significant. Table III shows this data in tabular form.

The above data show that altho both the Experimental and Control groups made significant gains as a result of the different programs that they followed, neither one made significantly greater improvement than the other.

The next chapter will contain a summary, conclusions, and recommendations for further study.

TABLE II

COMPARISON OF THE PRE-TRAINING AND FINAL TEST TIMES
FOR GROUP A (CONTROL GROUP)

Group A (Control A)	Number of Scores	Mean Score (Seconds)	Standard Deviation	Standard Error of Mean	Difference Between Means			
					Difference	r	S.E. Difference	t
Pre-Training Test	22	178.6	19.94	4.25	9.9	+.88	2.02	*4.41
Final Test	22	168.7	17.58	3.75				

*significant at .01 level of confidence

TABLE III

COMPARISON OF THE FINAL TEST TIMES
FOR GROUP A AND GROUP B

Between Groups	Number of Scores	Mean Score (Seconds)	Standard Deviation	Standard Error of Mean	Difference Between Means			
					Difference	r	S.E. Difference	t
Final Test (Control A)	22	168.7	17.58	3.75	1.80	+.76	2.46	**.73
Final Test (Experimental B)	22	170.5	14.98	3.19				

**not significant

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter contains a summary, conclusions, and, recommendations for further study.

Summary

The purpose of this study was to determine the effect of two different training programs upon the swimming speed of high school boys in the 200 yard crawl stroke event.

The forty-four subjects for the study were candidates for either the varsity or freshman-sophomore swimming teams at the Carl Sandburg Consolidated High School in Orland Park, Illinois. During a one week pre-training period the subjects were given three time trials in the 200 yard crawl stroke event. The fastest of these trials was used as a basis for dividing the subjects into two matched groups. One of the matched groups was selected at random to be the experimental group and the other became the control group. The experimental group followed a six week training program combining running and swimming, while the control group had only swimming. At the end of the training program all subjects were retested in the 200 yard crawl stroke event to determine if any improvement had taken place.

Conclusions

The following conclusions were derived from the findings of this study:

1. The experimental group made significant gains in speed in swimming the 200 yard crawl stroke event. These gains were significant at the one per cent level of confidence.

2. The control group made significant gains in speed in swimming the 200 yard crawl stroke event. These gains were significant at the one per cent level of confidence.

3. There was no significant difference between the groups in improvement of swimming speed.

4. With swimmers at this skill level it is possible to combine running with a swimming program without a detrimental effect on swimming speed.

Recommendations

The following recommendations for further study and research are made:

1. This experiment should be done with swimmers of championship caliber to determine the effectiveness of the programs on swimmers of a higher skill level.

2. The experiment should be done using a longer training period to determine if the same results would be gained over an entire competitive swimming season. A study of this nature would show if the experimental training plan would be better for conditioning swimmers in the early stages of the competitive season or would be good as a training procedure throughout the entire season.

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APPENDIX

TABLE IV

THE SUBJECTS, TEST SCORES, MEAN SCORE, X AND X^2, FOR GROUP A (CONTROL GROUP) DURING THE PRE-TRAINING PERIOD

Subject	Test Score	x	x^2
1	155.1	-23.5	552.25
2	176.4	- 2.2	4.84
3	178.2	- .4	.16
4	196.2	+17.6	309.76
5	199.1	+20.5	420.25
6	156.5	-22.1	488.41
7	169.1	- 9.5	90.25
8	169.5	- 9.1	82.81
9	191.0	+12.4	153.76
10	209.0	+30.4	924.16
11	163.3	-15.3	234.09
12	180.0	+ 1.4	1.96
13	183.0	+ 4.4	19.36
14	195.4	+16.8	282.24
15	206.8	+28.2	795.24
16	207.7	+29.1	846.81
17	143.4	-35.2	1239.04
18	156.5	-22.1	488.41
19	157.5	-21.1	445.21
20	163.1	-15.5	240.25
21	164.0	-14.6	213.16
22	208.9	+30.3	918.09
sum of scores	3929.7		sum of x^2 8750.51

Mean= 178.6

TABLE V

THE SUBJECTS, TEST SCORES, MEAN SCORE, x AND x^2, FOR GROUP A (CONTROL GROUP) DURING THE FINAL TESTING PERIOD

Subject	Test Score	x	x^2
1	149.5	-19.2	368.64
2	164.8	- 3.9	15.21
3	167.0	- 1.7	2.89
4	172.5	+ 3.8	14.44
5	165.0	- 3.7	13.69
6	139.5	-29.2	852.64
7	160.2	- 8.5	72.25
8	154.5	-14.2	201.64
9	173.1	+ 4.4	19.36
10	197.0	+28.3	800.89
11	161.9	- 6.8	46.24
12	171.2	+ 2.5	6.25
13	172.5	+ 3.8	14.44
14	195.0	+26.3	691.69
15	204.6	+35.9	1288.81
16	202.8	+34.1	1162.81
17	144.5	-24.2	585.64
18	152.5	-16.2	262.44
19	155.2	-13.5	182.25
20	160.7	- 8.0	64.00
21	169.0	+ .3	.09
22	180.1	+11.4	129.96
sum of score	3713.1		sum of x^2 6796.27

Mean = 168.7

TABLE VI

THE SUBJECTS, TEST SCORES, MEAN SCORE, X AND X^2, FOR GROUP B (EXPERIMENTAL GROUP) DURING THE PRE-TRAINING PERIOD

Subject	Test Score	x	x^2
1	161.2	-19.1	364.81
2	170.1	-10.2	104.04
3	184.0	+ 3.7	13.69
4	190.1	+ 9.8	90.64
5	210.0	+29.7	882.09
6	166.1	-14.2	201.64
7	168.5	-11.8	139.24
8	175.5	- 4.8	23.04
9	182.0	+ 1.7	2.89
10	210.3	+30.0	900.00
11	174.7	- 5.6	31.36
12	178.7	- 1.6	2.56
13	191.0	+10.7	114.49
14	195.2	+14.9	222.01
15	206.1	+25.8	665.64
16	210.8	+30.5	930.25
17	151.3	-29.0	841.00
18	156.0	-24.3	590.49
19	159.0	-21.3	453.69
20	159.5	-20.8	432.64
21	169.1	-11.2	125.44
22	198.2	+17.7	313.29
sum of scores	3967.4		sum of x^2 7444.94

Mean = 180.3

TABLE VII

THE SUBJECTS, TEST SCORES, MEAN SCORE, x AND x^2, FOR GROUP B (EXPERIMENTAL GROUP) DURING THE FINAL TESTING PERIOD

Subject	Test Score	x	x^2
1	163.3	- 7.2	51.84
2	162.5	- 8.0	64.00
3	182.1	+11.6	134.56
4	185.0	+14.5	210.25
5	187.7	+17.2	295.84
6	160.0	-10.5	110.25
7	158.3	-12.2	148.84
8	164.5	- 6.0	36.00
9	166.2	- 4.3	18.49
10	176.2	+55.7	32.49
11	159.6	-10.9	118.81
12	173.2	+ 2.7	7.29
13	172.2	+ 1.7	2.89
14	197.0	+26.5	702.25
15	187.8	+17.3	299.29
16	206.1	+35.6	1267.36
17	147.3	-23.2	538.24
18	157.1	-13.4	179.56
19	151.9	-18.6	345.96
20	152.5	-18.0	324.00
21	165.0	- 5.5	30.25
22	174.7	+ 4.2	17.64
sum of scores	3750.2		sum of x^2 4936.10

Mean = 170.5