EFFECT OF A LIQUID MEAL UPON PERFORMANCE

IN SELECTED TRACK AND FIELD EVENTS

APPROVED:

Graduate Committee:

Charles M. Calloway
Major Professor

Jack Watson
Minor Professor

Joseph R. Haynes
Committee Member

Roberta C. McCharen
Committee Member

Duane Kingery
Dean of the School of Education

Robert B. Toulouse
Dean of the Graduate School

EFFECT OF A LIQUID MEAL UPON PERFORMANCE IN SELECTED TRACK AND FIELD EVENTS

DISSERTATION

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By

Paul L. Gates, B. S., M. A.
Denton, Texas

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CHAPTER I

THE PROBLEM

Introduction

Competitive sports have many educational objectives. Williams expresses this viewpoint when he states that modern physical education may contribute through athletics to the educational objectives of health, morals, citizenship, vocations, home relationships, and worthy use of leisure (16). Examination of the contents of athletic journals indicates sincere efforts on the part of physical educationalists to relate athletics to these objectives.

Therefore, it is not unusual to discover that many new methods have been designed to improve physical performances and to enrich the educational experiences of students who are involved in athletics. Such methods attempt to provide the athlete with a better foundation upon which to build improved physical performances. A prominent example of newer methods in improving physical performances has been weight training programs. Strength and agility are maintained even when weight is considerably increased or decreased (6).

A second area of novel exploration with the purpose of betterment of physical performances is concerned with the pre-competition meal. The theory underlying such research is based upon the fact that an excess of food requiring a

blood supply to take away the products of digestion must not be in the digestive areas when muscles are vigorously employed. The blood is needed by the muscles so that the increased demand for transfer of waste products from the tissues and for transfer of oxygen and nutrients to the tissues can be more efficient. Gregg and Huvos support this by stating that "an exercise is usually associated with an increase in arterial blood pressure and cardiac output with the reduction in splanchnic flow caused by increased muscular resistance," (4, p. 632). Cannon adds to an understanding of the problem when he says that "the conditions favorable to proper digestion are wholly abolished when unpleasant feelings such as vexation and worry and anxiety are allowed to prevail," (2, p. 121). Since in strenuous exercise the fuel used by the muscles is mainly carbohydrate, it is desirable to have ready carbohydrate energy in the blood stream and to have a good carbohydrate storage in the liver. Thus, food should not be eaten too early before contest time since carbohydrate energy in the blood stream and stored in the liver will not be good.

In working in this area of the pre-competition meal researchers face two barriers. The first is the lack of availability of subjects who can be tested under actual competitive conditions. Only under such situations can a fair appraisal be made of the effect of different pre-competition meals. Subjects are emotionally different on the day they

are to compete in a regularly scheduled contest from what they are under laboratory conditions.

The second barrier is that which is concerned with the routine of certain pre-competition procedures. The established pre-competition meal is a part of a psychological buildup toward competition. To change the substance of pre-competition is difficult for the researcher because he has little evidence from past studies under competitive conditions to present to athletes which could justify a change in pre-competition procedures.

Clinical observations and studies conducted under a generally non-competitive atmosphere are available, however. Although both coaches and athletes are often dissatisfied with pre-competition meal procedures, they have not received sufficient stimulation and research data to warrant any change.

> The importance of well-designed and well-controlled experiments is thus particularly important in this field: perhaps one advantage of carrying out experiments directly on enthusiastic athletes is that they are constantly trying to better their previous performance, exerting an intense effort on each occasion and thus to a certain extent minimizing variations in motivation (9, p. 371).

If there is uncertainty concerning the pre-competition meal procedure, would not the possibility exist that this uncertainty can be reflected in some way in performance? One of the primary purposes of this study was to examine whether the use of a liquid substitute instead of a normal pre-competition meal resulted in improved performance.

The problem of this study was to search for possible effects of the pre-competition meal. This problem had two primary facets: (1) to determine performance scores secured by college varsity track and field men under two different pre-competition meal conditions and to study the relationship of the meal last ingested before competition to the scores; (2) to determine the concern for certain psychological and psycho-physiological factors under each of the two pre-competition meal conditions.

There were five major purposes of this study. These purposes were

1. To determine whether the partaking of a liquid substitute meal three hours before competition had a significant effect upon the competitive scores in selected track and field events as contrasted to the competitive scores in those events when the performance occurred four hours after eating a normal pre-competition meal.

2. To determine whether the use of a liquid substitute meal resulted in faster emptying of the contents of the stomach as contrasted to the use of a normal pre-competition meal.

3. To determine whether the partaking of a liquid substitute meal three hours before competition had a significant effect upon the competitive scores in the running events from 440 yards through two miles as contrasted to the competitive

scores in those events when performing four hours after eating a normal pre-competition meal.

4. To determine whether the partaking of a liquid substitute meal three hours before competition had a significant effect upon the competitive scores in the field events, hurdles, and running events from sixty yards through three hundred yards as contrasted to the competitive scores in those events when performing four hours after eating a normal pre-competition meal.

5. To determine whether the ingestion of a liquid substitute meal resulted in a lesser concern for psychological and psycho-physiological factors as contrasted to the concern for these factors due to ingestion of the normal pre-competition meal.

Additional aspects of the problem were to observe side effects of nausea, cramps, and diarrhea under each of the two treatment conditions, and to compile universal scoring tables based upon present world records for the events that were a part of this study.

Hypotheses

The following hypotheses were tested.

Hypothesis 1. There will be no significant difference in the competitive scores in the sixty yard dash, the sixty yard low hurdles, the sixty-five yard high hurdles, the two hundred and twenty yard dash, the three hundred yard dash, the four hundred and forty yard dash, the six hundred yard

run, the eight hundred and eighty yard run, the one thousand yard run, the mile run, the two mile run, the high jump, the shot put, and the pole vault when the subjects performed three hours after eating a liquid substitute meal as contrasted to the competitive scores in those events when the subjects performed four hours after eating a normal pre-competition meal.

Hypothesis 2. There will be a significantly greater emptying of the stomach food of the subjects when they eat the liquid substitute meal as contrasted to the emptying of the stomach food when the subjects ate a normal pre-competition meal.

Hypothesis 3. There will be no significant difference in the competitive scores in the 440 yard run, the 600 yard run, the 880 yard run, the 1,000 yard run, the mile run, and the two mile run when the subjects performed three hours after eating a liquid substitute meal as contrasted to the competitive scores in those events when the subjects performed four hours after eating a normal pre-competition meal.

Hypothesis 4. There will be no significant difference in the competitive scores in the sixty yard dash, the sixty yard low hurdles, the sixty-five yard high hurdles, the two hundred and twenty yard dash, the three hundred yard dash, the high jump, the pole vault, and the shot put when the subjects performed three hours after eating a liquid substitute meal as contrasted to the competitive scores in

those events when the subjects performed four hours after eating a normal pre-competition meal.

Hypothesis 5. There will be lesser concern for psychological and psycho-physiological factors after the ingestion of a liquid substitute meal as contrasted to the concern for these factors after the ingestion of the normal pre-competition meal.

Basic Assumptions

This study is based upon the following two assumptions.

1. It is assumed that physical performance is affected by the food last ingested prior to such performance. The basis for such an assumption lies in the need for nourishment readily available from the blood stream to supply energy needed by the vigorously exercising muscles.

2. A second assumption is that the nearer in time the ingestion is to the actual performance, the better will be the conditions for performing. A necessary condition is that the ingestion is not too near the time of such performing, for too much food will remain in the stomach and upper alimentary canal.

Background and Significance of the Study

The concern expressed about the pre-competition meal is reflected in the current literature. Numerous articles report the observations of trainers and coaches who have experimented with the use of a liquid meal (8;12;14).

Medical doctors have used their technical abilities to study the effects of the pre-competition meal (3;7;13). The factors of nausea, diarrhea, and reduction of tension received the most attention from these two groups of investigators. Recently, Pennsylvania State University began a nationwide survey inquiring into the pre-competition meal procedure of college coaches.

An excellent summary of nutrition is by Van Itallie, Sinisterra, and Stare (15). These medical doctors consider the effect of diet on physical performance at psychological and physiological levels. "The food that is consumed during training and immediately before an athletic contest may have a psychological significance for the athlete that exceeds its physiological and metabolic importance," they say (15, p. 1122). The strength of their investigation suggests that the pre-competition meal should be examined from psychological aspects.

The physiological respects involve in part digestion and expenditures of energy during athletic activity. Bensley (1) and Morehouse and Rasch (11) have pointed out that the chief attention in planning the pre-event meal should be directed toward the tenseness of the athlete. Loss of appetite, abdominal discomfort, even nausea, vomiting, or diarrhea may occur. Anxiety can interfere with digestion and appetite and the distended stomach may impair performance (15). These conditions generally can be avoided by serving the meal several hours before competition. This

practice leaves the athlete without the best available energy supply, however.

Great variations exist in the expenditure of energy by athletes. Henry (5) has researched extensively into time-velocity equations. His conclusion is that oxygen requirements are met in running even at the fastest speeds through 300 yards. After that distance steady-pace running physiologically results in a better performance. Sprinters and single-effort event men such as pole vaulters, high jumpers, and shot putters can make use of stored energy readily available. They can maintain severity of exercise by utilization of their oxygen debt.* Events longer than the 300 yard dash require an efficiency of operation** in which the oxygen intake meets the metabolic needs of the body. Morehouse and Miller (10) claim that running events beyond the 300 yard distance must be considered endurance contests.

The studies and reports mentioned above indicate a need for further research into the pre-competition meal. This is so because, while medical people and trainers are interested in improving the health and performance of the athletes, they have only limited information based upon work with athletes in competitive situations that is available to them.

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*Oxygen debt is the oxygen needed to make up the energy deficit incurred during muscular exertion in the absence of adequate oxygen intake.

**Efficiency of operation is the ratio of the energy or work that is obtained to the energy put into an operation.

Furthermore, coaches and teachers desire a better atmosphere for competition, and athletes want relief from pre-competition nervous symptons. More and better information is needed for both professional groups.

The uniqueness of this study is two-fold: (1) it considers the psychological and the physiological aspects of the pre-competition meal, and (2) its sample consists of members of an intercollegiate track and field team competing in regularly scheduled track meets. The tenseness of an athlete in the hours before competition provides for research which could give insight into related situations.

Limitation of Study

This study was limited to varsity track and field men at Slippery Rock State College, Slippery Rock, Pennsylvania, during the 1966 indoor track season. All of the data were collected from performances at home meets.

Definition of Terms

1. Universal scoring tables are tables which are mathematically conceived so as to compare performances in one event with performances in other events.

2. Competitive performance scores refer to the running times, jumping heights, throwing distances, and vaulting heights of track and field men and achieved during competitive conditions.

3. Competitive conditions are those which are incurred due to intercollegiate varsity track and field competition.

4. A liquid substitute meal as used in this study consists of ten ounces of a liquid commercial product called Dine-a-Pak plus four oatmeal cookies. The contents are described in Appendix A.

5. A normal pre-competition meal as used in this study consists of approximately 1200 calories. The items are found in Appendix B.

6. A self-rating scale as used in this study refers to a five point scale. Items are evaluated by the participant. Instructions for responding to the items on the scale are found with the items in Appendix F.

7. A criterion score is the value used to represent the several performance scores acquired by a subject.

Procedure and Methods of the Study

The 1966 varsity indoor track and field squad of Slippery Rock State College, twenty-eight men, served as subjects for the study. Seven home meets were used as performance days for the collection of data used in the testing of the hypotheses.

The subjects were alternately tested under two conditions. In one treatment they performed after eating a normal pre-competition meal. In the second treatment they performed after eating a liquid pre-competition meal. The competitive performance scores of the subjects were converted to standard

scores by use of universal scoring tables developed for the current study.

To determine emptying times of the stomach, x-rays were taken once after each meal and one hour before the subject's first competition of the meet. A barium sulphate mixture was used to outline the organs of the stomach.

A self-rating scale was developed to get an indication of the concern the subjects had for certain psychological and psycho-physiological factors. The subjects responded to the fifteen items on the scale after their first competition of each meet.

Fisher's t test for correlated data was the statistical measure used to test all data resulting from the performance scores and the x-rays. The data from the rating scale were tested by the use of Hotelling's T^2 procedure.

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CHAPTER II

SURVEY OF LITERATURE

Introduction

This study involved the investigation of the pre-competition meal of college varsity track and field performers. It considered the effects of a liquid substitute meal and the effects of a normal pre-competition meal both upon performance in selected track and field events and upon concern for certain psychological and psycho-physiological factors.

This chapters reviews what other investigations have revealed about liquid pre-competition meals and reviews what has been discovered in related areas. In a few of these investigations there were rigorous research procedures used to validate the observations, but the bulk of the reports are merely clinical observations.

The Liquid Meal

The several research reports reviewed in this section are all directly concerned with the liquid meal. The substitute meal used in this study was composed of both liquid and solid foods as explained in Appendix A.

Rose, Schneider, and Sullivan (23) found that gastro-intestinal mobility was far greater with a liquid meal.

X-rays of four freshmen football players on the day of a game indicated that the liquid meal had left the stomach and that much of it had left the small bowel in two hours after ingestion. Their observation was that there was no loss of strength or endurance. The nausea and cramps which occur to some athletes on the days of games were eliminated. Diarrhea was no worse than usual.

Jessica and Letourneau (17) were concerned with physical symptons which appeared in their basketball players during or before a game. They used a liquid meal in place of the normal pre-game meal and discovered that nausea, vomiting, and diarrhea were controlled. Muscular cramps no longer appeared. They subjectively concluded that team endurance and team morale were better.

Cooper, Bird, and Blair (7), working with the Oklahoma State University football team, found similar results. There was good control of nausea, vomiting, and cramps, more energy and stamina, and less sluggishness when a liquid meal was used before competition.

Two other reports of a clinical nature agree with the aforementioned ones. Sanko (26) found with a few football players who used a liquid as a dietary substitute that it eliminated some bad effects of pre-game nerves. Kriess (19) found similar results with athletes in different sports.

Theorizing that many things could be used to make a winner, Romo (22) used a liquid meal as both a substitute

and as a supplement. He found it ideal for road games since it eliminated worry about poorly prepared food and permitted mental preparation without distraction. He believes that the tenseness of the athletes in the hours before the game does not permit solid food to digest rapidly enough. He also used the liquid meal to control caloric intake. He gave his athletes the liquid meal instead of the normal meal during the week until they regained their playing weight. If the players lost weight, Romo used the liquid as a supplement to aid them in regaining their playing weight.

In an unpublished study of the running of the 440 yard dash after a normal meal or after a liquid substitute, Gates (10) found no statistical differences in the competitive times of the runners among eight subjects for four treatments. Emptying times of the stomach, which were determined by x-rays, not only varied from subject to subject but also varied with the amount of solid food ingested. The researcher received no report of cramps due to use of the liquid meal or the normal meal. All subjects had a slight discomfort in the upper abdominal area when the liquid was taken as a supplement to lunch. One of the subjects had diarrhea under the same conditions. The liquid meal used in this study was also employed in the current study.

Gates (11) in another unpublished study found that there was no effect on performance in the 660 yard run when running with the food content of the stomach twenty-five

percent or less after a normal lunch as contrasted to the times when running occurred four hours after a normal lunch. There was no effect on the times in the 660 yard run when running with food content of the stomach twenty-five percent or less after eating a liquid substitute as contrasted to the times when running ocourred three hours later. There was a one hour longer emptying time for subjects eating a normal lunch as contrasted to subjects eating the liquid substitute. Conclusions drawn from clinical observation and from a questionnaire each subject completed were that a period of familiarity with the ingestion of the liquid substitute is an asset toward later acceptance of it as a pre-competition meal.

The Use of Supplements to Increase Work Performance

The research in the area of supplements to the diet is much more scientifically conceived and reported than is the research with the liquid meal when it is used exclusively. These supplements are not a substitute for a pre-competition meal and apparently would have their usefulness with a disregard for the form of the pre-competition meal. The three studies reported here are the result of research by Russian physiologists. These are selected because they exemplify the degree to which research can aid in acquiring increased physical performance. Also, all three researchers suggest reasons for the improved performance and do not merely report the findings.

Rogozhin (21) found that two milligrams of phosphate mixed with fifty millimeters of water and combined with a glucose solution improved performance in such sports as the 1,500 and 3,000 meter runs, rowing, and swimming. He stated that a gradual supply of carbohydrates of three types was needed: glucose, sucrose, and starch. The decrease in glycogenolysis* is the reason for the decrease in blood sugar during athletic events. The reason is not an increase in glucose consumption. Thus, the phosphate is needed as it will cause an increase in glycogenolysis in the liver and will cause phosphorylation** in muscles. Keys (18) does not believe that there is satisfactory evidence supporting the claims made for phosphate. He is of the opinion that acid phosphate drinks have a possible psychological effect in relation to performance.

An increase in work performance through the use of citric acid was found by Yakovlev (28). Citric acid stimulates the processes of aerobic oxidation and thus contributes to the increase in work performance.

In a study by Kosmolinskii (20) the endurance of rats under "oxygen hunger" was increased when enzymatic changes

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*Glycogenolysis is the process occurring in the liver whereby glycogen is converted to glucose, the form needed for use as energy food.

**Phosphorylation results in the formation of an ester of phosphoric acid. The ester is chemically important in muscle glycogenolysis.

occurred due to use of tea tannins. The tannins affected activity of dehydrases and oxidases.*

Related Studies

Many of the related studies reported here have had their genesis at the State University of Iowa. All of these studies are valuable because they are directly concerned with the meal last ingested before performance.

In a series of studies, Asprey, Alley, and Tuttle (1;2;3;4) found that the eating of a cereal and milk meal of about 500 calories one-half hour, one hour, or two hours before a running event had no adverse effect on the running times for the 440 yard dash, the half-mile run, the mile run, the two mile run, the 200 yard free style swim, or the 400 yard free style swim. None of the subjects reported any adverse effects in the form of nausea or stomach cramps during or after the runs.

Youmans, Alley, and Tuttle (29) found that for six time intervals from one half hour, hour, to three hours between eating and running, the eating of a small meal of cereal, milk, and toast had no effect on the subsequent performance of sprinters in the fifty yard dash and the one hundred yard dash. None of the subjects suffered cramps, nausea, or vomiting either during or after the sprints.

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*Dehydrases and oxidases are enzymes that catalyze oxidation.

Ball (5) used the same time intervals as Youmans, Alley, and Tuttle and found that to eat the cereal and milk meal had no effect on subsequent performances in swimming the one hundred yard dash, freestyle. None of the swimmers suffered adverse effects in the form of nausea or stomach cramps either during or following the swims. Moreover, none of eighteen varsity swimmers from the State University of Iowa swimming team suffered any ill effects as a result of eating the cereal and milk meal at the various times before competing in a swimming meet.

Rose and Fuenning (24) explored the possibility that the pre-game meal was the cause of sluggishness on the part of University of Nebraska players in the first part of their games. Four players participating in the Alumni-Varsity game served as subjects for x-rays of stomach contents. Six and three-fourths hours after his pre-game meal, one player had food in the jejunum and the three other players were two to three hours behind expected stomach emptying schedules. The tremendous tension generated by the competitive atmosphere was considered to have slowed gastrointestinal motility more severely than under normal conditions.

Refined techniques of research are found in studies of the relationship of nutrition to the level of physical performance. Occasionally, these scientific studies consider the diet during the period immediately prior to an athletic contest. Hutchinson and Krahl (16) have recommended that

food be eaten three to four hours before competition. This allowance for emptying of the stomach did not consider tenseness such as found in athletes before athletic competition. Haldi and Wynn (13) have studied the efficiency of swimmers in relation to pre-exercise nutriment. The conditions for this experiment involved only twelve subjects. Motivation consisted in urging the subjects to try for a new record at each performance. There was no improvement. Wrightington (27) found no significant changes in muscular efficiency after the ingestion of either glucose or sucrose. Moderate exercise on a bicycle ergometer was used to test the effects of the treatments.

Other studies offering objective evidence are available. Haldi and Wynn (14) did not find any significant difference in the performances of swimmers two and a half to three hours after a high carbohydrate meal and an isocaloric meal containing a low percentage of carbohydrate. Haggard and Greenberg (12) used the questionnaire to assess the results of their investigation of between meal feeding in industry. The conclusion drawn was that such feeding was favorable to the social atmosphere. The inference was that this reflected better performances in work.

Dill, Edwards, and Talbott (8) found that a heavy carbohydrate meal one hour before treadmill running with glucose added during the exercise significantly increased the endurance. The subjects were dogs. Agreeing with this

basic conclusion that endurance is improved by a good carbohydrate storage are Christensen, Krogh, and Lindhard (6). They maintain that a two day rest before competition is helpful for this purpose.

Dupain (9) endorses the use of a rich carbohydrate intake. He studied highly trained athletes on different diets. His recommendation was for carbohydrates, fats, and proteins to be in the ratio of seven, one and one-half, and one for endurance events. For sprint events the ratio was three to one to two.

Henschel (15) also endorses the use of a carbohydrate diet. He has observed that industrial workers produce more efficiently because blood sugar concentrations remain normal during prolonged physical work.

Sangster, Grossman, and Ivy (25) were interested in emptying of the stomach. They used the onset of hunger pangs as a test for emptying times. Liquefied and non-liquefied meals were given on different days to the same subjects. One of the conclusions derived was that the liquefied meal left the stomach sooner than the non-liquefied meal.

Summary

All of the above reviewed studies and clinical observations displayed a concern for continuous improvement of performances and conditions. The conclusions derived are numerous. They are listed below.

1. Carbohydrate-rich food before moderate but extended work periods results in a greater efficiency (6;8;9).

2. Carbohydrate-rich food before vigorous exercise of short duration does not significantly result in improved performance (1;13;14).

3. A liquid meal leaves the stomach sooner than a normal meal leaves the stomach (11;22;23;24).

4. Nausea, vomiting, abdominal cramps, and diarrhea are as well controlled by the use of a liquid meal as by the use of a normal meal (1;2;3;4;7;10;17;19;23;26;29).

5. Endurance is not affected by the use of a liquid meal (1;2;3;4;7;10;11;17;23).

6. A high carbohydrate meal of 500 calories or less eaten shortly before performance does not reduce the performance level (1;2;3;4;7;15;29).

8. Supplements to the diet may be helpful because they are involved in the processes which provide more glucose to the active muscles (18;20;21;28).

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CHAPTER III

METHODS AND PROCEDURES

Introduction

During the fall semester, 1964-1965, a pilot study involving the use of a liquid meal was conducted with thirty-two subjects at Slippery Rock State College. Knowledge gained from the pilot study helped to refine the methods and procedure for the present investigation. Specifically, the following was observed: (1) A period of familiarity with the liquid meal helps eliminate pre-conceptions the subjects have about it; (2) Great variation occurred when the sample was drawn from the population at large; (3) The liquid meal leaves the stomach more quickly than an isocaloric meal; (4) Psychological conditions necessary to create an interruption of the digestive processes were not met by the laboratory-type atmosphere of the study; (5) Competing against one's own time is not strong enough motivation for consistently intense efforts; (6) Those who understood the nature of the study moved easily into the routine whereas those who did not comprehend the purpose for the study appeared to be affected by the change of routine; (7) A conditioning period of several weeks is a pre-requisite for consistency of performance; (8) X-ray techniques and the use of barium sulphate were quite satisfactory for the purposes.

The current study used objective methods for the collection of the performance data. The atmosphere of the intercollegiate competition tended to minimize variations in motivation. The use of the same subjects for each of the two treatments reduced the difference in experimental conditions; thus, the control of effects due to the psychological was somewhat exercised. The training period the athletes had previous to the collection of data controlled effects of conditioning upon performance.

With these more rigid criteria, information was acquired which lead to more rigorous research. Control of such variables, which might have a significant effect upon performance scores, enabled the execution of more precise research.

The Sample

The tenseness associated with the preparation for competition and associated with actual competition cannot be duplicated. Thus, the college varsity track and field team members of Slippery Rock State College in Slippery Rock, Pennsylvania, were used as subjects for this study. Twenty-eight members from eighteen to twenty-three years of age completed the experiment and served as the sample. All scores were obtained in conjunction with seven regularly scheduled intercollegiate track and field meets.

Nature of the Treatments

There were two treatments. In the first treatment the

subjects ate a normal pre-competition meal as described in Appendix B. In the second treatment the same subjects drank a liquid substitute meal as described in Appendix A. Thus, each of the subjects was tested under each of the two treatment conditions on different track event days. The two treatments were alternated to negate any effects of conditioning.

For each of the two treatments, the reliabilities of the means for the scores of the competitive events were determined by the use of the formula for intraclass correlation as described by Ebel. The formula is $r = M_{\bar{x}}$ minus $M / M_{\bar{x}}$, in which $M_{\bar{x}}$ is the mean square for persons and M is the mean square for error.

The Procedures for Collecting Data

The data necessary for testing the hypotheses of the study were collected in the manner described below.

Competitive Performance Scores

Each subject competed under each of the two treatment conditions. Each performance score was converted to a standard score by the use of the universal scoring tables as described below. The criterion score for each subject for each treatment was the mean of the separate trials under each treatment condition.

Universal Scoring Tables

So that performances in the many different events could be compared statistically to each other, universal scoring tables were compiled. These tables are found in Appendix D. They are based upon the latest available world indoor track and field records. The records were secured from the Amateur Athletic Union headquarters at New York City. The formulas for these tables have been developed by McCloy (2). The formulas are as follows.

$$\text{Track points} = \frac{925\ (\text{world's record})^n}{(\text{actual record})^n} - 25$$

$$\text{Field points} = \frac{925\ (\text{actual record})^n}{(\text{world's record})^n} - 25$$

The n is the exponent.* The exponents are as follows.

All running events have an exponent of 3.00.

The forty-two inch hurdles have an exponent of 2.50.

The thirty-six inch hurdles have an exponent of 2.25.

The high jump has an exponent of 2.24.

The pole vault has an exponent of 1.45.

The shot put has an exponent of 1.50.

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*The exponents differ in value because they are based upon certain mechanical principles involving velocity, range, power, force, and distance. Since the various activities differ in mechanical principles, the exponents based on physical laws and mathematically computed would differ.

Determination of Emptying Times of Stomach

Nineteen of the subjects had the stomach and the alimentary canal that is posterior to the stomach x-rayed twice. One x-ray was taken one hour before competition and two hours after eating a liquid substitute meal. A second x-ray was taken one hour before competition and three hours after eating a normal pre-competition meal. A barium sulphate mixture was used to outline the organs of the alimentary canal. The barium was taken orally immediately after eating. The sulphate mixes with the food and leaves the stomach at the same rate as the food leaves (5). Appendix C shows the percentage of food which has left the stomach of the subjects under each of the treatments. Appendix E is a reproduction of the radiologist's reports on the x-rays.

Preparation of the Rating Scale

In addition to the physiological aspect of this study there was a psychological aspect. Just as the results of the functioning of the digestive and distributive systems under each of the two treatment conditions of this study were worthy of investigation, so too were the psychological aspects associated with tenseness.

To investigate the awareness of the subjects for psychological and psycho-physiological factors which are present on the day of competition and to compare the responses made for the two treatment conditions, a self-rating

scale with fifteen items was developed. This scale is exhibited in Appendix F.

A list of items was compiled by graduate students at North Texas State University, Slippery Rock State College, and by the present researcher. This list was sent to a panel of selected juages for evaluation as to the relevance of the items in relation to the performance of the track squad subjects. Agreement for retaining an item by a majority of judges was necessary for its retention.

Each subject responded to each item after his first performance in each track meet. All of the subjects were familiarized with the instrument in a training session before the beginning of the competitive season. This session consisted of an explanation of the items followed by a question and answer period. The primary emphasis was placed upon a complete understanding of the items. The importance of a considered response to every item each day of competition was explained. A general overview of the study was given. The subjects were primarily physical education students. Some of the students knew the physiology involved from classroom and laboratory experiences. This knowledge aided in the general dissemination of information. The first track meet was not a home meet. After the meet, the subjects discussed the questions with the present researcher, indicated the responses they would have given to the items, and asked questions. Since this meet was not a part of the study,

it provided an opportunity to answer any uncertainties the subjects had.

Immediately after a subject's first competitive performance, he reported to a secretary to give his responses to the items. If he did not report before the beginning of the next event, a secretary found him. The subjects were not distracted from their concentration on their event by this method.

The criterion score was the mean of the responses made to each item for each subject in each treatment. These criterion scores were used in the computation of Hotelling's T^2, which was related to testing hypothesis five (4).

The six men who served as judges were Dr.Gene Asprey, Director of the Research Laboratory and Associate Professor of Physical Education at the State University of Iowa; Dr. Ernst Jokl, Professor of Physiology and Director, Physical Education Research Laboratory at the University of Kentucky; Mr. Donald Kallem, Associate Professor of Physical Education, Eastern Washington State University; Dr. Robert Kruse, formerly of the Cleveland Clinic and Slippery Rock State College; Dr. Donald K. Mathews, Professor and Coordinator of Research, The Ohio State University; and Dr. Arne Olson, Associate Professor of Physical Education at Temple University.

Procedures of Track Events

For each subject in each competitive home meet a schedule was made: the eating time and place, the type of meal to be eaten, and the running time. All subjects were checked-in at each competition meal by the present researcher or one of two managers appointed to the task.

All times were recorded by Bulova timepieces, especially synchronized and adjusted for accurate timing of track events. All timers and field events personnel as well as meet officials were physical education majors trained for their responsibilities by virtue of classroom and meet experience. They were instructed in the various aspects of track and field activities as part of their professional course work at the college. Their meet experience was acquired by officiating at college and high school meets held at the indoor track at the college during the previous years.

Procedures for Treatment of Data

The data in scoring form from the competitive events, the data from the self-rating scale, the data for the compilation of universal scoring tables, and the data for the reliabilities of the means of the performance scores were tabulated and processed by the data processing center at North Texas State University. The tenability of the hypotheses of this study was tested by treating these data in the following manner. The level of significance tested was .05.

1. To test hypothesis one, a Fisher's t test for related samples was used (4). The formula for this is

$$t = \frac{(\bar{D}-\bar{D}_p)}{\sqrt{\frac{N\Sigma D^2 - (\Sigma D)^2}{N^2(N-1)}}}$$

in which $\bar{D}$ equals the mean of the differences between the sets of scores, $\bar{D}_p$ is the mean of a population of differences.

2. To test hypothesis two, a Fisher's t test for related samples was used.

3. To test hypothesis three, a Fisher's t test for related samples was used.

4. To test hypothesis four, a Fisher's t test for related samples was used.

5. To test hypothesis five, Hotelling's T^2 procedure was used (1;4). The formula is T^2 equals $A' S^{-1} A$, in which S^{-1} equals the inverse of the variance-covariance matrix, A equals N x 1 matrix of N mean differences, and A' equals the transpose of matrix A. For the F test, F equals T^2 $(n-r+1)/nr$, in which n equals N_1-2 and r equals the number of variables. If F is significant, t tests will be used to determine which variable or variables are responsible for the difference.

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CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Introduction

The data of this study are presented and analyzed in this chapter. The basic purpose for this investigation was to ascertain the effect of a liquid pre-competition meal upon physical performances in selected track and field events, and the effect of the meal as contrasted to a normal meal upon psychological and psycho-physiological aspects in relation to competition.

All but one of the computations were done by the IBM computer at North Texas State. A Monroe calculator and hand computations were used to check on the correctness of the information given to the IBM computer. The reliability of the means of the performance scores was determined by use of the calculator. This reliability gives a measure of the consistency of the performances. The reliability between first performances and last performances was .97.

The procedure in this chapter is as follows.

1. An hypothesis is given.

2. A table showing the appropriate summary of the collected data is presented.

3. An explanation of the table is offered.

4. A discussion of the table in relation to the hypothesis and with relation to previous research and other data completes the analysis.

The level of significance at the .05 level or beyond was established to test the hypotheses.

Hypothesis 1

Hypothesis one stated that there would be no significant difference in the competitive scores in the sixty-five yard high hurdles, the sixty yard dash, the sixty yard low hurdles, the 220 yard dash, the 300 yard dash, the 440 yard run, the 600 yard run, the 880 yard run, the 1,000 yard run, the mile run, the two mile run, the high jump, the shot put, and the pole vault when the subjects performed three hours after partaking of a liquid substitute meal as contrasted to the competitive scores in those events when the subjects performed four hours after eating a normal pre-competition meal.

Table I contains the results of the t test for correlated data for all events participated in by the subjects. This formula was used because the twenty-eight subjects alternately performed under each of the two treatments. The treatment, N, referred to in this and similar succeeding tables indicates the normal pre-competition meal. The treatment assigned a D is in reference to Dine-a-Pak, the liquid substitute meal used in this study. In all of these tables, a positive t indicates that the mean of treatment D is larger than the mean of treatment N. A negative t

shows that treatment N is the larger mean.

TABLE I

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR ALL EVENTS

Mean of D	Mean of N	SE of Means	DF*	t	P
561.04	567.81	6.97	26	- .97	NS

*DF indicates degrees of freedom as in all tables.

An examination of Table I reveals that when considering all competitions in all events the mean of the competitive scores of the subjects who ran after eating a normal meal is 6.77 points higher than is the mean of the competitive scores of the same subjects when running after eating a liquid meal. This difference is not significant, and Hypothesis I is supported.

This information is consistent with available research. Gates (3;4) offers statistical support that there is no difference. However, his studies were each limited to one event: the 440 yard run in one study and the 600 yard run in the other. Two further limitations of the studies lie in the factors of motivation and lack of tenseness, as reported by the author in his summaries of the articles.

Several researchers (2;5;7) have given their professional observation on the efficiency of muscular work which was based upon their analysis of prevalent studies and complimented by their own theories. These investigators agree

that efficiency is practically the same regardless of the type of food consumed on the day of activity. A dissenting opinion is that of Haggard and Greenburg (6). Gemmill (5) does admit that a slight efficiency, about five percent, is noted when a carbohydrate meal is eaten than when a fat meal is eaten.

This current study was conducted with the viewpoint that a more accurate research report would evolve if primary consideration were given to the subjects as athletes and not as subjects per se. Thus, the development of the track men as individuals and as part of a team claimed priority. As a result, the subjects did not always participate in the same events at each track meet. During the season their first competition was not always the same.

Therefore, two other sets of data evolved from that summarized in Table I. The t test for correlated data was the statistical treatment for each of the two tables.

TABLE II

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR ALL SUBJECTS' FIRST PERFORMANCE SCORE OF EACH MEET FOR ALL EVENTS

Mean of D	Mean of N	SE of Means	DF	t	P
562.33	565.78	7.11	26	- .48	NS

An inspection of Table II indicates that when considering only the first performance score of each subject at all meets the scores of the subjects who ran after eating a normal meal is 3.45 points higher than is the mean of the scores of the same subjects when they competed after eating a liquid meal. This difference is not significant.

Two aspects of this first performance need to be introduced at this time since similar discussions with other data will appear below. The first comment is that a track athlete readies himself for his first effort. A remark by Wilt (12) indicates the intensity of such a preparation.

> It might prove comforting to the younger atheltes to realize that even the greatest athletes suffer extreme feelings of anxiety and helplessness prior to a race, and are often obsessed with an almost uncontrollable desire to withdraw from the race. Frequently even the best athletes will subconsciously seek socially acceptable reasons for withdrawing or quitting, and even go so far as to simulate illness or injury. The winner is attacked by such emotions as often as the quitter, but obviously is able to somehow control himself and overcome them (12, p. 93).

The second comment evolves from the first. A track athlete has a certain event toward which he directs his energies. Kresler (8) says that it is difficult to convince an athlete to compete in another event, but that he must believe in his coach and feel he would be asked to do so only if needed for the good of the team. If that particular event appears as his first competition in a meet, he will have available all of the forces necessary to a supreme effort. Psychological readiness and physiological reserves

are the primary forces. This situation is particularly true for track athletes competing in endurance events or in field events.

The next table considers only the same first events. This means that only one event per subject per track meet was used as a basis for computation and that only the same events under each of the two treatments were considered.

TABLE III

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR ALL SUBJECTS' FIRST-SAME-PERFORMANCE SCORES FOR ALL EVENTS

Mean of D	Mean of N	SE of Means	DF	t	P
574.54	565.43	5.41	27	1.68	NS

A study of Table III shows that when considering only the first-same-performance scores of each subject the scores of the subjects who ran after eating a liquid meal indicate a mean that is 9.11 points higher than is the mean of the same subjects when they competed after eating a normal meal. This difference is not significant.

An interesting change in the direction of the means is revealed in Table III, for the t ratio of 1.68 ($.11 > P > .10$) favors treatment D.

An analysis of the data combined with analysis of administrative track procedure and basic physiology provides

an explanation for the direction of the ratio above. Subjects who perform in the field events engage in their particular events at the beginning of the track meets. This is the official administrative procedure for track meets. Therefore, they have similar psychological and physiological preparations each meet day. The performances of the sprinters are less affected by the length of their first competition in a meet, since they are running at full speed in every sprint. The psychological buildup the endurance runners possess appears to strongly influence their first performance. Their succeeding performances in a meet are generally poorer due to physiological reasons. The length of their running is such that they utilize some of their carbohydrate reserves which are not restored until the next food intake. Thus, reduced to use of the less efficient* fat metabolism for part of his energy, an endurance runner performs at a physiologically inferior rate (10).

Hypothesis II

Hypothesis two is that a significantly greater emptying of the stomach food of the subjects will be noticed when athletes eat a liquid substitute meal as contrasted to the

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*Less efficient in that it takes more oxygen to metabolize fat than it takes to metabolize carbohydrates. One liter of oxygen yields five calories if used to burn carbohydrates as contrasted to 4.6 if used to burn fats.

emptying of the stomach food when the subjects eat a normal pre-competition meal. Table IV presents the results of the t test for correlated data between treatments D and N. The data are based upon x-rays of the contents of the stomach. The means represent the average amount of food which has left the stomach. All x-rays were taken one hour before competition.

TABLE IV

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR DIFFERENCES IN EMPTYING TIMES OF THE STOMACH

Mean of D	Mean of N	SE of Means	DF	t	P
46.58	70.26	5.51	18	-4.30*	.01

*Indicates favoring treatment N.

An examination of Table IV reveals that subjects x-rayed one hour before competition had 23.68 percent more food moved out of the stomach after eating a normal pre-competition meal than they had moved out after eating a liquid pre-competition meal. The hypothesis is not supported. Subjects who ate the normal pre-competition meal and were x-rayed three hours later had the contents of their stomach emptied in significantly less time than when they ate the liquid meal and were x-rayed two hours after ingestion.

Observations by the present researcher and the two team managers indicated that the subjects were eating most if not

all of the normal meal, and ate all of the liquid meal. Research has consistently indicated that a liquid meal digests more quickly than a bulk meal digests. As will be shown in later information, the subjects responded that they did not feel any more empty under one treatment than they did under the other. Moreover, they were not affected because they were part of an experiment any more than expected under one treatment than under the other treatment. These two items do not help to give direction to an understanding of the unexpected result.

An analysis of the problem leads to other explanations. The first explanation involves the time between eating and the x-rays. The subjects had two hours after eating and before the x-rays when they had eaten the liquid meal, but three hours when they had eaten the normal meal. This extra time for digestion of the food could have been an important factor in the results between the two treatments. X-rays just before competition would be more revealing, but in the present study this ideal was impossible for two primary reasons: (1) the interruption of the psychological and physiological buildup the athletes had nearly completed toward their events would have created an immeasurable effect upon their performances and health; (2) the facilities were thirty minutes from the fieldhouse.

A second source of information lies in the technical area. Appendix E indicates that two of the subjects probably

had pylorospasms* present. This retardation to stomach emptying conceivably could have affected some of the subjects in the early digestive moments, although not as severely as the two subjects who had pylorospasms. The familiarity with the meal was established especially since these x-rays were taken late in the study.

The final explanation is also a quite plausible reason for the confounding result. Track men under competitive conditions may digest familiar bulk food more readily than less familiar liquid food.

Hypothesis III

Hypothesis three stated that there would be no significant difference in the competitive scores in the 440 yard run, the 600 yard run, the 1,000 yard run, the mile run, and the two mile run when the subjects performed three hours after eating a liquid substitute meal as contrasted to the competitive scores in those events when the subjects performed four hours after eating a normal pre-competition meal.

Table V gives the results of the t test for correlated data between the two treatments.

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*Pylorospasms are closures of the pyloric sphincter, which opens from the stomach into the duodenum, the upper part of the intestine. The cause for this spasm is due to irritation by the materials in the stomach. Food is thus held in the stomach.

TABLE V

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR SUBJECTS' PERFORMANCE SCORES IN ENDURANCE EVENTS FROM THE 440 YARD RUN THROUGH THE TWO MILE RUN

Mean of D	Mean of N	SE of Means	DF	t	P
546.62	549.38	13.24	12	- .21	NS

A consideration of Table V reveals that the mean of the competitive scores of the endurance event subjects who ran after eating a normal pre-competition meal is 2.76 points higher than is the mean of the competitive scores of the same subjects when they ran after eating a liquid meal. This difference is not significant. Hypothesis three is upheld.

The variability of the performance scores is greatest for the endurance runners. Moreover, the differences between subjects in endurance events is great. The endurance groups have larger standard errors than the sprint groups. The difference between treatments must then necessarily be larger for the endurance group if a statistic is to reach significance.

Table V contains the summary of the data for all endurance performances. In the following table the summary of the data for all first runs is presented. Table VI shows

the results of the t test for correlated data between the two treatments.

TABLE VI

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR SUBJECTS' FIRST-PERFORMANCE SCORES THAT WERE ENDURANCE EVENTS

Mean of D	Mean of N	SE of Means	DF	t	P
546.77	544.54	13.63	12	.16	NS

An analysis of Table VI discloses that when considering the first competitive scores of the endurance events for subjects who ran after eating a liquid meal, the mean is 2.23 points higher than is the mean of the competitive scores for the same subjects when they ran after eating a normal meal. If a subject's first event in a meet was not an endurance competition, his score in any endurance event in that meet was not used in these computations. The difference is not significant.

Table VII presents the summary of the data for all first-same runs. This means that only the first events for each subject per track meet was used as a basis for computation and that only the same events under each of the two treatments were considered. Furthermore, if a subject's first event in a meet was not an endurance competition any

endurance event score for that subject in that meet was not used in these computations.

Table VII reveals the results of the t test for correlated data between the two treatments.

TABLE VII

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR SUBJECTS' FIRST-SAME-PERFORMANCE SCORES IN ENDURANCE EVENTS

Mean of D	Mean of N	SE of Means	DF	t	P
571.69	547.00	8.22	12	3.01*	.02

*Favors treatment D.

An examination of Table VII indicates that when considering the first competitive score for each subject in each meet the mean of the competitive scores of the endurance event subjects who ran after eating a liquid meal is 24.69 points higher than is the mean of the competitive scores of the same subjects when they ran after eating a normal pre-competition meal.

The sub-part of hypothesis three is significant. The difference between means suggests that performance in one aspect of endurance running is significantly affected by one type of pre-meet meal more than it is affected by another type. Specifically, the difference between means indicates that under the conditions of this study and under the terms

of this particular aspect of hypothesis three the liquid meal with the brand name of Dine-a-Pak indicated a significant superiority over a normal pre-competition meal when the subjects engaged in the first-same runs for the endurance events.

Several approaches can be made in a discussion of the above significance. The first concerns motivation. Question five in Appendix F concerns the desire to perform well. An examination of the data in Table XII shows a significant t ratio in favor of treatment D. These data were computed from the responses of all subjects and the data were based upon the subjects' own interpretations and judgments. The data suggest the possibility that the subjects may have been more motivated when they competed under the liquid meal treatment than when they competed under the normal meal treatment.

A second approach in the discussion of the significant difference of the liquid meal as contrasted to the normal meal can be related to item seven in Appendix F. The subjects responded that they felt significantly stronger after eating a normal meal as contrasted to when they had competed after they had eaten a liquid meal. The t ratio of -2.11 as shown in Table XII under variable seven is significant at the .05 level.

The third approach is that the subjects are affected psychologically. They respond more to one treatment than they do to another. This argument is often a valid one. It could have been responsible for the significance between the

One of three theories listed by Keys (9) suggests the principle that the supply of energy-yielding substrates is renewed by the use of a special dietary. One of the claims for the liquid meal is that it will supply energy nearer in time to the need because it can be eaten later and still be digested. The data in Table IV upon examination indicated that one hour before competition slightly more than half of the liquid meal remained in the stomach as contrasted to approximately thirty percent of the normal meal. The liquid food which had left the stomach remained in the small intestine, whereas the normal meal progressed farther along the digestive pathway into the colon (Appendix B). The availability for food to enter the blood stream by absorption in the small intestine is thus greater with the liquid meal under the existing conditions. The hour from x-ray to competition could have been an important period during which carbohydrate reserves were built up.

Hypothesis IV

Hypothesis IV states that there will be no significant difference in the competitive scores in the sixty yard dash, the sixty yard low hurdles, the sixty-five yard high hurdles, the 220 yard dash, the 300 yard dash, the high jump, the shot put, and the pole vault when the subjects performed three hours after eating a liquid substitute meal as contrasted to the competitive scores in those events when the subjects performed four hours after eating a normal pre-competition meal.

Table VIII presents the results of the t test for correlated data between treatment D and treatment N for all sprint and field events competitions.

TABLE VIII

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR PERFORMANCE SCORES OF SUBJECTS IN RUNNING EVENTS FROM SIXTY YARDS THROUGH 300 YARDS AND FOR ALL FIELD EVENTS

Mean of D	Mean of N	SE of Means	DF	t	P
574.13	582.80	5.23	14	-1.66	NS

An examination of Table VIII reveals that for all running and hurdling events from sixty yards through 300 yards and for all field events the mean of the competitive scores of the subjects who ran after eating a normal pre-competition meal is 8.67 points higher than is the mean of the subjects who ran after eating a liquid meal. This difference is not significant.

Although not significant, this ratio approaches significance ($.20 > P > .10$). Sprinters and field events athletes may perform better if they eat a normal pre-competition meal. The results can be reviewed in combination with emptying times of the stomach. For vigorous, all-out effort such as is necessary in sprinting, excess food in the stomach and upper digestive tract could be a liability. The possibility exists that more food was in the upper digestive tract

when the subjects performed under treatment D (Table IV). The liabilities to sprinters could occur due to abdominal pressure causing digestive gases, an uncomfortable starting position, or feelings of discomfort causing psychological disadvantages.

Table IX presents the result of the t test for correlated data between the two treatments for all first competitions by the sprint and field events subjects.

TABLE IX

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR FIRST-PERFORMANCE SCORES BY SPRINT AND FIELD EVENTS SUBJECTS IN EACH MEET

Mean of D	Mean of N	SE of Means	DF	t	P
578.87	580.73	4.95	14	- .38	NS

A study of Table IX discloses that when considering the first-performance scores by the sprint and field event subjects in each meet the mean of competitive scores of the subjects who ran after eating a normal meal is 1.86 points higher than is the mean of the same subjects who ran after eating a liquid meal. This difference is not significant.

Table X gives the result of the t test for correlated data between the two treatments for all first same competitions by sprint and field events subjects.

TABLE X

THE MEANS, STANDARD ERROR OF THE MEANS, t RATIO, AND LEVEL OF SIGNIFICANCE OF TREATMENT D VERSUS TREATMENT N FOR SUBJECTS' FIRST-SAME COMPETITIONS THAT WERE SPRINT OR FIELD EVENTS

Mean of D	Mean of N	SE of Means	DF	t	P
576.53	570.93	5.26	14	- .65	NS

An inspection of Table X reveals that when considering the first competition score in each meet the mean of the competitive scores of the sprint and field events subjects who ran after eating a normal pre-competition meal is 3.40 points higher than is the mean of the competitive scores of the same subjects when they competed after eating a liquid meal. If a subject's first event in a meet was not a sprint or a field event, his score in any sprint or field event in that meet was not used in these computations. This difference is not significant.

Hypothesis V

Hypothesis five states that the ingestion of a liquid substitute meal would result in a lesser concern for psychological and psycho-physiological factors as contrasted to the ingestion of the normal pre-competition meal.

Table XI shows the results of Hotelling's T^2, the statistical procedure used to test the difference between the two treatments on fifteen variables of psychological or

psycho-physiological orientation as measured by a self-rating scale.

TABLE XI

T^2 VALUE, F RATIO, AND LEVEL OF SIGNIFICANCE BETWEEN TREATMENT D AND TREATMENT N FOR FIFTEEN VARIABLES ON SELF-RATING SCALE

T^2	F	DF	P
15.15	.75	15/40	NS

The F ratio was not significant. Hypothesis five is not confirmed.

Although the F ratio is not significant, potentially valuable information about certain variables can be obscured by the other variables included in the analysis. The IBM computer not only processed the data, it calculated the t tests for correlated data for all fifteen variables. All of these variables were judged to have a relationship to performance and therefore a possible effect on performance. If there is a significant difference between the treatments on any variable, the information can give possible direction to an understanding of any performance difference between the two treatments. Therefore, Table XII presents the results of the t tests for correlated data between the two treatments on the fifteen variables of the self-rating scale.

TABLE XII

VARIABLES, DIFFERENCES OF MEANS, STANDARD ERROR OF THE MEANS, t RATIOS, AND LEVELS OF SIGNIFICANCE BETWEEN TREATMENT D AND TREATMENT N ON FIFTEEN VARIABLES ON A SELF-RATING SCALE

Variables[a]	Difference Between The Means[b]	Standard Error of Mean	The t	P
1	-.003	.154	- .02	NS
2	-.075	.198	- .38	NS
3	-.141	.187	- .76	NS
4	.188	.212	.88	NS
5	.587	.213	2.75[c]	.02
6	-.043	.113	- .38	NS
7	-.380	.180	-2.11[d]	.05
8	.256	.274	.94	NS
9	.232	.240	.97	NS
10	.044	.190	.23	NS
11	-.062	.239	- .26	NS
12	-.226	.231	- .98	NS
13	.134	.276	.49	NS
14	-.026	.242	- .11	NS
15	.181	.241	.75	NS

[a]Appendix F has an explanation of each variable.
[b]A minus difference indicates a higher mean for treatment D.
[c]Favors treatment D. N has the higher mean, undesired.
[d]Favors treatment N. D has the higher mean, undesired.

An examination of Table XII reveals two significant t ratios. The subjects responded that they had more desire to perform well after eating a liquid meal than they did after eating a normal pre-competition meal. The subjects also indicated that they felt stronger after their first performance when they had eaten a normal meal than when they had eaten a liquid meal.

The Supplementary Aspects of the Study

One of the supplementary aspects of this study was the development of universal tables based on existing world records of selected indoor track and field events. These tables are found in Appendix F.

There were two purposes for the establishment of a set of tables, in addition to their use to change performance scores into standard scores. They provide a basis for evaluation of track team members and they supply a tool for motivation.

A second supplementary aspect of this present study was the observation of side effects of nausea and diarrhea. The information secured from the subjects indicates no significant difference between the two treatments for these factors (Appendix F and Table XII, variables 12 and 20). On the basis these items give the liquid meal or a normal pre-competition meal affects the subjects similarly.

The intensity of the effect is indicated by the responses the subjects gave on the self-rating scale. The average for the responses made after eating a normal meal was 4.31 on the five point scale. The average of the responses made by the subjects after eating a liquid meal was 4.34. These scores indicate very little problem with nausea or diarrhea on the part of the subjects.

A clinical observation by the present researcher revealed that certain subjects had difficulty with either

TABLE XIII

SUMMARY TABLE OF MEANS, DIFFERENCES BETWEEN THE MEANS, STANDARD ERRORS OF THE MEANS, t RATIOS, AND LEVELS OF SIGNIFICANCE USED IN TESTING HYPOTHESES ONE THROUGH FOUR

Condition	Means	Difference Between Means	SE of Means	t	P
All Events-All Subjects	561.04[a] 567.81	- 6.77	6.97	- .97	NS
All Subjects First Comp.	562.33 565.78	- 3.45	7.11	- .48	NS
All Subjects First Same Events	574.54 565.43	9.11	5.41	1.68	NS
X-Rays	46.58 70.26	23.68	5.51	-4.30	.01
Endurance-All Scores	546.62 549.38	- 2.76	13.24	- .21	NS
Endurance First Events	546.77 544.54	2.23	13.63	.16	NS
Endurance First Same Events	571.69 547.00	24.69	8.22	3.01	.02
Sprints-All Scores	574.13 582.80	- 8.67	5.23	-1.66	NS
Sprints First Events	578.87 580.73	- 1.86	4.95	- .38	NS
Sprints First Same Events	576.53 579.93	- 3.40	5.26	- .65	NS

[a]Treatment D, liquid meal, is above figure.
[b]Treatment N, normal meal, is below figure.
[c]Favors normal meal.
[d]Favors liquid meal.

meal, but that they did not appear to be affected at meet time. The two subjects who had pylorospasms were bothered by the taste of the liquid meal but did not report nausea nor was it observed that they were adversely affected due to ingestion of the liquid meal.

Summary

The purpose of this chapter was to present and analyze the data collected in this study. The tenability of the hypotheses of this study was thus tested. A summary table for the first four hypotheses is on the preceding page.

In testing hypothesis one, a comparison involving track and field events for all subjects, no significant difference was found between the two treatments. This was the stated hypothesis based upon previous research and theory by medical doctors and physiologists. Two other comparisons were made. These were based on a track man's usual desires to have his special event and to have the preparation he makes for the first event he is to perform each meet day to be given special attention. Neither of these two comparisons was significant. A discussion of the t ratio which resulted when the first-same events were compared gave an indication that the endurance runners were reacting favorably to the liquid meal.

In testing hypothesis two, based upon x-rays of the stomach, a stated hypothesis that the liquid meal would empty from the stomach faster was not supported. The normal meal left the stomach significantly quicker than did the

liquid meal. The analysis of data lead to a possibility that the subjects had difficulty accepting the liquid meal. An hour earlier eating time for subjects eating the normal meal provided one extra hour for digestion under that treatment.

Hypothesis three concerned endurance runners. In testing hypothesis three, no significant difference was found between the two treatments for either all performance scores or for first performance scores considered separately. A significant difference in favor of the liquid meal resulted when a comparison was made of the two treatments by testing only the first performance of the meets, and the same length of race. A discussion was presented involving motivational and physiological explanations.

Hypothesis four concerned sprint and field event participants. In testing hypothesis four, no significant difference was found between any of the sprint groups. The relationship of this finding with previous research was discussed.

Hypothesis five was tested from the responses made by the subjects on a self-rating scale. The two treatments were compared for any difference in concern for psychological and psycho-physiological factors which could affect performance. There was no difference between the treatments for the scale as a whole. Two of the t tests were significant. The subjects responded that they felt stronger after their first competition when they had eaten the normal meal.

They responded that they had more desire to compete when they had eaten a liquid meal.

The chapter concluded with a brief presentation of the supplementary aspects of the study.

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CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was concerned with the performance of track men in selected track and field events when two different pre-competition meals were used. The primary dimension of the problem was to determine the effectiveness of a liquid pre-competition meal and the effectiveness of a normal pre-competition meal by comparing the results of the two treatments. A secondary dimension was to determine the concern for certain psychological and psycho-physiological factors under each of the two treatments.

The study was limited to the 1966 varsity indoor track and field squad of Slippery Rock State College, consisting of twenty-eight men. This study began in January, 1966, and ended in March, 1966. Seven regularly scheduled home indoor track meets served as trials for the collection of data pertinent to this investigation.

There were two instruments developed for use in this study. The first was the development of universal scoring tables based on existing world indoor track and field records. These tables were used to convert the performance scores into standard scores so that performances in one event could be

compared to performances in other events. The second instrument was a self-rating scale. A panel of six jurists selected fifteen items from a list submitted to them. All of the fifteen items were rated by each of the subjects after his first competition at every meet.

Five major hypotheses were tested to evaluate the experiment. The level of significance for rejecting a null hypothesis was the .05 level. The level of significance for acceptance of a research hypothesis was .05. Fisher's *t* test for correlated data was used to analyze the obtained data for the four hypotheses involving performances in selected events and for the x-rays. Hotelling's T^2 procedure was used to investigate the relationship of the fifteen variables under each of the two treatments.

In testing hypothesis one, it was found that no significant difference existed between the two treatments in the competitive performance scores in selected track and field events. There was no significant difference when comparison was made for all performances, for the first performance of each meet by a subject, or for the first-same-event performances. The stated null hypothesis was thus accepted.

In testing hypothesis two, it was discovered that there was a significantly better emptying of the food from the stomach when the subjects had eaten a normal pre-competition meal as contrasted to when they had eaten a liquid meal. As a result of testing hypothesis two, the hypothesis was not

accepted that the emptying time for food from the stomach would be significantly better after eating the liquid meal.

In testing hypothesis three, it was found that no significant difference existed between the two treatments in the competitive performance scores achieved in endurance events. The null hypothesis was supported. There was no significant difference between the two treatments in endurance events when comparing all such performances or the first such performances of the meets by the subject. There was a significant difference favoring the liquid pre-competition meal when comparison was made of the first-same-endurance-event performances.

In testing hypothesis four, it was discovered that no significant difference existed between the two treatments in the competitive performance scores achieved in the sprint events, the hurdle events, and the field events. There was no significant difference when comparing all such performances, the first such performances of the meets when the performances were the first event for the subjects in the meets, or the first-same performances in the meets. The stated null hypothesis was thus accepted.

In testing hypothesis five, it was found that no significant difference existed between the two treatments in certain psychological and psycho-physiological factors. The null hypothesis was upheld. An examination of the *t* tests between the two treatments for each of the items indicated

that when the subjects had eaten a liquid meal they significantly indicated desire to perform as contrasted to their responses after eating a normal meal. The subjects also responded that they felt stronger after their first competition when they had eaten a normal pre-competition meal as contrasted to their responses after eating a liquid meal.

Conclusions

Based on the data presented in this study and within the limitations of this study, the following was concluded.

1. Competitive performances in track and field events are not adversely affected by the ingestion of a liquid pre-competition meal as contrasted to performances achieved after eating a normal pre-competition meal.

2. One hour before the beginning of their competitive event, track and field events' men will have digested a significantly greater percentage of their normal pre-competition meal eaten four hours before their first competition as contrasted to the digestion of a liquid pre-competition meal eaten three hours before the first competition.

3. The eating of a liquid pre-competition meal ingested three hours before competition and one hour later than the ingestion of a normal pre-competition meal will result in better track performance by track men in events from the 440 yard run through the two mile run when comparison is made between the same events run by the subjects in their first competitions in meets.

4. The ingestion of a liquid pre-competition meal results in no significantly greater concern for certain psychological and psycho-physiological factors than does the eating of a normal pre-competition meal. Specifically, the eating of a liquid meal results in no significantly greater concern than does the eating of the normal meal for the following factors: feeling of emptiness, desire to drink water, desire for urination, amount of perspiration, effect due to participation in an experiment, concern about winning event, palpability of food, effect of change of diet from meet to meet, desire to eat after competition, enjoyment of pre-meet meal, recommendation for the meet meal, nausea, and energy before meet.

Implications

With one exception the results of the comparisons of performance scores achieved under the two treatments and reported in this study are not statistically significant. A study of the replies made by the subjects to items on a rating scale indicates no significantly greater concern by the subjects when competing after a liquid meal as when competing after a normal meal. Nevertheless, educational implications emerge from an examination of the data and conclusions of this study. These implications are as follows.

1. In individual athletic competitions engaged in by various members such as in track and field, swimming,

wrestling, or gymnastics, the differences in the hour for competition for the athletes pose a problem for the coaches. The usual pre-meet group meal must be eaten early enough to accommodate the athletes who are to compete at the beginning of the contest. The liquid meal has the advantages that is easily served at any hour with a minimum of expense. As indicated by the present study in which the athletes were under pre-meet stress conditions and as indicated by other research, nausea is not more common when the liquid meal is eaten than it is when the normal meal is eaten. There is a possibility that the liquid meal has applicability for use in stress situations in other sports similar to track and field in their accent on individual competitions.

2. An advantage was achieved under the conditions of this study for one endurance grouping. Research studies give indication that a slight increase in muscular efficiency results when carbohydrates are used as the prime food. Research also reports that since carbohydrates are the prime energy source for muscular work, the eating of a carbohydrate-rich pre-meet meal could result in better performances in endurance events than a meal not highly carbohydrate. In the present study the liquid meal was eaten one hour later than the normal meal. There is a possibility that during endurance events the liquid meal will provide more energy food for use during a race than the normal meal provides. The implication can be made of this to other athletic

competitions similar to track in type of muscular exertions. The best example of a similar athletic competition would be swimming.

3. The sprint group approached significance favoring the normal pre-competition meal. The endurance group reached significance in one instance favoring the liquid meal. The opposite reactions as reflected by competitive performance scores indicates that it may be advisable to treat the sprint group differently from the endurance group in regard to the type of the pre-meet meal.

4. The belief of physiologists is that digestion is retarded due to the influence of nervous tension associated with thoughts of competition. This belief is based partly upon the ability of higher nerve centers to influence the involuntary muscles and glands of the digestive organs. In the present study regular digestion occurred with subjects who had eaten the normal meal and who had been exposed to the effects of the pre-competition hours. The possibility exists that changes do not occur in digestive processes during the period just prior to competition if the food last ingested was a normal meal.

Recommendations

As a result of this study, recommendations for further research are as follows.

1. Present belief about emptying time of the stomach and digestive action when a subject is under emotional stress is based upon an inadequate amount of research collected under competitive conditions. This present study suggested that one hour before competition an athlete had digested a greater percentage of food after eating a normal meal as he had digested after eating a liquid meal. It is recommended that a study be conducted of large samples of athletes from various sports who could be x-rayed one hour before their first competition and could be x-rayed just a few minutes before their first competition.

2. Researchers report greater muscular efficiency in strenuous activities when subjects are on a carbohydrate-rich diet. A large sample of endurance runners should be put on a carbohydrate-rich diet and tested under both laboratory and competitive conditions.

3. This present study indicated opposing effects of the liquid meal upon performances of sprint groups contrasted to endurance groups. There is a possibility that the type of activity to be engaged in helps determine the acceptance of a liquid meal. A study should be conducted between sprinters in competitive conditions who freely choose a liquid meal and sprinters who are required to eat a liquid meal as a substitute for the normal meal. A second study would investigate endurance runners under the same situations.

4. The present study investigated some of the variables

associated with competitive athletics. Since knowledge of the possible effect of certain variables on competitive performance would be helpful to coaches, it is recommended that a scale be developed to obtain a measure of the various psychological factors operating on the day of competition.

5. So that some control could be had over effects of the treatment itself, a study of the effects of a liquid meal should be conducted in which a placebo containing but a few calories of nutrients, about two hundred, is used.

6. In view of its applicability to stress situations as found by athletes in competitive track and field events, it is recommended that a study be conducted investigating the liquid meal for use in other, non-athletic, situations.

7. Studies similar to the present research investigation should be conducted in other athletic areas such as swimming in which measurement of performance is also valid.

APPENDIX A

A LIQUID-OATMEAL COOKIES

SUBSTITUTE MEAL

Item	Discussion
Calories (650)	Approximately 430 calories in the liquid part, 220 calories in the four cookies.
Protein (23 grams)	20.3 in liquid and 2.7 in cookies.
Fat (24 grams)	15.0 in liquid, 9.0 in cookies.
Carbohydrate (85 grams)	55.0 in liquid, 30.0 in cookies.

APPENDIX B

A NORMAL PRE-COMPETITION MEAL

Food	Grams Per Serving	Proteins	Carbohydrates	Fats	Caloric Value
Meat	180	42.0	----	30.0	450
Vegetables	100	2.0	7.0	----	50
Salad	110	----	10.0	10.0	130
Baked Potato, Butter	110	15.0	17.0	10.0	160
Peaches, syrup	100	10.4	2.2	50.0	230
Toast, two slices	50	30.0	32.0	----	140
Orange juice	100	----	10.0	----	40

APPENDIX C

EMPTYING TIMES OF STOMACH

Subject	Liquid Meal-650 Calories	Normal Meal-1200 Calories
1	35	50
2	0	70
3	30	75
4	40	90
5	30	60
6	50	50
7	20	40
8	50	90
9	40	90
10	35	50
11	80	90
12	60	100
13	30	50
14	60	45
15	65	50
16	50	60
17	100	90
18	60	90
19	50	90

APPENDIX D

SAMPLES OF UNIVERSAL SCORING TABLES

High Jump

Height	Points
7' 5"	923.71
7' 3"	876.62
7' 1"	830.85
6' 11"	786.40
6' 9"	743.25
6' 7"	701.41
6' 5"	660.86
6' 3"	621.60
6' 1"	583.61
5' 11"	546.89
5 9"	511.44
5 7"	477.23
5 5"	444.27
5 3"	412.54
5 1"	382.04
4 11"	352.75

65 Yard High Hurdles

Time	Points
7.1	966.5
7.2	932.4
7.3	900.0
7.4	869.0
7.5	839.5
7.6	811.4
7.7	784.5
7.8	758.8
7.9	734.2
8.0	710.7
8.1	688.2
8.2	666.6
8.3	646.0
8.4	626.2
8.5	607.2
8.6	589.0
8.7	571.5
8.8	554.7
8.9	538.6
9.0	523.0
9.1	508.1
9.2	493.7
9.3	479.9
9.4	464.1
9.5	449.3
9.6	434.6
9.7	420.9
9.8	405.0
9.9	390.4

APPENDIX E

EXAMPLE OF RADIOLOGIST'S REPORT

GROVE CITY HOSPITAL
GROVE CITY, PENNSYLVANIA

Department of Radiology
T.Frederick Weiland, M.D.

SLIPPERY ROCK ATHLETIC STUDY 3-14-66 X-Ray No. R0509-4 Mr. Gates

ARMSTRONG, Mr. Chuck--Dine-a-Pak (D.A.P.) at 11 A.M. Barium at 11:05 A.M. X-ray at 12:50 P.M. About 65% of the barium remains in the stomach. The rest is scattered through the small bowel, but none has reached the colon.

BOLLER, Mr. Ronald--D.A.P. at 11 A.M. Barium at 11:10 A.M. X-ray at 1:14 P.M. Practically all of the barium is retained in the stomach. Some pylorospasm appears to be present. A small amount of barium is scattered through the small bowel, but none has reached the colon.

FAUPEL, Mr. John--D.A.P. at 11:15 A.M. Barium at 11:25 A.M. X-ray at 1:15 P.M. About 80% of the barium is retained in the stomach. There appears to be some pylorospasm, for there is no barium in the duodenum or upper small bowel. The rest of the barium is found in the distal small bowel, and a very small amount has entered the colon.

KLEIN, Mr. James--Normal meal at 11:05 A.M. Barium at 11:30. X-ray at 2 P.M. There are only traces of barium and food left in the stomach. Less than 10% of the barium is found in the stomach. The rest is scattered through the small bowel and the colon all the way down to the rectum.

WILSON, Mr. Gerry--Normal meal at 11:31 A.M. Barium at 12:02 P.M. X-ray at 2:21 P.M. Practically all of the barium has left the stomach. Less than 10% of the barium is retained in the stomach with a small amount of food. Most of the barium is in the distal small bowel and the colon. The head of the barium column has progressed to the sigmoid colon.

APPENDIX F

THE SELF-RATING SCALE

Instructions: To the left of each of the following items you will note a box with 1,2,3,4,5 typed inside the box.* Read the item carefully. Use the following scale to guide you in your selection of one of these numbers. Answer all items as you recall your feelings preparatory to competition with the exception of those questions which ask for post-competition feelings.

1. If you can answer "exceedingly so," cimle the one.
2. If you can answer "considerably so," circle the two.
3. If you can answer "somewhat so", circle the three.
4. If you can answer "only a little," circle the four.
5. If you can answer "not at all," circle the five.

*Only one example of the box is shown here, although all questions had them.

1,2,3,4,5	1. Did you experience a feeling of emptiness?
	2. Did you experience a desire to drink water?
	3. Has there been a greater urinary output under this treatment than under the other?
	4. Did you perspire more freely than usual?
	5. Did you have much desire to perform well?
	6. Are you affected because you know you are part of an experiment?
	7. Did you feel strong after the event in which you participated?
	8. Were you concerned about winning your event?
	9. Were you bothered by the tastiness of the food you had before competition?
	10. Does the change in diet from meet to meet affect your frame of mind for a meet?
	11. Is your desire to eat after competition greater under this treatment condition than under the other treatment condition?
	12. Did you enjoy your pre-meet meal?
	13. Would you recommend the meal you had today as a pre-meet meal for others?
	14. Were you affected more by nausea after this meal in comparison with the other?
	15. Did you feel that you had more energy before this meet than before the last meet?

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