The Effect of Marked and Sudden Weight Loss on Physiologic Response

By W. W. Tuttle
Department of Physiology, University of Iowa

ONE of the best indices of the reaction of an athlete to his training and competition is his bodyweight. There are certain weight changes which are to be expected during the season of training, and as a result of competition. Until the athlete becomes adjusted as to condition, diet, sleep and rest, there is apt to be a loss of weight resulting from the training program. In some cases, the stimulation of the appetite by strenuous exercise is so great that the athlete eats more food than is necessary to meet the work requirement. The result is a gain in weight. Sudden losses of body weight are common as a result of strenuous bouts of competition, especially where there is a great deal of sweating. All of these weight changes are normal, and to be expected.

The problem which we wish to discuss here has to do with the weight loss caused by measures such as those sometimes used by wrestlers in making a lower weight division. The practice of reducing the body weight by abstaining from water and food, and by profuse sweating, has raised the question as to the effects produced on the athlete's performance and health. Most people have the impression that the procedures used in such a weight-loss program are detrimental to efficiency and endurance.

In order to aid in clarifying the issues involved in voluntary weight loss, laboratory experiments have been carried out in which normal physiologic responses were compared with those secured under the same conditions soon after the weight loss.[1]

The experiment consisted of the measurement of six athletes with respect to eighteen types of response before and after weight loss. Since the responses measured are subject to considerable normal variations from time to time, five determinations of each response were made at weekly intervals. The responses selected were those which are generally agreed to be important in sports which require speed, accuracy, strength and endurance. As soon as the data were secured over the five-week period, the athletes, all wrestlers, voluntarily lost weight by methods considered orthodox by wrestling coaches. The objective was to have each athlete lose 5 per cent of his body weight, but the final result was a loss which varied from 3.6 to 4.9 per cent (6 to 10 pounds). Soon after the weight was lost, each athlete returned to the laboratory where the eighteen physiologic tests were repeated. The accompanying table shows the responses measured and the results obtained for one subject. Further data are omitted since a sample is sufficient to explain the basis upon which conclusions were drawn. It will be noted that the responses before weight loss are recorded as the range over a five-week period, but after weight loss as a single determination.

With few exceptions, the results obtained after weight loss fall within the range obtained before weight loss. Where this condition exists the conclusion is that the weight loss did not affect the physiologic responses studied. But there were some instances where the scores measured after weight loss fell outside the normal range. Where this occurred, the significance of the difference between the value obtained after weight loss and the highest or lowest number in the range, as the case might be, was considered in drawing conclusions. An example of such a situation is seen in Table 1 in the case of breath holding in inspiration; the time after weight loss is five seconds longer than the longest time recorded before weight loss.

The results of the experiments will be discussed under the following headings:

1. The neuro-muscular system
2. The cardio-vascular system
3. The respiratory system
4. The oxygen requirements

The Neuro-Muscular System. The strength index in every case after weight loss fell within the range of values secured before the weight was lost. The conclusion is that weight loss, to the extent investigated here, did not affect strength. In the case of accuracy of movement, every case after weight loss, except one, fell within the normal range, and the exception was not significantly different than the normal. Thus it can be concluded that weight loss does not alter accuracy of movement. In the steadiness of movement experiment, one case was better and one poorer than normal. The conclusion is that the weight loss is not detrimental to steadiness of movement. The results relative to reaction time are somewhat inconsistent. In two cases, the time was longer, and in one case it was shorter after the weight loss, while four cases fell within the normal range. In general, we are willing to state that reaction time does not suffer materially on account of weight loss.

The Cardio-Vascular System. Weight loss had no significant effect on either systolic or diastolic blood pressure. The resting heart rate is slightly higher after weight loss. This is explained as an emotional reaction to thirst and can be avoided by drinking a small amount of water. In the case of the heart rate after a standard stool-stepping exercise, there was no significant effect due to the weight loss.

Table 1

The range of various physiologic responses over a period of five weeks, as compared to the responses after voluntary weight loss

Test item	Range before	Score after	Test item	Range before	Score after
Strength index	1721 2351	2268	Breath holding in expiration (sec.)	16 23	23
Accuracy of movement	10 12	10	Breath holding in inspiration (sec.)	52 57	62
Steadiness of movement	4 6	5	Vital capacity (cc.)	4120 4250	3620
Reaction time (sec.)	.023 .274	.266	Tidal air (cc.)	434 520	405
Systolic blood pressure	114 138	118	Respiratory rate per min.	11 16	14
Diastolic blood pressure	70 78	78	Resting O_2 (cc./min.)	251 323	270
Resting heart rate	56 66	72	Recovery O_2 (cc.)	1940 2095	2021
Heart rate after exercise	100 110	110	O_2 debt (cc.)	777 968	863
Recovery time (sec.)	90 90	90	O_2 recovery time (min.)	3 5	3

[1] See Research Quarterly, A.P.E.A., 14:158-166 (May 1943) for a detailed report of these experiments.

The data relative to recovery time of the heart after the standard stool-stepping exercise show that with one exception recovery time was not significantly affected. The exceptional case is of interest because the recovery time after exercise was almost three times as long after weight loss as it was before. This reaction is of special interest because in the case of the other experiments which this subject performed, he did not differ significantly from the normal.

Electrocardiograms were made for each subject both before and after weight loss. It is of interest to note that one athlete showed premature beats before weight loss, but none afterwards. We offer no explanation for this. In the other five cases, there were no significant changes in the electrocardiograms.

The Respiratory System. The loss of weight did not affect the length of time that the breath could be held, either in inspiration or expiration. However, the data show that the vital capacity was reduced after weight loss. The tidal air data did not justify any definite conclusions since in two instances it was less, in two cases it was greater, and in the two it was unchanged. There was no significant change in respiratory rate after weight loss.

Oxygen Requirements. The resting oxygen, oxygen debt, and recovery oxygen requirements were determined. In all the experiments having to do with oxygen requirements, the weight loss caused no significant change.

Summary

In order to throw further light on the question of the effects of marked and sudden weight loss on physiologic reactions, a series of laboratory experiments, involving six athletes, was carried out. Considered as a whole, the results justify the conclusion that, except for a reduction in vital capacity, weight loss up to 5 per cent of the body weight does not cause the physiologic responses of the athlete to be affected adversely.

The Air Force Combat Trainer

By George Brent Fielding
Director of Medical Instruction,
354 Army Air Force College Training Detachment,
Eastern Oregon College of Education

THE army air forces have undertaken a tremendous job. They are in the process of training thousands of athletic trainers. Actually the medical instruction received at the various college training detachments is a great deal like the preliminary training an athletic trainer receives.

The duties of these men as pilots, bombardiers and navigators are dangerous undertakings and call for initiative, courage and intelligence. During combat missions, accidents will happen; men will get injured, and, consequently, the men must have a background of medical instruction to be able to meet any emergency that may arise.

In addition to this they are called upon to treat themselves and others for simple emergencies such as blisters, boils, rashes, athletes foot, sprains and disorders of a similar nature.

Teaching the techniques of how to become a proficient first-aider is a somewhat difficult problem, due to the fact that the men lack an adequate background for this type of work.

The men are enrolled in the course in groups of thirty-two men. This group is called a flying group or flight and represents a unit comparable to an ordinary college class. The flight attends classes for sixty minutes a day every day except Sunday. The course lasts from two and one-half to three months. It is divided up into three specific phases in the following manner; (1) the anatomy and physiology of the human body, (2) a study of specific injuries, and (3) laboratory work.

Since the average student has very little background in anatomy, it is necessary to spend a great deal of time on the basic anatomy of the human body. This is taught by means of lectures, films, charts and diagrams. Only the most important phases of the anatomy of the body are covered.

Specific injuries, covered by means similar to that of the anatomy of the body are; (1) wounds, all types; (2) burns; (3) muscular injuries, strains, sprains, dislocations and bruises; (4) shock; (5) bone injuries, fractures, and bone bruises; (6) poisons, including war gases; (7) artificial respiration; (8) minor injuries and infections, athletes foot, gym itch, boils, and blisters.

A complete study is made of these injuries, the causes, the symptoms, the specific structures involved in the injury and the treatment. Two types of treatments are given: One that could be given under ordinary circumstances, and the type of treatment that could be given under combat conditions.

The laboratory aspect is of great importance and is carried on as intensively as time and facilities permit. Each college training detachment has a complete infirmary with a competent staff which is a definite aid to the laboratory phase of the course.

The student may observe the specific injuries that are frequently treated in the infirmary. Advice and suggestions are made by the flight surgeon and registered nurses. The equipment of the infirmary is available to the student; such as heat lamps, medicinal aids, sterilizers and minor surgical instruments.

A good portion of the course is devoted to practical application of dressings and bandages. Emphasis is placed on the ability of the student to apply correctly, not only the triangular bandage, but also the roller bandages, to various types of injuries.

Practical applications of splinting are practiced. Means of devising splints are discussed and practiced, particularly traction splinting.

Working closely with the athletic department of the college training detachment, the student is able to observe and treat injuries that occur in the program such as sprains, muscle bruises, athletes foot, gym itch and other minor disorders. A considerable amount of time is devoted to the demonstration and practice of taping techniques. The student is given the opportunity to practice the application of tapings to wrists, ankles, shoulders, knees and other injuries, requiring the use of tape in their treatment. Along with taping techniques, some time is devoted to the construction of braces, pads, protective wraps and slings for certain injuries.

Other considerations included in the laboratory phase of the program are the use of counter irritants and the elastic bandage, and the use of canvas wraps as protective coverings.

The student is familiarized with the contents of a well-constructed first aid kit. The advantages and disadvantages are made of each kit and made clear to him, so that he may choose which kit will best fill his needs under combat conditions.

Periodic examinations are given, both orally and written, as well as practical problem demonstrations to test the ability of the student under as nearly as possible combat conditions.

Many instances reported from the combat zones have proven the value of this course. I feel that the army air forces are making an immeasurable contribution to the American athletic trainers of the high schools and colleges in bringing the importance of this work, and the highly specialized skills involved therein, to the attention of the public.