PHLEBOTOMY AND ITS EFFECT ON THE WORK OUTPUT OF ATHLETES

by

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Diploma of P.E. Sydney Teachers' College, 1955.
B.P.E. University of British Columbia, 1959.

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF PHYSICAL EDUCATION

in the School
of
PHYSICAL EDUCATION AND RECREATION

We accept this thesis as conforming to the
required standard

THE UNIVERSITY OF BRITISH COLUMBIA

July, 1960.

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Date September 7, 1960

ABSTRACT

The purpose of this study was to determine the effect of blood donation upon the work output of University athletes. Further, to determine whether the effect is physiological or psychological, suitable controls were exercised over the subjects. A suitable test item representing a specific measure of work output was predetermined for the study.

Twenty members of various University of British Columbia athletic teams were selected and equated into two groups of ten using their performance on the test item as a basis for division. The test item consisted of making as many pedal revolutions as possible over a two minute period on a standard bicycle ergometer set at a resistance of 14 kilograms.

Both groups were taken to the Blood Donation Clinic where the control group had 500 cc of blood removed. The experimental group underwent an identical procedure but no blood was drawn. Careful controls at the clinic ensured that neither group was aware of what occurred. Later questioning indicated that both groups believed all subjects had given blood.

All subjects were retested under standard conditions two hours, twenty-four hours and seven days after blood

donation. Results were subjected to standard statistical analysis.

The control group showed a significant gain in performance in the test item in all subsequent tests. The experimental group also showed a significant gain in performance in the test item in all subsequent tests. At no stage was any significant difference found to exist between the two groups.

It was concluded that under the conditions of the study, blood donation does not deleteriously affect the performance of athletes in an item involving a short period of muscular work. In fact, the mean performance was significantly improved. No psychological effect was found in the group which believed that it had donated blood.

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CHAPTER I

STATEMENT OF THE PROBLEM

Within the field of physical education and athletics in general, there has been much conjecture as to whether the giving of blood by an athlete will in any way affect his performance in activity involving muscular work. Karpovich (1) reported that athletes assert that blood donation will not seriously affect them, while coaches are definitely against the practice. Jones, Widing and Nelson (2) reported one institution in which a student was permitted to give blood only once a semester because one student became seriously ill following blood donation.

In all, very few studies have been conducted to determine the effects of donation. Most were concerned with items other than muscular work and found no ill effects of donation with normal healthy subjects provided a short resting period was allowed after the venesection.

However, in none of these reported studies was any psychological control exercised over the subjects. In each case the athletes were aware of giving blood and that their subsequent performance was being measured. On no occasion was an experimental group set up which involved athletes who thought that they had given blood but in fact had not done so.

This study will investigate whether performance is significantly affected by blood donation. If so, is the group who actually gave blood more or less affected than the group who believed they had done so? These figures will give some indication as to whether the effect on performance is actually physiological or a result of the belief that blood had actually been removed.

Performance in this study will be measured in terms of work output in a predetermined time period. Work output will be calculated by the performance of the subject on a standard bicycle ergometer.

In view of the varied opinions held by athletes as to whether blood donation will or will not prejudice their performance at their chosen sport, it seems appropriate that some investigation of the effect of this practice be made. Moreover, to isolate the all important physiological effect of the donation, the psychological aspects of the preconceived belief in what will occur must be suitably controlled.

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CHAPTER II

REVIEW OF THE LITERATURE

A study conducted by Karpovich and Millman (1) gave some indication of the effect of blood loss by athletes. They report that a bicycle rider, who had been practising on a bicycle ergometer, dropped considerably in riding performance after admitting to a loss of 500 cc of blood. Three weeks elapsed before his performance level was regained. A repetition of the experiment showed similar results.

A further investigation (1) by the same experimenters upon four subjects involved in bicycle riding showed that three of the four decreased in performance on the day of transfusion and on the following day. However, the two subjects who were involved in a "sprint" type of activity quickly regained their performance level. The "sprint" type of activity involved riding all out for one minute once a day. Those engaged in endurance work suffered a ten to eighteen day reduction in performance after transfusion.

This fact is further supported by Karpovich and Millman (1) who reveal similar results from blood donation by a long distance swimmer, a cross country runner, a sprinter and a sprint swimmer. The first two suffered considerably from the donation while the latter pair equalled their best performance a few hours later.

Reference is made to motivational factors by the investigators when they reveal that the bicycle rider previously mentioned actually increased his performance the day after donation before admitting to the loss of blood. It was felt that this subject, anxious to prevent the effect of his blood loss from being known, tried harder than usual to produce a good performance.

Karpovich and Millman (1) sum up the study by saying (1,p.168):

> Performance on the day of loss of blood, and the following day, was usually lowered, but occasionally slightly increased. This increase was probably due to the summation of the concomitant exciting factors. In our study the slight increase in two cases was probably due to a frantic effort to prove that loss of blood did not affect the subjects seriously.

Balke, Grillo, Konecci and Luft (2), investigating work capacity after blood donation, found slightly different results. These investigators used fourteen subjects. They were divided into two groups of seven subjects each and their performance was measured on a treadmill. A mean performance was established by testing each group on two separate occasions. Five hundred cc of blood was then removed from each subject and the first group was retested, under the same conditions, one hour, two days and ten days after transfusion. Similarly, the second group was retested one hour, three days and eight days after transfusion. In both groups a similar pattern was found. An initial fall in performance was followed

by a rapid recovery in two to three days and an improved performance in eight to ten days. The results are shown in Table I.

TABLE I

Effect of Blood Donation on Work Output[1]

Subjects	Controls	Blood 1	Blood 2		Blood 3	
		1 hr.	2 days	3 days	8 days	10 days
Group A = 7	970	903	940			1058
Group B = 7	1096	1002		1119	1200	
Av. Diff.		-93.7	-27	-8	+89.3	+76.5
S.D. of Diff.		68.78	93.95	58.8	74.4	57.9
P value		.01	.5	.5	.029	.013

Calculation in meter kilograms/minute

These investigators summarised their findings by saying that (2,p.236):

> Loss of blood in amounts customary in blood donation imposes significant limitations on physiological adjustment to severe exercise within the first few hours after venesection. But there is a rapid recovery of initial work capacity in two to three days and a marked improvement in performance after an interval of a week.

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1 Balke, B., Grillo, G.P., Konecci, E.B., and Luft, V.C., "Work Capacity After Blood Donation", Journal of Applied Physiology, 7, 1954, p.233.

Similar results were obtained by Spealman, Bixby, Wiley and Newton (3). These investigators studied the influence of hemorrhage by subjects on their performance in the heat. Using four subjects as a basis of investigation, the investigators concluded that removal of 500 cc of blood resulted in an immediate and marked decrease in ability to carry out physical activities. These activities consisted of active and passive standing and exertion on a bicycle ergometer in a high temperature. Several days elapsed before the control level of performance was regained again. Moreover, performance was affected but to a lesser degree following removal of 200 cc of blood. Infusion of serum albumin in quantities equivalent to 500 cc of blood plasma improved performance.

Hoffman, Litwins and Sussman (4) investigated electrocardiographic changes as a result of bloodletting. It was stated, in summary, that (4,p.1052):

> Our findings indicate that a complete return of the electrocardiogram to normal can be anticipated in a normal healthy donor, even if exercise is performed immediately after the phlebotomy, providing the person is given a rest period of at least several minutes following the blood letting. This point is of importance in that it is the custom of the average healthy donor to return immediately to work with all its attendant exercise, after giving blood. The practice of arising from the bleeding table immediately after the blood donation should be discouraged and a ten minute rest period rule be required.

It was further found that the heart rate, however, was significantly greater immediately after the post-phlebotomy exercise test.

Jones, Widing and Nelson (5) indicated vital capacity varied before and after blood donation. Sometimes total expired volume increased, other times it decreased. The greatest increase was found to be 250 cc but it was considered doubtful whether the increased vital capacity was significantly so or due to greater skill of operation of the measuring instrument.

Studies carried out by Martin and Myers (6), and further supported by Litwins, Sussman and Feltenstein (7), indicate that 500 cc of blood is a safe and convenient amount of blood to remove at any one time for transfusion purposes.

However, an experiment conducted by Ebert, Stead and Gibson (8) gave some indication as to the effects of acute blood loss (760 to 1220 ccs). These investigators found inter alia, that (8,p.580):

> The plasma volume began to increase immediately after hemorrhage and continued to increase for the next forty-eight to seventy-two hours. At the end of seventy-two hours it was approximately equal to the plasma volume before hemorrhage plus the volume of red cells removed.
>
> Furthermore, after hemorrhage the blood volume was not restored to normal until new plasma protein had been added to the circulation.

There appears to be no doubt from the evidence collected, that work output is affected by blood donation. Just how much effect takes place and for how long it lasts is not clear. Moreover, there is no indication of whether the effect was actually a result of the physical loss of blood or a belief, suggested by a feeling of weakness or nausea, or merely preconceived opinion, that work performance would be affected.

Related Studies

Studies concerned with work output as measured by performance on a bicycle ergometer reveal many and varied ways of using the ergometer.

Basically, Karpovich states (9,p.212):

> The general formula for work is F x D where F is force used and D, the distance covered. In the case of the bicycle, the force obviously is equal to the resistance to be overcome.

Karpovich (9) suggests that work done in a given time may be calculated in foot pounds by utilizing the resistance, the number of wheel revolutions and the circumference of the wheel. He further indicates a method whereby a specified amount of work may be done by adjusting the load and keeping the pedal revolutions constant.

Karpovich and Hale (10), while investigating the effect of tobacco smoking on physical performance, had

their subjects perform a prescribed amount of work on the ergometer. The amount of work selected was comparable to a one mile run on the track in the shortest possible time. It consisted in making a total of 425 pedal revolutions against a load of eight pounds. This resulted in a total distance covered of 6,116 feet and 48,928 foot pounds of work performed. The time range for subjects for the completion of the work was 3 minutes 45.7 seconds to 5 minutes 7.8 seconds.

In another study, Karpovich and Pestrecov (11) asked subjects to work at a rate of 0.506 horsepower at 117 pedal revolutions per minute. The maximum time achieved was 7 minutes 30 seconds.

Cogswell, Henderson and Berryman (12), in a similar type of study, measured maximum performance using a load such that each ride lasted approximately sixty seconds. It was found that a ten minute rest period between rides was sufficient to allow for recovery.

Walters (13) exercised her subjects for one minute at maximum work capacity. In this study the object was the determination of maximum work output. A field current of three amperes and a pedal revolution speed of sixty revolutions per minute on the bicycle ergometer required a work rate of 0.33 horsepower. Work was then converted into kilogram metres per minute directly from a conversion table. These investigators also found that a

single practice session three days before testing was sufficient.

Ulrich and Burke (14) measured work on a bicycle ergometer in terms of calories per hour. The work done was equal to 61.67 foot pounds per wheel revolution regardless of the speed of peddling. These investigators measured the amount of work done in one minute by utilizing the number of wheel revolutions.

Tuttle (15) investigated the effect of physical training on capacity to do work as measured by the bicycle ergometer. The subjects worked at a rate of 33 horsepower for either one or two minutes at a wheel rate of sixty revolutions per minute. As a result of this study, Tuttle felt the following conclusions justified (16,p.396):

> (1) The work which an individual performs in one minute of maximum effort is as good a criterion of work capacity as the amount accomplished in two minutes. In addition, by working only one minute, severe exhaustive reactions are avoided.
>
> (2) Maximum work rate is attained in approximately 15 seconds but it is maintained for only a few seconds after which there is a gradual decline in maximum work output. In physically well trained subjects this decline continues, on the average, 75 seconds after which a plateau or fatigue level of work is reached and maintained for the remainder of the two minute work period.

Finally, Nelson (16), Scott, Moody and Wilson (17), and Scott and Wilson (18) used the ergometer in different ways but gained highly satisfactory results.

In one of these studies (17) the criterion of capacity to do work was estimated by requiring each subject to ride the machine for two minutes at maximum speed. Resistance was set at three amperes. Work capacity was then computed in kilogram metres for two minutes.

In 1948, Scott and Wilson (18) studied physical efficiency tests for college women. In reference to the use of the ergometer they stated (18,p.131):

> The ergometer gives reliable and objective scores on the work done, and therefore, indirectly on the capacity of the subject to work hard for a brief period of time. The generated voltage is translated directly into kilogram metres of work and this is not possible in other types of work estimates. The ergometer also yields a relatively quick measure of work.

Nelson (16) studied the effects of alcohol on performance in selected gross motor tests....This investigator considered performance on a bicycle ergometer as an endurance item. The subjects were asked to perform for 45 seconds against a ten pound resistance and found that the mean performance for various groups ranged between 220 and 230 revolutions.

Nelson speaks highly of the reliability of the bicycle ergometer used in this way when he states (16,p.320):

> The timing device used in the speed and reaction test and the bicycle ergometer seemed to be the most precise measuring instruments, as evidenced by the small coefficient of variation.

The foregoing reported studies will be considered as a basis for defining the method of using the bicycle ergometer in the way best suited to the needs of this experiment.

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CHAPTER III

METHODS AND PROCEDURE

Twenty university athletes selected from various athletic teams from the University of British Columbia were the subjects for this study.

All subjects met before any testing took place and the purpose of the study was outlined. The instructions given were as follows:

> You will be tested on a bicycle ergometer, the object being to see how many pedal revolutions you can perform in two minutes. You will be given an opportunity to repeat the test one week later. Seven days after the second test you will go down to the Blood Donation Service and have 500 cc of blood removed by the doctor. You will immediately return to the gymnasium and repeat the test. Further tests will be conducted on the following day and again a week later. The object of the study is to determine if the blood donation will affect your performance. It is most important that you continue through with the experiment and that you cooperate to the best of your ability at all times.

The bicycle ergometer used in the study was manufactured by J.A. Preston Corporation and was fitted with a variable resistance and revolution counter.

Henry (1) notes that there is some element of acquired skill in performing efficiently on a bicycle ergometer. To familiarise each subject with the apparatus,

practice sessions were arranged which enabled each subject to perform with reasonable skill and to minimise the learning factor. The end of each practice session was devoted to the subjects' peddling for two minutes with a light resistance so as to become accustomed to the time period which was employed in the experiment.

In determining the procedure for the test item the following points were considered:

1. Work is measured by the product of force times distance travelled on the bicycle ergometer. Force is defined as the resistance against which the subject pedals while distance is the wheel circumference multiplied by the number of revolutions.

$$W = F\ S$$
$$= F \times 2\pi r \times \text{no. of revolutions}$$

2. The resistance will remain a constant as does the circumference of the wheel. Thus work output varies with the number of revolutions.

3. It seems that various psychological factors must be controlled which naturally affect the study when the subject is asked to work to exhaustion. The subject, then, was asked to work for two minutes only. It was felt that the two minute time interval would be large enough to obtain a suitable range of performance with different subjects and short enough to ensure continual effort by the subject and still avoid the effects of mental

fatigue or boredom.

4. The search of the related literature suggested that constant pedal revolutions per minute would be difficult to control whereas maximum revolutions in a given time forces no particular pace upon the subject but would allow him to extend himself as he desired.

5. It was felt that most subjects would "give of their best" for a limited period of two minutes provided they were continually aware how much time had elapsed and how much time remained.

One week after the practice sessions were completed the first test was given. The load was predetermined so as to bring the subjects close to physical exhaustion at the end of the two minute period. The resistance set was 14 kg:1. The instructions given to all subjects were standardised and were as follows:

> I want you to pedal as fast as you can for two minutes. I will call out the time in 15 second intervals. You will make as many pedal revolutions as you can in this time. It is most important that you keep working hard throughout the full two minute period.

After test I the results were analysed and the subjects were paired on performance into Group A and Group B. The method used was that described by Garrett (2,p.228). One week after test 1, test 2 was given under the same conditions. The results of test 2 were correlated against those of test 1 to establish a coefficient of

reliability for the test item. At no stage in the study did subjects know their own score nor the score of any other subject. This eliminated the competitive factor between individuals.

After a week's interval both groups were taken to the Blood Donation Centre. The procedure undergone by the two groups while at the Centre was identical. All subjects were told that they were giving 500 cc of blood and later questioning indicated that all were convinced that they had done so. In actual fact only the control group, designated as Group B, gave blood. The experimental group, designated as Group A, had a needle insertion made in the muscle and no blood was drawn. At all times before, during and after the actual donation period, the treatment administered to both groups was identical. During the venesection the subjects were prevented from seeing the procedure by the placing of a blindfold over their eyes and as an extra precaution, the covering of all pieces of apparatus by tape. The subjects were told that the blindfold was to alleviate any possibility of their performance being affected by the sight of blood.

As close as possible to two hours after venesection each subject reported fro test 3. This test was conducted under the same conditions except for the presence of a doctor in case an emergency arose.

Test 4 was administered twenty-four hours after venesection and test 5 seven days after.

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2 Garrett, H.E., "Statistics in Psychology and Education", Longmans, Green and Co., New York, 1958, p.228.

CHAPTER IV

RESULTS

The data obtained from the experimental group and the control group are summarized in the accompanying tables. The experimental group (A) did not donate blood but believed they had done so. The control group (B) did actually donate blood.

The statistical treatment of the results deals with the effect on performance in the test item in each group on each of the last four tests; the comparison between the performance of the two groups on each of the last three tests; and, in addition, a calculation of the coefficient of correlation existing between the results of each subject on the first two tests in order to establish a coefficient of reliability for the test item.

Reliability of the Test Item: The scores of twenty-two subjects on the bicycle ergometer in Test I were correlated with their scores in Test 2. The calculated coefficient of correlation was 0.98 which showed high reliability for the test item.

Test 3 (Two hours after donating blood): In group A each subject showed improvement in performance over his control score. The range of improvement was from one revolution to 25 revolutions with a mean increase of 10.2

revolutions. In group B, all subjects, except one, exhibited improved performances. This subject gave the same performance as in the control test. The improvement ranged from two revolutions to 28 revolutions with a mean increase of 8.5 revolutions.

The differences in the performance levels of each group two hours after donating blood are summarised in Table II. Both group A and group B showed differences between the control scores and the results on Test 3 which were statistically significant. The mean improvement of group A was 10.2 revolutions with a t-ratio of 3.8. This was significant at the 1 percent level of confidence. Group B showed an increase in mean performance of 8.5 revolutions with a t-ratio of 3.4. This was also significant at the 1 percent level of confidence.

TABLE II

Comparison of Results between Control Score Means and Means on Test 3

	M_2	SD_2	M_3	SD_3	M_3-M_1	t
Group A	254.8	9.97	265.0	13.0	10.2	3.8*
Group B	254.3	10.88	262.8	10.96	8.5	3.4*

* Significant at the 1 percent level of confidence

Test 4 (24 hours after donating blood): In group A each subject, except one, gave improved performances over the results in Test 3. This subject showed a fall

of two revolutions. The improvements ranged from 17 revolutions to one revolution with a mean improvement of 8.2 revolutions.

In group B eight subjects showed improvement over their performance in Test 3. The improvements ranged from 17 revolutions to one revolution. Two subjects showed decreases of ten and six revolutions. The mean improvement was 5.4 revolutions. Table III shows the differences in the performance levels of each group which occurred between two hours and 24 hours after giving blood. Both group A and group B showed mean differences which varied in significance. Group A showed a mean improvement of 8.2 revolutions and a t-ratio of 4.1, significant at the 1 percent level of confidence. Group B showed a mean improvement of 5.4 revolutions and a t-ratio of 1.9 which was not statistically significant.

TABLE III

Comparison of Results between Means of Performance on Test 3 and Test 4

	M_3	SD_3	M_4	SD_4	M_4-M_3	t
Group A	265.0	13.0	273.2	15.5	8.2	4.1*
Group B	262.8	10.96	268.2	9.38	5.4	1.9

* Significant at the 1 percent level of confidence

Table IV shows the difference in performance levels of each group which occurred between the control performance

and the performance 24 hours after giving blood (Test 4). Both group A and group B showed mean differences which were statistically significant. Group A showed a mean improvement of 18.4 revolutions and a t-ratio of 6.4, significant at the 1 percent level of confidence. Group B showed a mean improvement of 13.9 with a t-ratio of 5.7, also significant at the 1 percent level of confidence.

TABLE IV

Comparison of Results between Means of Performances on Control (Test 2) and Test 4

	M_2	SD_2	M_4	SD_4	M_4-M_2	t
Group A	254.8	9.97	273.2	15.5	18.4	6.4*
Group B	254.3	10.88	268.2	9.38	13.9	5.7*

* Significant at the 1 percent level of confidence

Test 5 (Seven days after donating blood): In group A, eight subjects gave decreased performances over their results in Test 4. The decreases ranged from 17 revolutions to five revolutions. Two subjects gave increases of seven and five revolutions. The mean decrease was 6.3 revolutions.

In group B, four subjects showed improved performances, five showed decreased performances and one remained the same. The mean decrease in performance was two

revolutions.

Table V shows the difference in performance levels of each group which occurred between the results of Test 4 and Test 5.

Group A showed a mean decrease of 6.3 and a t-ratio of 2.6, significant at the 5 percent level of confidence. Group B showed a mean decrease of two revolutions and a t-ratio of 0.8 which was not statistically significant.

TABLE V

Comparison of Results between Means of Performance on Test 4 and Test 5

	M_5	SD_5	M_4	SD_4	M_4-M_5	t
Group A	266.9	19.8	273.2	15.5	6.3	2.6*
Group B	266.2	11.7	268.2	9.38	2.0	0.8

* Significant at the 5 percent level of confidence

Table VI shows the difference in mean performance found in the two groups between the control score (Test 2) and the results in Test 5.

Group A shows a mean increase of 12.1 revolutions and a t-ratio of 2.9, statistically significant at the 1 percent level of confidence. Group B shows a mean increase of 11.9 revolutions and a t-ratio of 4.9, statistically significant at the 1 percent level of confidence.

TABLE VI

Comparison of Results between Means of Performances on Test 2 (Control) and Test 5

	M_2	SD_2	M_5	SD_5	M_5-M_2	t
Group A	254.8	9.97	266.9	19.8	12.1	2.9*
Group B	254.3	10.99	266.2	11.7	11.9	4.9*

* Significant at the 1 percent level of confidence

Table VII shows the difference in mean performance found in the two groups between the scores on Test 3 and the scores on Test 5.

Both groups show increases that were not statistically significant in performance over Test 3. Group A shows a mean improvement of 1.9 revolutions with a t-ratio of 0.6. Group B shows a mean improvement of 3.4 revolutions with a t-ratio of 1.55. Both t-ratios are not statistically significant.

TABLE VII

Comparison of Results between Means of Performances on Test 3 and Test 5

	M_3	SD_3	M_5	SD_5	$M_5- M_3$	t
Group A	265.0	13.0	266.9	19.8	1.9	0.6
Group B	262.8	10.96	266.2	11.7	3.4	1.55

Comparison between Group A and Group B:

As the groups were equated on the means of their performances on Test 1 and Test 2, there was a difference of 0.5 of a revolution between the control mean of Group A and the control mean of Group B. This difference was not statistically significant.

Comparisons were made of the differences between the means of the two groups on their results in tests 3, 4 and 5. It was further determined whether these differences were statistically significant.

Table VIII shows the results of the difference between the means of both groups on Test 3. It may be seen that the standard error of the difference is 5.37 with a mean difference of 2.2. This gives a t-ratio of 0.41, which is not statistically significant.

TABLE VIII

Comparison of Difference between Group A and Group B or Results of Test 3

M_A	M_B	M_A-M_B	SD_D	SE_D	t
265.0	262.8	2.2	12.02	5.37	0.41

Table IX shows the results of the difference between means of both groups on Test 4. It may be seen that the standard error of the difference is 5.64 with a mean difference of five. This gives a t-ratio of 0.88, which

was not statistically significant.

TABLE IX

Comparison of the Difference between Group A and Group B on Results of Test 4

M_A	M_B	$M_A - M_B$	SD_D	SE_D	t
273.2	268.2	5	12.62	5.64	0.88

Table X shows the results of the difference between the means of both groups on Test 5. It may be seen that the standard error of the difference is 7.35 with a mean difference of 0.7. This gives a t-ratio of 0.09, which is not statistically significant.

TABLE X

Comparison of the Difference between Group A and Group B on Results of Test 5

M_A	M_B	$M_A - M_B$	SD_D	SE_D	t
266.9	266.2	0.7	16.44	7.35	0.09

CHAPTER V

DISCUSSION

The studies of Karpovich and Millman (1) demonstrated that a difference in the effect of blood donation may be expected between subjects engaged in a "sprint" type of activity and those engaged in endurance work.

Both the sprint runner and the sprint swimmer, in the foregoing experiment, were able to equal their best performances a few hours after blood donation. Furthermore, Karpovich and Millman (1) were cognizant of the motivational factor when they offered an explanation for the slight increases in performance which were obtained from two subjects on the day of donation. They state (1,p.168):

> In our study, the slight increase in two cases was probably due to a frantic effort to prove that loss of blood did not affect the subjects seriously.

The experimental studies of Balke, et al (2) were primarily concerned with the adaptation of the blood donors to "severe" exercise shortly after donation. A fall in performance one hour after donation was obtained. In none of these studies was the psychological factor suitably controlled.

The present study, which involved university athletes in training, engaged in a test item which may be considered

as a "sprint" type. Riding for two minutes on a bicycle ergometer against a 14 kilogram resistance was shown to impose a short burst of strenuous effort upon the subjects. All subjects were able to complete the two minute riding period but it was observed that all displayed evidence of physiological stress, eg. increased pulse rate, increased breathing, profuse perspiration, etc.

Both groups gave significantly higher performances than their control efforts. Further, the differences exhibited between the two groups were not statistically significant. Hence, it would appear that both group A and group B were similarly affected by the test.

It is suggested that either one or all of three factors may have been responsible for the improved performance of both groups.

(1) A strong psychological desire to show that the blood donation had not affected them. Further, all but two of the subjects stated after the test that their performance had not been affected, although several complained of various effects, eg. stiffness, tiredness, numbness, etc., after the two minute ride.

(2) An improvement in the technique of riding a bicycle ergometer.

(3) An improvement in performance as a result of the training factor.

On being tested, twenty-four hours after donation, both groups showed further improvement, although group A, which had not given blood, showed a statistically significant improvement, while in the case of group B, which gave the blood, the improvement was not statistically significant. It is possible that the loss of blood may have shown its effects at this stage. If one accepts the actual blood donation of group B as the only variation between the groups then this premise is reasonable.

On being retested after six days of normal activity, group A showed a significant fall in performance. The results of this test, however, remained significantly greater than the control level. Group B, on the other hand, showed a fall in the six day period which was not significant statistically, but nevertheless, remained significantly above the control level.

Continual reference must be made to the fact that the test item was highly specific. The required time of riding was only two minutes, and this cannot be accepted as an all-out effort, nor does it suggest the requirement of great endurance. It is impossible to offer any conclusive explanation for the differences that occurred in performance. Possibly the aforementioned psychological drive deteriorated during the seven day period. However, even after seven days, the subjects seemed sufficiently

motivated to maintain their performance significantly above the control level. Further possibilities are the beneficial effects of the training and learning factors which, in themselves, could improve performance.

It may be observed, furthermore, that at no stage was any significant difference between the performances of the two groups observed. It is, therefore, suggested, that, under the conditions of this experiment, no significant differences will occur between a group that gives blood and a group that does not.

In addition, again under the limitations of the study, it appears that a blood donation of 500 cc will not deleteriously affect the performance of athletes on riding for two minutes on a bicycle ergometer against a resistance of 14 kilograms.

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2 Balke, B., Grillo, G.P., Konecci, E.B., and Luft, V.C., "Work Capacity after Blood Donation", Journal of Applied Physiology, 7, 1954, pp.231-236.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Twenty-six University of British Columbia athletes, engaged in various sports, were selected and tested. The test item consisted of riding a bicycle ergometer for two minutes against a resistance of 14 kilograms. The maximum number of revolutions performed in this time was recorded. On the basis of the test results, the subjects were divided into two equated groups. Both groups were taken to a blood donation clinic where each person in one group donated 500 cc of blood. The other group underwent the same procedure, but the needle insertion was made in the muscle and no blood was drawn. As both groups were blindfolded, neither had any knowledge of what was occurring, other than that they were giving blood. The test item was given to all subjects two hours, twenty-four hours and seven days after donation. The differences in mean performances were calculated statistically within each group and a comparison of this difference was made between the groups.

On the basis of statistical treatment the following results were evident:

1. The group which donated blood showed a significant gain in performance in the test item, two hours ($t=3.4$), twenty-four hours ($t=5.7$) and seven days ($t=4.9$) after the

time of donation.

2. The group which did not donate blood also showed a significant gain in performance in the test item, two hours (t=3.8), twenty-four hours (t=6.4), and seven days (t=2.9) after the time of donation.

3. At none of the three stages was any significant difference found to exist between the two groups.

On the basis of these results, evidence is provided which indicates that a blood donation of 500 cc does not deleteriously affect the performance of athletes on riding a bicycle ergometer for two minutes against a resistance of 14 kilograms. In fact, the mean performance is significantly improved. The improvement is maintained two hours, twenty-four hours and, to a lesser degree, seven days after donation. The psychological effect of the belief that blood donation will affect performance is not evident under the conditions of the study. No deleterious psychological effect was obtained in the performance of the group which believed that it had given blood.

It must be concluded, therefore, that blood donation of 500 cc will not deleteriously affect university athletes in riding a bicycle ergometer for two minutes against a 14 kilogram resistance, either physiologically or psychologically at stages of two hours, twenty-four hours or seven days after donation.

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APPENDIX A

STATISTICAL TREATMENT

Study Design

Two Groups A Experimental (N = 10)

B Control (N = 10)

One Test - performance of bicycle ergometer.

- administered five times to each subject.

Procedure

(1) Administration of test 1 to a group of subjects.

(2) Placement of subjects into two groups equated on performance in test 1.

(3) Test 2 administered to Group A and Group B.

(4) Calculation of reliability coefficient between test 1 and test 2.

(5) Administration of test 3.

(6) Administration of test 4.

(7) Administration of test 5.

Test 1

Group A	Group B
Test 2	Test 2
Test 3	Test 3
Test 4	Test 4
Test 5	Test 5

General Statistical Outline

1. Correlation of reliability coefficient between test 1 and test 2.
2. Significance of differences in performance of group A and group B on tests 3, 4, 5. (Four calculations)
3. Significance of difference in performance of group A on tests 2, 3, 4, 5. (Six calculations)
   Significance of difference in performance of group B on tests 2, 3, 4, 5. (Six calculations)

Procedure and Formulae

1. Correlation of reliability coefficient between results of test 1 and test 2.
   Tabulation of data (Garrett, 1,p.226)
   1. No. of subjects.
   2. Mean score $\frac{\Sigma X}{N}$
   3. Standard deviation $\sigma = \sqrt{\frac{\Sigma x^2}{N-1}}$

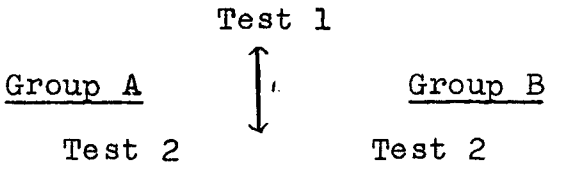
4. Standard error of means $S.E_{M} = \frac{S.D.}{\sqrt{N}}$

5. Difference between means $M_1 - M_2$

6. Correlation between initial and final results.

$$r = \frac{N\Sigma xy - \Sigma x \Sigma y}{\sqrt{\{N\Sigma x^2 - (\Sigma x)^2\}\{N\Sigma y^2 - (\Sigma y)^2\}}}$$

i.e.



2. Significance of difference in performance of group A and group B on tests 2, 3, 4, 5. (calculations 2, 3, 4, 5)

Difference of two independent means,

Ma - mean of group A

Mb - mean of group B

σ ma - standard deviation of group A

σ mb - standard deviation of group B

Differences in means = Ma - Mb

t ratio = $\frac{Ma - Mb}{\sqrt{\sigma_{Ma}^2 + \sigma_{Mb}^2}}$

and will be acceptable at the 5 percent level of confidence.

i.e.

Group A		Group B
Test 2	2	Test 2
Test 3	3	Test 3
Test 4	4	Test 4
Test 5	5	Test 5

3. Significance of difference in performance of group A on tests 2, 3, 4, 5. (Calculations 6, 7, 8, 9, 10, 11)

Method of difference (Garrett, 1,p.227)

M_D = Mean of difference between test 2 and test 3.

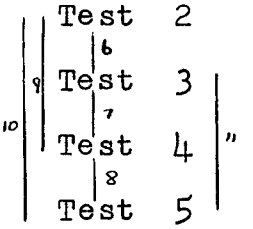
SD_D = Standard Deviation of mean of difference.

$S.E._{MD}$ = Standard Error of mean of difference.

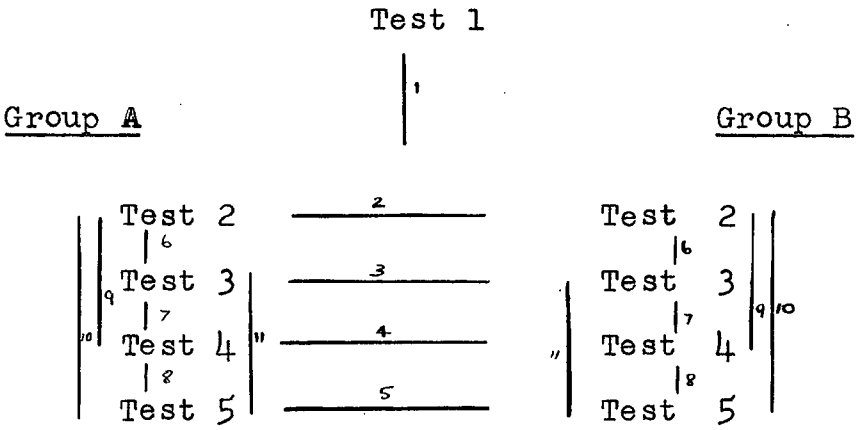
$t = \frac{M_D}{SE_{MD}}$ and will be acceptable at the 5 percent level of confidence.

Similar statistical procedure for group B.

i.e. Group A



Thus in Summary we have.



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APPENDIX B

TIME TABLE FOR PROCEDURE

(1) Practice sessions - on days to be arranged.

(2) Day 1 - last practice session.

Day 8 - Test 1

Day 15 - Test 2

Day 22 - Test 3 - two hours after venesection.

Day 23 - Test 4

Day 30 - Test 5

APPENDIX C

INDIVIDUAL SCORE SHEET

NAME -

ADDRESS -

PHONE -

HEIGHT -

WEIGHT -

SPORT -

FACULTY -

GROUP -

Date	Time	Test Number	Results
		Test 1	
		Test 2	
		Test 3	
		Test 4	
		Test 5	

Did you believe that blood donation affected you in this test?

Have you ever given blood before?

APPENDIX D

RAW SCORES FOR GROUP A

Subject	1	2	Mean 1 & 2	3	4	5
A	276	278	277	286	295	300
B	261	258	260	261	276	269
C	256	257	257	268	282	271
D	256	257	257	282	290	297
E	253	256	255	270	281	267
F	248	258	253	284	285	267
G	248	260	254	255	272	268
H	246	249	248	251	256	247
I	247	250	249	252	250	245
J	238	238	238	251	255	238
Mean			254.8	265.0	273.2	266.9
SD			9.97	13.0	15.5	19.8
SE_m			3.15	4.1	4.9	6.3

APPENDIX E

RAW SCORES FOR GROUP B

Subject	1	2	Mean 1 & 2	3	4	5
A	276	276	276	278	279	284
B	267	263	265	271	282	280
C	256	255	256	266	268	260
D	258	254	256	264	281	267
E	256	254	255	258	266	272
F	252	255	254	254	259	258
G	250	254	252	263	257	276
H	250	250	250	278	268	276
I	239	244	242	249	262	262
J	236	237	237	247	260	248
Mean			254.3	262.8	268.2	266.2
SD			10.88	10.96	9.38	11.7
SE_m			3.44	3.47	2.97	3.7