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SOME EFFECTS OF EXERCISE ON THE URINARY SEDIMENT

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In the course of investigations into various changes produced in the body and its functions by exercise, several workers have studied the urine. Diminution of volume and increase in concentration were early recognized. The occurrence of proteinuria and certain factors related to its occurrence were shown. The fact that urea excretion is impaired by vigorous activity was demonstrated. De la Camp is said to have been the first to note the occurrence of a general increase in the number of formed elements in the sediment. His observations have been repeated several times.

This report gives the first data which are quantitative and which show time relationships.

METHODS AND MATERIAL

The urine studied was obtained from a group of thirty-one apparently healthy young male athletes. Specimens produced before, during, and after exercise were examined. The exercise was strenuous: football and handball. The duration of the period of exercise varied from forty minutes to four hours. Several series of specimens from three members of the group were studied; one series from each of the others. A series of specimens consisted of (1) a timed specimen pro-

duced in the period before exercise, (2) a timed specimen produced during the period of exercise, and (3) one or more timed specimens produced after exercise. During the periods before and after exercise the subjects were under conditions of ordinary activity, i.e., up and about their usual school duties. No attempt was made to control fluid intake. Specimens from each subject were collected successively and were examined within two hours.

Determinations were made of the rate of excretion of urine, the specific gravity, the rate of excretion of protein, and the rates of excretion of red blood cells, white blood cells and renal epithelial cells, and casts.

Protein was determined by the method of Shevky and Stafford (10). The formed elements in the sediment were counted by the method devised by Addis (1).

RESULTS

The rate of excretion of urine varies greatly. Most individuals, however, show a reduction in the rate of production of urine while exercising which, upon cessation of vigorous activity, is followed by a rapid return toward the rate existing

TABLE I

Summary of data for averages shown in figures

| Measurement | Number of subjects | Number of observations | Mean with its standard error | | |
|---|--------------------|------------------------|------------------------------|-----------------|-----------------|
| | | | Before exercise | During exercise | After exercise |
| Rate of production of urine, cc. per hour | 31 | 41 | 50.2 ± 10.2 | 28.5 ± 3.0 | 48.9 ± 5.2 |
| Specific gravity | 31 | 41 | 1.026 ± 0.00051 | 1.029 ± 0.00051 | 1.028 ± 0.00059 |
| Rate of excretion of red blood cells, thousands per hour | 31 | 41 | 2.98 ± 0.56 | 3.56 ± 0.65 | 1.72 ± 0.31 |
| Rate of excretion of white blood cells and renal epithelial cells, thousands per hour | 31 | 41 | 16.73 ± 6.85 | 71.23 ± 22.98* | 23.03 ± 3.83 |
| Rate of excretion of casts, thousands per hour | 31 | 41 | 2.09 ± 0.09 | 37.94 ± 11.16 | 10.00 ± 3.83 |

* One widely divergent observation (262) has been excluded. If it is included this figure becomes 75.88 ± 42.96

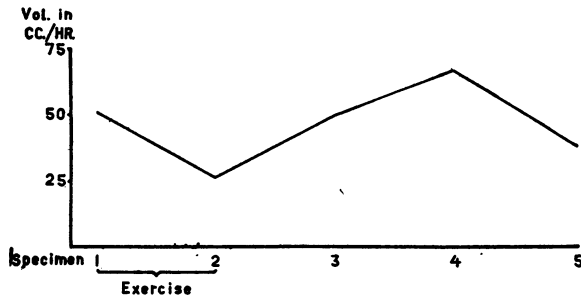


FIG. 1. EFFECT OF EXERCISE ON THE RATE OF PRODUCTION OF URINE.

under conditions of ordinary activity. Figure 1 represents the average response of the group.

The specific gravity increased during the period of exercise, Figure 2. Here again the individual

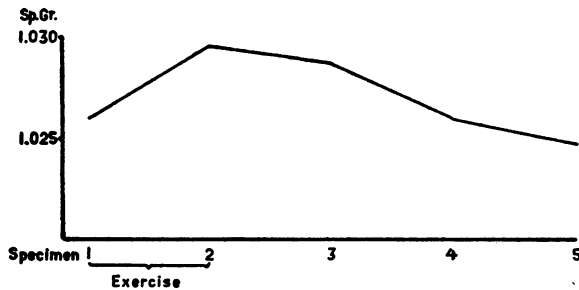


FIG. 2. EFFECT OF EXERCISE ON THE SPECIFIC GRAVITY OF THE URINE.

variation was great. As pointed out by Barach (4), in the individual no correlation seems to exist between the change in rate of excretion and the change in specific gravity; a fall in the volume per hour was often associated with a lower specific gravity.

The effect of exercise on the rate of protein excretion, Table II, was inconstant. It varied in different individuals and in the same individual on different occasions. In one subject who had a functional proteinuria, on some occasions the rate of protein excretion increased; on other occasions it decreased.

The number of red blood cells found in the urinary sediment was unaffected by exercise, Figure 3.

In the number of white blood cells and renal epithelial cells appearing in the urine, exercise produced approximately a four-fold increase, Figure 4. In only one instance, however, did the

TABLE II

The rate of excretion of protein in the urine

| Number of observations | Rate in mgm. per hour | | |
|------------------------|-----------------------|-----------------|----------------|
| | Before exercise | During exercise | After exercise |
| 14 | 0 | 0 | 0 |
| 1 | 0 | 1.7 | 0 |
| 1 | 0 | 3 | 3 |
| 1 | 0 | 4 | 0 |
| 1 | 0 | 4.5 | 0 |
| 1 | 0 | 4.8 | 6 |
| 1 | 0 | 12 | 3 |
| 1 | 0 | 21.8 | 0 |
| 1 | 0 | 30 | 28.8 |
| 1 | 0.8 | 0.4 | 0 |
| 1 | 1 | 0 | 0 |
| 1 | 1.4 | 0 | 0 |
| 1 | 2 | 2 | 2 |
| 2 | 2 | 0 | 0 |
| 2 | 2.4 | 0 | 0 |
| 2 | 3 | 2 | 0 |
| 1 | 3 | 6 | 14 |
| 1 | 4 | 7 | 1 |
| 1 | 4 | 3 | 1 |
| 1 | 4.4 | 4 | 3 |
| 1 | 6 | 0 | 3 |
| 1 | 8 | 2 | 4.5 |
| 1 | 11 | 0 | 3 |
| 1 | 14 | 54 | 3.8 |
| 1 | 29 | 140 | 32 |

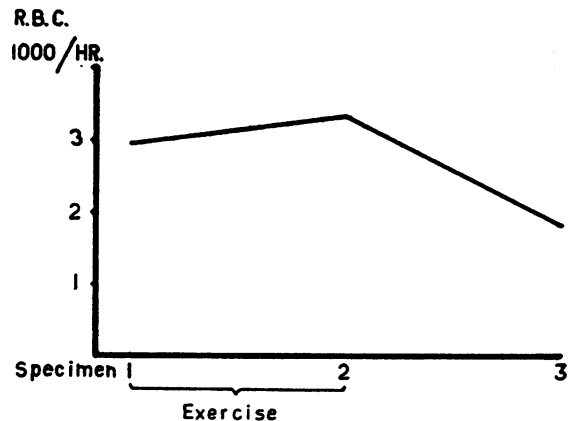


FIG. 3. EFFECT OF EXERCISE ON THE INCIDENCE OF RED BLOOD CELLS IN THE URINE.

number of white blood cells and renal epithelial cells exceed the upper limit of normal (Addis). Return to low levels occurred in every instance, usually within three hours.

Exercise produced a great increase in the number of casts found in the urine, Figure 5. In every observation the number of casts excreted during exercise greatly exceeded the upper limit of normal. The casts were largely hyaline, but occasional granular casts were encountered. No

cellular or blood casts were found. The increase in the number of casts excreted persisted for as long as twelve hours after cessation of activity.

in the rate of excretion of red blood cells. Recovery occurs within a few hours after activity is curtailed.

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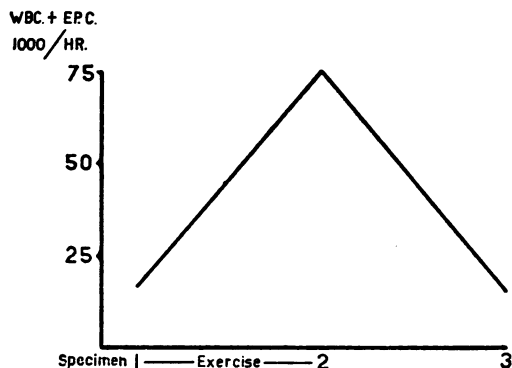


FIG. 4. EFFECT OF EXERCISE ON THE RATE OF EXCRETION OF WHITE BLOOD CELLS AND RENAL EPITHELIUM IN NORMAL URINE.

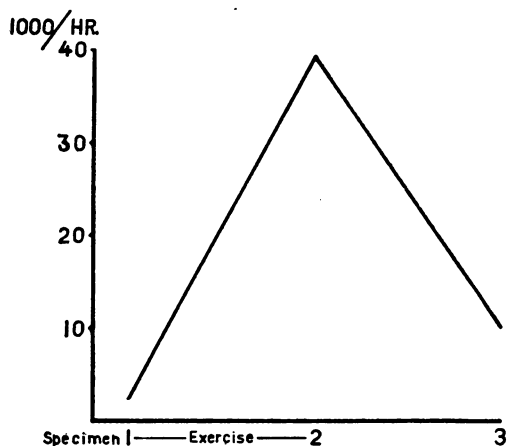


FIG. 5. EFFECT OF EXERCISE ON THE RATE OF CAST EXCRETION.

CONCLUSION

Vigorous exercise produces a marked increase in the rate of excretion of hyaline casts, a moderate increase in the rate of excretion of white blood cells and renal epithelial cells but no change