Effect of Exercise on the Plasma Concentration of Anorexigenic Substance in Man[1] (36948)

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A loss of appetite immediately following strenuous exercise in man is compensated for by an increased caloric consumption 24 to 48 hr later (1). Reduced food intake also has been noted following exercise in experimental animals (2–4). The mechanism by which exercise suppresses appetite and food intake has not been elucidated. It has been suggested that increased catecholamine secretion or decreased insulin release may be involved (5, 6), but other evidence indicates that the duration of action of these substances is such that they cannot play a substantial role in the response (7–10).

A urinary anorexigenic substance, first demonstrated by Stevenson *et al.*, might provide a more satisfactory explanation (11). This material has since been isolated from plasma and a method has been devised for determining its concentration (12). A homogenous preparation of the anorexigenic substance has been prepared and tentatively identified as a glycopeptide on the basis of its staining reaction on thin-layer chromatography and paper and disc electrophoresis (13). This study was designed to determine if the reported loss of appetite following severe exercise is correlated with an increased concentration of this anorexigenic substance in the plasma.

Materials and Methods. Subjects in this study were seven healthy young men. These men were examined and a venous blood sample obtained in the post-absorptive state. Sixty and ninety minutes later, second and third venous blood samples were withdrawn. Twenty-four hours later the subjects returned to the laboratory and a pre-exercise venous blood sample was obtained. The subject then engaged in exhaustive treadmill exercise (14). In summary, the exercise consists of walking on the treadmill at 3.0 miles/hour at zero grade for 3.0 min. Thereafter, the treadmill is elevated 3% every 3 min while the speed is held constant. This procedure is followed until the subject is unable to continue the exercise. Heart rate was determined from the ECG and any abnormality in rhythm or *S–T* segment would have been an indication for termination of exercise. None of the subjects was excluded from the study on the basis of these criteria. Oxygen consumption was determined by the standard open-circuit technique at 3-min intervals during exercise. Sixty and ninety minutes after termination of the exercise task, the second and third venous blood samples were withdrawn. The hematocrit and plasma anorexigenic substance concentration were determined in all samples (12).

In preliminary experiments we observed that some subjects displayed a peak post-exercise elevation in plasma anorexigenic substance concentration at 60 min, while others displayed a peak at 90 min. Thus, the change in plasma anorexigenic substance concentration was based on the maximum increases observed.

The hematocrit and the change in plasma anorexigenic substance concentration during the control and exercise periods were compared statistically by the *t* test for correlated samples (15). The mean and standard errors were calculated for oxygen consumption and heart rate. The null hypothesis was rejected at the 2 per cent level.

Results. The oxygen consumption and heart rate values indicate that this exercise load produced values that were near maximal for these subjects (16) (Table I). The oxygen

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TABLE I. The Effect of Exhaustive Exercise on Oxygen Consumption, Heart Rate, Hematocrit and Plasma Anorexigenic Substance Concentration.[a]

Oxygen consumption (liter/min)	Exercise heart rate (beats/min)	Hematocrit (%)				Plasma anorexigenic substance (mg/100 ml)			
		Control		Exercise		Control		Exercise	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
3.35 ± 0.18	186 ± 4	46.6 ± 1.1	46.6 ± 1.4	47.1 ± 0.87	45.5 ± 0.81[b]	270 ± 23	253 ± 21	281 ± 11	340 ± 9[c]

[a] The values shown are the means and standard errors ($n = 7$).
[b] $P = 0.007$ compared to pre-exercise.
[c] $P = 0.008$ compared to pre-exercise.

consumption levels attained by these subjects is comparable to Category IV (Good) as established by Cooper (17). The hematocrit did not vary during the control period; however, there was a highly significant decrease after exercise (Table I). Fluid intake was not restricted in the post-exercise period, therefore an increase in fluid intake could have occurred and would have explained the hemodilution noted. During the control period the plasma concentration of anorexigenic substance remained unchanged, but following exercise there was a highly significant increase (Table I). The magnitude of the increase was variable from subject to subject, but an increase occurred in every subject. The increase in concentration occurred even though the hematocrit data indicated that hemodilution occurred after such exercise.

Discussion. There is general agreement that there is a loss of appetite in man following strenuous exercise (1). A comparison has been made of the caloric intake between farm workers and students during harvest labor (18). The students, over a period of a few days, consumed 2100 calories/day less than farm workers. There is some inhibitory effect on food intake by very high caloric expenditures, especially in subjects not accustomed to hard work.

In experimental animals food intake can be controlled and measured accurately. It has been shown that exercise of appropriate duration and intensity can reduce food intake (5). Also, food intake correlates well with energy expenditure over a wide range, but compensation fails at very low caloric expenditures and an excess caloric intake occurs. The possibility exists that the plasma concentration of anorexigenic substance may reflect a change in equilibrium of this compound and be responsible for decreased food intake following exercise and the more precise regulation of appetite at higher caloric expenditures. The definitive mechanism responsible for loss of appetite following exercise, however, has been unknown.

Changes in the plasma concentration of the anorexigenic substance originally discovered by Stevenson *et al.*, may play a role in the loss of appetite following exercise (11). It may be significant that an intraperitoneal in-

jection of 60 mg/kg of this material into rats suppresses food intake for 24 to 48 hr by causing an approximate 50% increase in the plasma concentration of this substance (8). The increase noted in this study (21%) would probably suppress appetite, but for a much shorter duration.

Obesity has been identified as one of the contributing factors to increased mortality when complicated by such diseases as atherosclerosis, coronary artery disease, liver and biliary tract disease, and maturity-onset diabetes mellitus (19–21). Up to 50% of the population of the western world is 10% above their optimal body weight (21). If a duration or intensity of exercise could be defined which would be capable of causing a net caloric deficit, or would minimize the excess caloric intake, it would assist an individual to achieve optimal body weight.

Summary. Sixty to ninety minutes after exhaustive treadmill exercise in man there was a 21 per cent increase in the plasma concentration of anorexigenic substance. The injection of anorexigenic substance in amounts sufficient to cause a 50% increase in its plasma concentration has previously been shown to depress food intake for 24–48 hr in rats. This substance therefore, may be responsible for the decreased appetite and food intake following exercise in man.

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