A STUDY OF THE EFFECT OF ACUTE EXERCISE ON PLASMA CORTISOL LEVEL IN CONDITIONED AND UNCONDITIONED MALES

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Summary: The effect of short lived intense exercise on plasma Cortisol levels of conditioned and unconditioned subjects has been studied. There was a significant rise following exercise in both the groups even though the initial cortisol levels were significantly lower in conditioned subjects. No significant difference was found in the amount of Cortisol release as judged by blood levels. It appears, therefore, that the initial response in both the groups is similar.

Key words: conditioned subjects, pre-exercise levels, un-conditioned subjects, post-exercise levels, plasma cortisol

INTRODUCTION

Several workers have attempted to study the effects of exercise on Adrenal gland secretions in animals and human beings. Staechlin *et al.* (15) have reported an initial rise followed by fall in plasma Cortisol levels in untrained subjects. Cornil *et al.* (1) on the other hand have shown fall in plasma Cortisol levels which, they believe, is produced by increased utilisation of plasma Cortisol during prolonged exercise. More recently Raymond *et al.* (12) reported fall in serum Cortisol levels following nonexhausting exercise in healthy military men. None of these studies have revealed the immediate effects of intense exercise. Moreover, the effect of conditioning on these changes is also not clearly understood. An attempt has been made to obtain this information in the present investigation.

MATERIALS AND METHODS

This study was conducted in 20 male subjects aged between 18 and 26 years. Ten normal medical students with no previous exercise training formed the unconditioned group while the conditioned group comprised of 10 cycle-rickshaw pullers who had been regularly pulling rickshaw for atleast 6 months.

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Each subject carried out strenuous exercise on a Bicycle Ergometer (Friction type) for two min. The rate of work was calculated with the method described by Harris, Gilding and Smart (5) as follows:—

Work/minute = force x distance/minute
= (T-S) nc in foot lbs/minute
$= \frac{nc(T-S)}{3,087}$ Calories/minute
= .....Watts

Where, T = actual weight suspended in pounds
S = weight recorded on spring balance while the wheel is moving
c = circumference of wheel in feet
n = number of revolutions of the wheel per minute
1 Cal. = 3,087 foot pounds
1 Cal/minute = 70 Watts

In our experiment, $T = 6$ lbs : S=0.0 lbs : $c = 68'' = \frac{68}{12}$ feet : n=130/minute

Therefore,

Work/minute = 4420 foot lbs/minute
$= \frac{4420}{3087}$ Calories/minute
= 1.43 Calories/minute

Since, 1 Cal./minute = 70 Watts
Therefore, 1.43 Cal/minute = 100.1 Watts

Thus our subjects carried out exercise with a work out put of 4420 foot lbs/minute or 100 Watts continued for two minutes.

The plasma Cortisol levels were estimated by the technique of Peterson and Pierce (9,10) based on Porter-Silber reaction (11). Briefly, the method consists of collecting 10 *ml* of blood and separating the plasma. The bound and free Cortisol is extracted in dischloromethane and reacted with sulphuric acid-ethanol reagent containing phenyl-hydrazine. The yellow coloured hydrazone is formed at room temperature in about 24 hours. The optical density was then measured on Pye-Unicam spectrophotometer at 410 m. micron ($m\mu$.).

A pre-exercise blood samole was collected in each individual between 9 and 9.30 A.M. The subjects then carried out the preplanned exercise and a second sample was collected immediately afterwards. Plasma Cortisol levels were determined in both these samples and the difference indicated the change produced by exercise. The mean values of various sets of observations and their standard errors were calculated in the usual manner in both the groups and the significance of the difference was assessed by Student's 't' test at 99 percent level of confidence ($p<0.01$).

RESULTS

Un-conditioned Group: The age and surface area of various subjects in this group have been shown in Table I. The table also shows the plasma Cortisol levels before and after exercise and the percentage rise. The initial plasma Cortisol levels ranged 13 to 47 $\mu g/100\ ml$, the average being $30.8 \pm 3.61\ \mu g/100\ ml$. There was an increase following exercise in each case, the range being 35 to 77 $\mu g/100\ ml$ of plasma with an average of $56.9 \pm 3.71\ \mu g/100\ ml$ of plasma. The difference between the two means is significant at over 99.9 percent level of confidence ($P < 0.001$).

TABLE I: Effect of exercise on plasma Cortisol levels in un-conditioned subjects (normal male medical students)

S. No.	*Age years*	*Body surface area Sq. M.*	*Plasma Cortisol levels*		*Percentage increase*
			Pre-exercise $\mu g/100\ ml$	*Post-exercise* $\mu g./100\ ml.$	%
1	18	1.53	43	53	23.25
2	18	1.47	47	59	25.5
3	18	1.65	40	60	50.0
4	19	1.66	13	60	361.5
5	19	1.80	40	67	67.5
6	20	1.56	26	49	88.4
7	20	1.58	19	46	142.12
8	21	1.58	30	35	16.6
9	21	1.62	30	77	156.6
10	23	1.39	20	63	215.0
Mean	19.7	1.58	30.8	56.9	114.65
S.E.M.	±0.52	±0.49	±3.61	±3.71	±25.1

Conditioned Group: The variance parameters of this group are similarly shown in Table II. The initial Cortisol levels were lower in this group, the range being 10 to 29.9 $\mu g/100\ ml$ of plasma with an average of $18.2 \pm 2.01\ \mu g.$ post exercise levels were also lower having a range of 20 to 67 $\mu g/100\ ml$ of plasma giving an average of $36.5 \pm 4.57\ \mu g.$ In this group also the pre-exercise and post-exercise levels of plasma Cortisol had a highly significant difference ($p < 0.0025$).

TABLE II: Effect of exercise on plasma Cortisol levels in conditioned subjects (Cycle-rickshaw pullers).

S. No.	*Age years*	*Body surface area Sq. M.*	*Plams Cortisol levels*		*Percentage increase*
			Pre-exercise	*Post-exercise*	
			μg/100 *ml*	μt/100 *ml.*	%
1	20	1.51	10	22	120.0
2	22	1.43	11	30	172.7
3	22	1.41	18	29	61.1
4	23	1.41	12	20	66.6
5	23	1.55	20	67	235.0
6	24	1.64	20	46	130.0
7	25	1.53	19	27	42.11
8	25	1.68	29	49	68.9
9	25	1.47	16	35	118.75
10	26	1.56	27	40	48.14
Mean	23.5	1.52	18.2	36.5	106.33
S.E.M.	±0.56	±0.06	±2.01	±4.57	±20.-6

The pre-exercise levels of plasma Cortisol were significantly higher in the un-conditioned group as compared to conditioned group ($p<0.005$). Similarly post exercise level of plasma Cortisol was also higher in unconditioned group ($p<0.0025$). The mean rise in plasma Corti sol levels in the conditioned group was 18.3 ± 3.7 μg/100 *ml* as compared to 26.1 ± 4.8 μg/100 *ml* in case of the un-conditioned group. The difference between the amounts of plasma Cortisol increase in the two groups is, however, not significant statistically ($p>0.050$).

DISCUSSION

A number of observers have attempted to analyse Cortisol levels in the plasma in response to a precalculated degree of exercise stress in untrained humans and animals (1,6.12, 13, 14, 15, 16). No observations seem to have, however, been made on the effects of exercise stress on plasma Cortisol levels in subjects who have been conditioned to same type of exercise for any length of period prior to testing. This prompted us to compare the acute responses of persons who habitually carried out exercise (conditioned) with normal (un-conditioned) subjects.

Staechlin *et al.* (15) studied plasma Cortisol levels in 12 normal students after 15,30,60 and 120 minutes of onset of exercise. They observed maximal 40 percent rise thirty minutes after start of exercise. This was followed by a continous fall in Cortisol levels reaching to 50 percent of pre-exercise values in 120 minutes. The subjects carried out widely spread out exercise for a period of two hours.

Cornil *et al.* (1) observed the effects of exercise on Cortisol levels in 10 subjects between ages of 24 to 50 years, having no previous exercise training. These subjects carried out exercise for 20 minutes which was found to be maximal for them. The Cortisol levels were estimated 10 and 20 minutes after onset of exercise and 30 minutes after termination of exercise. They found almost no change in levels after 10 and 20 minutes of exercise. A significant fall was, however, observed 30 minutes after termination of exercise.

Raymond *et al.* (12) have also reported a prompt reduction in serum Cortisol level in 10 military subjects after non-exhausting treadmill exercise. They found these effects to persist upto 60 minutes after exercise.

In our studies we have observed that the un-conditioned subjects riding on the bicycle ergometer were extremely breathless and unable to carry out exercise beyond two minutes. These subjects had a work output of 4420 foot lbs/minute or 100 watts, and the exercise carried out by them proved to be fairly exhausting resulting in a state of fatigue. This state of fatigue was considered as the steady state for serum Cortisol estimations.

In the un-conditioned group in the present study, though the mean pre-exercise value of plasma Cortisol is within limits, some of the individual values apear to be relatively higher than the basal values reported by serveral workers (2,3,4 & 8). An important factor contributing to these higher values could be a certain degree of apprehension to exercise in these un-conditioned individuals. This has been reported to be a contributary factor by other workers also (6,12 & 13).

A comparison of pre-exercise Cortisol levels revealed that in conditioned subjects these values, though within normal range, were significantly lower than in un-conditioned group. This could be partly accounted for by lack of apprehension in these subjects. It appears likely that the hypertrophied skeletal muscles in the conditioned subjects probably extract more Cortisol leading to a decrease in plasma Cortisol levels.

After carrying out exercise, a burst of Cortisol production occured in both the groups. These observations are in agreement with the results of Staechlin *et al.* (15). It is interesting to note that a marked increase in plasma Cortisol levels could be obtained in the present series even after two minutes of exhausting exercise whereas in the experiments of Staechlin *et al.* (15) the exercise of about 30 minutes was required. This could be because of very intense nature of exercise in our experiments leading to greater amount of stress in a short period of two minutes.

It is difficult to explain the lack of initial rise of plasma Cortisol levels in the studies of Cornil *et al.*(1) and Raymond *et al.*(12). In the former case the blood samples were collected ten minutes after conset of exercise and it is conceivable that the phase of raised plasma Cortisol started levelling off by then.

Another interesting finding of the present investigation has been the lack of significant difference in the amount of Cortisol release in conditioned and un-conditioned subjects after performing same amount of exercise. Though the conditioned subjects had skill of performing exercise and were apparently not fatigued by doing same amount of work, they reacted similarly as the un-conditioned subjects in terms of Cortisol production.

It appears, therefore, that conditioning does not modify the initial adrenocortical response to short-lived intense exercise.

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