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ABSTRACT

The purpose of this study was to provide basic information concerning the acute effects of a small, moderate, and large dose of d-amphetamine sulfate upon muscular endurance; a secondary purpose involved the effect upon resting (R), and submaximal, and maximal (MAX) heart rate (HR). Twelve male university students underwent four separate trials of a progressive work task on an electric bicycle ergometer. Prior to each trial the subject consumed either a placebo (0 mg), small (5 mg), moderate (10 mg), or large (15 mg) dose of d-amphetamine sulfate per 70 kg body weight. A repeated measures ANOVA revealed significant F ratios (P.05) for the RHR and MAX HR. The Neuman Keuls analysis indicated the RHR for the moderate dose was higher than the placebo condition, while all three amphetamine doses elicited a higher maximal heart rate than the placebo. It was concluded that variant dosages of d-amphetamine sulfate do not influence maximal endurance capacity or the heart rate during submaximal exercise, while the effect exerted upon RHR and MAX HR may have been due to chance occurrence. (Author)

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THE EFFECT OF VARIENT DOSAGES OF AMPHETAMINE UPON ENDURANCE

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THE AUTHORS EXPRESS GRATITUDE TO GERVAS TAYLOR, M.D. AND JOHN IVY FOR THEIR MEDICAL AND TECHNICAL ASSISTANCE, RESPECTIVELY, IN THE CONDUCT OF THIS STUDY.

ALTHOUGH NOT A THESIS OR A FINAL RESEARCH PROJECT, JOHN THOMPSON EARNED THREE GRADUATE CREDITS (INDEPENDENT STUDY) FOR HIS ROLE IN THIS STUDY.

ABSTRACT

1. The purpose of this study was to provide basic information concerning the acute effects of a small, moderate and large dose of d-amphetamine sulfate upon muscular endurance; a secondary purpose involved the effect upon submaximal and maximal heart rate (MAX HR). Twelve male university students underwent four separate trials of a progressive work task on an electric bicycle ergometer. The criterion for muscular endurance was time to exhaustion. Prior to each trial the subject consumed either - placebo (0 mg), small (5 mg), moderate (10 mg), or large (15 mg) dose of d-amphetamine sulfate per 70 kg body weight. A repeated measures ANOVA revealed a significant F ratio ($P<.05$) for MAX HR. The Neuman Keuls analysis indicated all three amphetamine doses elicited a higher MAX HR than the placebo. It was concluded that variant dosages of d-amphetamine sulfate do not influence maximal endurance capacity or the heart rate during submaximal exercise, while the significant effect exerted upon MAX HR needs further exploration.

INTRODUCTION

2. The prevailing opinion concerning amphetamine usage in athletics is that they may exert an ergogenic effect. Consequently, most major amateur athletic governing bodies, such as the NCAA, AAU, and IAAF, as well as the Committee on the Medical Aspects of Sports of the AMA (27) condemn their use in association with athletic events. In the 1972 Olympic games, Rick DeMont, an asthmatic, was eliminated from competition and deprived of an earned

gold medal because his medication contained ephedrine, a sympathomimetic amine analogous in action to amphetamine.

3. However, Lovingood (20) noted the basic question of whether amphetamines improve general physical performance has not been completely elucidated; in a more specific context, Plotnicki (26) reaffirmed this statement relative to the effect of amphetamines upon muscular endurance. While several investigations have found a beneficial effect of amphetamines upon muscular endurance (1) and bicycle ergometer endurance (8, 18, 19), others noted no influence upon static or dynamic muscular endurance (5, 11, 31), exhaustive bench stepping (10) or exhaustive runs on a treadmill (12,17)

4. The purpose of this investigation was to provide basic information regarding the acute affects and trend effects of varient dosages of amphetamine upon muscular endurance. A subsidiary purpose was to evaluate the drug effects upon the submaximal and maximal exercise heart rate.

METHODOLOGY

5. Subjects and medicaments. Twelve male undergraduate and graduate students at Old Dominion University, with an age range of 21-32, mean 23.95 and S.D. 3.32, served voluntarily as subjects. Mean weight was 77.73 kg with S.D. of 13.00 kg. Each subject was given a thorough medical examination prior to the experiment. During four different sessions approximately three days apart, each subject consumed one of four dosages of d-amphetamine sulfate (Dexedrine). Dosages were based on body weight and included a cornstarch placebo, 5 mg (small), 10 mg (moderate)

and 15 mg (large) of d-amphetamine sulfate per 70 kg body weight; the drugs were taken orally in capsule form. A standardized workload was administered 2-3 hours following the ingestion of the drugs, since this time period has been shown to be most effective in providing peak subjective and behavioral effects (32).

6. Workload and criterion measures. A continuous progressive workload on the Quinton electric bicycle ergometer was utilized as the standardized test for the four phases of the experiment. The workload was initiated at 400 kpm and each minute was increased by 200 kpm. Subjects pedalled to exhaustion, which was indicated by an RPM reading of 40 on the control panel; at this point, the workload becomes inoperative on the Quinton ergometer. The main criterion measure was time to exhaustion. In addition, the HR was monitored continuously during the exercise via a graphically recorded EKG on a Narco physiograph.

7. General Procedure. The subject received his capsule two hours prior to the testing period and consumed it while in a fasted condition. The order of administration of the dosages was counterbalanced in order to confound the training effect. The subject reported to the Human Performance Laboratory in a rested condition and undertook a non-taxing reaction time and strength test. Following a short rest period, the subject was seated on the bicycle ergometer where his RHR was monitored prior to the initiation of the test. The heart rate was monitored continuously during the work period, and when the workload began to approach maximal levels for each individual, verbal encouragement was the only motivational technique utilized. The test was terminated when the subject was unable to maintain the workload.

RESULTS AND DISCUSSION

8. Table 1 presents the means and standard deviations for the endurance time and the submaximal and maximal heart rates. Submaximal HR was analyzed through the 1200 kpm workload as all subjects completed this level under the four treatment conditions. MAX HR was determined during the last 20 seconds of exercise. A one-way repeated measures ANOVA was performed on each of the seven variables in order to determine differences among the treatment conditions. Although the mean values in table 1 indicate a greater endurance time and higher HR during most levels of exercise following the consumption of amphetamine, only the MAX HR (Table 2) values reached conventional levels of significance ($P<.05$). The F ratio for MAX HR was 4.39; 2.90 was needed for significance. The Neuman-Keuls analysis (Table 3) revealed all three dosages of amphetamine elicited a higher MAX HR than the placebo, but were not significantly differentiated from each other.

9. The predominant theory relative to work capacity and amphtamines indicates they exert a direct sympathomimetic effect upon the CNS. Peripheral effects include increased heart rate and cardiac output, increased blood pressure and increased glycogenolysis-factors which may offer physiological rationale for increased muscular endurance capacity. If the amphetamine-induced increase in cardiac output would be additive to the increase normally associated with exercise, max VO_2 might increase and consequently enhance endurance. However, Margaria and others (21) revealed no significant effect of 10 mg pervitan upon max VO_2.

10. In general, the results of this study concur with the majority of other reports involving the effect of amphetamine on endurance capacity. Golding and Barnard (12) reported no effect of 15 mg d-amphetamine sulfate upon treadmill endurance time with a constant workload of 10 mph at 8.5 percent grade. Karpovich (17) also reported 10 mg amphetamine did not influence performance of a treadmill run to exhaustion at 7.2 mph and 5 percent grade. Studying the effect of phenamine on bicycle ergometer performance as well as other standardized work tasks, Bujas and his colleagues (5) concluded amphetamines do not affect performance of a subject who is in a state of physical freshness and good motivation for work. Foltz and others (10) revealed no significant effect of 10 mg amphetamine upon bench stepping performance. In a subsequent study using a workload of 1235 kgm on a bicycle ergometer, Foltz (11) reported no effect of benzadrine upon work capacity, but a beneficial effect of pervitin (a stronger amphetamine) upon the same test of work capacity. However, his N of four was extremely small.

11. In other studies that are not in agreement with the results of the present investigation, several methodological problems existed. Knoefel (18) reported an ergogenic effect of 10-20 mg benzedrine and pervitin upon a progressive bicycle ergometer task. Five of his seven subjects exhibited greater work output; however, no evidence of counterbalancing the order of administration of the tests was indicated. Cuthbertson and Knox (8) also indicated increased endurance capacity on a bicycle ergometer following the ingestion of 15 mg benzedrine or 10 mg methedrine. No statistical analysis was performed, and as the authors noted, there was wide

individual variation. The percentage increase in performance under the influence of amphetamines were often interpreted, in these older reports, as a significant effect even though no statistical analysis was performed. If the same criteria were applied to the present study, an average 3.5 percent increase in endurance performance would be found between the placebo and drug effects. However, the statistical analysis indicated no significant difference among the three drug conditions and the placebo condition.

12. One of the underlying purposes of this study was to evaluate the effect of increasing dosages of amphetamine upon muscular endurance. The absence of a significant F ratio eliminated any need for trend analysis; furthermore, inspection of the means in Table 1 reveals nearly identical values for endurance time under the three drug conditions.

13. Although the mean values for the heart rate under all drug conditions were higher than the placebo test for the vast majority of the submaximal exercise periods, no significant differences were noted. These findings are in contrast to Bujas and his colleagues (5) who reported a higher pulse rate during rest and during work when under the influence of phenamine. Administering 5mg dexedrine, Blyth and his associates (4) reported a significantly higher HR during submaximal work as contrasted to the placebo condition.

14. The finding of increased MAX HR following all dosages of amphetamine is in contrast to several reports. Using 10 mg pervitin with three trained subjects, Margaria and others (21) indicated the MAX HR was unaffected by this dose of amphetamine, and

Wyndham and his colleagues (40), using two champion bicyclists, noted no differential effect of amphetamine upon MAX HR.

15. Although it may appear that the greater MAX HR under amphetamine conditions, as contrasted to the placebo, would indicate the subject could drive himself to a higher level, the increased HR may be offset by a concomitant decrease in stroke volume, thus not affecting cardiac output. In addition, MAX HR in itself, does not appear to share any substantial common variance with endurance capacity, as reflected by an r=-.19 between MAX HR and endurance time.

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CONCLUSIONS

This investigation would seem to permit the following conclusions:

1. Varient dosages of d-amphetamine sulfate do not increase maximal endurance capacity as tested on a bicycle ergometer.

2. Varient dosages of d-amphetamine sulfate do not significantly affect the HR during submaximal work.

3. A small, moderate and large dose of d-amphetamine sulfate caused a significant increase in the MAX HR. However, further research in needed to substantiate this point.

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TABLE 1. MEAN AND STANDARD DEVIATIONS FOR ENDURANCE TIME AND SUBMAXIMAL AND MAXIMAL HEART RATES

	PLACEBO		SMALL DOSE		MODERATE DOSE		LARGE DOSE	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Endurance Time (Seconds)	391.16	72.92	407.41	84.77	404.33	59.80	406.91	73.32
400 kpm-HR	119.75	13.38	123.25	14.77	125.66	19.29	123.50	15.60
600 kpm-HR	133.25	15.89	137.75	17.74	140.25	18.58	140.25	19.48
800 kpm-HR	156.75	15.30	156.50	17.94	158.50	17.99	160.75	17.56
1000 kpm-HR	163.16	15.00	166.33	18.37	167.75	16.25	170.25	16.18
1200 kpm-HR	170.00	14.03	175.50	16.99	173.75	14.99	176.75	16.99
Maximal HR	184.75	12.30	190.25	10.10	188.75	11.11	189.50	10.99

TABLE 2. REPEATED MEASURES ANOVA FOR MAXIMAL HEART RATE

SOURCE	DF	MS	F
Treatment	3	72.16	4.39[B]
Residual	33	16.41	

B = $P < .05$

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TABLE 3. NEUMAN-KEULS MULTIPLE RANGE TEST FOR MAXIMAL HEART RATE

COMPARISON	OBSERVED DIFFERENCES	VALUE NEEDED FOR SIGNIFICANCE
MAX HR		
Placebo - Small Dose	5.50[B]	4.47
Placebo - Moderate Dose	4.00[B]	3.37
Placebo - Large Dose	4.75[B]	4.06
Small Dose - Moderate Dose	1.50	4.06
Small Dose - Large Dose	.75	3.37
Moderate Dose - Large Dose	.75	3.37

[B] $P<.05$

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