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THE EFFECT OF CARRYING VARIOUS
BACKPACK LOADS ON SERUM CREATINE PHOSPHOKINASE
(CPK)

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SUMMARY

↓ This study was designed to examine serum creatine phosphokinase (CPK) response of walking with various backpack loads. Twelve, healthy, male volunteers attempted eight, 12-hour treadmill walks at three mph at a 0% grade (20-minute walk/40-minute rest per hour). Subjects carried either 0, 25, 50, or 75% of their respective body weights (BW) as a backpack load during the walks. Each subject performed half of the eight walks wearing a light weight cotton uniform (CAMMIE) and the other half wearing a chemical defense uniform including mask (MOPP). Blood samples were obtained before and after each walk. Results demonstrated that 0% and 25% loads did not significantly ($p < 0.05$) elevate serum CPK levels. The 50% and 75% loads, however, resulted in significant increases in CPK following both MOPP and CAMMIE trials. Lastly, there was a linear increase in both post-exercise CPK, and delta CPK when compared across 0, 25, and 50% work loads. No difference was found, however, between MOPP and CAMMIE trials. These results suggest that significant skeletal muscle damage occurs when carrying backpack loads of greater than or equal to 50% of body weight. Furthermore, the magnitude of increase in CPK is linearly related to intensity of work.

Keywords: Chemical Defense, Creatine Phosphokinase, CPK, Sustained Operations, Backpack Loads, Lactate Dehydrogenase, CAMMIE, MOPP

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(16)

INTRODUCTION

Several previous studies (Fowler et al. 1968; Gardner et al.; Houston et al; Pate et al. 1978) have shown that prolonged, strenuous exercise produces an elevation in serum enzyme levels in humans. In particular, the serum level of creatine phosphokinase (CPK) is known to increase following exercise, with skeletal muscle being the predominate source (Siegal et al. 1978).

Although it is clear that exercise will produce changes in the serum CPK level, previous studies have drawn conflicting conclusions regarding the relative importance of intensity and duration of work in relation to the exercise-induced increase. For example, Shapiro et al. (1978), Hunter and Critz (1971), Cerny and Haralambie (1975), and Pate et al. (1978) all have shown that intensity is the major factor. On the other hand, Gardner et al. (1964), Fowler et al. (1968), and Sanders and Bloor (1975) have reported that the duration of exercise is the factor most responsible.

Interestingly, in most of the above cited studies, the intensity of exercise was varied by changing the speed at which the subject ran or walked. Such a design has limited practical applications for backpacking or military field operations where a major factor involved with intensity is the weight of the pack or carried load.

In light of the above, the purpose of this study was designed to examine the serum CPK response of walking with various backpack loads. Such a design has direct military applications, and should help to answer the intensity vs. duration question that exists in the literature.

METHODS

The subjects for this study were 12 healthy, male volunteers. Each subject performed a maximal treadmill test, and attempted eight, 12-hour treadmill walks. The eight treadmill walks consisted of walking at three mph at 0% grade (20 minutes on, 40 minutes off) carrying either 0, 25, 50, or 75% of their body weight as a backpack load. Each subject performed all of the above procedures (i. e., maximum test, walks with 0, 25, 50, and 75%) both by

wearing a light weight cotton camouflaged uniform (CAMMIE) and while wearing a chemical defense uniform (MOPP). The order of the eight treadmill walks was randomly assigned. Blood samples were obtained via venipuncture from an antecubital vein before each trial and at five-minute post exercise.

Blood samples were centrifuged for 10 minutes, and the resulting serum was analyzed for CPK, lactate dehydrogenase (LDH), lactate, and hemoglobin. CPK was measured enzymatically using a modification of procedure outlined by Szasz et al. (1976). The test-retest reliability was 0.92. LDH was measured using the enzymatic procedure of Wacker et al. (1956), and had a reliability of 0.91. Lactate was measured using a Y.S.I. lactate analyzer. The test-retest reliability was 0.94. Lastly, hemoglobin was measured using the cyanide technique, and had a reliability of 0.86.

Paired t-tests were used to determine if significant differences existed between the pre- and post-value for each condition. Significance was set at the $p < 0.05$ level, and was adjusted using the Bonferroni correction. Pearson product-moment correlations were computed on relevant variables.

RESULTS

Creatine Phosphokinase (CPK)

Mean CPK levels were unchanged following either of the maximal treadmill tests (CAMMIE: Pre-test = 86 IU/L and Post-test = 95 IU/L; $P = 0.3$; MOPP: Pre-test = 111 IU/L and Post-test = 109 IU/L; $p = 0.7$). These results were expected since the maximal treadmill tests lasted for only 10-15 minutes; minimal skeletal muscle damage probably occurred.

Figure 1 presents the mean CPK levels before and after the 12-hour walks with 0% load. As illustrated, neither the CAMMIE or MOPP trial resulted in a significant increase in CPK.

Figure 2 presents the CPK data obtained before and after the 12-hour walks with the 25% load. Again, neither the CAMMIE nor MOPP trial resulted in a significant increase in CPK.

Figure 1
PRE and POST CPK with the 0% load

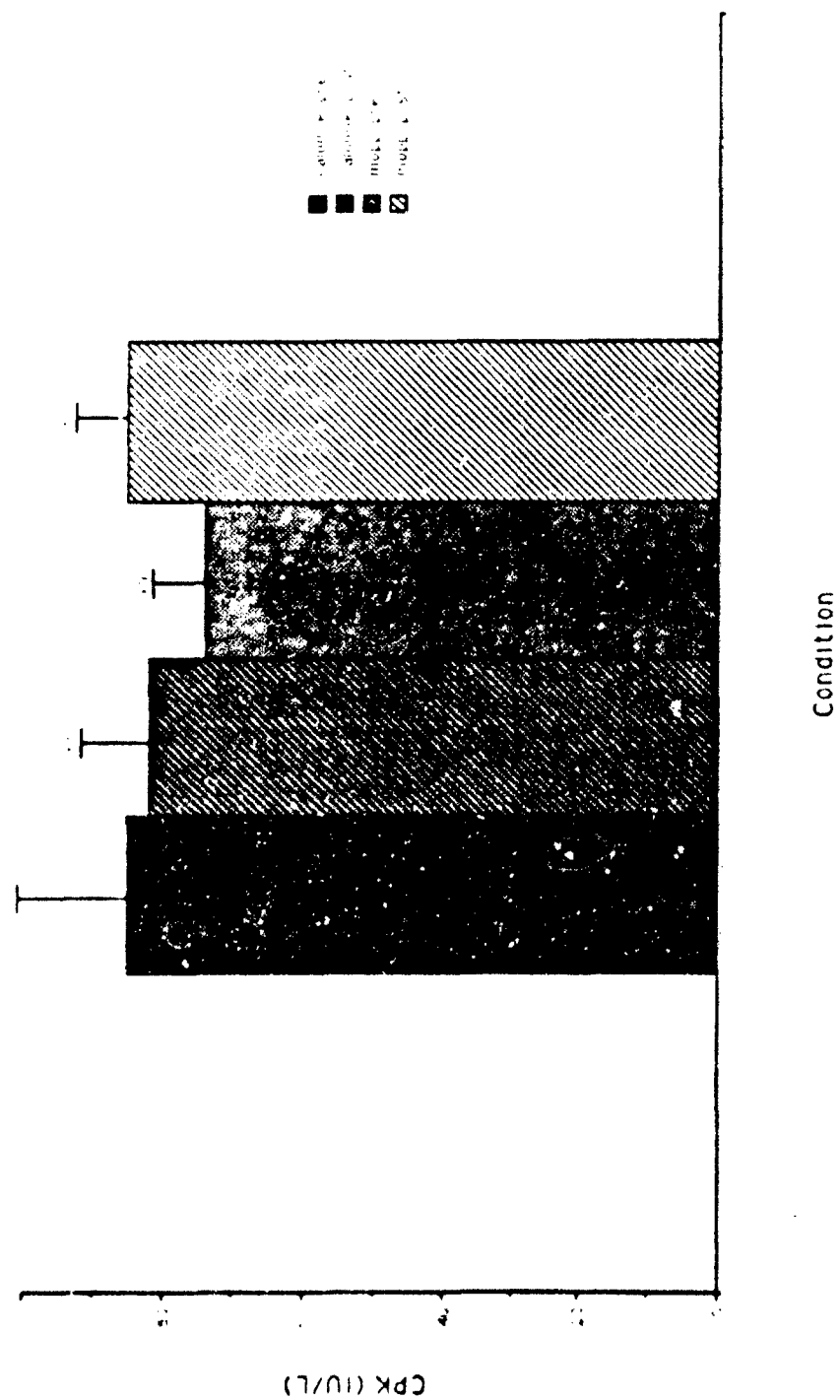


Figure 2
PRE and POST CPK with the 25% Load

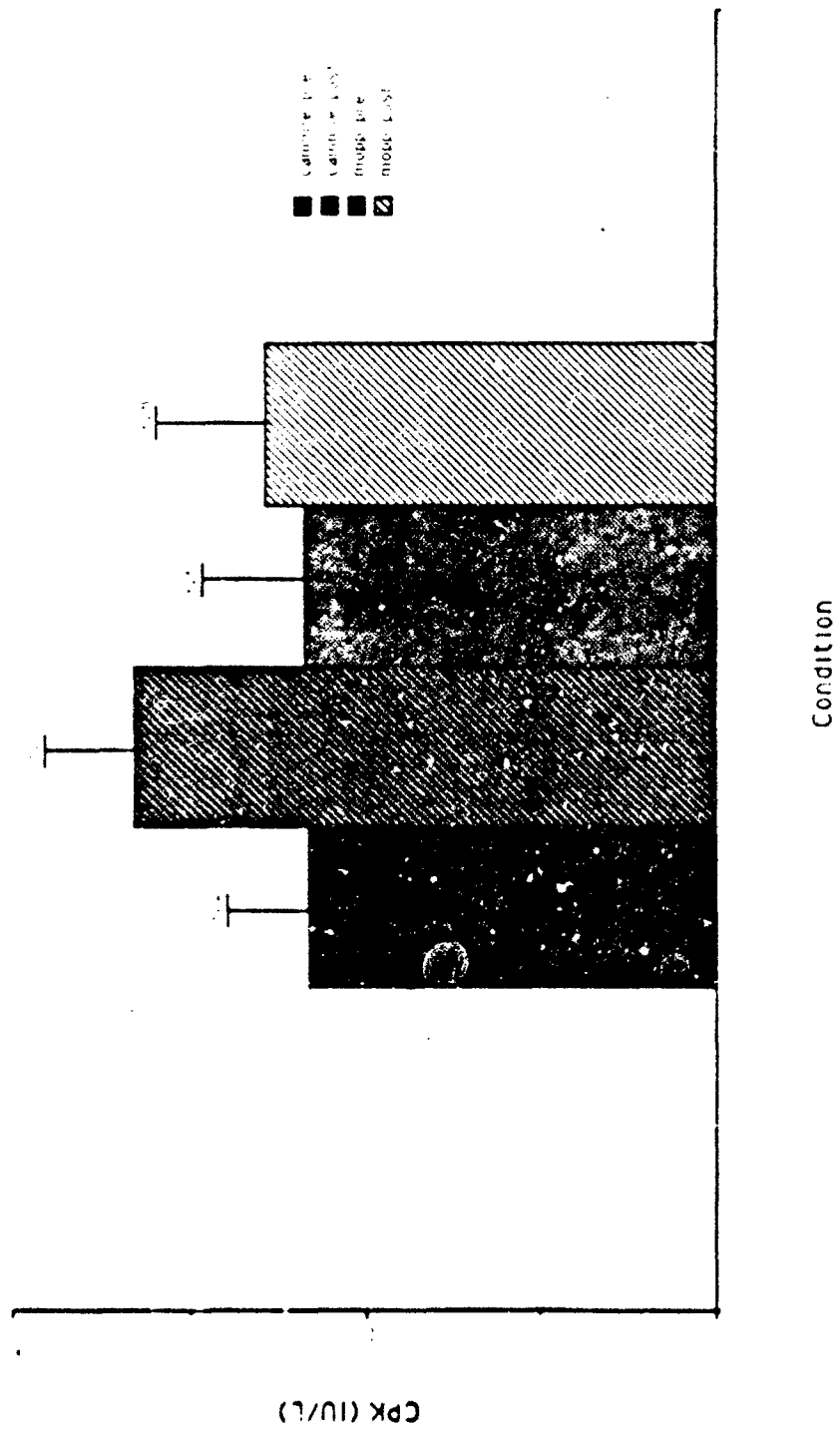


Figure 3 presents the pre- and post-CPK values for the 50% load trials. In this case, both the CAMMIE and MOPP trials resulted in significant ($P = 0.002$ and 0.003 , respectively) increases in CPK. The CAMMIE and MOPP trials, however, did not differ significantly in the delta (Post value - pre value) CPK response: MOPP delta = 113 IU/L , CAMMIE delta = 111 IU/L .

Figure 4 presents the CPK values obtained before and after the 75% loads. Again, both conditions resulted in significant increases in CPK (MOPP: $P = 0.001$, CAMMIE: $P = 0.002$). Interpretation of the data from the 75% load conditions, however, must be viewed cautiously since the subjects, due to fatigue, only performed a mean of 5.5 sessions (i. e., one session = a 20-minute walk and a 40-minute rest) during these trials, while they performed 10-12 sessions during the 0, 25, and 50% trials. Because of these differences, direct comparison between the 75% load and the other conditions is difficult, and, therefore, data from the 75% trial has been left out of subsequent analyses. However, it should be noted that the 75% load data is underestimated since it was obtained approximately six hours earlier than the other trials. A summary of all pre- and post-CPK data obtained from all four trials is presented in Table 1.

TABLE 1

Creatine Phosphokinase (CPK) Values Before and After the 12-Hour Walks
in CAMMIES and MOPP Gear

	0% Load		25% Load		50% Load		75% Load	
	CAMMIE	MOPP	CAMMIE	MOPP	CAMMIE	MOPP	CAMMIE	MOPP
Pre	85±17	74±9	117±22	118±26	89±14	125±38	76±10	107±19
Post	82±11	85±7	166±26	129±28	198±31	238±64	180±31	156±22

CPK values are expressed in IU/L.

Values are means ± S. E.

Figure 3
PRE and POST CPK with the 50% Load

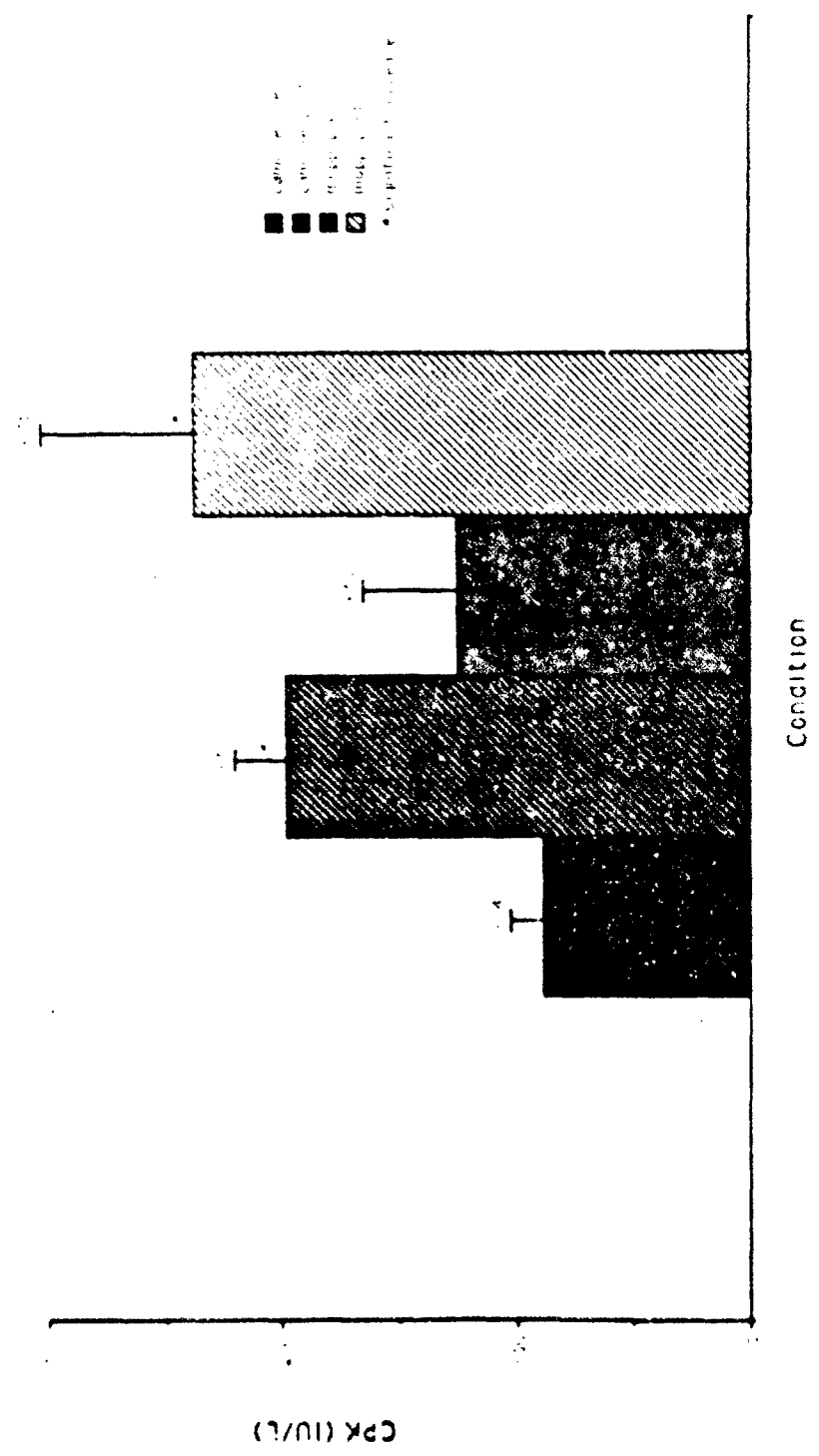


Figure 4
PRE and POST Cpk with the 75% Load

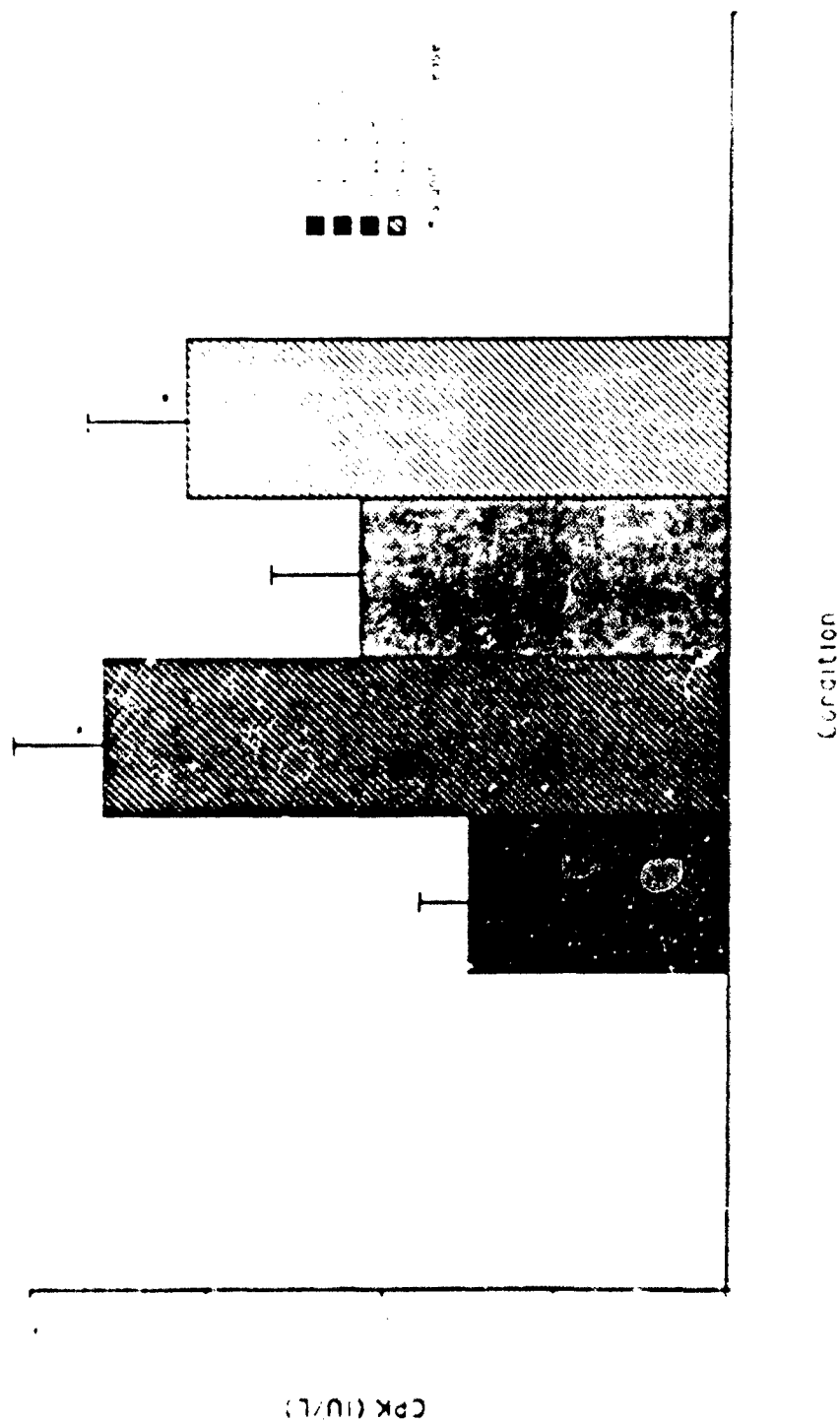


Figure 5 shows that there was essentially a linear increase in the post-exercise CPK values obtained for the 0, 25, and 50% load trials. Furthermore, the linear trends were similar for the CAMMIE and MOPP conditions, with the CAMMIE condition having a slope of 2.3, and the MOPP having a slope of 3.0 IU/L.

Figure 6 shows that the delta CPK values also increased in a linear fashion with increasing pack weight. Again, the MOPP and CAMMIE conditions produced similar results.

LACTATE

The pre- and post-lactate data following maximal treadmill tests is presented in Figure 7. Both the CAMMIE and MOPP trials resulted in significant increases in lactate. There was no significant difference, however, between the post-test data of the CAMMIE vs. MOPP trials. This suggests that the MOPP uniform did not inhibit nor enhance anaerobic energy production during the maximal effort.

Table 2 shows the pre- and post-lactate data for all four loads (0, 25, 50, and 75%). Interestingly, there was no change in lactate after any pack load condition. In fact, all values were within a 1mM range.

TABLE 2

Lactate Values Before and After the 12-Hour Walks in CAMMIE and MOPP Gear.								
0% Load		25% Load		50% Load		75% Load		
CAMMIE	MOPP	CAMMIE	MOPP	CAMMIE	MOPP	CAMMIE	MOPP	
Pre	1.6 $\pm$.2	1.8 $\pm$.1	1.7 $\pm$.2	1.8 $\pm$.2	1.7 $\pm$.2	1.5 $\pm$.2	1.8 $\pm$.2	1.8 $\pm$.2
Post	1.0 $\pm$.1	1.0 $\pm$.1	1.2 $\pm$.1	1.1 $\pm$.2	1.3 $\pm$.2	1.1 $\pm$.1	1.6 $\pm$.2	1.5 $\pm$.1

Lactate values are expressed in mM/L.

Values are means $\pm$ S. E.

Figure 5 - POST CPK at the 0, 25, and 50% Loads

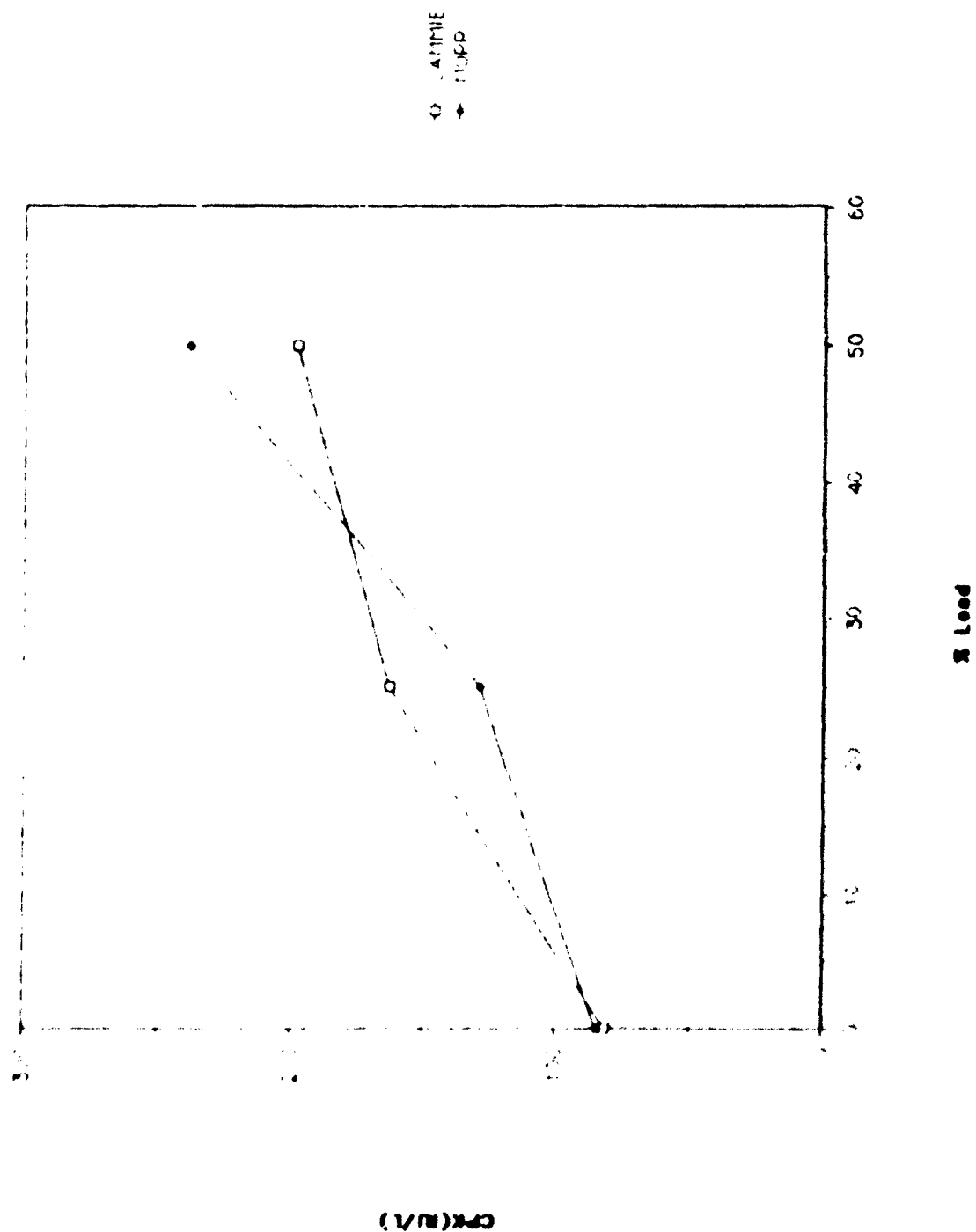


Figure 6 - Delta CPK at the 0, 25, and 50% Loads

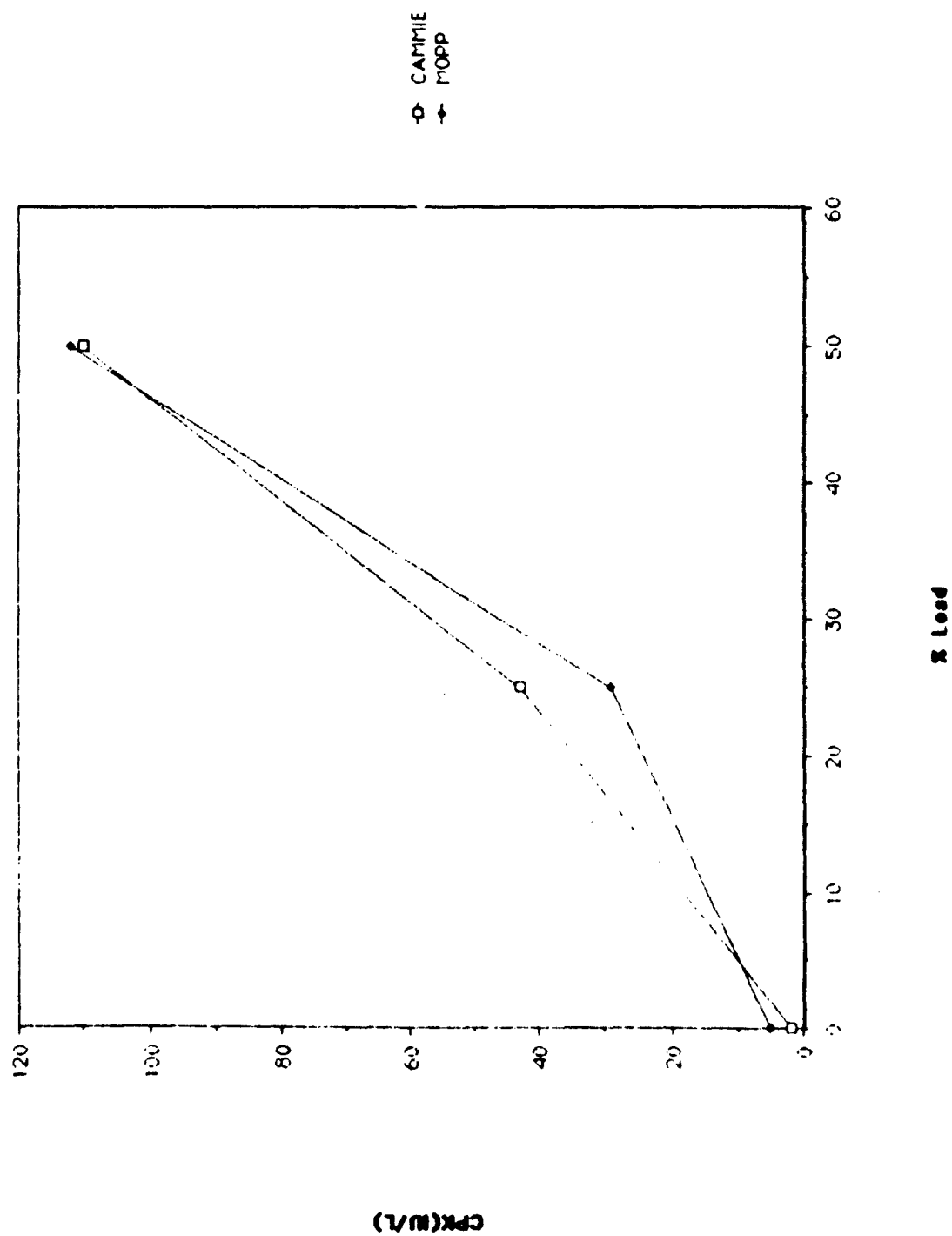
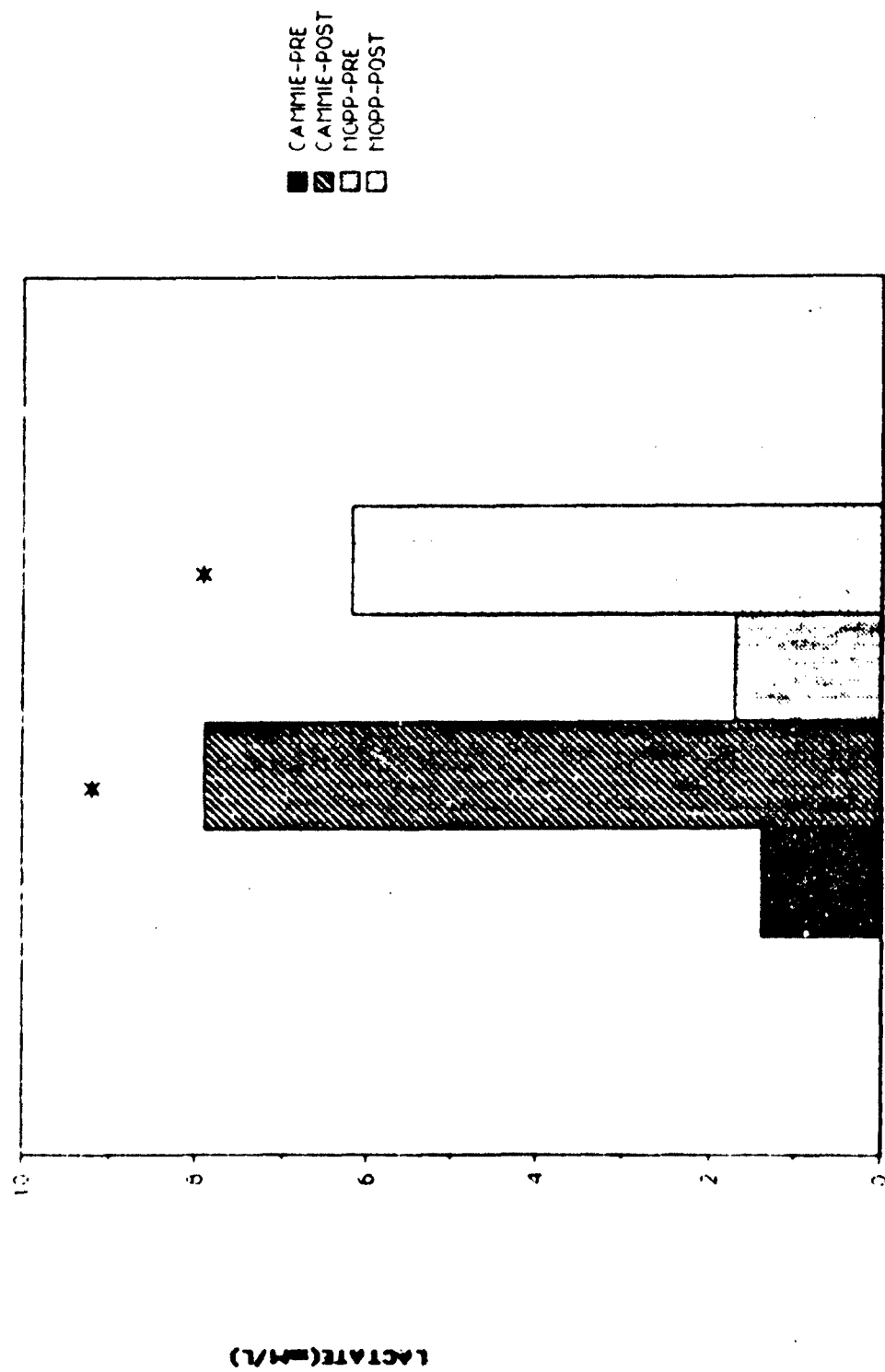


Figure 7

PRE and POST LACTATE with the MAX Load



PLASMA HEMOGLOBIN

Plasma hemoglobin levels were below the measurable range in all samples. This finding suggests that intravascular hemolysis was minimal under all of the tested conditions.

LACTATE DEHYDROGENASE (LDH)

Mean LDH levels were within the "normal" range for all pre- and post-exercise conditions. This finding agrees with the work of others (Hunter and Critz, 1971, and Sanders and Bloor, 1975) and suggests that LDH levels are not a sensitive index of exercise stress.

DISCUSSION

The major finding of this study is that the CPK data suggests that there is a linear increase in skeletal muscle damage with increased backpack loads. As illustrated in Figures 6 and 7, both mean post-exercise CPK values, and delta CPK values increased in a linear fashion with increased pack weight. Such a finding is in agreement with the data of Pate et al. (1978), and Cerny and Haralambie (1975). Both of these studies showed that increases in CPK are related to the intensity of work. For example, Pate et al. (1978) found a linear increase in CPK with increased work loads between 60 and 80% VO_2 max. Specifically, they reported a mean 8% increase following 60 minutes of treadmill running at 60% VO_2 max, a 26% increase following 70% max, and a 43% increase following 80% max. Both of the above studies, however, increased the work load by increasing the running speed of the subjects. This study is the first to report that increasing work load by increasing the backpack load (i.e., 0, 25, 50 or 75% of body weight) during a constant three mph walk also results in a linear increase in CPK levels. Such a finding has direct practical application to both recreational and military personnel, both of whom can alter the intensity of work via changes in backpack weight.

Interestingly, Figures 1 through 6 show essentially identical CPK responses between the CAMMIE and MOPP conditions. These data suggest that wearing the MOPP uniform does not accentuate skeletal muscle damage during exercise.

Lastly, it has been previously suggested (Houston et al. 1978) that increases in CPK levels are related to the degree of anaerobic stress experienced by the individual, and that muscle hypoxia is the primary factor in elevating serum enzyme levels during exercise. The results of the current study do not support this hypothesis since there was no relationship ($r = -0.32$, n. s.) between mean CPK levels and blood lactate levels.

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