

Blood Pressure Responses During The USFS Arduous Wildland Firefighter Pack Test

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General Summary

Forty-six healthy individuals were evaluated to see if load carriage during the arduous pack-test required by the U.S. Forest Service and BLM for wild land firefighters, increases blood pressure (BP) over similar intensity exercise without carrying a pack.

The results showed that there is a slight increase in BP during the pack test over not carrying the load, but in healthy individuals the increase is very minimal (< 4 mmHg). However, in individuals with elevated resting BP, there seems to be an exaggerated BP response to the pack test. While further study, in individuals with high blood pressure needs to be completed, the data from this study suggest that



even modest increases in resting BP result in exaggerated BP response during load carriage. The subjects in this study all remained within safe limits, but if the trends continued,

hypertensive individuals could have systolic BP values during the pack test that would put them at increased risk for cardiovascular events.

Older individuals, and individuals with known high blood pressure, should be screened prior to the pack test and closely observed if medical permission is given to take the pack test.



Scientific Summary begins on the following page.

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Abstract

The USFS pack test requires carrying a 20.5kg pack for 4.8 km in less than 45 minutes. The test is used as the fitness criteria for most wildland firefighting positions in the U.S. where individuals will work in proximity to the fire line. Purpose: To evaluate the blood pressure (BP) response to the pack test compared to exercise performed at the same metabolic workload without the pack. Subjects were apparently healthy students recruited by word of mouth (N=46,



females=23, males=23). Methods: Subjects walked for at least five min at 107.2 m/min (4 miles·hour⁻¹) at a one percent incline while wearing a 20.5 kg pack to simulate the pack test. BP measurements were taken at min 3 and 5. HR and VO₂ were also monitored continuously. ACSM metabolic equations (Kenney 1995) were then used to estimate the % grade necessary to duplicate the average VO₂ requirement of the pack test at 4 miles·hour⁻¹. Subjects then walked at the predicted grade. Adjustments to the grade were made if necessary until steady state oxygen consumption was within ±0.2 ml·kg⁻¹·min⁻¹ of the

pack trial. BP was taken again at min 3 and 5 while HR and VO₂ were monitored continuously. These two trials, pack and no pack, were repeated a second time in random order. Results:

Although there were no differences in the metabolic demand (VO₂), there was a small significant increase in both systolic and diastolic blood pressure with pack carriage (Δ systolic = 3.2 ± 8.1 mmHg, Δ diastolic = 2.9 ± 3.3 mmHg). Additionally, the 15 subjects with the highest resting SBP values (mean = 137.2 ± 4.2 mmHg) increased their SBP 12.9 ± 3.26 mmHg more with load carriage than during uphill walking. The 15 subjects with the lowest resting SBP had lower exercise SBP and DBP responses with no difference between modes. Conclusion: These data suggest that there may be a more exaggerated BP response to the USFS pack test in individuals with existing or borderline hypertension. Additional attention prior to completion of the pack test to minimize work related injury might be indicated in at risk individuals.



Introduction

For firefighters who will be on the fire line, the U.S. Forest Service and Bureau of Land Management requires passing the 'arduous' Pack Test requiring walking on a flat, 4.8 km (3 mile) trail carrying a 20.5 kg (45 lbs) pack in less than 45 min. Over the past few years a small number of incidents have been associated with the administration of the Pack Test raising concerns over possible cardiovascular events and even a few fatalities during the administration of the Pack Test. However, there has been no overall increase in cardiovascular (CV) events since the incorporation of the pack test. In the decade prior to Pack Test there were an average of 3.2 fatalities/year related to CV events. During the 2000 fire season, with 25% more individuals in the field and many retired or older firefighters recalled there were only 2 fatalities.



Purpose

The purpose of this study was to evaluate the blood pressure (BP) response to the pack test compared to exercise performed at the same metabolic workload without the pack.

Methodology



Subjects (N=46) were healthy individuals, mostly between 18 and 25 years of age with a few older individuals. Subjects were similar in fitness and age to new fire-recruits. Descriptive data were collected on all subjects. Height and weight were measured and BMI was calculated.

A graded exercise test (4mph, 1% grade increase each minute to volitional exhaustion), was used to evaluate VO_2 max. Metabolic data were collected using a calibrated metabolic cart (Parvo Medics, Salt Lake City) and a workload, without a 40 pound pack, similar to that required for the pack test was determined.

Subjects then performed two trials in the following order. The first trial was a simulated pack test on a treadmill walking at 4 mph (107.2 m/min) at a 1% incline to simulate outdoor walking while wearing a 45-pound (20.5 kg) pack. Subjects walked a minimum of 5 minutes or more until BP and HR were at steady state. Blood Pressure was taken at min 3 and 5 (and again at 7min if values at 3 and 5 minutes were not consistent). HR and VO_2 were monitored continuously using a metabolic cart and polar HR monitor.

The second trial consisted of walking at 4 mph (107.2 m/min) up an incline simulating VO_2 ($\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$) the workload during the pack trial but without a pack. ACSM metabolic equations (Kenney 1995) were used to estimate the % grade necessary to duplicate the avg. VO_2 requirement of the pack test. Subjects walked at predicted grade. Adjustments were made if necessary until a steady state O_2 consumption within $\pm 0.2 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ of the pack trial was achieved. The pack trial VO_2 averaged $24.4\pm 2.1 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$. BP taken at min 3 and 5 and again at 7 min if necessary to reach steady state. HR and VO_2 were monitored continuously during the trials.

The two trials were repeated a second time in random order and the values from the two tests of each mode (with and without pack) were averaged.

Means and standard deviations were calculated for the descriptive data. A within subjects T-test was then used to evaluate pack vs. no-pack differences for SBP, DBP and VO_2 .

Results

Descriptive Data:

N = 46 (females=23, males=23)
 Age = 22.7 \pm 2.07 years
 Weight = 73.8 \pm 13.9 kg
 Height = 174.0 \pm 9.1 cm
 BMI = 24.2 \pm 3.2
 VO_2max = 48.1 \pm 6.8 $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$

Figure 1 shows that there was no difference in aerobic work between the pack and no-pack trials. Differences in blood pressure should thus be related to differences in load carriage.

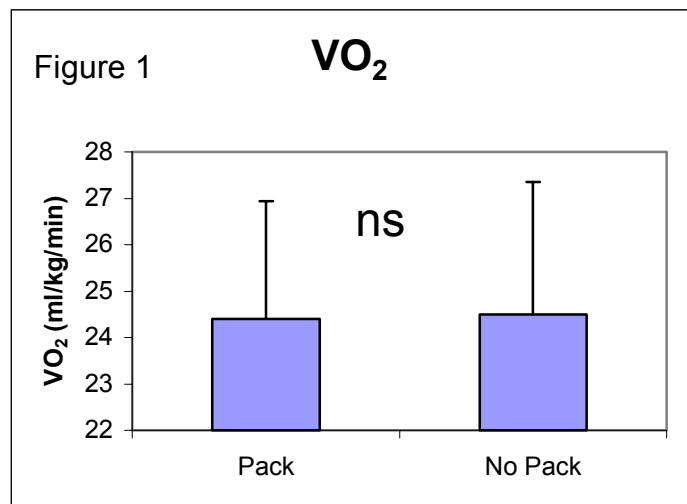


Figure 2 shows that there was a small 3.1 mmHg increase in Systolic Blood Pressure during the pack trial compared with the no-pack trials.

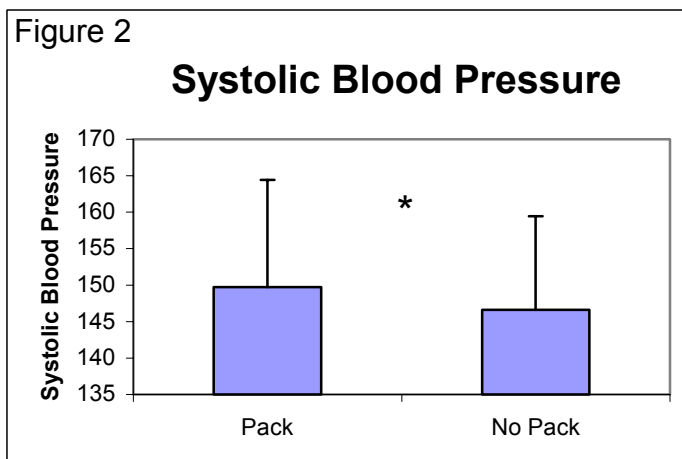
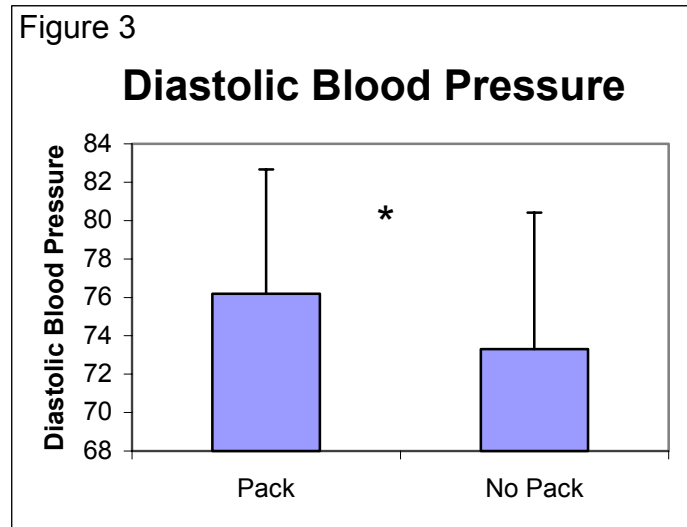


Figure 3 shows that there was a small 2.9 mmHg increase in Diastolic Blood Pressure during the pack trial compared with the no-pack trials.



In the 15 subjects with the highest resting SBP (mean resting SBP = 137.4 mmHg), their average SBP during the exercise trials increased 12.9 ± 3.26 mmHg more with load carriage than during uphill walking. This difference was much greater than the overall group difference between trials of 3.1 mmHg. In the 15 subjects with the lowest SBP (mean resting SBP = 116.4 mmHg) there were no differences in SBP and DBP responses between pack and no-pack modes.

Discussion

Overall, in this group of healthy, normo-tensive individuals, pack carriage vs. similar work of uphill walking slightly increased SBP and DBP. This slight increase is not of concern as the average value of 149.7 mmHg is normal for this intensity of exercise. However, when the subjects with the highest resting systolic blood pressure were evaluated their blood pressure response to load carriage was much more exaggerated than the response to similar work without load carriage. While the systolic BP remaining relatively safe (165.3 mmHg) it was higher than expected for this work rate.

These data suggest there may be a more exaggerated BP response to the USFS arduous pack test in individuals with existing or borderline hypertension than in individuals with normal BP. These data were from a healthy, moderately fit, young sample. Further research needs to be conducted in a typical wildland firefighter population including individuals with greater risk for CVD. If the trend for individuals with higher baseline SBP to have an exaggerated BP response to load carriage increases with hypertensive individuals older individuals, and those with elevated BP may be at increased risk for CV events during the pack test and may require screening prior to participating.

Acknowledgements

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