Dynamic Chiropractic

SPORTS / EXERCISE / FITNESS

Exercise Physiology Issues, Part III

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Exercise and HDL Cholesterol

An inverse relation between blood concentrations of high-density lipoprotein cholesterol (HDL-C) and coronary heart disease has been described, and exercise training has been shown significantly to increase concentrations if HDL-C. Harley et al.,[1] examined exercise as a factor in elevating HDL-C concentrations in middle-aged male runners. Studies were done in 147 runners and joggers aged 35-66 years and 78 healthy control men in the same age range. Fifty-nine runners were classified as a high-mileage group, having averaged 25 miles a week or more for at least six months.

The groups were similar in age and height. Total cholesterol concentrations were significantly lower in the high-mileage group than in controls. Plasma HDL-C concentrations were significantly higher in both groups of runners than in controls and higher in the high-mileage group than in the low-mileage group. Runners had lower triglyceride concentrations than inactive subjects. The ratios of HDL-C to total cholesterol were 35% in the high-mileage group, 28% in the low-mileage group and 21% in the control group. The distance run in the past year was significantly correlated with HDL-C concentration in both groups of runners. Group differences in HDL-C concentrations remained when body weight and cigarette smoking were controlled for.

Jogging 11 miles a week may for some men result in dramatic increases in HDL-C, whereas others have only modest increases despite running as much as 40 miles a week. In general, the data support the view that regular endurance activity elevates HDL-C concentrations over a prolonged period. An exercise-mediated increase in HDL-C concentration may take months or years to manifest itself.

Exercise Endurance Recovery

Much of the work on recovery after either rhythmic or sustained isometric exercise has focused on recovery of strength. Stull et al.,[2] assessed the recovery of submaximal (50% maximum voluntary contraction) isometric endurance after recovery intervals ranging from five seconds to 42 minutes 40 seconds in 22 men with a mean age of 21.8 years. An isometric grip flexion device was used to test each subject 11 times, with at least three days between successive trials.

Recovery was 20% complete in five seconds, 50% complete in 80 seconds and 87% complete in 42 minutes 40 seconds. Inspection of the data suggested that the pattern of recovery was exponential. Analysis of percentage of recovery at various intervals indicated´ followed a three-component exponential curve.

Exercise hyperemia is insufficient to satisfy the metabolic demands of the muscles. Although adenosine triphosphate levels probably remain reasonably constant, levels of creatine phosphate apparently fall significantly during sustained contractions at 30-50% of maximum. Accumulation of lactate and lowering of pH have also been documented. There may also be potassium ion imbalances and an efflux of phosphate ions. These reactions almost certainly have a negative influence on the ability of the contractile apparatus to generate force. Considerably more work is needed to elucidate the physiologic mechanisms responsible for recovery.

Physiologic Response to Weights

Traditional weight training has been shown to improve strength, muscular power, and endurance. Traditional circuit training improves cardiovascular endurance. Wilmore et al.,[3] hypothesized that placing weight training into a circuit training format would promote significant changes in most major components of performance, thus identifying an ideal off-season conditioning activity for many sports.

In circuit weight training, the subject lifts a weight representing 40-60% of maximum strength for that lift as many times as possible in a defined period and, after a short rest interval, proceeds to the next lift. A 10-week program of circuit weight training was evaluated in 24 female and 26 male college students. Three 7 1/2 minute circuits were completed each day, three days a week. Each circuit consisted of 10 stations with 30-second work periods and 15-second rest periods.

No significant changes in weight or fat weight were observed, but lean body weight increased significantly in both men and women, and relative fat decreased in women. The only significant change in girth measurements was that of flexed biceps girth, which increased in both sexes. Treadmill time to exhaustion improved by about 5% in men. Women showed significant increases in maximum oxygen consumption and treadmill time to exhaustion. Flexibility measures showed significant improvement only in women. Men exhibited significant gains in strength for some lifts. Women made gains in strength that were identical to or greater than those made by men.

Circuit weight training appears to be an efficient mode of training for altering body composition, strength, endurance time to exhaustion and, to a limited extent, flexibility. Use of this approach for off-season conditioning programs is advocated for sports that require high levels of strength, power and muscular endurance, and cardiovascular endurance capacity to a lesser degree.

It is often difficult to motivate many patients to perform the necessary endurance training to achieve cardiovascular fitness. It seems to favor increasing strength with weight training. Circuit weight training may be a more appealing form of endurance training for these individuals. However, there is probably no one program that will meet all the requirements of strength, flexibility and endurance. Strength, flexibility and endurance types of exercise must be included in a well-rounded rehabilitation program. Generally, a single portion of the program must not be overstressed at the expense of the rest of the program.

Exercise and Edema

Traumatic edema results from loss of the gradient that causes filtered plasma to be reabsorbed.[4] Disruption of the capillary endothelium causes more plasma protein to enter the interstitial space. This is aggravated by vasodilation due to histamine release after cell death. Enzymatic proteins also increase and contribute to a local increase in osmotic pressure in the interstitium promoting fluid retention. Edema is nearly undetectable until the interstitial fluid volume has risen by more than 30%. The only way that protein is removed from the interstitium is via the lymphatic system. Increased pressure on the connective tissue stretches the anchoring filaments of the lymphatic pores permitting flow into the lymph vessel. The interstitial fluid, as lymph, activates a smooth muscle stretch reflex in the vessel, which causes contraction and promotes lymph flow to the veins. Too large and edematous pressure leads to overdistention of the lymph vessels, making the pores ineffective. Interstitial pressure itself can oppose the flow from lymphatic capillaries; therefore, early treatment to limit edema is important.

Lymph flow can be enhanced by elevation, external compression and muscle contraction. Intermittent compression, massage and elastic support all are effective means of compressing the lymph vessels and moving lymph. Exercise, especially cryokinetics, and high-voltage galvanic stimulation can improve lymph flow and protein mobilization. Both contrast treatment and galvanic stimulation at subthreshold levels can reduce edema. Once interstitial fluid has been reabsorbed by the circulatory system, treatments that primarily increase circulation, such as a hot whirlpool bath, can be effective. It must be stressed that heat not be utilized until the edema has been reabsorbed by the circulatory system.

Exercise Headache

Rehabilitative activities, especially aerobic movements, may produce effort or exertional headache, which is often associated with nausea and has many features suggesting that it is migrainous.[5] The headache is aggravated by heat and high humidity. The causes of effort headache are unclear, but it is similar to the headache of acute mountain sickness or altitude headache in which cerebral vasoconstriction, edema and subsequent hypoxia may account for the symptoms. Effort headache can occur at any age and in both sexes. Strenuous exertion may induce vascular headache even in´

Intracranial disease must be considered in patients with a picture of effort headache, but recognition of the possibility of benign exertional headache may spare some patients from expensive, potentially harmful studies. Exertional headache may occur in patients with various known intracranial lesions such as subdural hematoma, unruptured cerebral aneurysm or vascular anomaly, or basilar impression. Subarachnoid bleeding from a ruptured aneurysm may follow effort.

Diamond6 studied 15 patients who had prolonged, benign exertional headaches. The eight females and seven males had a mean age of 45 years. Headaches occurred only during physical effort in five patients; the others also had headaches during maneuvers such as coughing and stooping that increase intrathoracic pressure. The site of headache was variable, but it was quite consistent within patients. It was bilateral in nine patients. Headaches lasted a mean of four hours. Both throbbing and stabbing pains were common. Three patients had extremely severe headaches. Two patients also had cluster headaches, and four had nonclassic migraines. Two patients had muscle contraction headaches independent of those occurring during exertion.

Benign exertional headaches occur during maneuvers that increase intrathoracic pressure and in other circumstances in which the blood pressure may suddenly increase, such as excessive exercise. The prognosis appears to be fairly good, although many patients have these headaches for some time. In many cases, no explanation for the headache is found. All patients with prolonged exertional headache should have a complete neurologic examination, cervical spine and skull roentgenography, and computed tomography with infusion. Hypertensive patients should undergo catecholamine studies.

References

1. Harley GH, Hartung, Squires WG. Physician Sportsmed Jan 1980;8:74-79.
2. Stull GA, Kearney JT. Med Sci Sports Summer 1978;10:109-112.
3. Wilmore JH, Parr RB, Dirandola RN, et al. Med Sci Summer 1978;10:79-84.
4. Kolb P, Denegar C. Athletic Training Winter 1983;18:339-341.
5. Massey W. Headache May 1982;22:99-100.
6. Diamond S. Headache May 1982;22:96-98.

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