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ENVIRONMENTAL ERGONOMICS

RECENT PROGRESS AND NEW FRONTIERS

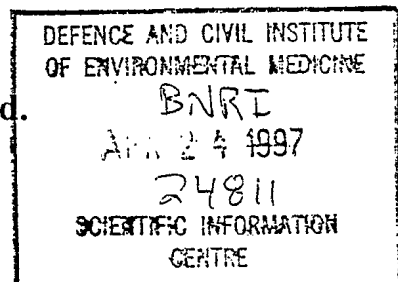
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D. S. Moran
Y. Epstein

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ICEE 96 The 7th International Conference on Environmental Ergonomics
Jerusalem, Israel 27 October - 1 November, 1996

Freund Publishing House, Ltd.
London and Tel Aviv



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ISBN 965-294-123-9

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Suite 500, Chesham House, 150 Regent Street,
London W1R 5FA, England

P.O.B. 35010, Tel Aviv, Israel

PHYSIOLOGICAL CONSIDERATIONS FOR THE USE OF ERGOGENIC AIDS IN MILITARY SETTINGS

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INTRODUCTION

Operational requirements for some military personnel can challenge their physiological capacities. The range of challenges can eventually lead to physical performance impairments and these impairments, and/or the physiological challenge itself, can cause the failure of a mission and may therefore endanger life. Physical performance impairments can be ameliorated by employing "ergogenic aids." Such aids are pharmacological and/or nutritional substances, and physiological procedures or strategies which induce an improvement of one or more physical fitness components. Ergogenic aids (EA) are not only considered to be effective if they improve physical performance, but also if their effect causes a delay, reduction, or avoidance of decrements in physical work capacity caused by various environments (e.g. heat, cold, altitude).

Some EA have significant health risks associated with their use. There are also ethical implications which have linked EA and "cheating" in the minds of the public and the athletic community. There are similarities between elite competitive athletes and some military units in terms of the amount of time dedicated to physical training, and the actual demand for high levels of physical performance. With regard to EA, the difference between athletes and the military is that the "cheating" associated with the use of EA by the former, is of no consequence for the latter. The health risks of employing EA, however, are of concern to both groups, although here again there is an important difference; it is conceivable that health risks might be more acceptable to combat units when they are considered in light of the implications of mission failure.

Competitive athletes and members of combat units share a desire for gaining an "edge" over their opponents, and they are therefore willing consumers of purported EA, frequently expending significant personal financial resources. There are many unsubstantiated claims about the ergogenic effects of nutritional supplements in particular, made by their manufacturers and distributors, which have created a huge commercial market. There is a significant body of scientific literature which documents not only the ergogenic effects of specific EA, but also that there are many purported EA which have no measurable performance enhancement effects. Most of this information has been restricted to scientific *fora*, and has not reached the public at large.

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We were concerned about the lack of information and the misinformation that may prompt military personnel to purchase and use purported EA. Therefore, together with an international group of experts (1) we reviewed EA to evaluate whether or not physical performance is likely to be acutely affected by the use of a specific EA, and any associated health risks. In light of the rapid response capability that characterizes special warfare units, a prime consideration in evaluating the efficacy of a purported EA was if there was a documented or likely "acute" effect of treatment. For the purposes of our review "acute" refers to the effect occurring within one week of treatment. For example, erythropoietin administration will increase red blood cell content in whole blood, and affect endurance exercise performance, but this adaptation requires a few weeks of treatment. Thus, the use of erythropoietin would not be considered an acutely effective EA.

RESULTS AND DISCUSSION

Considering the number of purported EA, our review of relevant literature is too extensive to cite here. A table is shown below, however, in which a summary judgment is made about the efficacy of purported EA. This paper is not intended to be an endorsement for the use of specific substances. Some of the items listed in the table may be controlled, restricted, illegal to possess, or require medical support to be employed because of associated health risks.

Purported Ergogenic Aid	Summary Judgment
Acetazolamide; methazolamide; carbonic anhydrase inhibitor	More research required.
Alcohol; ethanol	Of no known ergogenic benefit.
Amino acid supplements	Unlikely to be effective with acute treatment.
Anabolic steroids; testosterone; androgenic anabolic steroids	Unlikely to be effective with acute treatment.
anti-oxidants	Unlikely to be effective with acute treatment.
Antidiuretic Hormone; vasopressin; DDAVP; 1-desamino-8-D-arginine vasopressin	More research required.
Arginine	Unlikely to be effective with acute treatment.
Aspartate salts; magnesium aspartate; potassium aspartate	More research required.
Bee pollen	Unlikely to be effective with acute treatment.
Beta-adrenergic antagonists; beta blockers; atenolol; propranolol; metoprolol	No known direct ergogenic benefit, but may enhance performance indirectly by effects on arousal and neuromuscular mechanisms which reduce tremor.
Biotin; vitamin H	Unlikely to be effective with acute treatment.
Blood loading; blood doping; induced erythrocythemia; polycythemia	Effective ergogenic aid of benefit to maximal aerobic power. More research required.

Branched chain amino acids (BCAA; leucine; isoleucine; valine)	More research required.
Caffeine; methyl xanthines	Effective ergogenic aid of benefit to aerobic capacity and potential benefit to anaerobic capacity/muscular endurance. More research required.
Carbohydrate	Effective ergogenic aid of benefit to aerobic capacity. More research required.
Carnitine; L-carnitine;	Unlikely to be effective with acute treatment.
Carnosine	More research required.
Choline	Of no known ergogenic benefit.
Clenbuterol; beta-agonist; beta-adrenergic agonist	More research required; based on anabolic mechanism of action it is unlikely to be effective with acute treatment.
Co-enzyme Q; ubiquinone	More research required.
Cocaine	Of no known ergogenic benefit.
Cold adaptation	Unlikely to be effective with acute treatment.
Creatine	Effective ergogenic aid.
Dexedrine; amphetamines	Effective ergogenic aid.
Dichloroacetate: DCA	More research required.
Eccentric exercise training	Effective ergogenic aid of benefit to muscle strength by reducing decreases in strength otherwise caused by subsequent eccentric exercise.
Ephedrine; beta-adrenergic agonist; adrenalin; sympathomimetic; Ma Huang	Of no none ergogenic benefit.
Erythropoietin; recombinant human erythropoietin: r-HEPO	Unlikely to be effective with acute treatment.
Folic acid; folate	Unlikely to be effective with acute treatment.
Furosemide	Of no known ergogenic benefit in humans.
Ginseng; ginsenosides	Unlikely to be effective with acute treatment.
Glycine	Of no known ergogenic benefit. More research required.
Growth hormone; somatotropin	Unlikely to be effective with acute treatment.
Heat acclimatization; heat acclimation	Effective ergogenic aid of benefit to aerobic capacity and general work tolerance in hot environments.
Hydration	Effective ergogenic aid of benefit to maximal aerobic power and aerobic capacity. More research needed.
Hyperhydration; glycerol	More research required.
Insulin	Unlikely to be effective with acute treatment.

Marijuana; cannabis	Of no known ergogenic benefit.
Minerals; calcium; magnesium; phosphorous; zinc; copper; selenium; chromium; iron	Unlikely to be effective with acute treatment.
Modafinil	More research required.
Morphine	No known direct ergogenic benefit, but may enhance performance via perceptual mechanisms due to sedative effects.
Multivitamin supplements	Unlikely to be effective with acute treatment.
Niacin; vitamin B3; NAD/NADP	Of no known ergogenic benefit.
Nucleic acids; inosine; purine ribonucleotide; adenosine; adenine	Of no known ergogenic benefit.
Omega-3 fatty acids	Unlikely to be effective with acute treatment.
Ornithine	Unlikely to be effective with acute treatment.
Pantothenic acid; vitamin B5	Unlikely to be effective with acute treatment.
Phosphate; inorganic, sodium, glucose, or calcium phosphate	Unlikely to be effective with acute treatment.
Plasma volume expansion	Effective ergogenic aid of benefit to maximal aerobic power and capacity.
Salbutamol; albuterol; beta-adrenergic agonists	More research required.
Short term physical training lasting less than 7 days	Effective ergogenic aid of benefit to aerobic capacity, but not maximal aerobic power.
Sodium bicarbonate; sodium citrate	Effective ergogenic aid of benefit to anaerobic power, anaerobic capacity, and muscular endurance. More research required.
Tryptophan	More research required.
Tyrosine	No known direct ergogenic benefit, but may enhance performance via cognitive or perceptual mechanisms.
Vitamin E; a-tocopherol	Unlikely to be effective with acute treatment.
Vitamins; vitamin A, C, E, B complexes, D, K	Unlikely to be effective with acute treatment.

REFERENCE

1. Jacobs, I., Allsopp, A., Goforth, H., Murray, N., Stroud, M. and Vogel J. 1994. Assessment of potential ergogenic aids for elite combat units. Final Report of The Technical Cooperation Program, Subgroup U, Action Group 12.

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