The Whitehall-Robins Report

MARCH 2004 VOL. 13, NO. 1

Nutrition and Physical Activity

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Introduction

Physical activity is important for decreasing risks of cardiovascular disease, hypertension, type 2 diabetes, obesity, cancer, osteoporosis, and early mortality[1-7]. Health Canada recommends that optimal health benefits can be achieved with mild physical activity (i.e. easy walking) for 60 minutes/day everyday, moderate physical activity (i.e. brisk walking or biking) 30 minutes/day, 4 days/week, or vigorous activity (i.e. aerobics, jogging) 20-30 minutes/day, 4 days/week[8]. Activities which increase cardiovascular function (i.e. aerobic exercise) and flexibility (i.e. yoga) should be performed 4-7 days/week, while strength activities should be performed 2-4 days/week. The Centers for Disease Control, the American College of Sports Medicine, and the Institute of Medicine have issued similar guidelines[9-11].

Increased physical activity leads to increased nutritional needs to support increased energy metabolism, and building or repair of tissues such as muscle and bone. Most nutritional needs of physically active individuals can be achieved by increased consumption of energy from a variety of foods. Active people should ensure that they meet the Dietary Reference Intakes (DRIs) to achieve maximal health benefits. This article outlines the roles of the macronutrients and important micronutrients in physical activity, in the context of the DRIs. This article outlines the needs of adults and does not cover children or adolescents. Previous issues of the Whitehall-Robins Report give a complete explanation of DRIs[12,13].

The Macronutrients

Carbohydrates[11,14]: The Recommended Dietary Allowance (RDA) for carbohydrates is 130 g/day, the amount of glucose needed by the brain without development of ketosis. Only people on very low carbohydrate diets would fail to meet this RDA. The acceptable macronutrient distribution range is 45-65% of total calories from carbohydrates. People below this range may be lacking in fiber and water-soluble vitamins, and consuming too much fat, while people above this range may be consuming inadequate fat and protein. A carbohydrate intake above this range may result in elevated triglycerides and decreased high-density lipoprotein, but this may be offset by physical activity. It is recommended that not more than 25% of total calories be derived from added sugars (i.e. sugars and syrups added to food products), and that more slowly-absorbed starchy foods are healthier. Carbohydrates are important for active people for maintenance of blood glucose levels during exercise and to replace muscle glycogen, which is a major fuel source during exercise. Active people should consume between 6 to 10 g carbohydrate/kg body weight/day. The active person can achieve this level and stay inside the acceptable macronutrient distribution range by increasing their caloric intake in proportion to their energy expenditure. Consumption of carbohydrate (i.e. at a concentration of 4-8% in a sport drink) before and during exercise can help enhance performance of endurance activities that last greater than an hour. Consumption of carbohydrate immediately after exercise (i.e. 1.5 g/kg at 2 hour intervals) can enhance the rate of glycogen re-synthesis, allowing a faster recovery before the next exercise session.

Protein[11,14]: The RDA for protein is 0.8 g/kg/day. Physically active people need adequate protein for repair of exercise-induced muscle damage and to support gains in lean tissue mass. Heavy endurance exercise may require a small amount of protein as an energy source. It is suggested that people involved in heavy endurance activity require 1.2 g protein/kg/day and those involved in strength training require 1.6-1.7 g/kg/day. A higher RDA has not been set for physically active people because the evidence to support an increased requirement was not considered strong. In any case, a physically active person can meet requirements if consuming a well-balanced diet of sufficient energy to offset energy expenditure. For people involved in strength training the timing of protein intake may be important to maximize accretion of lean tissue. Protein or amino acid consumption immediately before and after exercise enhances the rate of protein synthesis and accretion of lean tissue mass[15,16]. Some have suggested adverse effects of excessive protein consumption to include bone loss, renal insufficiency, and increased risk of cancer and coronary heart disease; however, the evidence for these risks is weak.

Fat[11]: Adequate fat intake is important for essential fatty acids and absorption of fat soluble vitamins (A, D, E, K). The adequate intake for the essential fatty acid linoleic acid, found in nuts, seeds, safflower and sunflower oil, is 17 g/day for males and 12 g/day for females. The adequate intake for the essential fatty acid alpha-linolenic acid, found in vegetable oils and fish, is 1.6 g/day for males and 1.1 g/day for females. These fatty acids are important for structure of cell membranes and for synthesis of eicasanoids, which are important for immune function, and normal neurological function. Intake of saturated fats (from animal products) and trans-fatty acids (from margarines and vegetable oil shortening) should be limited. This can be achieved by consumption of lean meats, poultry, and low-fat dairy products. The acceptable macronutrient distribution range is 20-35% of total calories from fat. An intake below this range may increase triglycerides and reduce high-density lipoproteins, while an intake above this range can increase risk of heart disease and cancers. There is evidence that active individuals with very low fat intakes may have compromised immune systems[17]. Although fats are a major fuel source during longer-duration exercise, there is little evidence that high-fat diets increase exercise performance[14].

The Micronutrients

The DRIs for vitamins and minerals have been outlined in detail in two previous issues of the Whitehall-Robins Report (January and April 2003)[12,13] and therefore are not repeated here. Important micronutrients for physical activity are discussed below.

B-vitamins[14,18,19]: Thiamin, riboflavin, vitamin B_6, niacin, biotin, and pantothenic acid are involved in energy metabolism, while folate, vitamin B_{12}, and choline are important for cell regeneration. Physically active people need sufficient amounts of B-vitamins because exercise stresses many of the metabolic pathways that require these vitamins. Training results in biochemical adaptations (i.e. increase in muscle mitochondria) that results in increased levels of enzymes that require B-vitamins or their products as co-factors. Exercise may also increase the turnover of these micronutrients, and increase their loss in urine and sweat. Physically active people require B-vitamins for adequate red blood cell production, which is important for oxygen delivery to tissues, and for amino acid and nucleic acid synthesis which is required for protein synthesis, tissue building and repair. Important sources of B-vitamins include fruits, vegetables, legumes, whole grains, milk (for riboflavin), and lean meats (for niacin, thiamin, vitamins B_6 and B_{12}). Separate RDAs have not been set for physically active people, but it is suggested that they may require up to twice the RDA. These increased needs can be met by a higher energy intake to offset increased energy expenditure. Supplementation may be required for physically active people that are trying to lose body mass through energy-restricted diets. Because vitamin B_{12} is mainly found in animal products, vegetarians may also need to consume this as a supplement.

Iron[14,20]: The RDA for iron is higher in pre-menopausal women (18 mg/day) than post-menopausal women and men (8 mg/day) because of menstrual losses. Iron is a constituent of hemoglobin and myoglobin, which are important for oxygen delivery in blood and muscle. Iron is also a constituent of mitochondrial cytochromes, which are important for performance of endurance activities. Physical activity can increase iron losses through sweat and gastro-intestinal blood loss. Runners may also need increased iron intake because of foot-strike hemolysis of red blood cells, a phenomenon where red blood cells are damaged from the impact of the feet while running. Iron deficiency can lead to anemia, which increases fatigue during physical activity. It is recommended that very physically active people, especially female long-distance runners be screened periodically for iron deficiency. The most bio-available form of iron is found in meat, fish and poultry. Iron of lower bioavailability can be obtained from breakfast cereals, legumes and green leafy vegetables. Vegetarians may have increased susceptibility to deficiencies. Iron supple-mentation should be medically supervised because high intake can be toxic.

Calcium: Dietary calcium and physical activity are both important for skeletal health and prevention of osteoporosis[21]. Calcium and physical activity may interact to affect bone health. For example, increased calcium intake without adequate physical activity, as with bed-rest or space flight, is insufficient for preventing loss of bone[22]. Conversely, exercise training may only be effective for increasing bone mass if calcium intake is adequate[23]. Very heavy exercise in hot environments may lead to large losses of calcium through sweat and decreased bone mass, which can be offset by calcium supple-mentation[24]. A higher RDA has not been set for physically active people[25], but because of increased sweat loss, their needs may be slightly higher.

Other micronutrients[14,20,25,26]: Exercise can result in a substantial elevation in oxygen consumption, which increases oxidative damage to DNA and cell membranes. Anti-oxidant micronutrients include vitamins A, E and C, selenium, and beta carotene. Vitamin E, found in seeds and green leafy vegetables, protects cell membranes and interacts with other anti-oxidant micronutrients to increase their effectiveness. Vitamin C, found in fruits and vegetables, is important for collagen synthesis in bone tissue and prevents oxidation of vitamin E. Although acute exercise increases oxidative damage, chronic exercise training can lead to enhancement of the body's natural anti-oxidant system; therefore, there is controversy whether physically active people have an increased need for anti-oxidant micronutrients.

Zinc (mainly from animal products) and magnesium (found in whole grains and green leafy vegetables) are important in energy metabolism and the building and repair of muscle tissue. Most physically active people will consume an adequate amount with increased energy intake, but those attempting to lose weight may be deficient.

Fluid and Electrolytes[14]: Adequate fluid replacement is important, especially in hot, humid environments. Loss of fluid through evaporation of sweat is the body's primary mechanism for cooling during exercise. Excessive fluid loss can compromise the cardiovascular system functions, leading to heat exhaustion or heat stroke, which can be fatal. The recommended consumption of fluid is 400-600 mL in the 2-3 hours before exercise, 150-350 mL at 15 to 20 minute intervals during exercise and 450 to 675 mL of fluid for every 0.5 kg of body weight lost through sweat after exercise. This will vary with intensity and duration of exercise and environmental conditions. Some sodium is lost through sweat; therefore it is recommended that sodium in amounts between 0.5 and 0.7 g/L be included during exercise that lasts more than one hour. The increased sodium will enhance palatability and the desire to drink; therefore increasing fluid consumption.

Summary and Conclusions

Physical activity is important for maintenance of optimal health. An increase in physical activity will increase nutritional requirements, but most of these requirements can be met through a balanced diet[27] that contains adequate energy to offset increased energy expenditure. Those consuming vegetarian diets, low carbohydrate or other weight-loss diets may benefit from multi-vitamin/mineral supplementation.

The Whitehall-Robins Report is a Wyeth Consumer Healthcare Inc. publication that focuses on current issues on the role of vitamins and minerals in health promotion and disease prevention. Complimentary copies are distributed to Canadian health care professionals active or with a special interest in nutrition. Each issue is written and/or reviewed by independent health care professionals with expertise in the chosen topic.

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