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Effect of dietary fat intake on total body and white blood cell fat oxidation in exercised sedentary subjects

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Abstract

The effect of fat intake on total body (TB) and white blood cell (WBC) fat oxidation (FO) was studied during exercise in sedentary subjects. Four men and 6 women consumed diets of 19% and 50% energy from fat for 3 weeks each compared with their regular diet (30%). Before and after each diet, TB FO was measured at each stage of a treadmill test and WBC FO was determined. Fat intake had no effect on TB and WBC FO. Total body FO decreased as exercise intensity increased. WBC FO decreased postexercise as a result of an increase in WBC count. Total body FO in sedentary subjects was not influenced by diet at rest or during exercise. There was no effect from diet but exercise had a small effect on WBC FO. WBC FO may indicate a genetic predisposition for FO.

Keywords: High-fat diet; Respiratory exchange ratio; Oxygen consumption; Energy balance; Genetics

1. Introduction

Fat oxidation (FO) is an important metabolic pathway for energy production particularly during low-intensity and prolonged exercise. The rate of FO varies among individuals. A previous study has shown that total body (TB) FO is very low in patients with genetic

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defects in FO but very high in endurance athletes [1]. Genetic influence may be a primary factor determining the ability to oxidize fat, whereas environmental factors may modulate this pathway.

It has been shown that carbohydrate (CHO) oxidation decreased and FO increased after training when exercising at the same absolute pretraining workload [2,3]. The increased FO posttraining may be a result of changes in mitochondria, including increased size and number and enzyme levels [4-6]. In addition, training may increase capillary density [6], membrane-associated fatty acid–binding proteins [7], and carnitine palmitoyltransferase (CPT) I activity [8], which could enhance fatty acid delivery and transport.

Previous studies in trained subjects have indicated that both short- and long-term high-fat diets can increase FO [9-11] and improve endurance performance [9]. The enhanced performance is most likely a result of glycogen sparing and increased intramuscular fat stores [12,13]. In untrained individuals, higher FO in response to increases in fat content in the diet has also been observed [14].

The rate of FO reported in previous diet and/or exercise-training studies using the respiratory exchange ratio (RER) represents the oxidation of fatty acids mainly in the muscle. As muscles undergo adaptation, FO has been shown to be up-regulated and, thus, determined in part by environmental factors. White blood cells (WBCs) or leukocytes are simple cells that can produce energy through both anaerobic and aerobic pathways [15]. They have been used as a convenient tool for the metabolic study of abnormalities of CHO and fat metabolism [16-19]. A study by Wanders et al [20] has shown that leukocytes were able to oxidize octanoate and palmitate primarily in mitochondria, and the oxidation of these fatty acids was impaired in patients with mitochondrial β-oxidation defects.

Recently, a screening test for fatty acid oxidation was developed by measuring the production of $^{3}H_2O$ from 9,10-^{3}H palmitate incubated with EDTA-preserved whole blood [21]. This method does not require isolation or permeabilization of cells because whole-blood β-oxidation of fatty acids largely represents mitochondrial metabolism in WBC. With this method, it has been shown that patients with β-oxidation defects have low whole-blood palmitate oxidation [1,21,22]. In preliminary work, we found that this assay is valid, reliable, and could apply to the general population because the values were normally distributed [1,22]. The extremely low WBC FO in the patients with FO defects reported in the previous studies [1,21,22] indicates that WBC FO reflects the genetic predisposition for FO. However, environmental factors such as diet and exercise may also play a role on WBC fat metabolism.

The influence of dietary fat intake on TB FO has been extensively studied; however, the effect of dietary fat intake and exercise on WBC FO has not. The purpose of this study was to examine the influence of dietary fat intake on both TB FO and WBC FO in response to maximal exercise in untrained male and female subjects. We hypothesized that high fat intake in individuals on an energy-balanced diet will enhance TB FO but not WBC FO.

2. Methods and materials

2.1. Subjects

Four male and 6 female subjects, aged 18 to 35 years, who did not participate in regular exercise were studied. The study was approved by the Institutional Review Board, and the