Science & Sports (2015) 30, 321—327

Disponible en ligne sur ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com

ORIGINAL ARTICLE

Carbohydrate and fatty acid metabolism responses to a graded maximal exercise test and recovery period in athletes and sedentary subjects

Réponse du glucose et des AGL après un effort maximal chez des sujets sportifs et sédentaires

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Received 16 October 2014; accepted 18 February 2015
Available online 15 July 2015

KEYWORDS
Glycaemia;
Free fatty acids;
Maximal exercise test;
Trained (elite athletes) and untrained subjects

Summary
Objective. — Was to investigate glucose and free fatty acid (FFA) responses to a graded maximal exercise test and recovery period in athletes and sedentary subjects.
Subjects and methods. — Twelve trained man (TG) and twelve untrained men (UTG) performed an incremental maximal treadmill test. Blood samples were taken from all subjects in the morning before, at the end of the test and after 30 minutes of recovery. Insulin, glucose and FFA levels were determined at these points in time.
Results. — Glucose concentration did not differ between TG and UTG at rest. Glucose levels increased steadily during exercise in both groups, but this increase was significant only in UTG at the end of the exercise test (+18.71%; $P < 0.05$) and after 30 min of recovery (+12.05%; $P < 0.05$) compared to basal levels. FFA concentrations at rest were significantly higher in TG than UTG ($P < 0.05$). FFA concentration initially significantly decreased during exercise in TG (—50.00%; $P < 0.05$), and increased during recovery period, but stayed significantly lower than rest values (—25.00%; $P < 0.05$). In UTG, FFA levels insignificantly decreased ($P > 0.05$) during exercise and

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http://dx.doi.org/10.1016/j.scispo.2015.02.011

recovery period. Insulin concentration significantly increased during exercise in both groups (+23.89% in TG and +47.64% in UTG, $P < 0.05$), and stayed significantly higher in recovery period in UTG (+60.82%; $P < 0.05$).
Conclusion. — The data presented indicate that chronic physical training markedly influences serum FFA profile in trained group. Our findings also indicate that metabolic response to one bout of maximal-intensity exercise test depends on training status of the subjects and that trained subjects (athletes) could have higher substrate flexibility under high energy demand.

MOTS CLÉS
Glycémie ;
Acides gras libres ;
Test d'effort maximal ;
Entraînement ;
Athlète de haut niveau ;
Sédentarité

Résumé
Objectifs. — Étudier les réponses de glucose et d'acides gras libres (AGL) lors d'un test d'effort maximal et durant la période de récupération chez des sportifs et des sujets sédentaires.
Sujets et méthodes. — Douze sujets entraînés (SE) et douze sujets non entraînés (SNE) ont effectué un test maximal incrémental sur tapis roulant. Des échantillons de sang ont été prélevés chez tous les sujets au repos le matin, à la fin de l'exercice et après 30 minutes de récupération. L'insuline, le glucose et les AGL ont été mesurés lors de ces prélèvements.
Résultats. — La glycémie ne différait pas entre SE et SNE au repos. Elle augmentait régulièrement au cours de l'exercice dans les deux groupes, mais cette augmentation n'était significative que chez les SNE à la fin de l'épreuve d'effort (+18,71 %; $p < 0,05$) et après 30 minutes de récupération (+12,05 %; $p < 0,05$) par rapport aux valeurs de repos. Les concentrations d'AGL au repos étaient significativement plus élevées chez les SE que chez les SNE ($p < 0,05$). Les AGL diminuaient fortement au cours de l'exercice chez les SE (—50,00 %; $p < 0,05$), et augmentaient pendant la période de récupération, mais en demeurant nettement inférieurs aux valeurs de repos (—25,00 %; $p < 0,05$). Chez les SNE, la baisse des AGL n'était pas significative ($p > 0,05$) au cours de l'exercice et de la période de récupération. La concentration d'insuline augmentait significativement au cours de l'exercice dans les deux groupes (+23,89 % chez les SE et +47,64 % chez les SNE, $p < 0,05$). Elle restait significativement plus élevée dans la période de récupération chez les SNE (+60,82 %; $p < 0,05$).
Conclusion. — Ces données indiquent que l'activité physique régulière influence nettement le profil des AGL chez les sujets entraînés. Nos résultats indiquent également que la réponse métabolique à un exercice maximal est influencée par l'état d'entraînement des sujets et que les sujets entraînés (sportifs) sembleraient avoir une plus grande flexibilité métabolique en cas de demande énergétique importante.

1. Introduction

It is well established that regular practice of aerobic physical activity exerts beneficial effect on health and consequently prevention of metabolic diseases like metabolic syndrome, obesity, diabetes mellitus, hypertension, etc. [1—3]. A positive impact on lipid profile and glycaemic control in elite athletes is expected considering duration of long-term participation in physical activity. However, numerous studies have showed that chronic participation in aerobic activities can have adverse effect on lipid parameters in athletes [2,4—6]. In addition, there is no conclusive evidence of positive impact of prolonged exercise on lipid profile including plasma free fatty acids (FFA), especially in a large subset of elite athletes [5].

In recent decades the effect of chronic exercise on serum FFA and glucose utilization has been examined in humans [4,7,8]. The results of cross-sectional studies led to a belief that a trained individual alters the mix of substrates oxidized during prolonged exercise [9]. It is generally accepted that prolonged moderate-intensity physical activity increases the use of fat as a fuel during exercise in physically active population [7]. On the other hand, high-intensity exercise is almost entirely dependent on glucose and glycogen for energy, irrespective of the time interval from the last meal [8]. The effect of acute response of the carbohydrate and FFA on exercise has been extensively studied in obese, sedentary individuals and in athletes [2,10,11]. Marion-Latard et al. [10] reported that compared to a basal level, aerobic exercise performed at 50% VO_2max, increased fat oxidation and FFA level, and lowered plasma insulin level in both lean and obese sedentary individuals. Similarly, Kern et al. [11] showed that 30 min aerobic exercise performed at 70% VO_2max lowered serum glucose and increased FFA levels in minimally active women.

Nevertheless, the literature data on the effects of one bout of maximal-intensity exercise on FFA and glucose concentration in plasma is sparse and unclear, particularly in elite athletes. For example, when and if FFA is utilized during graded maximal exercise test is still uncertain. Also, whether the metabolic response to one bout of maximal-intensity exercise is influenced by training adaptation is undetermined. It is essential to appreciate the fundamental differences in the metabolic responses to one bout of maximal-intensity exercise in trained and untrained men. Regarding most recent guidelines recommending, an