Studies in Physical Culture and Tourism
Vol. 19, No. 3, 2012, 135-138
ISSN 0867-1079

Insulin sensitivity and blood lipid profile in women recreationally practicing horseback riding

Agnieszka Kaczmarek, Alicja Nowak, Łucja Pilaczyńska-Szcześniak

Department of Hygiene, Chair of Physiology, Biochemistry and Hygiene, University School of Physical Education, Poznań, Poland

ABSTRACT

Introduction. The increased number of metabolic disorders associated with modern sedentary life indicates the need for a health-promoting activity. Horseback riding has become popular among some people, especially women, who seek attractive forms of physical exercises.
Aim of Study. The purpose of the study was to evaluate the levels of glucose metabolic indices and blood lipid profile in adult women practicing horseback riding on a recreational basis.
Material and Methods. The study was carried out on a sample of 22 subjects who recreationally practiced horseback riding for at least 5 years, and 19 non-training, age- and body mass-matched controls. In all participants, somatic parameters and levels of glucose, total cholesterol, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, triglycerides and QUICKY insulin sensitivity index were assessed.
Results. Comparative analysis did not show significant differences in the levels of somatic and biochemical variables. Associations of the percent of body fat with insulin levels ($p < 0.05$) and QUICKY index values ($p < 0.05$) were found in all investigated women. Daily and weekly training volumes correlated negatively with LDL-cholesterol levels ($p < 0.05$) and positively with the HDL-cholesterol to LDL-cholesterol ratio ($p < 0.05$).
Conclusions. The results showed that the long-term horseback riding was not an efficient stimulus to induce significant metabolic effects in adult healthy women. The high frequency of training sessions with the large contribution of eccentric muscle contractions could play a role in those effects; however, this explanation requires further investigation.

KEY WORDS quicky, serum lipids, equitation.

Introduction

The increased number of metabolic disorders associated with modern sedentary life such as obesity, type 2 diabetes and cardiovascular diseases, indicates the need for a health-promoting activity. Regular physical exercise may be a way of prevention or management of most chronic diseases [1, 2]. It has been well documented that systematic training improves the blood lipid profile [3-5], modifies glucose tolerance, increases insulin sensitivity and prevents the development of type 2 diabetes [6-9].

In recent years horseback riding has become popular among some people, especially women, looking for attractive forms of physical activities [10]. This type of activity is characterized by a major component of eccentric muscle contractions [11, 12]. Although, both aerobic and anaerobic exercises such as strength training are effective in the improvement of insulin sensitivity and blood lipid profile [13, 14], the influence of resistance exercises with the large contribution of eccentric contractions on insulin action remains controversial [15, 16].

It has been shown that the postural adjustments induced by horseback riding are sufficient to produce metabolic and cardiorespiratory responses in the rider [17, 18]. However, available literature contains very few works examining the metabolic response induced by physical exercise performed during horseback riding [10, 17, 19].

Aim of Study

The purpose of the present study was to evaluate the insulin sensitivity and blood lipid profile in adult women who owned a horse and practiced horseback riding at least for 5 years.

Material and Methods

The study was performed on 42 women, aged between 25 and 36 years, including 22 subjects recreationally practicing horseback riding (horseback riding group, HRG), for mean 14 ± 4.5 years (from 5 to 23 years), and 19 non-training controls (control group, CG). The horseback riders declared that their daily training lasted on average 131 minutes (from 40 to 360 minutes) and was repeated on average 6 times a week (from 3 to 7 times a week). In winter they performed exercises indoors, and from spring to autumn outdoors. Women from the control group were recruited with respect to their age and body mass index (BMI) according to results obtained in the training group and declared no participation in systematic recreational exercise during the study period.

All participants declared good health status. Subjects with inflammatory and hormonal disorders, recent infections, hypertension, diabetes mellitus and drinking more than two alcoholic drinks per day were not included in the study. The study protocol was approved by the Ethics Committee for Human Research at the Poznań University of Medical Sciences, and all participants gave their informed consent to participate in the experiment.

In all participants, in the fasting state, body mass and body height were measured using the WPT 60/150.O certified digital medical scale (Radwag, Radom, Poland, accuracy 0.01 kg) with a mechanical measuring rod for body height (accuracy 0.5 cm). Subjects' body fat content was estimated using the bioimpedance method (BODYSTAT 1500 analyzer, UK).

Blood was collected between 8 and 10 a.m. after 14 hours of fasting. The blood samples were centrifuged at 5000 rpm and 4°C. Insulin serum concentrations were measured with a radioimmunoassay (BioSource Europe S.A., Belgium). Glucose, total cholesterol, high-density lipoprotein cholesterol (HDL-C) and triglycerides concentrations were analyzed with commercially available assays (Cormay, Poland).

The levels of low-density lipoprotein cholesterol (LDL-C) were calculated with the formula proposed by Friedewald et al. [20] and the Quantitative Insulin Sensitivity Check Index (QUICKY) according to the formula of Katz et al. [21]:

$$1/[\log \text{fasting insulin } (\mu U/ml) + \log \text{fasting glucose } (mmol/l)].$$

The values were given as means, standard deviations, medians and an interquartile range. The normality of data distribution was verified with the Shapiro-Wilk test. Comparisons between both investigated groups for normally distributed variables were assessed with the T-test and for non-normally distributed variables with the Mann-Whitney test. Spearman's rank analysis was used to calculate correlation coefficients. P value < 0.05 was considered significant. All analyses were performed using the Statistica 9.0 software package.

Results

Basic characteristics of the examined groups of women are presented in Table I. There were no significant differences between the groups with respect to age, body height, body mass, waist circumference, body mass index (BMI) and body fat content. The comparative analysis did not show significant differences in the levels of insulin, glucose, QUICKY index, total cholesterol, HDL-C, LDL-C and triglycerides between HRG and CG (Table II).

Spearman's rank correlation analysis showed a negative relationship between the fat content and QUICKY index (r = –0.37, p = 0.0183) and a positive relationship with insulin concentrations (r = 0.32, p = 0.0423) in all investigated women. The daily and weekly volume of training correlated negatively with LDL-C levels (r = –0.49, p = 0.0200 and r = –0.49, p = 0.0206, respectively) and positively with the HDL-C to LDL-C ratio (r = 0.48, p = 0.0238 and r = 0.51, p = 0.0161, respectively) in the HRG.

Table I. Basic characteristics and somatic variables in women practicing horseback riding (HRG) and controls (CG)

Variable	HRG N = 22	CG N = 19	*p*-value
Age [years]	29.5 ± 3.81	27.9 ± 2.93	0.1538
Body height [cm]	167.9 ± 5.49	167.4 ± 5.42	0.9903
Body mass [kg]	60.4 ± 6.47	59.1 ± 5.70	0.8360
BMI [kg/m^2]	21.4 ± 2.10	21.1 ± 1.74	0.6968
Waist circumference [cm]	71.2 ± 5.50	72.1 ± 5.28	0.6131
Body fat content [%]	27.7 ± 4.07	29.2 ± 3.62	0.1054

Data expressed as means ± SD

Table II. Biochemical indices in women practicing horseback riding (HRG) and controls (CG)

Variable	HRG N = 22	CG N = 19	*p*-value
Total cholesterol [mg/dl]	170.1 ± 18.03 (168.5, 160.3-176.7)	181.0 ± 21.48 (173.5, 164.9-202.7)	0.0832
HDL-C [mg/dl]	52.4 ± 9.61 (49.6, 45.1-61.6)	57.1 ± 9.56 (57.3, 49.5-62.4)	0.1266
LDL-C [mg/dl]	104.5 ± 21.46 (100.9, 93.9-117.1)	111.6 ± 18.53 (109.6, 103.0-121.0)	0.2657
Triglycerides [mg/dl]	65.8 ± 27.87 (59.1, 44.7-79.8)	61.6 ± 30.12 (52.6, 45.7-63.5)	0.5740
Glucose [mg/dl]	93.5 ± 12.14 (93.3, 88.5-100.7)	92.2 ± 11.22 (90.6, 82.3-101.1)	0.7262
Insulin [μU/ml]	8.56 ± 2.97 (7.84, 6.25-9.08)	8.81 ± 1.91 (8.41, 7.31-10.76)	0.3671
Index QUICKI	0.62 ± 0.06 (0.63, 0.58-0.68)	0.61 ± 0.05 (0.62, 0.58-0.63)	0.4203

Data expressed as means ± SD (median, interquartile range)

Discussion

There is a growing body of evidence to indicate a relationship between physical activity and metabolic profile; however, the results of this study demonstrated no significant effect of horseback riding on glucose and lipid metabolism in healthy adult women, which is consistent with Meyers's results [10]. Although values of biochemical indices of the HRG fell within established norms, they did not differ from results of non-training, age- and body mass-matched controls. Numerous studies have documented the significant metabolic response to physical activity programs in people with metabolic disorders, such as obesity or type 2 diabetes [7, 22, 23], as well as in healthy people subjected to systematic training [13, 14, 24].

The mechanism through which physical exercise normalizes glucose tolerance may be multifactorial. According to numerous studies, this phenomenon is associated with an increased affinity of insulin receptor to its agonist [25], enhancement of signal cascade element expression such as substrate-1 of the insulin receptor and the receptor itself [7, 26], enhanced expression of glucotransporters [7, 27], higher uptake of glucose due to muscular contraction [9, 28], or increased utilization of free fatty acids by muscle cell mitochondria [29]. The last mechanism also leads to the improvement of lipid metabolism [30].

Horseback riding is the type of activity which involves eccentric contractions [11, 12]. These exercises are involved in all activities where muscles exert a braking action to control body movement. Although the beneficial results of both aerobic and resistance exercises on glucose and lipid metabolism have been extensively recognized, several studies have demonstrated that eccentric contractions may cause deleterious effects [15, 31].

Eccentric exercises may lead to skeletal muscle damage and through increased TNF-α secretion from monocytes induce transient downregulation of insulin signaling pathway activity and glucose transporter (GLUT-4) protein content [16]. Several deleterious effects may occur up to several days after an acute bout of eccentric exercise [32]. On the other hand, Paschalis et al. [13] showed that a single weekly bout (30 min) of eccentric exercise performed for 8 weeks decreased resting insulin resistance and improved blood lipid profile in adult women. The authors concluded that the very low frequency of eccentric exercise per week and the short duration of each exercise session might be recommended to induce health-promoting effects. However, it is worth noting that owning a horse requires systematic daily riding and the majority of participants in our study practiced horseback riding 6-7 times per week. Although, such frequent physical activity is in accordance with health promotion recommendations [33], the obtained results documented no significant metabolic benefits of this type of training. It can not be excluded that such large doses of eccentric exercises are unfavorable for metabolic effects.

On the other hand, the lack of differences in metabolic indices between horseback riding women and controls may be the result of the adaptation to unalterable duration of a single training session applied during several years. Nikolaidis et al. [34] assessed the acute effects of muscle damaging eccentric exercise on time-course changes of blood lipid profile and the effect of the repeated bout on blood lipids. They found that the response of lipids and lipoproteins was higher after the first session of exercise compared to those induced by the second identical session performed four weeks later. Although Meyers [10] showed the significant effect of a 14-week equitation (1 h of horseback riding, 5 days/week) on the muscular power of young women, this training program failed to provide an adequate stimulus to improve cardiorespiratory fitness and lipid profile, which is in accordance with our results. The study by Meyers was performed among college females with prior equestrian experience which might have resulted in pre-study habituation to riding.

Although the present study revealed no significant effect of recreational horseback riding on glucose and lipid metabolism in adult healthy women, the study performed on middle-aged, diabetic patients, documented that daily passive exercise (30-min riding session a day, 7 times a week, for 3 months) using a horseback riding machine improved insulin sensitivity and resting metabolism [35]. It is worth noticing that the metabolic equivalent on the mechanical horse, which involves light intensity activities, might be efficient for metabolic changes in sedentary diabetic patients. The present study showed a significant negative relationship between the duration of daily and weekly horse riding and LDL-cholesterol levels or a positive association with HDL-C to LDL-C ratio, which may confirm the metabolic effects of this activity However, we found no association between the training volume and glucose metabolism, and the QUICKY index values negatively correlated with body fat content in all investigated participants. The last relationship highlights the contribution of fat tissue to insulin activity [36].

Conclusions

The obtained results showed that long-term horseback riding is not an efficient stimulus to induce significant metabolic effects in adult healthy women. The high frequency of training sessions with the large contribution of eccentric muscle contractions could play a role in those effects; however, this explanation requires further investigation.

References

1. Larson-Meyer DE, Heilbronn LK, Redman LM, et al. Effect of calorie restriction with or without exercise on insulin sensitivity, ß-cell function, fat cell size, and ectopic lipid in overweight subjects. Diabetes Care. 2006; 29: 1337-1344.
2. Ricanati EH, Golubić M, Yang D, et al. Mitigating preventable chronic disease: Progress report of the Cleveland Clinic's Lifestyle 180 program. Nutr Metab (Lond). 2011; 8: 83.
3. Durstine JL, Grandjean PW, Davis PG, et al. Blood lipid and lipoprotein adaptations to exercise. A quantitative analysis. Sports Med. 2001; 31 (15): 1033-1062.
4. Kelley GA, Kelley KS, Tran ZV. Aerobic exercise and lipids and lipoproteins in women: a meta-analysis of randomized controlled trials. J Womens Health (Larchmt). 2004; 13 (10): 1148-1164.
5. Scheers T, Philippaerts R, Van Langendonck L, et al. Lipid profile in men and women with different levels of sports participation and physical activity. Public Health Nutr. 2008; 11 (11): 1098-1106.

6. Colberg SR, Sigal RJ, Fernhall B, et al. Exercise and Type 2 Diabetes. The American College of Sports Medicine and the American Diabetes Association: joint position statement. Diabetes Care. 2010; 33 (12): e147-e167.
7. Holten MK, Zacho M, Gaster M, et al. Strength training increases insulin-mediated glucose uptake, GLUT4 content, and insulin signaling in skeletal muscle in patients with type 2 diabetes. Diabetes. 2004; 53: 294-305.
8. Kang J, Robertson RJ, Hagberg JM, et al. Effect of exercise intensity on glucose and insulin metabolism in obese individuals and obese NIDDM patients. Diabetes Care. 1996; 19: 341-349.
9. Santos JM, Ribeiro SB, Gaya AAR, et al. Skeletal muscle pathways of concentration-enhanced glucose uptake. Int J Sports Med. 2008; 29: 785-794.
10. Meyers MC. Effect of equitation training on health and physical fitness of college females. Eur J Appl Physiol. 2006; 90: 177-184.
11. Brockett C, Warren N, Gregory JE, et al. A comparison of the effects of concentric versus eccentric exercise on force and position sense at the human elbow joint. Brain Res. 1997; 771: 251-258.
12. Whitehead NP, Allen TJ, Morgan DL, Proske U. Damage to human muscle from eccentric exercise after training with concentric exercise. J Physiol. 1998; 512 (2): 615-620.
13. Paschalis V, Nikolaidis MG, Theodorou AA, et al. A weekly bout of eccentric exercise is sufficient to induce health-promoting effects. Med Sci Sports Exerc. 2011; 43 (1): 64-73.
14. Poehlman ET, Dvorak RV, Denino WF, et al. Effects of resistance training and endurance training on insulin sensitivity in non-obese, young women: a controlled randomized trial. J Clin Endocrinol Metab. 2000; 85 (7): 2463-2468.
15. Del Aguila LF, Krishnan RK, Ulbrecht JS, et al. Muscle damage impairs insulin stimulation of IRS-1, PI 3-kinase, and Akt-kinase in human skeletal muscle. Am J Physiol. 2000; 279: E206-E212.
16. Kirwan JP. Cellular regulation of exercise-induced insulin resistance. Br J Sports Med. 2010; 44: i17-i18.
17. de Barros Souza F, Pacheco MTT, Strottmann IB, et al. Metabolic and cardiorespiratory parameter analysis of young female adults during horseback riding at a walking gait. IES. 2008; 16: 263-267.
18. Devienne MF, Guezennec CY. Energy expenditure of horse riding. Eur J Appl Physiol. 2000; 82: 499-503.
19. Meyers MC, Sterling JC. Physical, hematological and exercise response of collegiate female equestrian athletes. J Sports Med Phys Fitness. 2000; 40: 131-138.
20. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972; 18: 499-502.
21. Katz A, Nambi SS, Mather K, et al. Quantitative insulin sensitivity check index: a simple, accurate method for assessing insulin sensitivity in humans. J Clin Endocrinol Metab. 2000; 85 (7): 2402-2410.
22. Hansen E, Landstad B, Gundersen K, et al. Insulin sensitivity after maximal and endurance resistance training. JSCR. 2012; 26 (2): 327--334.
23. Fenkci S, Sarsan A, Rota S, Ardic F. Effects of resistance or aerobic exercises on metabolic parameters in obese women who are not on a diet. Adv Ther. 2006; 23 (3): 404-413.
24. Śliwicka E, Pilaczyńska-Szcześniak Ł, Nowak A, Zieliński J. Resistin, visfatin and insulin sensitivity in selected phases of annual training cycle of triathletes. Acta Physiol Hung. 2012; 99 (1): 51-60.
25. Dylewicz P, Przywarska I, Szcześniak L, et al. The influence of short--term endurance training on the insulin blood level, binding and degradation of ^{125}I- insulin by erythrocyte receptors in patients after myocardial infarction. J Cardiopul Rehab. 1999; 19: 98-105.
26. McGee SL, Hargreaves M. Exercise and skeletal muscle glucose transporter 4 expression: molecular mechanisms. Clin Exp Pharmacol Physiol. 2006; 33: 395-399.
27. Seki Y, Berggren JR, Houmard JA, Charron MJ. Glucose transporter expression in skeletal muscle of endurance-trained individuals. Med Sci Sports Exerc. 2006; 38 (6): 1088-1092.
28. Katz A, Broberg S, Sahlin K, Wahren J. Leg glucose uptake during maximal dynamic exercise in humans. Am J Physiol Endocrinol Metab. 1986; 251: E65-70.
29. Talanian JL, Galloway SD, Heigenhauser GJ, et al. Two weeks of high--intensity aerobic interval training increases the capacity for *fat oxidation* during *exercise* in women. J Appl Physio. 2007; 102 (4): 1439-1447.
30. Horowitz JF. Regulation of lipid mobilization and oxidation during exercise in obesity. Exerc Sport Sci Re. 2001; 29 (1): 42-46.
31. Kirwan JP, Hickner RC, Yarasheski KE, et al. Eccentric exercise induces transient insulin resistance in healthy individuals. J Appl Physio. 1992; 72 (6): 2197-2202.
32. Paschalis V, Koutedakis Y, Jamurtas AZ, et al. Equal volumes of high and low intensity of eccentric exercise in relation to muscle damage and performance. JSCR. 2005; 19 (1): 184-188.
33. Haskell WL, Lee IM, Pate RR, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc. 2007; 39 (8):1423-1434.
34. Nikolaidis MG, Paschalis V, Giakas G, et al. Decreased blood oxidative stress after repeated muscle-damaging exercise. Med Sci Sports Exerc. 2007; 39 (7):1080-1089.
35. Hosaka Y, Nagasaki M, Bajotto G, et al. Effects of daily mechanical horseback riding on insulin sensitivity and resting metabolism in middle-aged type 2 diabetes mellitus patients. Nagoya J Med Sci. 2010; 72: 129-137.
36. Kahn SE, Prigeon RL, Schwartz RS, et al. Obesity, body fat distribution, insulin sensitivity and islet -cell function as explanations for metabolic diversity. J Nutr. 2001; 131 (2): 354S-360S.

Correspondence should be addressed to: Alicja Nowak, Chair of Physiology, Biochemistry and Hygiene, Department of Hygiene, University School of Physical Education, Królowej Jadwigi 27/39, 61-871 Poznań, Poland, tel. (0-61) 8355179, e-mail: anowak@awf.poznan.pl