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# Effects of indoor cycling associated with diet on body composition and serum lipids

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## Summary

*Study aim*: To determine the effects of indoor cycling training combined with restricted diet, lasting 12 weeks, on serum lipid concentrations in obese women.
*Material and methods*: Twenty women aged 23.8 ± 3.6 years were randomly assigned into two groups: control (C) and experimental (E), the latter subjected to indoor cycling at various loads, 3 sessions weekly, every session lasting 45 min, combined with restricted diet (about 1200 kcal daily) for 12 weeks. The following variables were recorded: body height and mass, BMI, relative body fat content (from 7 skinfolds), fat-free mass, triglycerides, cholesterol and lipoproteins (HDL, LDL, VLDL).
*Results*: Significant increase in HDL and significant decreases in all other variables (except body height) were noted only in the experimental group.
*Conclusions*: Indoor cycling associated with restricted diet is an excellent option in controlling obesity and serum lipids.

Key words: Obesity – Diet – Indoor cycling – Serum lipids

## Introduction

The prevalence of obesity increased enormously over the past few decades and overweight can be considered an epidemic in both developed and developing countries [2,32] across all socio-economic categories and age [4]. At present, about 1.6 billion of people are afflicted by overweight and 0.4 billion by obesity, the forecast for 2015 amounting to 2.3 and 0.7 billion, respectively [34]. It was estimated that in 2025 Brazil would become number 5 in the world in that respect [22].

Obesity is a complex disorder associated with an excess of adipose tissue, genetic, physiological and behavioural factors playing significant role in its aetiology. Numerous diseases, e.g. cardiovascular, type 2 diabetes, hypertension and dyslipidemia have been attributed to obesity [3,5,18].

One of the most common manifestations of excess body fat, particularly its accumulation in the abdominal area, is atherogenic dyslipidemia [33], manifested by a triad of lipid disorders: elevated triglycerides (TG) and low-density lipoproteins (LDL), and reduced high-density lipoproteins (HDL). It constitutes a significant risk factor for cardiovascular disease, primarily due to its contribution to the fibrous plaque build-up within the artery walls [24].

Obesity and dyslipidemia increase the risk of morbidity and mortality from cardiovascular and related diseases in Brazil [1]. A change of the lifestyle consisting of practicing regular aerobic activities combined with dietary restrictions has been strongly recommended in order to prevent obesity-related disorders [6]. These two factors, i.e. diet and activity, were unequivocally shown to prevent the obesity-related cardiovascular diseases and to maintain body components at appropriate levels [28,30].

Indoor cycling became an essential activity in fitness centres due to its beneficial effects on cardiovascular fitness, body fat reduction and the risks of developing cardiovascular diseases [16]. Thus, the aim of this study was to assess the body composition and serum lipid levels in overweight women following 12 weeks of indoor cycling associated with restricted diet.

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## Material and Methods

A group of 20 healthy women aged 23.8 ± 3.6 years volunteered to participate in the study. They were randomly divided in two groups, 10 subjects each: control and experimental. The subjects gave their written consents to participate after having been informed of the study aim and protocol. The study was approved by The Human Research Ethics Committee at Castelo Branco University. The following variables were recorded:

*Anthropometric*: Body mass, body height, percent body fat, body mass index (BMI) and fat-free mass, according to Lohman's protocol [12]. Body mass was measured with an accuracy of 0.1 kg on digital scales (Filizola, Brazil) combined with a standard stadiometer for measuring body height. Body fat content was calculated from seven skinfolds according to Jackson and Pollock [8] using a manual skinfold caliper (Lange, USA) and classified according to Pollock and Wilmore [19]. All measurements were made by one investigator.

*Serum lipid profile*: Triglycerides (TG), total cholesterol (TC) and high-density lipoproteins (HDL) were determined by enzymatic colorimetry, low-density lipoproteins (LDL) and very-low-density lipoproteins (VLDL) were computed by Friedewald's equation, all values being expressed in mg/dl. Blood samples were assayed at a commercial laboratory (Sérgio Franco, Brazil). The subjects reported to the laboratory in the morning, in the preprandial state. The results were classified according to the III[rd] Brazilian Guidelines for Dyslipidemia and Atherosclerosis issued by the Department of Atherosclerosis of the Brazilian Society of Cardiology [24].

*Experimental procedures*: The study lasted 12 weeks. At the beginning and at the end of that period all subjects underwent all the measurements. Women from the experimental group were subjected to indoor cycling sessions, 45 min each, 3 times weekly. Details of the experimental protocol are presented in Table 1. Individual maximal heart rate (HRmax) was determined by Inbar's equation [7]. Their heart rates were monitored by Polar F1 devices (Polar, Finland) throughout the session. The cycling cadence was controlled by rpm-related musical bpm, an important motivating instrument. The perceived exertion was monitored by Borg's scale ratings. All sessions were instructed and supervised by the same investigator.

**Table 1**. Indoor cycling protocol

| Time (min) | Borg's rating | % HRmax | Position (stimulation) |
|---|---|---|---|
| 1 – 5 | 9 | 55 – 60 | Warm-up |
| 5 – 10 | 11 – 13 | 68 – 72 | Position 1 – Standard pedalling (1 min)<br>Position 3 – Slow, heavy, standing (30 s) |
| 10 – 15 | 15 – 16 | 72 – 76 | Position 3 (1½ min)<br>Position 2 – Seated climbing (30 s) |
| 15 – 20 | 11 – 13 | 68 – 74 | Position 2 (1 min)<br>Position 3 (30 s) |
| 20 – 25 | 15 – 17 | 74 – 90 | Position 3 (2 min)<br>Position 2 (45 s) |
| 25 – 30 | 11 – 14 | 68 – 72 | Position 2 - accelerations |
| 30 – 35 | 15 – 16 | 72 – 85 | Position 3 (1½ min)<br>Position 2 (1 min) |
| 35 – 40 | 9 – 11 | 55 – 65 | Position 1 + stretching (upper extremities) |
| 40 – 45 | – | – | Stretching (lower extremities) |

*Diet*: Control subjects were instructed to stay on their habitual diet and to refrain from physical activities; their diet was monitored by a dietician* every two weeks by 24-h recalls, their daily energy uptake amounting to about 1200kcal. At every meeting with the dietician, the participants related their difficulties in following previous recommendations and received advices. Subjects from the experimental group ate usually 8 meals a day, spaced by 2 – 4-h intermissions, total energy intake amounting to about 1200 kcal/day. They were instructed to observe the recommended diet throughout the study and not to substitute the meals by snacks, to observe schedules and to ingest at least 2 l of water per day. Body mass was monitored twice weekly.

The data were subjected to a conventional statistical treatment [27]. All variables proved normally distributed by applying Kolmogorov-Smirnov's test. Differences between mean values were assessed by Student's *t*-test for dependent or independent data, the level of p≤0.05 being considered significant.

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## Results

Anthropometric data recorded before (‘Pre’) and after (‘Post’) 12 weeks of indoor cycling are shown Table 2. According to the commonly used criteria of obesity (BMI≥30kg.m$^{-2}$, body fat: 30-35%) and overweight (BMI≥25kg.m$^{-2}$, body fat:25-30%), both groups were overweight.

The 12-week training brought about significant decreases in body fat content (by about 21%), body mass and BMI (by about 10% each) only in the experimental group; moreover, the ‘Post’ body fat content in the experimental group proved significantly lower than in the control group. No significant change was noted in the fat-free mass. In the control group, both body mass and fat content significantly increased (see Table 2).

**Table 2**. Mean values (±SD) of anthropometric variables recorded in obese women aged 20-30 years

| Group / Variable | Control (n = 10) Pre | Control (n = 10) Post | Experimental (n = 10) Pre | Experimental (n = 10) Post |
|---|---|---|---|---|
| Body mass (kg) | 71.9 ± 6.1 | 72.6 ± 6.3*** | 74.4 ± 8.3 | 67.1 ± 8.9*** |
| Fat content (%) | 31.7 ± 3.2 | 32.1 ± 3.1*** | 33.9 ± 5.4 | 26.7 ± 6.0*** º |
| BMI | 27.5 ± 1.7 | 27.8 ± 1.6 | 29.4 ± 3.5 | 26.5 ± 3.5*** |
| Fat-free mass (kg) | 49.2 ±3.3 | 49.3 ± 3.2 | 49.0 ± 5.5 | 48.8 ± 4.9 |

*** Significantly ($p<0.001$) lower from the respective ‘Pre’ value; º Significantly ($p<0.05$) lower from the respective value in the Control group

**Table 3**. Mean values (±SD) of lipid levels in serum of obese women aged 20-30 years

| Group / Variable | Control (n = 10) Pre | Control (n = 10) Post | Experimental (n = 10) Pre | Experimental (n = 10) Post |
|---|---|---|---|---|
| TG | 98.1 ± 6.5 | 98.9 ± 5.9 | 100.4 ± 18.4 | 92.7 ± 18.6*** |
| TC | 173.3 ± 10.9 | 175.0 ± 11.2 | 172.4 ± 28.1 | 161.8 ± 26.3*** |
| LDL | 114.8 ± 10.7 | 116.6 ± 10.9 | 112.7 ± 27.7 | 103.5 ± 26.6*** |
| HDL | 41.2 ± 2.6 | 41.5 ± 2.3 | 41.3 ± 3.9 | 44.6 ± 2.7*** º |
| VLDL | 17.3 ± 3.5 | 17.7 ± 2.9 | 18.4 ± 5.9 | 13.3 ± 3.1*** ººº |

Legend: TG – Triglycerides; TC – Total cholesterol; LDL – Low-density lipoproteins; HDL – High-density lipoproteins; VLDL – Very-low-density lipoproteins; *** Significantly ($p<0.001$) lower from the respective ‘Pre’ value; Significantly lower from the respective value in the control group: º $p<0.05$; ººº $p<0.001$

The ‘Post’ – ‘Pre’ changes in all studied serum lipid components were significant only in the experimental group (Table 3), highest decrease being noted for VLDL (by nearly 28%), other changes amounting to 6 – 8%. Similar differences were observed for HDL and VLDL between the experimental and control groups.

## Discussion

At the beginning of the study, all subjects had very high body fat content according to Pollock and Wilmore’s classification [19]. Similar values were reported also by others [10]. According to the Brazilian Society of Cardiology [24] , subjects from the control group had markedly elevated levels of TG, TC, HDL and VLDL, and acceptable ones of LDL.

This study demonstrated that a 12-week training in indoor cycling, combined with restricted diet, brought about marked decreases in body mass, BMI and body fat content, the fat-free mass remaining unchanged. Weight loss induced by dietary restriction is known to be accompanied by a loss in fat-free mass [15,17]. Yet, a combination of restricted diet with aerobic exercise training proved effective in maintaining FFM.

However, the degree of preventing the reduction of FFM depends on the type and volume of exercise [26]. Thus, in this study, as well as in that of Mayo *et al.* [14], the weight loss was attributable to a loss of fat. The mechanisms by which exercise might prevent a loss of FFM remain unclear but may involve a preferential mobilisation of fat stores as an energy source.

Inducing negative energy balance is the most important aim of weight loss programmes, physical activity in conjunction with dietary energy restriction being claimed an important component. The results of many recent studies support the beneficial role of a combination of the two (e.g. [29]). Rector *et al*. [20] observed the effect of a diet reduced by about 500 kcal/day and moderate-intensity aerobic exercise training (45 min/day, 5 days/ week) in 9 male and 21 female subjects aged 18 – 50 years, overweight to obese (BMI equal to 26 – 43), for 6 months. The subjects reduced their body mass from 96.6 ± 3.1 to 87.6 ± 2.7 kg and BMI from 33.3 ± 0.8 to 29.9 ± 0.7.

Shadid and Jensen [23] observed the effect of diet and aerobic exercise applied for 18 – 20 weeks to 19 volunteers aged 41 ± 2 years. The subjects stayed on a 500 kcal deficit diet; the exercise programme started with 15 min, 3 times a week at 50% of individual heart rate reserve, then gradually increased to 45 min, 4 times a week, at 60 – 70% of heart rate reserve. Their body mass decreased from 97.5 ± 3.3 to 85.8 ± 3.1 kg ($p<0.001$) and BMI from 32.1 ± 0.7 to 27.7 ± 0.8 ($p<0.001$), the fat-free mass remaining unchanged ($p = 0.07$). Utter *et al*. [29] observed the effects of diet and moderate exercise (60 – 80% of HRmax) in obese women for 12 weeks. The subjects were assigned into 4 groups: diet (D), diet + exercise (DE), exercise (E) and control (C); in Groups D and ED body mass and body fat were reduced, no significant changes being noted in Groups E and C. Those studies demonstrated the importance of combination of dietary modification and exercise in body weight reduction. Our research supports those findings suggesting indoor cycling as an excellent option in obesity control. That latter report [29] provided a basis for our study. Namely, we considered it useless to repeat Utter's experimental design and focused on the combined effect of reduced diet and exercise.

The last component to consider in determining the most effective way of educating individuals about decreasing the risk of cardiovascular diseases is the interplay of diet and exercise in reducing serum lipid levels [13]. Physical activity is strongly recommended in that respect by the Centers for Disease Control and Prevention and the American College of Sports Medicine [20]. Their recommendation documents the improvements in cardiovascular risk factors associated with aerobic training.

According to a recent meta-analysis of Kelley and Kelley [9], aerobic exercise reduces TG and TC and increases HDL. Stefanick *et al*. [25] indicated significant reductions in LDL in both men and women who observed a reduced diet combined with exercise (1 h/day, 3 times/week). Additionally, Lofgren *et al*. [11] stated that even modest changes in body mass in response to reduced energy and carbohydrate intakes, combined with increased physical activity, improved cardiovascular health as evidenced by decreased LDL. This was observed in this study in the experimental group. Moreover, our results support the findings of Roberts *et al*. [21], who observed the effects of a short-term, rigorous diet and exercise intervention consisting of walking at the training heart rate (70 to 85% of HRmax) for 45 – 60 min, for 3 weeks. The TG decreased from 117.4 ± 9.7 to 102.4 ± 7.5 mg/dl, TC from 189.5 ± 4.3 to 174.4 ± 3.5 mg/dl and LDL from 116.8 ± 4.1 to 104.9 ± 3.1 mg/dl. Like in Roberts' study [21], all those decreases were significant.

In conclusion, our data reveal that weight loss induced by indoor cycling training associated with restricted diet brought about health benefits: improved serum lipid levels and body composition. Of course, each individual is expected to select the preferred diet/exercise combination for attaining maximum benefits.

## References


1. Araújo F., A.T.Yamada, M.V.M.Araújo, M.R.D.O.Latorre, A.J.Mansur (2005) Perfil lipídico de indivíduos sem cardiopatia com sobrepeso e obesidade. *Arquivos Brasileiros de Cardiologia* 84:405-409.
2. Bastos A.A., R.G.Boto, O.M.González, S.A.Valle (2005) Obesidad, nutrición y actividad física. *Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte* 5:140-153.
3. Bouchard C. (2004) Handbook of Obesity: Etiology and Pathophysiology. 2nd ed. M.Dekker Inc., NY.
4. Christakis N.A., J.H.Fowler (2007) The spread of obesity in a large social network over 32 years. *New Engl.J.Med*. 357:370-379.
5. Flocke S.A., A.Clark, K.Schlessman, G.Pomiecko (2005) Exercise, diet, and weight loss advice in the family medicine outpatient setting. *Fam.Med*. 37:415-421.
6. Hubert H.B. M.Feinleib, P.M.Mcnamara, W.P.Castelli (1983) Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation* 67:968–977.
7. Inbar O., A.Oren, M. Scheinowitz, A.Rotstein, R.Dlin, R.Casaburi (1994) Normal cardiopulmonary responses during incremental exercise in 20- to 70-yr-old men. *Med.Sci.Sports Exerc*. 26:538-546.
8. Jackson A.S., M.L.Pollock (1978) Generalized equations for predicting body density of men. *Br.J.Nutr*. 40:497-504.
9. Kelley G.A., K.S.Kelley (2006) Aerobic exercise and lipids and lipoproteins in men: a meta-analysis of randomized controlled trials. *J Mens Health Gend*. 3:61–70.
10. Lockwood C.M., J.R.Moon, S.E.Tobkin, A.A.Walter, A.E.Smith, V.J.Dalbo *et al*. (2008) Minimal nutrition intervention with high-protein/low-carbohydrate and low-fat, nutrient-dense food supplement improves body composition and exercise benefits in overweight adults: A randomized controlled Trial. *Nutr.Metab*. 5:11.

11. Lofgren I., T.Zern, K.Herron, K.West, M.J.Sharman, J.S. Volek, N.S.Shachter, S.I.Koo, M.L.Fernandez (2005) Weight loss associated with reduced intake of carbohydrate reduces the atherogenicity of LDL in premenopausal women. *Metabolism* 54:1133-1141.

12. Lohman T.G., A.F.Roche, R.Martorell (1988) Anthropometric standardization reference manual. Champaign IL, Human Kinetics Books.

13. Lyons L.M.S., L.P.Cahalin (2002) The effects of diet and exercise on serum lipids and risk of cardiovascular disease: a literature review and case study. *Cardiopulm.Phys.Ther.J*. 13: (September issue).

14. Mayo M.J., J.R.Grantham, G.Balasekaran (2003) Exercise-induced weight loss preferentially reduces abdominal fat. *Med.Sci.Sports Exerc*. 35:207-213

15. Meirelles C.M., P.S.C.Gomes (2004) Acute effects of resistance exercise on energy expenditure: revisiting the impact of the training variables. *Rev.Bras.Med.Esporte* 10:122-130.

16. Mello D.B. (2004) Ciclismo Indoor. Ed. Sprint, Rio de Janeiro.

17. Menozzi R, Bondi M, Baldini A, M.G.Venneri, A.Velardo, G.Del Rio (2000) Resting metabolic rate, fat-free mass and catecholamine excretion during weight loss in female obese patients. *Br.J.Nutr*. 84:515-520

18. Orzano A.J., J.G.Scott (2004) Diagnosis and treatment of obesity in adults: an applied evidence-based review. *J.Am.Board Fam.Pract.* 17:359-369.

19. Pollock M.L., J.H.Wilmore (1993) Exercícios na saúde e na doença: avaliação e prescrição para prevenção e reabilitação. 2nd ed., MEDSI, Philadelphia.

20. Rector R.S., S.O.Warner, Y.Liu, P.S.Hinton, G.Y.Sun, R.H.Cox *et al*. (2007) Exercise and diet induced weight loss improves measures of oxidative stress and insulin sensitivity in adults with characteristics of the metabolic syndrome. *Am.J. Physiol.Endocrinol.Metab*. 293:E500-E506.

21. Roberts C.K., Ng.Carey, Ng., S.Hama, A.J.Eliseo, R.J. Barnard (2006) Effect of a short-term diet and exercise intervention os inflammatory/anti-inflammatory properties of HDL in overweight/obese men with cardiovascular risk factors. *J.Appl.Physiol*. 101:1727-1732.

22. Romero C.E.M., A.Zanesco (2006) O papel dos hormônios leptina e grelina na gênese da obesidade. *Rev.Nutr*. 19: 85-91.

23. Shadid S., M.D.Jensen (2003) Effects of pioglitazone versus diet and exercise on metabolic health and fat distribution in upper body obesity. *Diabetes Care* 26:3148-3152.

24. Sociedade Brasileira de Cardiologia (2001) III Diretrizes brasileiras sobre dislipidemias e diretriz de prevenção da aterosclerose do departamento de aterosclerose da sociedade brasileira de cardiologia.

25. Stefanick M.L., S.Mackey, M.Sheehan, N.Ellsworth, W.L. Askell, P.Wood (1998) Effects of diet and exercise in men and postmenopausal women with low levels of HDL cholesterol and high levels of LDL cholesterol. *N.Engl.J.Med*. 339:12-20.

26. Stiegler, P. A.Cunliffe (2006) The role of diet and exercise for the maintenance of fat-free mass and resting metabolic rate during weight loss. *Sports Med*. 36:239-262.

27. Triola M.F. (2006) Introdução à Estatistica. 7th ed. Livros Técnicos e Científicos Editora, Rio de Janeiro.

28. Tsintsifa E., P.Faxantidis, A.Tsiligkiroglou-Fachantidou, A.Deligiannis (2006) Interactions among habitual physical activity, eating patterns and diet composition. *Angiology* 57:205-209.

29. Utter A.C., D.C.Nieman, E.M.Shannonhouse, D.E.Butterworth, C.N.Nieman (1998) Influence of diet and/or exercise on body composition and cardiorespiratory fitness in obese women. *Int J Sport Nutr*. 8:213-222.

30. Warburton D.E.R., C.W.Nicol, S.S.D.Bredin (2006) Prescribing exercise as preventive therapy. *Can.Med.Assoc.J.* 174:961-974.

31. Westcott W.L., R.A.Winett, E.S.Anderson, J.R.Wojcik, R.L.Loud, E.Cleggett, S.Glover (2001) Effects of regular and slow-speed resistance training on muscle strength. *J.Sports Med.Phys.Fitness* 41:154–158.

32. Westman E.C., R.D.Feinman, J.C.Mavropoulos, M.C. Vernon, J.S.Volek, J.A.Wortman *et al.* (2007) Low-carbohydrate nutrition and metabolism. *Am.J.Clin.Nutr*. .86:276-284.

33. Wilborn C., J.Beckham, B.Campbell, T.Harvey, M.Galbreath, M. *et al.* (2005) Obesity: prevalence, theories, medical consequences, management, and research directions. *J.Int.Soc. Sports Nutr*. 2:4-31.

34. World Health Organization (2006) Facts about overweight and obesity. Fact sheet N°311. www.who.int.

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