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THE EFFECT OF REGULAR EXERCISE ON MENSTRUAL CYCLE PATTERN AND EARLY FOLLICULAR HORMONAL AND PHYSIOLGICAL PARAMETERS IN TURKISH SPORTSWOMEN

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Abstract. Objective The aim of this study was to establish the effects and duration of regular exercise on the menstrual pattern and the early follicular hormonal parameters in young sportswomen. Methods: The study included a total of 94 female students from the Firat University made up of 30 sedentary living, 32 involved in active sports for equal or less than 5 years and another 32 involved in sports for over 5 years. Group 1 was composed of 30 girls while Group 2 and Group 3 each containing 32 sportswomen involved in active sports for equal or less than 5 years and over 5 years, respectively. Results: The levels of (free)fT_3, fT_4, fT_3, fT_4, TSH, PRL, follicle stimulating hormone (FSH) and Luteinizing hormone (FSH) levels in the sera of the subjects were determined by the chemiluminiscence. The thyroid stimulating hormone values of the subjects was found to be higher in the sedentary group than that in the sportswomen groups, while the PRL, (totally) tT_3 and tT_4 levels was below that in both sportswomen groups. The difference was statistically significant ($p<0.01$). Conclusions: We concluded that whereas regular but moderate level exercise does not affect serum gonadotropin and free thyroid hormone levels, and don’t cause a disturbance on menstrual cycle pattern, it may lead an increase in serum PRL and total thyroid hormone levels.

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Key words: Exercise – Menstruation - Hormone and sportswomen

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Introduction

Regular aerobic physical activity increases exercise capacity and plays a role in both the primary and secondary protection of cardiovascular diseases [3,15]. In addition to the cardiovascular diseases, exercise also increases the functional capacity in healthy individuals and reduces the oxygen requirement of the myocardium at any given physical activity level. Exercise also in addition to the control of lipid abnormalities, diabetes and obesity, has a small blood pressure lowering effect in some hypertensive groups [14]. Physical inactivity, apart from being a risk factor in the genesis of cardiac diseases (Coronary Heart Disease) is closely related to cardiovascular mortality [16].

These effects of exercise are accomplished through changes in both the endocrine and the metabolic parameters. Several metabolic events resulting from regular exercising in women have been studied. Severe exercise in sportswomen has been reported to lead to menstrual irregularities, delay in the menstrual interval (oligomenorhea) and even amenorrhea [8], however no complete consensus has been reached on this subject [22].

Thyroid hormones by increasing the oxygen consumption of the cells in the body tissues serve to regulate the carbohydrate and lipid metabolism. Among the most important hormones are free Triidothyronine (fT_3), free Thyroxine (fT_4), Total T_4 (tT_4) and total T_3 (tT_3). Under exercise the increase in the secretion of T_4 and T_3 serves as the regulator of the energy balance. For this reason, the thyroid hormones show an increase under sustained, severe exercise [24]. The thyroid stimulating hormone (TSH) and the adrenocorticotropic hormone (ACTH) both regulators of thyroid gland function are also hormones whose levels show an increase under sustained and severe exercise [9]. Another hormone showing an increase due to exercise is prolactin (PRL). High PRL levels are known to lead to menstrual irregularities in women [23].

Despite the fact that the hormones mentioned above have been studied during exercise, nothing is known about the nature of the hormonal changes that take place under regular exercise and the relationship between regular exercise and the serum hormonal changes in the early follicular period of the menstrual cycle in women.

In the light of the information presented above, this study was conducted with the aim of establishing the effects of regular exercise on the pattern of the menstrual cycle and the hormonal parameters of the early follicular phase in young women.

Materials and Methods

A total of 94 female students from the Firat University without history of endocrine, metabolic or chronic disease, and non-smoking, 30 of whom were leading sedentary lives and 32 each of the remaining engaged in active sports for a period of equal or less than 5 years and over 5 years. The 30 students leading sedentary lives (Students from the Health Academy) formed Group 1 while Groups 2 and 3 each composed of 32 students from the Physical Education Academy engaged in active sports for five years and over 5 years respectively. The subjects from the sporting groups were entirely engaged in basketball, volleyball, and handball with none involved in sports requiring any long intensive effort (like marathon).

The VO_2 max. consumption of the subjects was estimated by the Shuttle Run Test. All the subjects were made to run on a 20 m. race course at a speed of 8 km/hr. To determine the racing speed a tape measure appropriate to the protocol was used. The racing speed was increased by 0.5 km/hr every min. The test was continued when the subject readjusted to the next rhythm even after missing the previous signal. The phase at which the subject was stopped was recorded as the test result for the subject. The VO_2 max. value was expressed as ml/kg/min [11,17,18].

After determination of the resting heart beat rate (HR) of the subjects 5 ml blood samples were drawn from the subjects in the early follicular phase. The samples were centrifuged at 2500 rpm for 10 min and the sera separated. In the sera the sT_3, sT_4, tT_3, tT_4, TSH, PRL and the Gonadotropin hormones, Follicle stimulating hormone (FSH) and Luteinizing hormone (LH) levels determined by the chemiluminiscence method in an IMMULYTE (DPC, Diagnostic Product Corporations, Los Angeles USA) hormone analyzer. Information about menstrual pattern was recorded as declared by the subjects through questioning.

The data were expressed as average ±SD. For the statistical evaluation the one way Analysis of variance (ANOVA) was used and $p<0.05$ values determined by the Tukey HSD test. $p<0.05$ was considered statistically significant. All statistical analysis was done with the SPSS 10.0 program kit.

While the TSH of the groups was found to be higher in the sedentary subjects than in the sporting subjects, that of the PRL, tT_3 and tT_4 levels were lower than in both sporting groups. The difference was statistically significant ($p<0.01$)

Results

The demographic and physical properties of the subjects are shown in Table 1. The groups did not different in terms of average age and height (p>0.05). Groups 2 and 3 weighed lower, and they had lower resting HR and higher max. VO_2 values than Group 1 (p<0.05). The duration of sporting age was significantly higher in group 3 than in group 2 (p<0.05).

Table 1
The demographic and physical properties of the subjects (average ±SD)

n=94	Group 1 (n=30)	Group 2 (n=32)	Group 3 (n=32)
Age (years)	21.90±1.79	20.20±2.68	23.14±3.07
Height (cm)	1.66±3.46	1.68±2.45	1.69±3.34
Weight (kg)	64.30±3.46[a]	59.64±3.54	57.87±4.11
Sporting age (years)		3.10±1.76[b]	7.72±2.16
Resting HR	75.33±5.27[a]	63.78±3.81	59.92±4.21
Max VO_2 (ml/kg/min)	35.74±2.51[a]	46.16±3.25	51.85±4.55

a: p<0.05, group 1 vs. group 2 and 3; b: p<0.05, group 2 vs. group 3

Table 2
Comparison of the hormonal parameters between Groups 1, 2 and 3

	Group 1 (n=30)	Group 2 (n=32)	Group 3(n=32)
sT_3 (ng/dL)	3.8±0.5	4.0±0.5	5.1±0.7
sT_4 (ng/dL)	1.3±0.2	1.3±0.1	1.6±0.4
tT_3 (ng/dL)	7.5±0.8[a]	9.1±1	10.8±1.4
tT_4 (ng/dL)	184.9±11.0[b]	198.8±10.0	218.8±13.0
TSH (uIU/mL)	1.9±0.6[c]	1.5±0.3	1.4±0.4
PRL (ng/mL)	5.4±1.3[d]	7.2±2.4	8.6±2.6
FSH (mIU/mL)	6.2±1.7	6.6±2.1	6.5±2.5
LH (mIU/mL)	5.2±1.4	5.1±8.7	6.4±6.3
Estradiol (pg/mL)	38.5±15.8	36.3±13.7	40.9±14.0
ACTH (pg/mL)	42.08±6.11	40.67±8.13	37.20±10.20

a: p<0.003, Group 1 vs. Group 2 and 3; b: p<0.001, Group 1 vs. Groups 2 and 3
c: p<0.001, Group 1 vs. Group 2 and 3; d: p<0.001, Group 1 vs. Group 2 and 3

The TSH in the sedentary group was higher than that in the sporting groups while that of the PRL, tT_3 and tT_4 levels were found to be lower. The difference between them was statistically significant ($p<0.01$). In the comparison of the sporting groups, despite the differences in the levels, they failed to reach statistical significance ($p>0.05$), (Table 2).

Discussion

This study was designed with the aim of establishing the effects of the duration of regular exercise on the menstrual cycle pattern and hormonal parameters in women

In questioning the subjects about the menstruation pattern no single subjected admitted to having oligomenorrhea, amenorrhea or any complaints related to menstrual irregularity. It has been reported that especially during vigorous physical activity, in addition to the release of ACTH from the hypothalamus under the effect of CRH, the opiod peptides also release and lead irregular release of gonadotropin releasing hormone (GnRH) which in turn affects the functioning of the hypothalamo – hypophysial – ovarian arc leading ultimately to irregular menses, an effect reported especially in marathon runners [7,9]. The fact that none of our subjects engaged in active sports had irregular menses could have been due to the fact that they did not engage in vigorous exercise. Similar to our findings, it has been reported that regular but mild or moderate intensity exercise did not negatively affect the menstruation pattern [22]. The menstrual pattern disturbing effect of the vigorous exercise mentioned above does not appear in the regular but mild or moderate intensity exercise as in our subjects. The hypothalamo – hypophysial – ovarian arc is either affected to a limited degree or not at all only even after prolonged periods of mild or moderate exercise.

In studies assessing the effect of hemoglobin concentration on the maximum O_2 consumption capacity (VO_2 max) [2,19], acute exercise has been reported to decrease the hemoglobin concentration in men, leading to a fall in the VO_2 max. accompanying the reduced oxygen carrying capacity [13]. It is possible to observe similar relationship between regular exercise and the intensity of the training. The intensity of training is at the same time considered a percentage of the VO_2 max. Another marker of training severity is the resting HR. During exercise the VO_2 max and HR both increases. At rest, however, this relationship is reversed, with higher VO_2 max. and lower HR depending on the level of exercise in the sporting group than in the sedentary group [4,13]. The VO_2 max and HR observed in our study groups agrees with that in the literature. Regular exercise leads to an increase in VO_2 max. and a decrease in HR.

Production of adequate amounts of thyroid hormone depends on adequate intake of elemental iodine in the diet. However, exercise has been shown to have an affect on the thyroid hormones with physical activity increasing both the secretion and the catabolism of T_4 [5]. In general, thyroid hormones have increasing effects on the metabolic rate, oxygen consumption, and heat production. In this study, the levels of serum tT_3 and tT_4 was found to be higher in both sporting groups than in the sedentary group independent of the sporting age while the TSH level was found to be lower. The high thyroid hormone levels in the sporting women can be explained by the effect of catecholamine release and the increased fatty acid oxidation during sub maximal exercise [24]. The lack of change in fT_3 and fT_4 levels in circulation to exercise is in agreement with the production and release of the thyroid hormones. No matter the severity or duration of exercise, as a result of increased metabolism, the organism is able to increase the thyroid hormone levels in circulation to the required levels. However, immediately following exercise, this increase returns to normal to prevent increased metabolic state from continuing after exercise [5]. The increased circulatory tT3 and tT4 levels and the decreased TSH in sporting individuals are thought to result from the adaptation after exercise. The cause of the decreased TSH has been reported to be the result of decreased stimuli from the hypothalamus and hypophysis, which is thought to be a way of preserving energy in sporting women [1,4].

PRL, secreted from the lactotrophic cells of the anterior lobe of the hypophysis is a hormone which stimulates milk production in the breast. The increase in PRL level during exercise is reported in current literature [20]. The high levels of PRL observed in our study was thought to be the result of the relatively short intervals between training sessions in our subjects. To reduce the serum PRL requires long periods like 3 – 4 weeks. The interval between training sessions in our sporting groups did not exceed one week. We believe this period was not enough for the PRL levels to return to normal. Although the PRL level was higher in the sporting individuals than that in the sedentary individuals the average values were below 20 ng/mL. PRL levels above this value may lead to galactorrhea and menstrual irregularities. We can infer therefore that in women performing moderately intense exercise an increase in serum PRL occurs but remains within the physiological limits.

In this study, the early follicular serum FSH, LH and estradiol levels in the sporting women did not show any differences with the sedentary group. Different results have been reported from studies investigating the effect of exercise on the serum gonadotropins. Whereas some investigators report increased gonadotropin levels after exercise [20] others report that it is increased only in women having irregular menses without any effect on women experiencing regular menses [12]. Though the serum levels of these hormones change after vigorous exercise like marathon running no changes has been reported in moderate degree activities like in the water sports [6]. Considering the fact that sporting subjects in this study were all subjected to moderate intensity exercise without any resulting menstrual irregularity, it can be said to agree with those of similar studies [6,10]. We are of the opinion that regularly performed moderate exercise affects the gonadotropins but does not lead to menstrual disturbances.

ACTH, a hormone responsible for the secretion of hormones from the Adrenal or suprarenal gland increases the release of glucocorticoids and mineralocorticoids. Beta endorphins which increases together with the elevated ACTH through suppression of gonadotropins especially in women engaged in vigorous exercise like marathon running can lead to menstrual disturbances [18,21,24]. Similar to our findings, it has been reported that moderate intensity exercise does not lead to menstrual disturbance in women [22].

In conclusion, we believe that regularly performed non-vigorous exercise does not affect the gonadotropic hormones of the anterior hypophysis and the free thyroid hormones, but increases the PRL and the total thyroid hormone levels without any effect on the menstrual pattern.

References

1. Baylor L.S., A.C.Hackney (2003) Resting thyroid and leptin hormone changes in women following intense, prolonged exercise training. *Eur.J.Appl.Physiol.* 88:480-484

2. Bemben D.A., P.C.Salm, A.J.Salm (1995) Ventilatory and blood lactate responses to maximal treadmill exercise during the menstrual cycle. *J.Sports Med.Phys.Fitness* 35:257-262

3. Chandrasheckhar Y., I.S.Anand (1991) Exercise as a coronary protective factor. *Am.Heart J.* 122:1723-1739

4. Ciloglu F., I.Peker, A.Pehlivan, K.Karacabey, N.Ilhan, O.Saygin, R.Ozmerdivenli (2005) Exercise intensity and its effects on thyroid hormones. *Neuro.Endocrinol.Lett.* 26:830-834

5. Guyton A.C., E.Hall, Jhon (1996) Text Book of Medical Physiology. W.B. Saunders Co. A. Division of H. Brace Co., pp. 629-642

6. Hale R.W., T.Kosasa, J.Krieger, S.A.Pepper (1983) Marathon: the immediate effect on female runners' luteinizing hormone, follicle-stimulating hormone, prolactin, testosterone, and cortisol levels. *Am.J.Obstet.Gynecol.* 1:146:550-556

7. Heitkamp H.C., W.Huber, K.Scheib (1996) Beta-endorphin and ACTH after incremental exercise and marathon running female responses. *Eur.J.Appl.Physiol.* 72:417-424

8. Heitkamp H.C., H.Schulz, K.Rocker, H.H.Dickhuth (1998) Endurance training in females: changes in beta-endorphin and ACTH. *Int.J.Sports Med.* 19:260-264

9. Karacabey K, O.Saygin, R.Ozmerdivenli, E.Zorba, A.Godekmerdan, V.Bulut (2005) The effects of exercise on the immune system and stress hormones in sportswomen. *Neuro Endocrinol Lett.* 26:361-366

10. Kumru S, R.Ozmerdivenli, C.Parmaksız, C.Gundoğdu (2004) Bayan Sporcularda Düzenli Egzersizin Menstrual Adet Düzeni Ve Erken Foliküler Hematolojik ve Fizyolojik Parametrelere Etkisi. Spor ve Tıp Dergisi 5:29-32

11. Leger L., C.Gadoury (1989) Validity of the 20 m shuttle run test with 1 minute stages to predict VO_2 max in adults. *Can.J.Sports Sci.* 14:21-26

12. Loucks A.B., S.M.Horvath (1984) Exercise-induced stress responses of amenorrheic and eumenorrheic runners. *J.Clin.Endocrinol.Metab.* 59:1109-1120

13. Lucia A., J.Hoyos, A.Santalla, M.Perez, J.L.Chicharro (2002) Curvilinear VO_2: power output relationship in a ramp test in professional cyclists: possible association with blood hemoglobin concentration. *Jpn.J.Physiol.* 52:95-103

14. Martin J.E., P.M.Dubbert, W.C.Cushman (1990) Controlled trial of aerobic exercise in hypertension. *Circulation* 81:1560-1567

15. Morris C.K., V.F.Froelicher (1991) Cardiovascular benefits of physical activity. *Herz* 16:222-236

16. Powell K.E., P.D.Thompson, C.J.Caspersen, J.S.Kendrick (1987) Physical activity and the incidence of coronary heart disease. *Annu.Rev.Public Health* 8:253-287

17. Quadagno G., L.Faquin, G.Lim, W., Kuminka, R.Y., Moffatt (1999) The menstrual cycle, does it affect athletic performance. *Phys.Sports Med.* 19:38-41

18. Ramsbottom R., J.Brewer, C.Williams (1988) A progressive shuttle run test to estimate maximal oxygen uptake. *Br.J.Sports Med.* 22:141-144

19. Richardson R.S., K.Tagore, L.J.Haseler, M.Jordan, P.D.Wagner (1998) Increased VO_2 max with right-shifted Hb-O2 dissociation curve at a constant O_2 delivery in dog muscle in situ. *J.Appl.Physiol.* 84:995-1002

20. Schmid P., H.H.Pusch, W.Wolf, E.Pilger, H.Pessenhofer, G.Schwaberger, H.Pristautz, P.Purstner (1982) Serum FSH, LH, and testosterone in humans after physical exercise. *Int.J.Sports Med.* 3:84-89

21. Tabata I., Y.Atomi, Y.Mutho, M.Miyashita (1990) Effect of physical training on the responses of serum ACTH hormone during prolonged exhausting exercise. *Eur.J.Appl.Physiol.* 61:188-192

22. To W.W., M.W.Wong, K.M.Chan (1995) The effect of dance training on menstrual function in collegiate dancing students. *Aust.NZ.J.Obstet.Gynaecol.* 35:304-309

23. Wieck A., P.M.Haddad (2003) Antipsychotic-induced hyperprolactinaemia in women: pathophysiology, severity and consequences. Selective literature review. *Br.J.Psychiatry* 182:199-204

24. Williams N.I., D.L.Helmreich, D.B.Parfitt, A.Caston-Balderrama, J.L.Cameron (2001) Evidence for a causal role of low energy availability in the induction of menstrual cycle disturbances during strenuous exercise training. *J.Clin.Endocrinol.Metab.* 86:5184-5193

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