Effect of Different Types of Exercise on Menstrual and Immunological Functions in Female Athletes

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Background: it is well documented that the effect of exercise on the physiological and immunological functions depends on its intensity, duration and regularity However, few studies had analyzed the impact of aerobic and anaerobic exercise on the menstrual and immunological functions in female athletes.

purpose: To evaluate the effect of different types of exercise on menstrual and immunological functions in female athletes.

Subjects and Method: Twenty-eight female athletes participated in this study. Fifteen of them participated in aerobic exercise, while thirteen of them participated in anaerobic exercise. Their ages ranged from 16 to 20 years old and their body mass index (BMI) ranged from 16 to 25 kg/m^2. The menstrual function was evaluated through a self–administered questionnaire and serum estradiol while the immunological function was assessed through serum immunoglobulin A (IgA).

Results: There were non-significant differences between the aerobic and anaerobic groups regarding the percentage of eumenorrhea and menstrual dysfunction, menarche age, number of menstrual cycles in the last year, menstrual cycle length, serum estradiol and serum IgA ($P>0.05$). Additionally, there were non-significant correlations between serum estradiol and serum IgA in both aerobic and anaerobic groups ($P>0.05$).

Conclusion: Both aerobic and anaerobic exercises have the same impact on menstrual and immunological functions in female athletes.

Keywords: aerobic, anaerobic, menstrual function, immunological function, female athletes.

Introduction

The number of females participating in sport has increased significantly. Therefore, more females have been able to experience the social, educational and health-related benefits of sport participation. However, the menstrual dysfunction is one of the risks associated with sport participation [1].The reported prevalence of menstrual dysfunction (including primary, secondary amenorrhea or oligomenorrhea) among female athletes ranges from 12% to 54% [2].

Physical exercise modulates not only physiological systems but also regulatory systems such as the immune system. In fact, performance of physical exercise has been associated with lower susceptibility to infections and other pathologies related with the immune system compared to sedentary subjects. There is a wealth of information on the effects of physical exercise on the immune function of adult experimental humans. However, conflicting results have been obtained, depending on the type, intensity and frequency of exercise, as well as the immunological function studied and state of the subject [3].

Research revealed a relationship between different reproductive processes (including ovulation and menstruation) and the immune system [4]. Kazuhiro et al. [5] found that eumenorrheic runners had higher salivary IgA secretion rates than amenorrheic runners.

Although it is well documented that the effect of exercise on the physiological and immunological functions depends on its intensity, duration and regularity [3], few studies had analyzed the impact of aerobic and anaerobic exercise on the menstrual and immunological functions in female athletes. Therefore, the aim of this study was to compare the effect of different types of exercise on the menstrual and immunological functions in female athletes. Additional objective was to investigate the correlations between serum estradiol and serum IgA in female athletes participating in different types of exercise.

Subjects, Instrumentations and Methods

Subjects:

Design

The study was an observational cross sectional design

Recruitment

A sample of thirty female athletes were enrolled in the study; fifteen of them participated in aerobic exercise (half marathon runners), while the other fifteen participated in anaerobic exercise (long jumpers). However, 2 female athletes in the anaerobic group did not complete the study because of coagulation problems in their blood samples. They were selected from Al Ahly Sporting Club,

Cairo, Egypt. Informed consent was obtained from each participant after explaining the nature, purpose and benefits of the study, informing them of their rights to refuse or withdraw at any time and about confidentiality of any obtained information. This study was approved by the Research Ethical Committee of the Faculty of Physical Therapy, Cairo University (No:P.T.REC/012/001499, 25/12/2016).

The inclusion and exclusion criteria:

To be included in the study, the participants were chosen healthy, non-smoking, virginal female athletes. Their ages ranged from 16 to 20 years old and their BMI ranged from 16 to 25 kg/m^2. They started sports training at least one year before the onset of menarche. Injured female athletes who were absent from training for at least three months before starting the study were excluded from this study. In addition, female athletes who used any drug or supplementation known to affect the immune function or those who used oral contraceptives or any hormonal treatment in the previous six months were excluded from this study.

Outcome measures

Anthropometric measures

Weight–Height scale was used to measure the weight and height for each female athlete in both groups (aerobic and anaerobic). Then, BMI was calculated by dividing weight by height squared (Kg/m^2).

Questionnaire

Aself–administered questionnaire was given to each female athlete in both groups (aerobic and anaerobic) to assess her training history and menstrual status [6]. It contained questions about age of participation to sports (years), training experience (years) and training hours per week (h/wk)). Also, each female athlete was asked about her menarche age (years), number of menstrual cycles in the last year and menstrual cycle length (days).

According to the menstrual history in the last year, subjects were defined as eumenorrheic, amenorrheic, oligomenorrheic or polymenorrheic. Eumenorrhea was defined as menstrual cycles that are at intervals 21-35 days or ten to thirteen menstrual cycles per year. Primary amenorrhea was regarded as reaching the age of 15 without menstruation. Secondary amenorrhea was defined as the absence of menstrual cycle for at least 3 months or three or fewer cycles per year. Oligomenorrhea was defined as menstrual cycles that were at intervals more than 35 days or four to nine menstrual cycles per year. Polymenorrhea was defined as menstrual cycles that were at intervals less than 21 days. Primary amenorrhea, secondary amenorrhea, oligomenorrhea and polymenorrhea were all defined as menstrual dysfunction [6-7].

Laboratory investigation

Blood samples were obtained on the 2nd day of the menstrual cycle at 10.00 a.m. following overnight fasting

and rest. The female athletes were instructed to refrain from performing strenuous exercise on the day of sampling. Blood samples were separated and stored at −80°C till analysis of serum estradiol and IgA levels. Serum estradiol was measured by ADVIA Centaur XPT System (made in Germany) to evaluate the menstrual function. Serum IgA was measured by COBAS Integra 400 plus (made in Switzerland) to reflect the immune function.

Statistical analysis

Results were expressed as mean ± standard deviation or number (%). Comparison between percentages of eumenorrhea and menstrual dysfunction in the two groups was performed using Chi square test. Test of normality, Kolmogorov-Smirnov test, was used to measure the distribution of data. Accordingly, comparison between variables in the two groups was performed using Mann Whitney test. Correlation between different parameters in the two groups was performed using Spearman's rho correlation coefficient. Statistical analysis was performed using SPSS computer program (version 19 windows). P value ≤ 0.05 was considered significant.

RESULTS

The participants' anthropometric and training data are summarized in Table 1. Age, weight, height and BMI showed non-significant differences (P>0.05) between aerobic and anaerobic groups. Concerning the training-related characteristics of female athletes, results revealed non-significant differences between aerobic and anaerobic groups in age of participation to sport (P=0.268), training experience (P=0.184) and training hours per week (P=0.923).

Table 1.Baseline characteristics of aerobic and anaerobic groups.

Variables	Aerobic group (n = 15)	Anaerobic group (n = 13)	P value
Age (yrs.)	17.53 ± 1.41	17.46 ± 1.20	0.887
Weight (Kg)	53.87 ± 5.25	56.08 ± 5.52	0.288
Height (cm)	162.80 ± 4.72	165.85 ± 5.49	0.126
BMI (kg/m^2)	20.33 ± 1.89	20.45 ± 2.47	0.884
Training-related characteristics			
Age of participation(yrs.)	11.13 ± 2.23	10.31 ± 1.49	0.268
Training experience(yrs.)	6.27 ± 1.98	7.15 ± 1.35	0.184
Training hours per week (h/wk)	14.13 ± 4.16	14.31 ± 3.64	0.923

Percentages of eumenorrhea and menstrual dysfunction

Results showed that 73.3% of the female half-marathon runners in the aerobic group experienced eumenorrhea, while 26.7% of them met the criteria of menstrual dysfunction (all of them experiencing oligomenorrhea). In the anaerobic group, 69.2% of the female long jumpers had eumenorrhea, while 30.8% of them met the criteria of menstrual dysfunction (half of them experienced oligomenorrhea and the other half experienced polymenorrhea). The percentages of eumenorrhea and menstrual dysfunction revealed a statistically non-significant difference between aerobic and anaerobic groups (P=0.254), (table 2).

Table 2.Percentages of eumenorrhea and menstrual dysfunction in aerobic and anaerobic groups.

Variables	Aerobic group (n = 15)	Anaerobic group (n = 13)	χ2 value	P value
Eumenorrhea	11 (73.3%)	9 (69.2%)		
Menstrual dysfunction	4 (26.7%)	4 (30.8%)	2.738	0.254 (NS)
Oligomenorrhea	4 (26.7%)	2 (15.4%)		
Polymenorrhea	0 (0.0%)	2 (15.4%)		

Menstrual function

Results showed statistically non-significant differences between aerobic and anaerobic groups regarding menarche age (P=0.501), number of menstrual cycles in the last year (P=0.907), menstrual cycle length (P=0.869) and serum estradiol (P=0.447), (table 3).

Table 3.Menstrual function in aerobic and anaerobic groups.

Variables	Aerobic group (n = 15)	Anaerobic group (n = 13)	P value
Menarche age (yrs)	13.33 ± 1.63	13.69 ± 1.03	0.501
Number of menstrual cycles in last year	11.47 ± 2.95	12.46 ± 3.46	0.907
Menstrual cycle length (days)	34.13 ± 13.39	30.77 ± 8.23	0.869
Serum estradiol (pg/ml)	33.31 ± 9.80	35.87 ±7.96	0.447

Immune function

The serum IgA revealed a statistically non-significant difference between aerobic and anaerobic groups (P=0.117), (table 4).

Table 4.Immune function in aerobic and anaerobic groups.

Variables	Aerobic group (n = 15)	Anaerobic group (n = 13)	P value
Serum IgA (mg/dl)	142.03 ± 31.02	162.85 ± 40.27	0.117

Correlation between serum estradiol and serum IgA

There was no statistical significant correlation between serum estradiol and serum IgA in the aerobic group, (r =-0.018; P = 0.950) as well as anaerobic group, (r =0.225; P = 0.459).

DISCUSION

Physical exercise induces structural and functional changes in various physiological systems as well as regulatory systems, including the immune system. However, data from studies have been controversial according to the type, intensity and regularity of exercise [3, 8]. Therefore, this cross-sectional study aimed to compare the effect of different types of exercise on the menstrual and immunological functions in female athletes.

The present study found that 73.3% of the female half-marathon runners in the aerobic group had eumenorrhea, while 26.7% of them had menstrual dysfunction (all of them experiencing oligomenorrhea). This result agreed with Muia et al. [9] who reported that 67.8% of elite Kenyan runners had eumenorrhea, while 32.7% of them had menstrual dysfunction. Additionally, Thein-Nessembaum et al. [10] reported that 24.3% of the aerobic endurance athletes had menstrual dysfunction. Roupas and Georgopoulos [11] had attributed the higher prevalence of menstrual disorders among female runners to the specific optimal

somatotype demands combined with dietary adaptations and restrictions. The distance of running represents also a key factor in the development of menstrual dysfunction among female runners.

The present study showed that 69.2% of the female long jumpers in the anaerobic group had eumenorrhea, while 30.8% of them had menstrual dysfunction (half of them had oligomenorrhea and the other half had polymenorrhea). This finding was consistent with Thein-Nessembaum et al. [10] who reported that 30.5% of the anaerobic female athletes had menstrual dysfunction. In addition, Carbuhn et al. [12] found that jumpers had a low total body mass, fat mass and body fat percentage. Therefore, the resultant low energy availability could induce menstrual dysfunction in female jumpers [13].

Regarding the percentages of eumenorrhea and menstrual dysfunction, there was a statistically non-significant difference between aerobic and anaerobic groups. This result was in line with Thein-Nessembaum et al. [10] and Thein-Nessembaum et al. [14] who found a statistically non-significant difference between aerobic endurance athletes and anaerobic athletes regarding the percentage of menstrual dysfunction.

Regarding menarche age, the results of this study showed that there was a statistically non-significant difference between aerobic and anaerobic groups. This finding was in agreement with Thein-Nessembaum et al. [10] who reported a statistically non-significant difference in the age of menarche between aerobic and anaerobic athletes.

Results of this study revealed that there were statistically non-significant differences regarding the number of menstrual cycles in the last year and the menstrual cycle length between aerobic and anaerobic groups. Eumenorrhea and menstrual dysfunction were defined according to the number of menstrual cycles in the last year and the menstrual cycle length. Consequently, the non-significant difference in the percentages of eumenorrhea and menstrual dysfunction between aerobic and anaerobic groups could be associated with non-significant differences regarding the number of menstrual cycles in the last year and the menstrual cycle length between both groups.

Concerning serum estradiol, it showed a statistically non-significant difference between

aerobic and anaerobic groups. This result coincided with Najafi et al. [15] who investigated the effect of aerobic and anaerobic exercises on estrogen levels in non-athletic middle-aged men. They found a statistically non-significant difference between both groups after 8 weeks of training. This finding supported with Vahid et al. [16] who found a statistically non-significant difference regarding serum IgA between aerobic and anaerobic groups in male runners. Additionally, Nabia and Saad [17] reported that both aerobic and anaerobic exercises improve the serum IgA in male athletes.

On the other hand, Karacabey et al. [18] found that after two and five days of training, there was a significant increase in IgA levels in the aerobic group while there was no significant change in IgA values in the anaerobic group. In addition, Mohamed and Taha [19] reported that 12 weeks of moderate aerobic training improves immunity compared with moderate resisted training in obese women. The contrast among studies can be attributed to the variations in training protocol (such as type, intensity, duration and frequency of exercise); the difference in the level of subject's` adaptation to exercise or the difference in study sample (some studies were conducted on sedentary subjects while others were conducted on athletes). Moreover, some studies were conducted on males while others on females.

Results of the current study showed that, in both aerobic and anaerobic groups, there were no statistical significant correlations between serum estradiol and serum IgA. These findings were consistent with Gonzalez-Quintela et al. [20] who found that male sex, but not female sex, was associated positively with serum IgA levels. In contrast, Oertelt-Prigione [21] reported that sex hormones, mostly estrogen, influence immune cells quantitatively and qualitatively, increasing the immune response.

Conclusion

Aerobic and anaerobic training have similar effects on menstrual and immunological functions in female athletes. Both of them are associated with increased percentage of menstrual dysfunction. Thus, educational programs should be designed to balance the energy intake with the energy expenditure and restore menstruation.

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Conflicts of interest

There are no conflicts of interest.

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الملخص

الموجات البلانارية مقابل الموجات الريديالية على السليولايت بعد شفط الدهون

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الخلفية:السليولايت هو تغييرفى سطح الجلد يمكن أنيؤديإلى مشاكل جمالية وصحية. شفطالدهون يسبب تفاقم في مظهرالجلدالمدمل والسليولايت.

الغرض من هذه الدراسة: المقارنة بين الموجات البلانارية مقابل الموجات الريديالية على السليولايت بعد شفط الدهون

الوسائل : تم تقسيم ستين مريضة من النساء تعانى من السليولايت الدرجة الثالثة بعد شفط الدهون عشوائيا إلى مجموعتين متساويتين فى العدد (المجموعة الأولى البلانارية و المجموعة الثانية الريديالية). وتضمنت طريقة التقييم تحديد درجة السليولايت الموجودة وقياس سمك الجلد لكل مريض. تلقت المجموعة الأولى الموجات البلانارية مرتين بالأسبوع لمدة 12أسبوع ،بينما تلقت المجموعة الثانية الموجات الريديالية مرتين بالأسبوع لمدة12 أسبوع.

النتائج :أظهرت نتائج هذه الدراسة تحسن كبيرفي درجة السليولايت الموجودة وقياس سمك الجلد في مجموعة الموجات الريديالية مقارنة بمجموعة الموجات البلانارية.

الاستنتاج: تم استنتاج أن الموجات الريديالية كانت اكثرفعالية علاجية من الموجات البلانارية في السيطرة على السليولايت عن طريق خفض درجة السليولايت وتحسين مظهره.

كلمات البحث: السليولايت،العلاج بالموجات الصوتية،الموجات البلانارية،الموجاتالريديالية.