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The Effect of Aerobic Exercise (Swimming) and Oral Contraceptives on Some Hormonal Variables According to Age and Childbirth: Analytical Study

Aerobik Egzersiz (Yüzme) ve Oral Kontraseptiflerin Yaş ve Çocuk Doğurmaya Göre Bazı Hormonal Değişkenlere Etkisi: Analitik Çalışma

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ABSTRACT Objective: This study aims to examine the effect of aerobic exercise (AE) (swimming) and oral contraceptives (OCs) on some hormonal variables according to the variables of age and childbirth through analyzing the parameters of weight, body mass index (BMI), triglycerides, cholesterol, glucose and progesterone. **Material and Methods:** Our study includes a sample of 16 married women (between 20-30 years of age). The sample were enrolled in the same-discipline, and were divided in 2 groups, the 1st group (G1) has kids while the 2nd group (G2) does not. The subjects have been taking OCs (3rd generation; Meliane®, Microgynon®) for at least the last 6 months, and they haven't been pregnant for the last year. AE (swimming) was practiced 2-3 times/week for 75 min maximal in moderate-intensity, for 13 weeks. The changes in hormonal parameters (pre- and post- intervention) were measured. The data were analyzed by SPSS 22.0 program, descriptive statistics (mean±standard deviation), Student's t and ANOVA tests. **Results:** The results showed that most parameters including weight and BMI ($p \leq 0.005$), progesterone ($p \leq 0.001$) changed significantly in post-intervention in comparison to pre-intervention for both groups. Cholesterol and glucose ($p \leq 0.05$) changed for G2. In addition, progesterone in post-intervention changed significantly between the 2 groups ($p \leq 0.05$). **Conclusion:** In conclusion, the results confirm that the variables of age and childbirth do effect the hormonal values of women during the period of taking OCs especially in progesterone hormone which has implications for the shape of women's body. Therefore, we propose that practicing AE such as swimming is a safe and useful method for the stability of hormone values in the normal and ideal level. This practise aids in preventing obesity, the risk of developing heart disease, and artery disease for women in realtion to the factors of aging and childbirth.

Keywords: Women; oral contraceptives (pills); swim; hormonal parameters; childbirth

ÖZET Amaç: Bu çalışmanın amacı aerobik egzersizin (AE)(yüzme) ve oral kontraseptiflerin (OK) yaş ve çocuk doğurma gibi değişkenlere göre bazı hormonal değişkenler üzerindeki etkilerini vücut ağırlığı, beden kitle indeksi (BKİ), trigliserid, kolesterol, glukoz ve progesteron parametrelerini incelemek suretiyle araştırmaktır. **Gereç ve Yöntemler:** Çalışmamızın örneklemini (20-30 yaşları arasında) 16 evli kadın oluşturmuştur. Örneklem aynı disiplinde alınmıştır ve 2 gruba ayrılmıştır, 1.gruptakilerin (G1) çocuğu varken 2.gruptakilerin (G2) yoktur. Katılımcılar en az 6 aydır OK (3.kuşak; Meliane®, Microgynon®) almaktaydılar ve son 1 yıl içinde gebelik yaşamamışlardı. On üç haftadır haftada 2-3 kez, orta yoğunlukta, en fazla 75 dak olmak üzere aerobik egzersiz (yüzme) yapıldı. Hormonal parametrelerdeki değişiklikler (girişim öncesi ve sonrası) ölçüldü. Veriler SPSS 22.0 programı, tanımlayıcı istatistikler (ortalama standart sapma), Student t-testi ve ANOVA testleri ile incelendi. **Bulgular:** Sonuçlar vücut ağırlığı ve BKİ ($p \leq 0.005$), progesteron ($p \leq 0.001$) gibi çoğu parametrenin her iki grupta girişim öncesi değerlere göre girişim sonrasında anlamlı olarak değiştiğini göstermiştir. G2'de kolesterol ve glukoz değişmiştir ($p \leq 0.05$). **Sonuç:** Sonuç olarak, bulgular yaş ve çocuk doğurma değişkenlerinin kadınların OK kullandıkları süreçte hormonal değerleri, özellikle kadın vücudunun şekillenmesinde etkileri olan progesteron hormonunu etkilediğini doğrulamaktadır. Bu nedenle, yüzme gibi AE yapmanın hormon düzeylerinin normal ve ideal düzeylerde kalması için güvenilir ve faydalı bir yöntem olduğunu düşünüyoruz. Bu uygulama kadınlarda yaşlanma ve çocuk doğurma ile ilişkili olarak obezitenin önlenmesi, kalp hastalığı ve arter hastalığı gelişim riskini önlemeye yardımcı olur.

Anahtar Kelimeler: Kadınlar; oral kontraseptifler (hap); yüzme; hormonal parametreler; çocuk doğurma

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Regular sporting exercises prevent aging and diseases that may arise by improving physical fitness, therefore regular exercises are an important factor in human life in terms of health protection.[1] In addition to increasing the level of physical activity (PA) of women in daily life, it should be ensured that the PA is sustained and the quality of the PA is increased.[2] The possibility of programming and practicing a PA for women attracts considerable interest particularly after aging and postnatal. This evidence supports the hormonal parameter alterations associated with anthropometric measures after postnatal, particularly values of weight and bone mineral content (BMC).[3] The menstrual loop (which is necessary for pregnancy/ovulation and under the control of the endocrine system) refers to the process of physiological changes that may occur in fertile women. The average cycle lasts for 28 days, and the length of this period differs depending on the woman and the cycle.[4] The physiological changes occurring during this period are not seen in the pre-menstrual period, but are composed only of changes that are specific to the menstruation period.[5] The changes are caused by the fact that the amount of hormones in the circulatory system is not constant and leads to some negative psychological and physiological effects.[6] Body composition parameters are frequently used in evaluating the changes in body functions during PA. However, the discovery of new hormones, the influence of these hormones on the effects of the exercise, and the identification of the body composition as a result of determining that these hormones started to be examined in detail.[7] This hypothesis is supported by a growing number of observational and experimental studies. In this respect, the fact that progesterone blocks ovulation in the 1950's and the development of combined oral contraceptives (OCs) in the following period are considered as the milestones of fertility control in humans.[8]

The use of hormonal contraceptives has become widespread all over the world in a very short time due to providing safe fertility control, OCs are steroidal drugs that are used orally by women in order to prevent conception (contraception), which is close to 100% efficiency, high security limits and other important contributions to health by today's most effective reversible birth control method.[9] The mechanism of action of OC agents, which is a widely used drug in the world, is artificially changing sex hormone levels.[10] Drugs used as OCs include synthetic estrogen (ethinylestradiol or mestranol) and various progestin (norgestrel, levonogestrel, noretisteron, ethinodiol or linestrenol) hormones.[11] There are varieties of OCs used in monophasic, biphasic or triphasic forms. Monophasic forms; each tablet contains a stable amount of estrogen and progesterone.[12] They are used for 21 days and the 2nd application starts after 7 days of drug-free period. The amount of estrogen in the biphasic forms is stable and the amount of progesterone increases in the 2nd half of the cycle. The amount of estrogen in staphasic forms can be stable or variable and the amount of progesterone increases at the same level in 3 phases.[13,14] For women using OCs, progesterone and estrogen hormone levels are continuously elevated in the blood, thus inhibiting follicle-stimulating hormone and luteinizing hormone secretion from the pituitary gland. Thus, pregnancy is prevented by preventing ovulation.[15,16] Thus, there is a relationship between the hormones and functions of the body and body shape, which are largely designed by the accumulation of excess fluid and fat. Hormones play a vital role in the functions of the body. Therefore, any change in hormone levels in the blood, no matter how small, can seriously affect health. However, it can occur naturally at some stages of life, such as menopause and pregnancy, where hormonal imbalance is associated with many health problems. Hence, improving the practice of PA can help optimize the body's performance and contribute to restoring a more normal body shape.

In this context, we have conducted the present study specifically to evaluate the effect of aerobic exercise (AE) (swimming) and OCs on some hormonal variables according the variables of age and childbirth. Also, we have evaluated the relationships between the values of pre/post-test in the selected variables.

MATERIAL AND METHODS

The current study is a comparative analysis between 2 values results of tests (hormonal analysis). To achieve that, the researchers used the experimental method for

2 experimental groups. The study was carried out in accordance with the Helsinki Declaration principles.

*__Ethical approval:__ Abdelhamid Ibn Badiss University Ethics Committee approved the study (approval date: 14.12.2019 and approval number: 06/2019). All participants provided written informed consent before commencing the study to the investigator, with the condition of keeping personal data secret like names...etc.

*__Sample size:__ Sixteen married women (between 20 and 30 years) who were taking OCs volunteered to participate as subjects in this study. The sample was divided in 2 groups, Group 1 consists of 8 women participants who have kids (age=28.875±1.356 years, height=1.627±0.035 m, weight=75.337±6.389 kg), and Group 2 consists of 8 female participants who do not have kids (age=25.750±1.982 years, length= 1.626±0.037 m, weight=80.425±8.790 kg). These women were recreationally active (moderate-intensity, endurance-type exercise 1 days/week for 30 min maximal), non-smokers, non-users of specific medication, and did not have any documented history or clinical signs or symptoms of pulmonary, cardiovascular, or metabolic disorders or orthopedic and metabolic disorders, that would influence their participation in the swim training intervention. All women reported regular menstrual cycles (i.e., occurring on a 24 to 30-days cycle) and were using combined OCs (OCs 3rd generation; Meliane® (Bayer Healthcare, Germany): Gestodene 75 mcg, Ethinylestradiol 20 mcg, also Microgynon® (Bayer Healthcare, Germany): Levonorgestrel 150 mcg, Ethinylestradiol 30 mcg) for at least 6 months (range 6-18 months) prior to the study and continued their OCs throughout the experimental period, and had not been pregnant in the last year. Third-generation OCs were characterized as being low-androgenic.[17]

*__Exclusion criteria were:__ Sports training more than twice every week within the last 6 months. Other types of physical training: More than 1 hour per week, and being on a hypocaloric diet to reduce weight.

*__Experimental design:__ The sample visited the swimming sports complex “P. FERADJ” of Mostaganem city on the first occasion. This visit was used to obtain written informed consent, undertake preliminary health screening, and familiarize the subjects with the experimental procedures and equipment. All participants were asked to complete a detailed medical history questionnaire that highlighted any illness or any other factor that might have prevented participation in the study. The investigator then explained all testing procedures and all related risks and benefits associated with the experiment before the subjects were familiarized with the testing procedures and equipment. It was also agreed to set the practice time program for the sample in the swimming sports complex “P. FERADJ” of Mostaganem city, where the sample of research was supposed to practice swimming (moderate-intensity, endurance-type exercise 2-3 days/week for 75 min maximal) for 13 weeks (Figure 1).

*__Blood sampling and processing:__ This process was done in the second time when the sample visited the medical analysis laboratory of BOUADJEDJ, where all processes for obtaining and analyzed the blood samples were done by the medical analysis laboratory of BOUADJEDJ (street Zahana, Akid Lotfi, Mostaganem). All blood samples were taken in the morning after an overnight fast (>7 h) and from an antecubital vein. For each variable, all samples were measured in the same assay run (medical analysis laboratory of BOUADJEDJ).

*__Blood parameters analysis:__ The analysis of triglycerides (mg/dL), cholesterol (mg/dL), glucose (mg/dL) and progesterone (ng/mL).

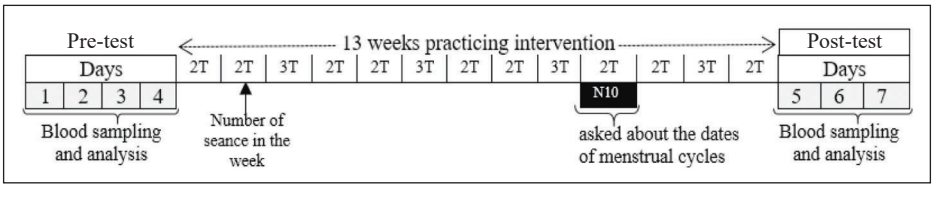

FIGURE 1: Study overview.

***Statistical analyses:** The obtained data were analyzed by using a software IBM SPSS Statistics 20, we used Student's t-test to differentiate between 2 numerical data for 1 group, and ANOVA test to differentiate between groups. All data are presented as mean±standard deviation and standard error mean (for subject characteristics). A value of $p \leq 0.05$ was considered a threshold of statistical significance.

RESULTS

The groups were comparable regarding weight, body mass index (BMI), triglycerides (mg/dL), cholesterol (mg/dL), glucose (mg/dL) and progesterone (ng/mL). Also, the sport activity logs were checked for the sample during the practice period, none of the participants performed an additional PA besides the swimming. All participants completed the study. All participants followed and received group supervision in all training session, and compliance with the practicing protocol was 100% for 13 weeks complete.

Table 1; shows the description results of all variables analyzed weight, BMI, triglycerides, cholesterol, glucose and progesterone, the results explained the values of mean±standard deviation and standard error in pre and post-tests.

For our analysis in this section, we will be interested in collating these variables after practice the swim sport. Table 2 shows the significant differences and correlations coefficients between pre/post-tests, and between the groups post-test in all variables analyzed; weight, BMI, triglycerides, cholesterol, glucose and progesterone, a value of $p^{*} \leq 0.05$ and $p^{**} \leq 0.01$ was considered a threshold of statistical significance.

For the analysis of the subjects result between pre/post-tests, the weight and BMI variables were affected by the AE (swimming) practicing protocol for G1 and G2 ($p \leq 0.005$). The range decreased for weight and BMI at ratio 0.074% for G1 and at 0.054% for G2. The differences in weight between pre- and post-test AE practicing ranged from 75.337 kg to 70.125 kg, and in BMI from 28.431 to 26.485 for G1. For G2, the differences ranged from 80.425 kg to 76.300 kg in weight, and in BMI from 30.492 to 28.915. The triglycerides were unaffected by the AE (swim) practicing protocol for G1and G2. The average range stayed the same for G1 in 86.251 mg/dL, and for G2 in 83.751 mg/dL. The cholesterol and glycemic variables were affected by the AE (swimming) practicing protocol for G2 ($p \leq 0.05$). The differences in cholesterol between pre- and post-test AE practicing ranged from 141.300 mg/dL to 136.700 mg/dL, and in glucose from 0.900 mg/dL to 0.875 mg/dL. The range decreased for cholesterol at ratio 0.017%, and for glucose at ratio 0.007%. For G1, the cholesterol and glycemic variables were unaffected by the AE practicing protocol, the value between pre- and post- AE practicing was 147.600 mg/dL to 145.000 mg/dL for cholesterol (0.033%),

TABLE 1: Descriptive samples statistics.

Tests		Group 1			Group 2		
		Mean	SD	SE mean	Mean	SD	SE mean
Weight kg	Pre	75.337	6.389	2.259	80.425	8.790	3.107
	Post	70.125	4.940	1.746	76.300	7.504	2.653
BMI	Pre	28.431	2.097	0.741	30.492	4.007	1.416
	Post	26.485	1.843	0.651	28.915	3.367	1.190
Triglycerides mg/dL	Pre	86.251a	0.342	0.120	83.751a	0.370	0.130
	Post	86.251a	0.342	0.120	83.751a	0.370	0.130
Cholesterol mg/dL	Pre	147.600	0.172	0.060	141.300	0.116	0.041
	Post	145.000	0.178	0.063	136.700	0.089	0.031
Glucose mg/dL	Pre	0.862	0.058	0.020	0.900	0.088	0.031
	Post	0.856	0.062	0.022	0.875	0.075	0.026
Progesterone ng/mL	Pre	16.950	0.023	0.008	16.760	0.022	0.008
	Post	16.700	0.025	0.008	16.430	0.021	0.007

SD: Standard deviation; SE: Standard error; BMI: Body mass index.

TABLE 2: The statistical analysis of significant difference and correlation between the results pre/post-tests of the samples.

		Paired Samples "T" Test						ANOVA	
		Group 1			Group 2			Between groups (post-tests)	
Tests		T	Significant (2-tailed)	Correlation significance	T	Significant (2-tailed)	Correlation significance	F	Significant
Weight kg	Pre	5.292	0.001**	0.002**	4.608	0.002**	0.002**	3.779	0.072
	Post								
BMI	Pre	5.437	0.001**	0.004**	4.308	0.004**	0.004**	3.205	0.095
	Post								
Triglycerides mg/dL	Pre	0.000	1.000	0.000**	0.000	1.000	0.000**	0.020	0.890
	Post								
Cholesterol mg/dL	Pre	1.986	0.087	0.000**	3.110	0.017*	0.000**	1.363	0.262
	Post								
Glucose mg/dL	Pre	1.000	0.351	0.000**	2.646	0.033*	0.000**	0.293	0.597
	Post								
Progesterone ng/mL	Pre	13.229	0.000**	0.000**	19.858	0.000**	0.000**	5.086	0.041*
	Post								

Tests are significant at *p≤0.05 and **p≤0.01; BMI: Body mass index.

and 0.862 mg/dL to 0.856 mg/dL for glucose (0.007%). The progesterone was affected by the AE practicing protocol for G1 and G2 (p≤0.001). The range decreased at a ratio of 0.014% for G1 and at 0.020% for G2. The differences in progesterone between pre- and post-test AE practicing ranged from 16.950 ng/mL to 16.700 ng/mL for G1, and from 16.760 ng/mL to 16.430 ng/mL for G2 (Figure 2).

For the analysis of the post-test result between groups, there was a significant difference only in progesterone variable between groups (p<0.05), in other variables analysed, there was no significant difference between groups. Furthermore, we can see the significant correlation between the values of pre/post-test for the 2 groups at (p≤0.005) in all variables previously presented.

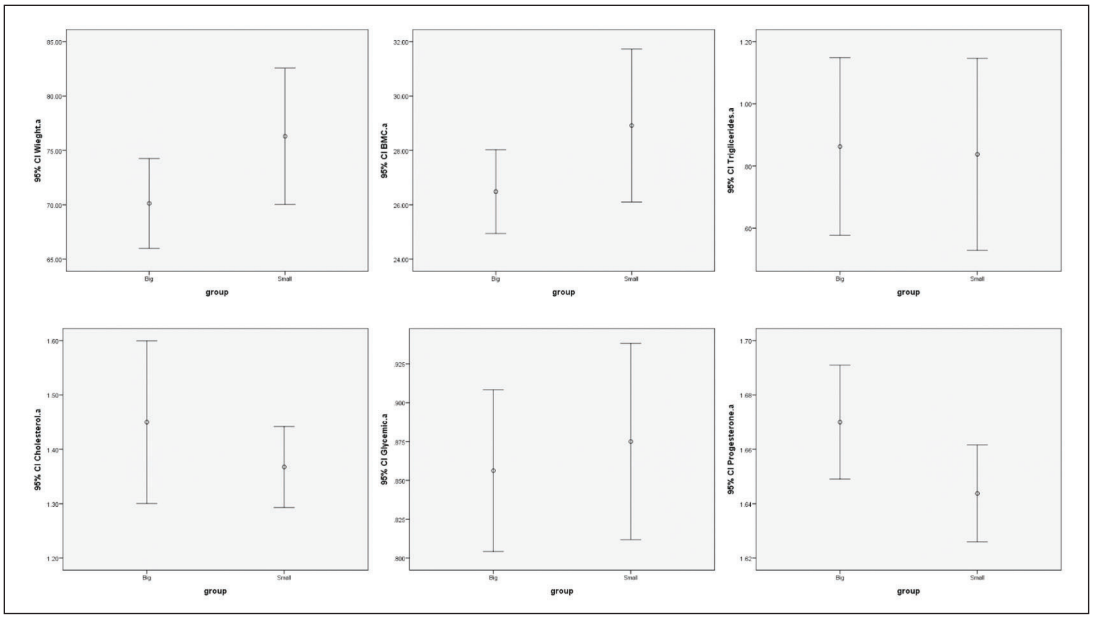

FIGURE 2: Graph error bar of the differences exist between the post-test results of groups.

DISCUSSION

PA is an important component of health maintenance programs. It has beneficial health effects on most women.[18] Some notable medical advantages of expanded AE and endurance improved cognitive function, neuromuscular co-ordination, management of body composition, and improved mental well-being.[1] Thus, the scientific interest in the effects of PA on physiological parameter levels in the human body is increasing both for health and performance implications.[19,20]

In recent decades, the numbers of women participating in recreational exercise and athletic training and competition have increased dramatically.[21] Currently, the studies investigating the effect of taking OCs and PA practices are very few and conflicting in our area. Therefore, our study is conducted to examine the effect of AE (swimming) and OCs on some hormonal variables according the variables of age and childbirth. Here, we present the first data based on a controlled intervention, where the participants performed group supervised AE with a high level of compliance and a controlled moderate intensity (2-3 days/week for 75 min maximal) for 13 weeks. These factors are important when interpreting the results since other studies have used a mix of OCs.

Our results show significant differences in hormonal progesterone between groups, Consistent with these changes (Figure 2). Sung et al. demonstrated that follicular phase-based resistance training had a greater effect on muscle strength, compared with luteal phase-based strength training. This research suggests that the fluctuation of hormones during the menstrual cycle influences the trainability of muscle strength, with more strength adaptation in skeletal muscle in the follicular phase.[22] Moreover, few previous studies concluded that the striking decline in muscle strength occurring during the premenopausal and postmenopausal period can be reversed by hormone replacement therapy (HRT).[23] In postmenopausal women, muscle performance, muscle mass, and muscle composition are improved by HRT. Though, the benefit of HRT with high impact AE practicing may improve performance, mass, and composition of muscle.[24] Apart from the effects of androgens, the more pronounced increase in muscle strength and muscle diameter in follicular phase compared to luteal phase may be explained by the alterations of ovarian hormones throughout the menstrual cycle.[25] In addition, estrogen may also influence post-damage repair processes through activation and proliferation of satellite cells.[26]

Furthermore, it has recently been postulated that the beneficial effect of estrogen on muscle is accomplished by improving the intrinsic quality of the skeletal muscle, whereby fibers are enabled to generate force, i.e., myosin strongly binds to acting during contraction.[27] Hence, OCs-induced alterations in blood concentrations of exogenous sex hormones may also effect training adaptation in OC users.[28] Earlier studies have failed to detect significant differences in muscle strength during OC phases, suggesting that the effects of OC use on muscle strength and performance are minimal.[29]

The data on the effects of OC use on muscular strength and performance are minimal and inconclusive.[30] As the intake of fixed doses of synthetic estradiol and progesterone in OCs suppresses endogenous estradiol and progesterone, the factors for strength capacity and performance.[25,31] Strength training adaptation may differ between OC users and non-users in as-yet unrecognized ways.[17,30] Also, other hormones may serve as markers of exercise related disorders in women using OCs. Moreover, we found that OC users before childbirth could have the same possibility of AE practicing effects as women who use OCs after childbirth.

In OC users before childbirth, we found statistically significant differences between pre and post-tests in cholesterol and glucose. Accumulating evidence suggests large swings in blood glucose (glycemic variability) may be as deleterious as/or potentially even more damaging than chronic hyperglycemia.[32] Both aerobic and resistance exercise can induce improvements in glycaemic regulation, with some suggestions that exercise regimens including both may be more efficacious than either exercise mode alone.[33] Thus, maintenance of glycemic control may be one mechanism by which adequate PA protects the human body against the development and progression of metabolic and cardiovascular diseases.

The physiological response of the human body to exercises in the water varies from the exercises on land. In water, there is an increasing pressure on the surface of the body, which leads to the restriction of breathing. The respiratory system and the cardiovascular system are affected. When the human body is in a supine position, the venous returning to the heart will increase compared to the standing posture, which will lead to a decrease in heart rate. As a result of the high energy consumption of athletes for women practicing exercise, the decrease in body fat and low body weight, the increase in the prolactin hormone during exercise, and suppression of ovaries suppressed and prevented maturation.[12] Furthermore, the women needed to be within 35% of ideal body weight. The women weighing more than 90 kg may be at increased risk of contraceptive failure with the use of the patch.[34] While some (but not all) studies suggest that obesity reduces the efficacy of OCs, a mechanism for this effect has not been elucidated. Overweight and obese women are at increased risk of pregnancy complications including gestational diabetes, hypertensive complications, and cesarean delivery.[18] Some previous researches demonstrate that progestins influence cardiovascular regulation, Brunt et al. (2013) report that the athletic practice for women affect weight control as it burns calories in the body, and increases the effectiveness of building and demolishing processes in the body, by converting adipose tissue into muscle tissue. It also contributes to increasing strength and reducing osteoporosis. Because many women suffer from this problem, PA increases the sensitivity of fat cells to the leptine, which in turn helps in burning fat, and in preventing calcium loss inside the body.[35]

In addition, the practice of swimming is an integrated sport that requires the work of the whole body with a coordinated, sequential and integrated kinetic performance. This is in line with most studies that highlight the role of sports practice through its proposed training and recreational programs in reducing excess weight and trying to maintain the ideal body weight, especially for the research sample that deals with birth OCs. The OCs works to accumulate lipids in the body around the waist and lower arm due to the hormonal changes and secretions of the components of the pill that are mainly based on the progestogen and estrogen hormones. The data presented here provide evidence that PA directly impacts glycemic control, independent of altering fitness or adiposity. So, the current and future tracks of research, in the light of what we have presented from third-generation OC use are sure to develop. The data included in this study confirm the beneficial effects of regular of AE practice (swimming) on some hormonal levels for the women taking OCs.

CONCLUSION

In conclusion, this study offers support to the hypothesis that there are effects of AE (swimming) on hormone concentration progesterone, weight and BMC values of women taking OCs before childbirth. The same is true for those using OCs after childbirth. Nonetheless, the findings that showed a decrease in the progesterone hormone concentration favored the first sample (women taking OCs before childbirth). In addition, they proved that the value of cholesterol and glycemic variables have implications for the shape of women's body. Therefore, it is proposed that practicing AE like swimming activity is a safe and useful method for the stability of hormone values in the normal and ideal level. As such, this discipline should aid in the prevention of obesity, the risk of developing heart disease, and artery disease especially after aging and childbirth. Hence, more research is warranted to investigate the relation between PA and the menstrual/OC cycle and using OCs for women without negative health consequences.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Guebli Abdelkader;* ***Design:*** *Guebli Abdelkader, Yağmur Kocaoğlu;* ***Control/Supervision:*** *Guebli Abdelkader, Nurtekin Erkmen, Zerf Mohammed;* ***Data Collection and/or Processing:*** *Guebli Abdelkader, Sahioualdi Bouchra*; ***Analysis and/or Interpretation:*** *Guebli Abdelkader, Nurtekin Erkmen;* ***Literature Review:*** *Yağmur Kocaoğlu, Francisco Jeci De Holanda;* ***Writing the Article:*** *Guebli Abdelkader, Yağmur Kocaoğlu;* ***Critical Review:*** *Zerf Mohammed, Nurtekin Erkmen;* ***References and Fundings:*** *Guebli Abdelkader,* ***Materials:*** *Guebli Abdelkader, Sahioualdi Bouchra, Zerf Mohammed.*

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