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Effects of fitness training on the cardiovascular system of sedentary women aged 25-40

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Abstract:

Our study aims to evaluate the effect of fitness training on the cardiovascular system of women aged 25-40.
To do this, we used the experimental methodology on 14 women who were sedentary and practiced fitness twice a week, 60-90' each session for 3 months. Cardiovascular parameters collected by a blood pressure monitor for heart rate, systolic and diastolic blood pressure, and a heart rate monitor for the fatigue index
Analysis of the results obtained showed: a statistically highly significant difference for heart rate and VO_{2max} ($p<0.01$), a very highly significant difference for systolic blood pressure and the fatigue index ($p<0.001$) and a significant difference for diastolic blood pressure ($p<0.05$).
This study advocate’s fitness training to improve the cardiovascular system of women aged 25-40.

Keywords: Fitness; Cardiovascular system; Sedentary woman.

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Introduction:

The objective is to organize a program of personalized physical activities is to fight against a sedentary lifestyle and inactivity, and to increase the level of daily physical activity, Maintain and improve physical condition (cardio-respiratory endurance, muscular strength, flexibility, balance), develop pleasure and give a taste for physical and sporting practice, create social relationships, improve the spatio-temporal sensation.

The practice of physical activity is recognized for its health benefits. Its action on the cardiorespiratory system would be explained through its effect on muscle strength, body composition and fat mass distribution (Jakes et al, 2002). Indeed, weight gain is significantly associated with lung dysfunction (Chen, Horne & Dosman, 1993).

Physical activity has benefits; In the short term, the practice of physical activity improves health, reduces stress, strengthens the heart and lungs, increases energy levels, helps to achieve and maintain a healthy weight, promotes a positive philosophy of life and provides a general feeling of well-being. In the long term, better physical condition reduces the risk of having health problems. And while physical activity carries some risks, such as injury and overtraining, sedentary living carries many more. (Fahey & al, 2013, 28-29)

We can refer to the heart rate to measure the physical state of the individual which allows the planning and the orientation of the training process according to the capacities of each practitioner, moreover this heart rate directly reflects the response of the cardiovascular system in training. (Fox, 1981, 90).

To experience the health benefits, physical activity must be of moderate or vigorous intensity, or a combination of both. Physical activities are generally classified into three levels: light activities, such as walking, cleaning, shopping, requiring little energy and effort. Moderate activities, such as brisk walking, recreational skating, or cycling, cause increased sweating and respiratory rate. At this level of intensity, one can normally speak without too much difficulty. Supported activities, such as running, soccer, cross-country skiing. This level should cause shortness of breath that interferes with conversation and causes more profuse sweating. (Fahey et al, 2013, 31)

The chronic lack of AP leads to a progressive deterioration of the physical condition. (Watts et al, 2005, 381). In intervention studies, the promotion of physical activity, apart from any action aimed at diet or a sedentary lifestyle, improves body weight and reduces the risk of overweight and obesity (Dwyer & al. 1983; Catenacci & Wyatt, 2007). The level of physical activity required could be moderate to intense activity for about 60 minutes per day (Fogelholm & Kukkonen-Harjula, 2000; Oppert, 2003; Jakicic & Otto, 2005).

In addition to improving weight status, physical activity has a set of beneficial effects on many medical parameters (Oppert, 2003). Promoting regular physical activity can significantly reduce the metabolic syndrome score.

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The increase in sedentary activities in recent decades has a deleterious effect on energy balance, by reducing expenditure related to physical activity and increasing food calorie intake through an increase in snacking and the size of the portions consumed.

Physical activity and sports seem to be a determining factor for the acquisition of an active lifestyle. In addition, physical activity measurement tools are complex. However, the beneficial effects of physical activity in healthy women have been demonstrated for the prevention of osteoporosis, atherosclerosis, dyslipoproteinemia and for the improvement of cardiovascular and respiratory capacity during exercise. (Thibault, 2008)

The heart is a muscle. Therefore, it gets stronger if you make it work harder from time to time by doing physical activity of moderate intensity (like light jogging) or high intensity (like cycling up a steep hill). This is why the heart of physically active people is vigorous and well oxygenated. (Knight, 2016, 23)

The available data indicate that there is an inverse dose-response relationship between the volume of usual physical activity and the risk of cardiovascular mortality and morbidity in general, and coronary events in particular. (Oppert, 2004, 31)

The choice of our study fell on sedentary women who wanted to pasticate a physical and sporting activity of the fitness type in order to fight against sedentary lifestyle, given that nowadays, it is a problem that presents itself more and more. within our society.

Hypotheses:

- ✓ There is a statistically significant difference in heart rate between pre- and post-test in sedentary women after the fitness training period.
- ✓ There is a statistically significant difference in systolic blood pressure between pre- and post-test in sedentary women after the fitness training period.
- ✓ There is a statistically significant difference in diastolic blood pressure between pre- and post-test in sedentary women after the fitness training period.
- ✓ There is a statistically significant difference in the fatigue index between pre- and post-test in sedentary women after the fitness training period.

General objective of the study:

The objective of this research is to compare some cardiovascular parameters of Constantine women practicing fitness aged between 25-40 years.

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1. Definition of the research concepts:

1.1. Physical activity and sports:

The WHO defines physical activity as any bodily movement produced by skeletal muscles that requires the expenditure of energy. Physical activity refers to all the movements that we perform in particular in the context of leisure, at the workplace or to move from one place to another. Physical activity of moderate or sustained intensity has beneficial effects on health. (WHO, 2022).

1.2. Fitness:

According to the Le-Robert dictionary, fitness is a set of activities intended to maintain physical shape through exercises performed using equipment.

1.3. The cardiovascular system:

The cardiovascular system consists of a set of parameters that are related to the cardiovascular system such as: heart rate, systolic and diastolic blood pressure, peripheral resistance… (Malmejac, 1976, 210-211).

1.4. Sedentarity (Physical inactivity) :

According to the National Agency for Food Safety, Environment and Work (NAFSEW or ANSES in french), "sedentary lifestyle is defined by a state of wakefulness characterized by low energy expenditure [...] in a seated position or elongated" (ANSES, 2012)

2. Method and tools:

This study took place between March 09 and May 31, 2022, the women trained fitness twice a week, 60-90 'per session, at the El-Hana Sidi Mabrouk gym in the wilaya of Constantine-Algeria.

2.1. Population :

14 women participated in this study, the criteria of which are:

2.1.1. Inclusion criteria:

Participants with the following characteristics:

- ✓ The age between 25-40 years old.
- ✓ Did not practice any physical activity before.
- ✓ Sedentary.

2.1.2. Exclusion criteria:

- ✓ Smokers.

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- ✓ Subjects with pathologies anyone.
- ✓ Subject who did not train regularly.

2.1.3. General characteristics:

They are presented in the following table:

Table 1. Characteristics of the sedentary group

Parameters:	Age (an)	Height (m)	Weight (Kg)	BMI (Kg/m²)
M±SD	29,928±4,028	1,634±0,039	72,125±10,420	26,533±4,093

Source: Values established by the authors.

2.1.4. Ethical considerations:

The subjects were reassured that the data will be collected with respect for confidentiality and anonymity. This is a study that did not lead to any particular risk. All subjects (14 women) signed informed consent about the purpose and protocol of the study.

2.2. Data collection method:

Data collection was carried out through cardiovascular examinations at the fitness gym.

2.2.1. Evaluation of the heart rate (HR):

Resting heart rate (HR) is assessed.

- **Equipment:**

An Omron M7 Intelli IT tensiometer with an accuracy of 10 millimeters of mercury (mmHg).

2.2.2. Assessment of blood pressure (BP):

The subject should remove any tight clothing from the left arm. He should be relaxed and seated comfortably, at a ambient pleasant room temperature, to take a measurement, sit in a chair with his back straight, legs uncrossed and feet flat on the floor, The cuff should be placed on the arm at the same level of the heart between 1 to 2 cm above the elbow. He should remain still and not talk during the measurement.

The display will show heart rate in beats per minute (bpm) and both systolic and diastolic pressures in mmHg. (Bounab & Kheiri, 2022, 334)

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Figure 1. Omron M7 Intelli IT blood pressure monitor.

Source : (Bounab & Kheiri, 2022, 334)

We assessed cardiovascular adaptation to physical exertion using Ruffier Dikson's test for adults, and this at two important moments in the adaptation of the heart: immediately upon stopping the exertion and after one minute of post-exercise rest (Gaubert & al, 2014, 187).

- **Equipment:**

ONRHYTHM 110 heart rate monitor watch.

We installed the heart rate watch on the subject's wrist and the corresponding belt on the thorax so that the sensors touch the skin in front of the heart.

Straight chest, arms stretched forward, buttocks touching the heels

The evaluator takes the P0 pulse before starting the test. The subject standing, legs apart at shoulder width, he performs 20 knee flexions in 45 seconds, the evaluator takes the pulse P1 after 15 seconds from the end of the exercise then P2 after one minute at the end of the exercise. (Bounab, 2021, 48)

Figure 2. ONRHYTHM 110 heart rate monitor watch.

Source: (Bounab, 2021, 48)

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The heart rate monitor allows you to know, in real time, the pulses: P0, P1 and P2 in beats per minute (bpm), and allows you to calculate the Fatigue Index (FI) according to the equation: (Mhimdet & Bounab, 2016, 138-139)

$$FI = ((P0+P1+P2)-200)/10$$

The results will be processed according to the following table:

Table 2. Fatigue Index levels (FI).

Heart	Very good	Normal	Untrained	Tired
FI	< 5	[5-10[	[10-15[	≥ 15

Source: (Gaubert & al, 2014, 188)

2.2.3. Assessment of VO_{2max}:

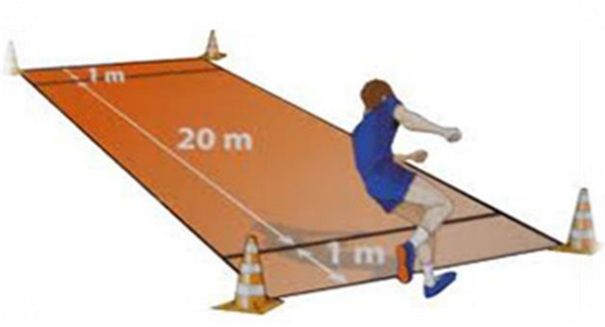
Endurance is evaluated from the Léger test which makes it possible to determine the VMA, it is the speed beyond which the share of energy provided by the anaerobic system becomes increasingly important. Between 2 lines spaced 20 m apart, run as long as possible while respecting a running rhythm that increases by 0.5 km/h every one minute (Gaubert et al, 2014: 41).

Equipment:

A 24m track, cones within 20m and 2m safety on each side, a speaker or tape recorder, mobile phone, an application of the Léger test.

The subject stands in front of the plot. The application then starts up and it must be in front of the next plot when the beep sounds on the baffle and this with each beep. Each level lasts approximately 2' and the pace is increased at each level by 1 km/h. The first stage generally corresponds to a speed of 8 km/h. It is therefore not necessary to perform a warm-up. This one being incorporated in the first bearings. When the subject is no longer in agreement with the beep and the plot, he has then reached his VMA. He must then stop and identify the level at which he has arrived as well as the number of blocks crossed after the last lap. (Bounab, 2022, 1113)

Figure 3. Illustration of the organization of the Progressive 20-meter Shuttle Race - Luc Léger – 1981.



Source : (Bounab, 2022, 1113)

$VO2_{max}$ is predicted from the following equation:

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$$VO_{2max} (ml.\ mn^{-1}.\ Kg^{-1}) = 14,49 - 2,143\ V + 0,00324.V^2$$

V: the speed reached at the last level achieved expressed in km/h.

3. Statistical analysis:

Data were analyzed using the statistical program SPSS (version 20.0). Quantitative parameters are presented as mean ± standard deviation, and analyzed by T-test or Wilcoxon test for difference between means.

4. Results and discussion of the research:

We will first present the results, analyze them and finally discuss them.

4.1. Results:

We first confirm the normal distribution of our group in the four parameters studied so that we can choose the appropriate statistical test for the comparison of the means.

4.1.1. The distribution of parameters:

Table 3. Normality tests of cardiovascular parameters

Functional parameters		Kolmogorov-Smirnova			Shapiro-Wilk			
		Statistic	Df	Sig.	Statistic	df	Sig.	
Pre-test	Heart rate	0,271	14	0,006	0,825	14	0,010	**NS**
Post-test		0,159	14	0,200*	0,898	14	0,104	**S**
Pre-test	Systolic blood pressure	0,175	14	0,200*	0,949	14	0,552	**S**
Post-test		0,152	14	0,200*	0,949	14	0,551	**S**
Pre-test	Diastolic blood pressure	0,120	14	0,200*	0,976	14	0,943	**S**
Post-test		0,256	14	0,013	0,867	14	0,038	**NS**
Pre-test	Fatigue index	0,142	14	0,200*	0,944	14	0,472	**S**
Post-test		0,223	14	0,058	0,926	14	0,268	**S**
Pre-test	VO_{2max}	0,202	14	,126	0,900	14	0,111	**S**
Post-test		0,323	14	,000	0,853	14	0,025	**NS**

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction
S : Significaticant NS : Not significant.
Source: Values established by the authors

Table 3 shows that the value of the test (Shapiro-Wilk) is significant (greater than 0.05) for the systolic blood pressure (SBP) and the fatigue index (FI), it reflects a normal distribution of the sample in these two parameters. So we directly use the parametric test T Test to find the nature of the difference between the Pre-test and Post-test.

And a statistically insignificant result in the parameters: resting heart rate (HR), diastolic blood pressure (DBP) and VO_{2max} so we use the non-parametric Wilcoxon test.

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4.1.2. Heart rate:

Table 4. Difference in averages between pre and post heart rate test.

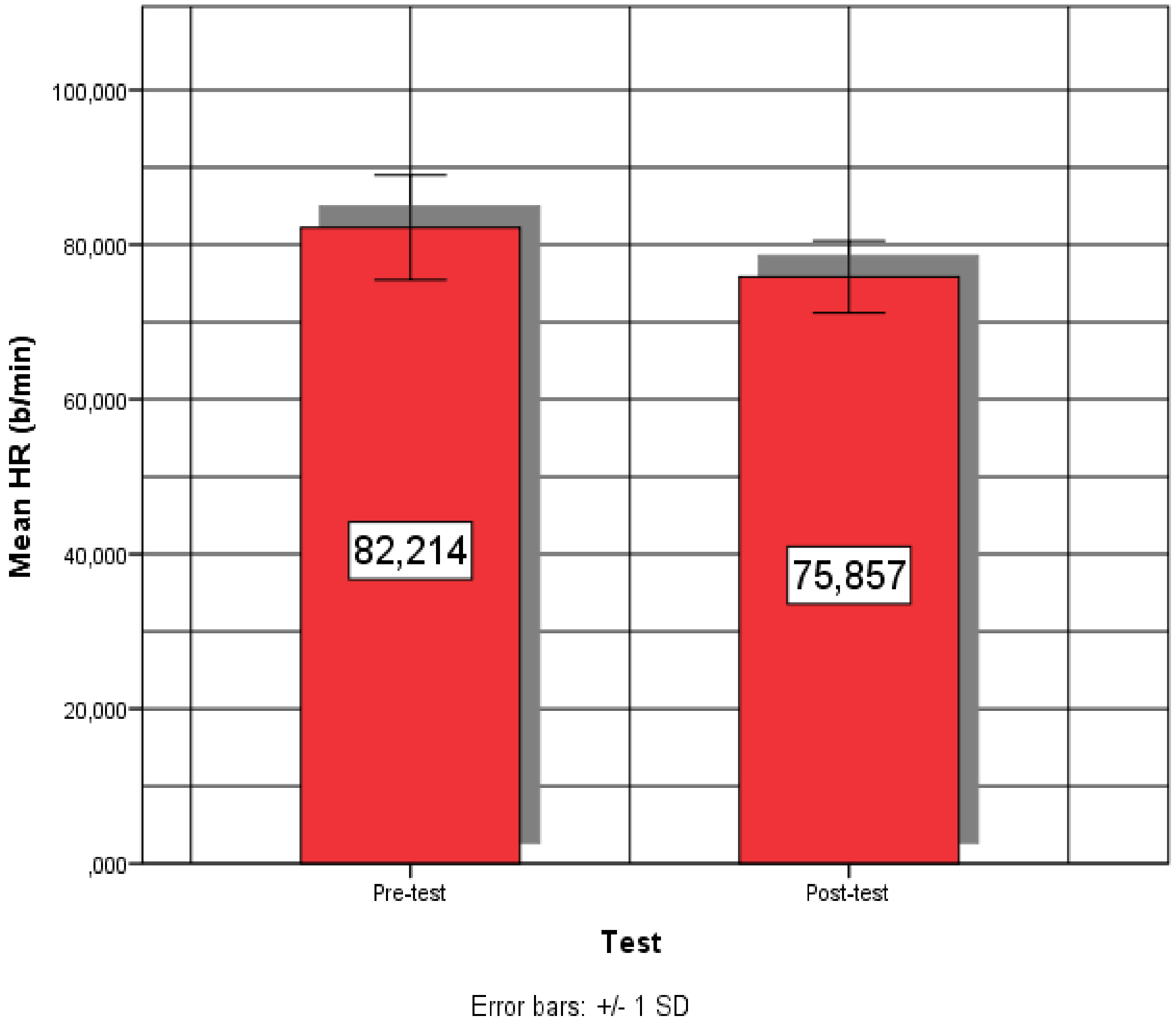
Test	Pre-test		Post-test		Wilcoxon Test	df	Sig.
Heart rate (b/min)	82,214	6,784	75,857	4,655	8,132	13	0,001**

*Highly significant result (p<0.01).

Source: Values established by the authors

The heart rate of our research group was 82.214 ± 6.784 b/min before the training period, and it is around 75.857 ± 4.655 b/min after the training period, our sample showed a decrease highly significant (p<0.01) as shown in Figure 4, with a percentage of 7.732%.

Figure 4. Comparison of heart rate (b/m) from pre and post test



Source: Histogram established by the authors

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4.1.3. Systolic blood pressure:

Table 5. Difference in means between pre and post systolic blood pressure test

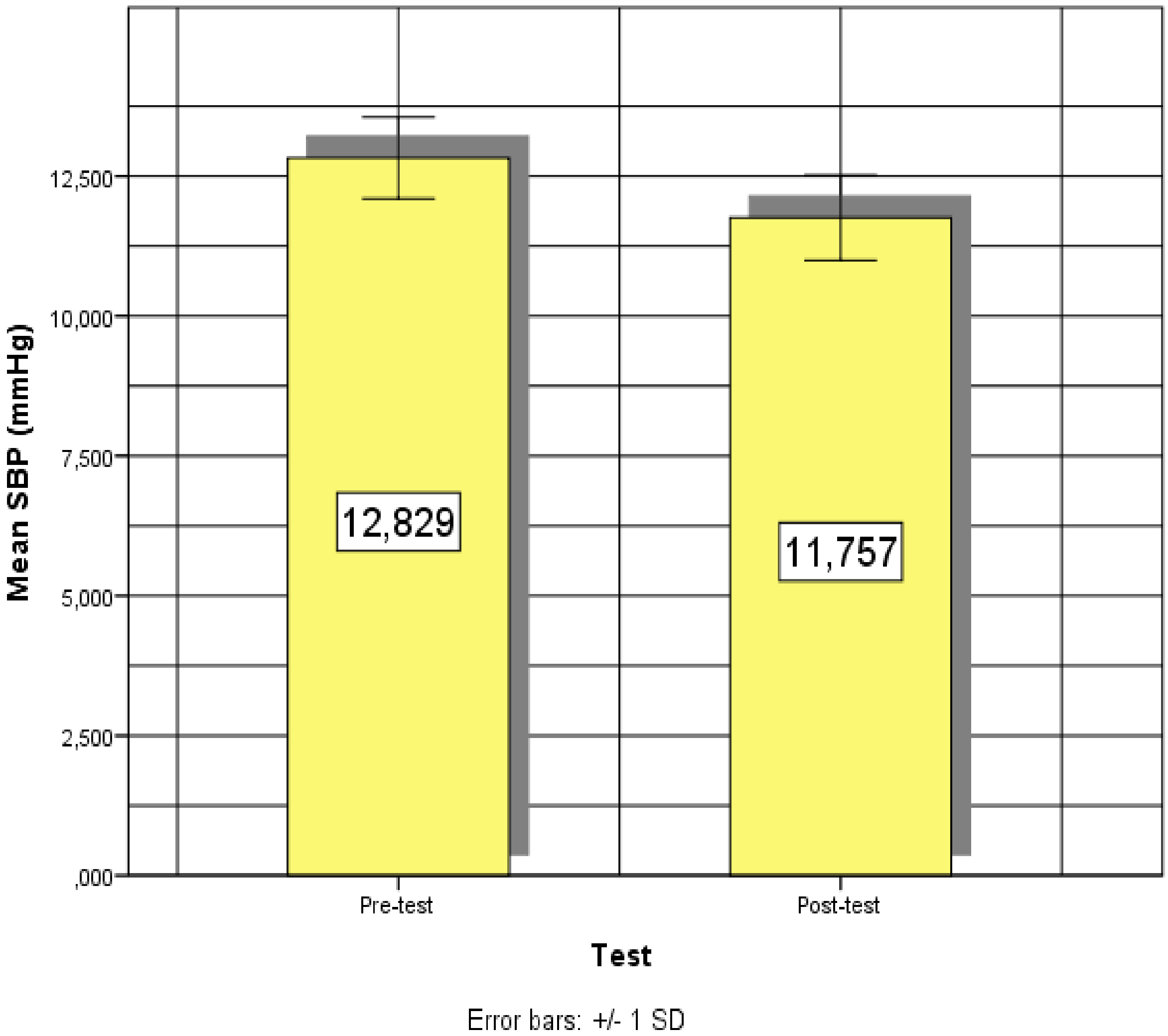
Test	Pre-test		Post-test		df	T Test	Sig.
Systolic blood pressure (mmHg)	12,829	0,728	11,757	0,760	13	11,326	0,000***

***Very highly significant result (p<0.001).

Source: Values established by the authors

The systolic blood pressure of our research group was 12.829 ± 0.728 mmHg before the training period, and it is around 11.757 ± 0.760 mmHg after the training period, our sample showed a very highly significant drop. (p<0.001) as shown in Figure 5, by a percentage of 8.352%.

Figure 5. Comparison of systolic blood pressure (mmHg) from pre and post test



Source: Histogram established by the authors

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4.1.4. Diastolic blood pressure:

Table 6. Difference in means between pre and post diastolic blood pressure test

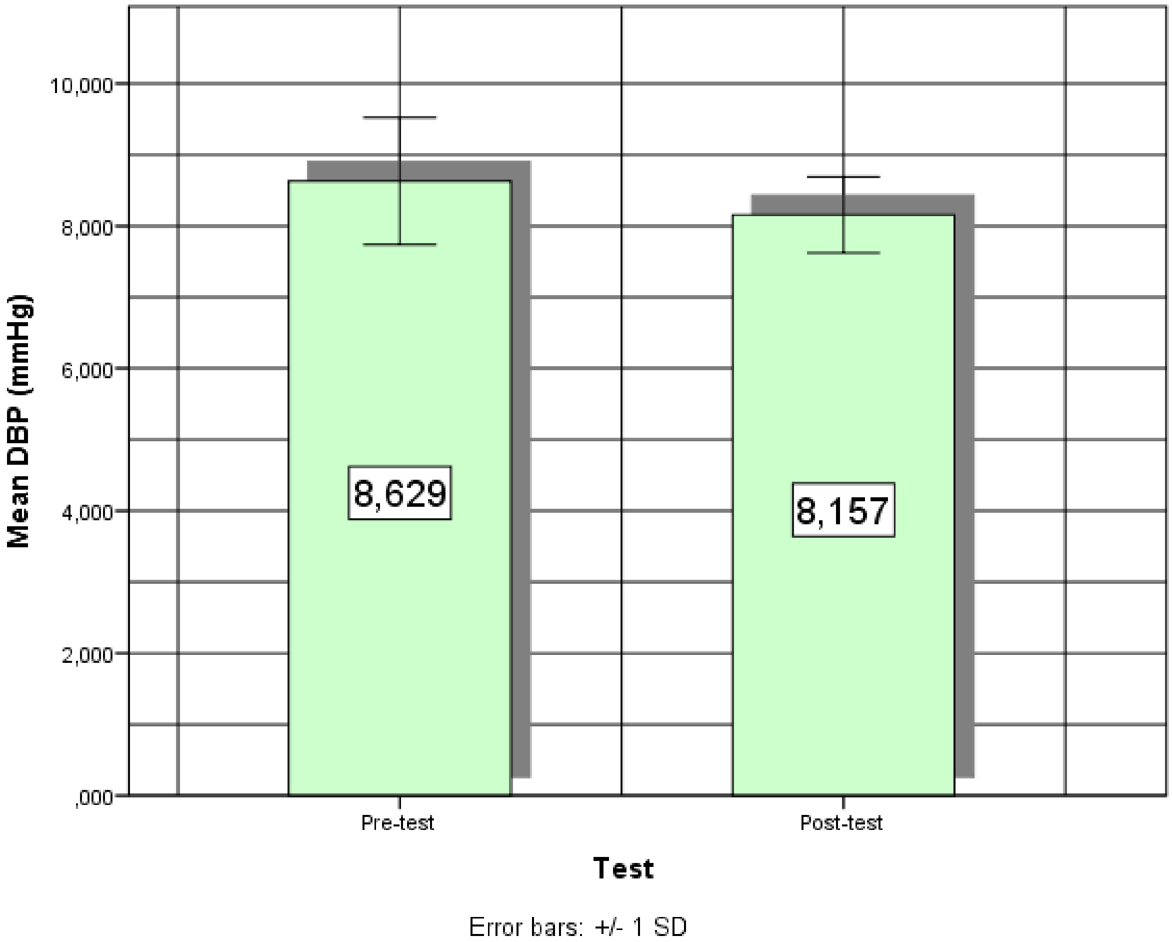
Test	Pre-test		Post-test		df	Wilcoxon Test	Sig.
Diastolic blood pressure (mmHg)	8,629	0,890	8,157	0,535	13	3,100	0,014*

* Significant result (p<0.05).

Source: Values established by the authors

The resting diastolic blood pressure of our research group was 8.629 ± 0.890mmHg before the training period, and it is around 8.157 ± 0.535mmHg after the training period, our sample showed a statistically lower significant ($p<0.05$) as shown in Figure 6, by a percentage of 5.464%.

Figure 6. Comparison of diastolic blood pressure (mmHg) from pre and post test



Source: Histogram established by the authors

4.1.5. Fatigue index:

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Table 7. Difference in means between pre and post-test of the fatigue index

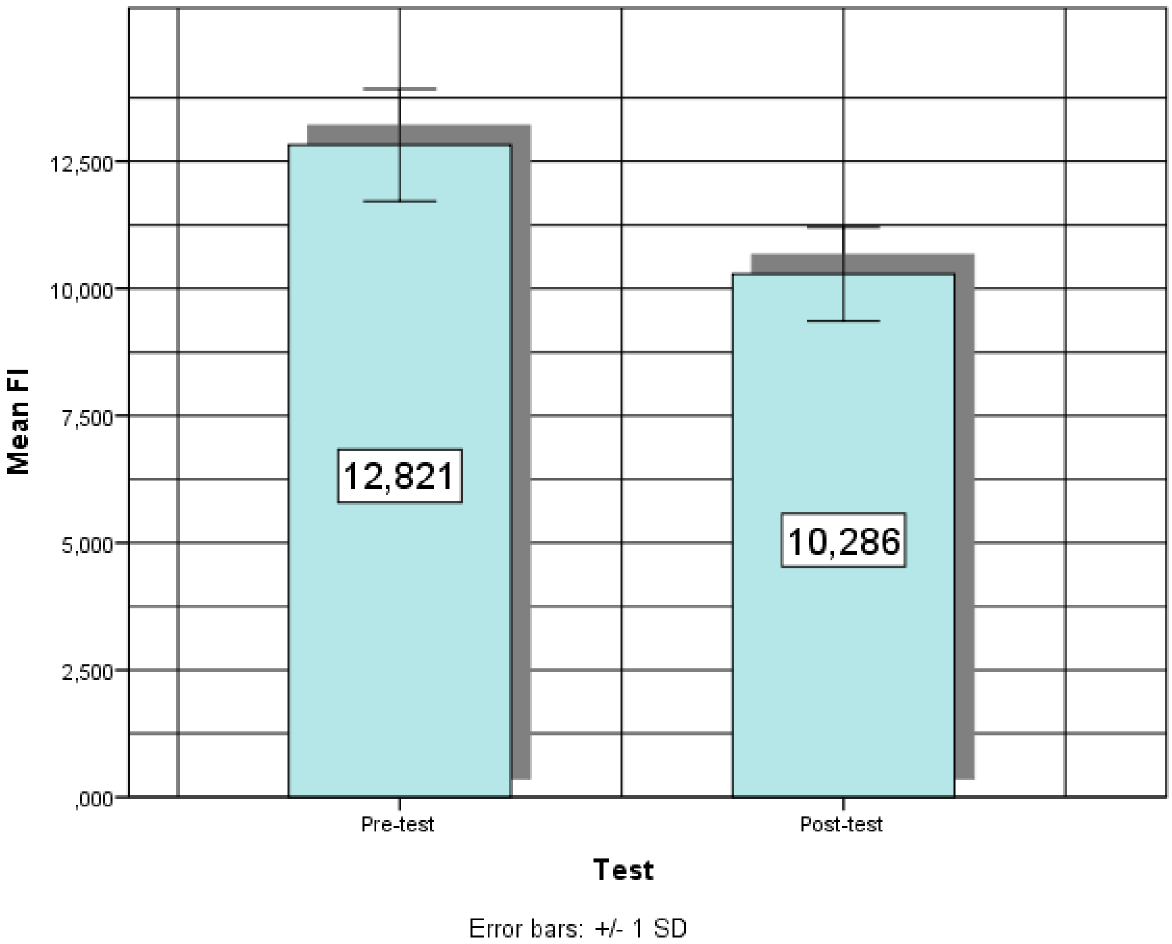
Test	Pre-test		Post-test		df	T Test	Sig.
Fatigue index	12,821	1,101	10,286	0,923	13	12,350	0,000***

***Very highly significant result (p<0.001).

Source: Values established by the authors

The fatigue index of our research group was 12.821 ± 1.101 before the training period, and it is around 10.286 ± 0.923 after the training period, our sample presented a statistically very highly significant decrease as shown in Figure 7, by a percentage of 19.777%.

Figure 7. Comparison of fatigue index from pre and post test



Source: Histogram established by the authors

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4.1.6. VO_{2max}:

Table 7. Difference in means between pre and post-test of the VO_{2max}

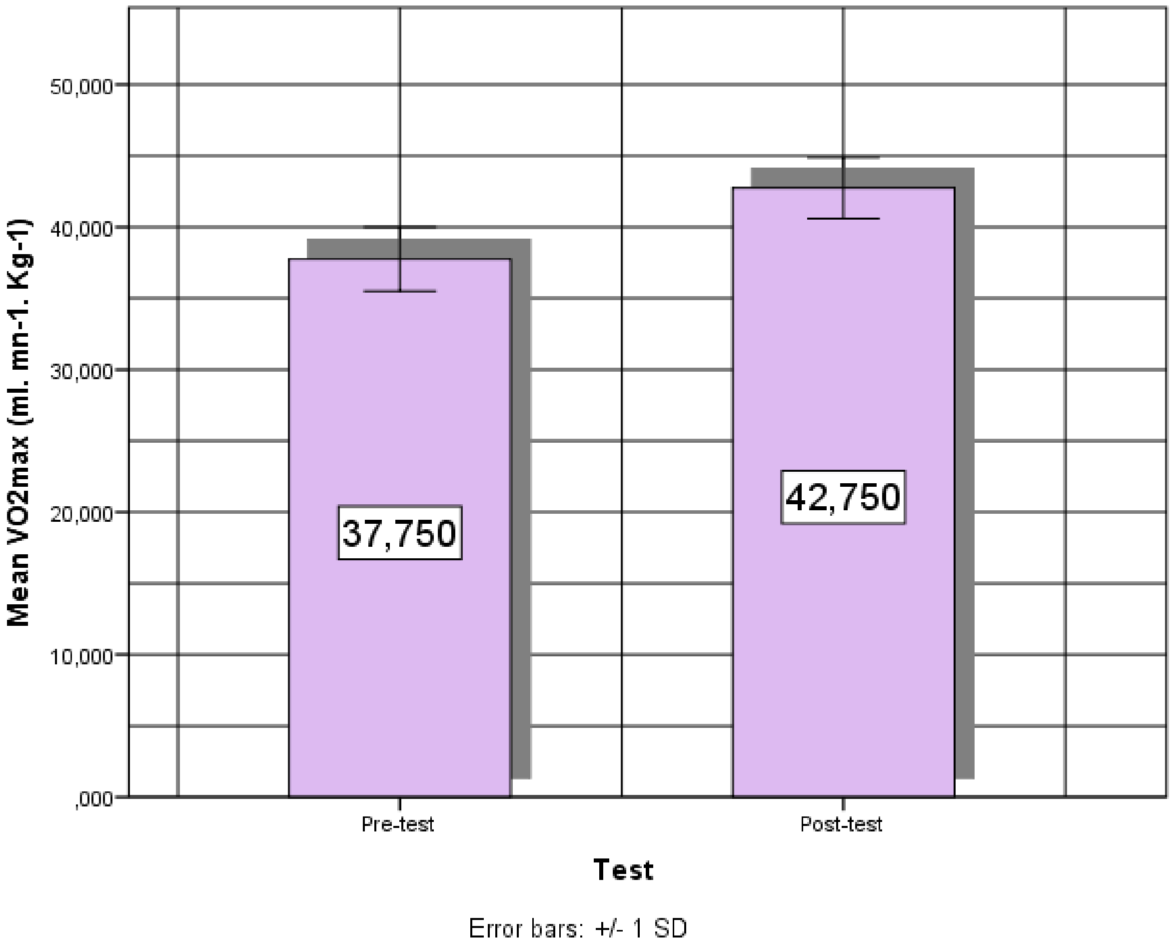
Test	Pre-test		Post-test		df	T Test	Sig.
VO_{2max} (ml. mn^{-1}. Kg^{-1})	37,750	2,247	42,750	2,139	13	-10,408	0,000***

***Very highly significant result (p<0.001).

Source: Values established by the authors

The VO2max of our research group was 37,750± 2,247before the training period, and it is around 42,750± 2,139 after the training period, our sample presented a statistically very highly significant increase as shown in Figure 8, by a percentage of 11.696%.

Figure 8. Comparison of VO_{2max} from pre and post test



Source: Histogram established by the authors

All of the studied cardiovascular parameters of our research group: resting heart rate, systolic blood pressure, systolic blood pressure and fatigue index decreased after their

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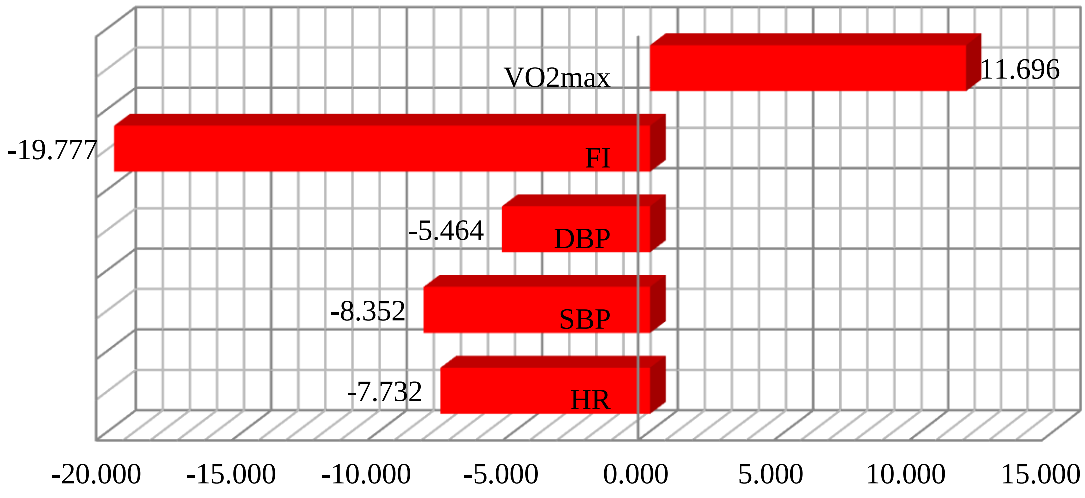
3month training period while VO_{2max} was increased, and the rate higher was for the fatigue index as shown in Figure 9.

Figure 8. Evolution of: heart rate, systolic and diastolic pressure and fatigue index after the training period



Source: Histogram established by the authors

4.2. Discussion:

From a methodological point of view, the choice of a reduced number of the sample does not contribute with precision to the evolution of the various parameters observed and their independence. In our study, this choice is justifiable because even with this small number we encountered difficulties in getting them to continue a three-month training program.

Our results agree with the explanation of Fox 1981 which confirms that the decrease in heart rate at rest is a good sign of the improvement of the physical condition as well as its rapid return after the effort. (Fox, 1981, 82).

The SV increases by approximately 30% to 40% until the intensity reaches 50% of VO2max after which it remains constant. (Jack et al, 2010). For low levels of exercise, the increase in cardiac output is due to both the increase in heart rate and the increase in stroke volume. But, as soon as the exercise exceeds 40% to 60% of the maximum possibilities, the systolic ejection volume peaks or increases less and the rise in cardiac output is then essentially explained by the acceleration of the heart rate. Thus, stroke volume seems to contribute more to performance during high-intensity exercise in highly trained athletes. (Wilmore et al, 2006, 196)

At the start of exercise in a standing position, the contraction of skeletal muscles mobilizes the blood volume of the lower limbs, resulting in an increase in central blood volume, SV and cardiac output. (Notarius and Magder, 1996). When all the blood has been mobilized, the SV remains constant despite the increase in workload, with values similar to

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those in the lying position. The initial 30-40% increase in stroke volume should therefore be seen as a simple filling phenomenon and not as a process of regulating blood circulation according to exercise. (Wilmore et al, 2010). Lindan has shown that there are several physical and physiological reasons why preventing ventricular dilation is beneficial to the heart (Linden, 1994)

The most important is that expressed by Laplace's law: the increase in the diameter of the ventricle increases the tension exerted on its walls. The dilation of the ventricle during exercise would therefore reduce its mechanical efficiency by increasing the load exerted on the cardiac muscle fibers. (Thomas, 2010).

SV does not contribute to the increase in cardiac output in response to exercise. Furthermore, the ratio of resting SV to maximum SV is not a marker of cardiac response to exercise. (Thomas, 2010).

Not to mention that exercise regulates blood pressure. In addition, at rest, a healthy heart supplies the cells of the body with blood more easily: it needs fewer beats per minute because, being stronger, it can eject a greater quantity of blood with each contraction. of the left ventricle than a sedentary heart. For example, the trained heart beats, at rest, at 60 beats per minute, instead of 75 beats for the untrained heart. As for the highly trained hearts of elite cyclists and marathon runners, they often beat at 40 beats or less per minute. (Knight, 2016, 23)

Long-term training will cause resting heart rate to slow, cardiac output to increase, and stroke volume to increase. The practice of physical activity increases plasma volume, therefore, venous return and stroke volume increase. The heart rate (HR) decreases with each level of exercise, this is what we saw in our research group.

Training programs improve physical efficiency and diastolic blood pressure, in addition to blood viscosity, which can affect its passage through vessels and capillaries. Aerobic exercise reduces this viscosity and facilitates the functioning of blood circulation and thus improves blood pressure, which is why the higher the viscosity of the blood, the higher the blood pressure. (Abdelmaksoud, 2003, 47).

The heart adapts to regular exercise leading to a decrease in resting heart rate. The reason for this is the increase in the amount of blood propelled in one shot. (Dickson, 1980, 125).

Scientific evidence shows that people who are physically active have lower death rates (from all causes) as well as lower rates of coronary heart disease, high blood pressure, stroke, diabetes type 2, metabolic syndrome, colon cancer, breast cancer and depression. These studies also reveal that adults and older people who engage in regular physical activity have better cardiovascular fitness, better muscle capacity, better body composition and are less likely to have cardiovascular disease, diabetes type 2 and bone problems. Physical activity is in fact an extraordinary preventive treatment. (Fahey et al, 2013, 29).

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Overall, the athlete's heart is normal and the adaptations observed are beneficial for the cardiovascular system. Functional changes characterized by moderate bradycardia, low resting BP, improved echographic ventricular filling, are seen as soon as a regular sports practice of three hours per week is carried out. The clinical, electrocariographic and ultrasound characteristics grouped under the term athlete's heart syndrome are only seen when the practice is intense (above the threshold of breathlessness), exceeds 8 hours per week and lasts for more than 6 successive months. (Boisseau & al, 2009, 51)

Our research group experienced an increase in VO2max of 11,696 in a 12 week period of fitness. A training period of 2-3 months (consisting of 30-60 minutes of exercise at 70-80% of VO2max, 3-5 times per week) resulted in a 40-50% increase in muscle oxidative enzyme content as well as mitochondrial density. (Hoppeler & al, 1985, 224). In adults 20-35% increases in glycolytic enzyme content following sprint training. (Gollnick et al, 1972, p. 317). So the increase in mitochondrial enzymes subsequently increases the aerobic system which ends up improving VO_{2max}.

5. Conclusion:

By way of conclusion, the physical and sporting activity carried out at the aerobics gym has a tangible impact on heart rate, systolic and diastolic blood pressure, the fatigue index and the VO_{2max} respectively in sedentary women aged between 25- 40 years.

As a result, we believe that long-term cardiovascular adaptations require on the one hand a well-structured sports practice, namely in civilian clubs.

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