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Quality of sleep and physical condition after a physical activity program among leisure-time physical activity enthusiasts in the municipality of Cocody (Abidjan, Côte d'Ivoire) in 2022

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Abstract

Regular physical activity can improve health, particularly physical fitness and sleep quality. The aim of this study was to evaluate the effects of an eight-week fitness program on physical condition, anthropometric parameters and sleep quality in recreational exercisers in Côte d'Ivoire.

This study was conducted in Abidjan with 23 subjects, including nine men and 14 women with an average age of 35±8 years. The subjects completed a moderate-intensity fitness training program (32 sessions) consisting of four weekly sessions of aerobic-type exercise and muscle strengthening (1 hour 30 minutes). Physical fitness and sleep quality (assessed using the Spiegel scale) were measured. The Man Withney U test and the Wilcoxon rank test were used to compare the effects of the training program.

The results revealed a reduction in body mass (-2.7 kg) and BMI (-0.9 kg/m2; $p < 0.001$), and the waist-to-hip circumference ratio was significantly reduced ($p < 0.001$). The subjects' physical condition improved, with a significant drop in the Ruffier-Dickson index (-2.09; $p < 0.001$). Sleep quality was significantly improved after the eight-weeks of training in 22 subjects, compared with 9 (+ 13 subjects; $p < 0.001$) at the start of the program.

In the light of these results, it is necessary to promote physical activities to improve health, with a view to treating sleep disorders and improving people's physical condition.

Keywords: Physical activity; Sleep quality; Training; Fitness; Physical condition

1. Introduction

Sleep is a reversible physiological state that results in unconsciousness and a loss of reactivity to external stimuli, as well as generalized muscle inactivity [1]. It is an important factor in protecting health [1;2]. It is therefore essential for everyone to get a very good night's sleep in order to maintain good health [2]. Sleep quality can be assessed through global sleep satisfaction parameters involving an interaction between personal, social and environmental factors [3;4].

It has also been proven that compliance with recommendations on sleep duration improves health [4;5]. In fact, the quality and quantity of sleep play an important role in maintaining long-term health [6], especially from childhood

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onwards [7]. Dissatisfaction with these two aspects of sleep quality and quantity is strongly associated with a decline in cognitive performance, and alterations in memory, psychological and metabolic functions, which could lead to body weight gain and obesity [1;8].

Numerous studies have shown that poor sleep is associated with poor emotional regulation [9], health problems such as cardiovascular disease [10], obesity [9] and a sharp increase in mortality [11].

In sub-Saharan African countries such as Côte d'Ivoire, sleep disorders exist, but very few people consult a doctor. For a large proportion of the population, sleep disorders do not represent a medical problem. For others, the low level of income does not always allow them to pay for consultations or medication. In general, when people suffering from sleep disorders consult doctors, they are treated by prescribing sleeping pills [12]. These sleeping pills are generally hypnotics or sedatives, which are in fact drugs.

The benefits of these drugs are generally temporary, as in most cases patients quickly become resistant to them, the substances no longer having any effect after two or four weeks of repeated ingestions [13]. Moreover, regular use of these substances can have serious consequences for health and is likely to lead to dependence [13].

Given this reality, regular physical activity has been proposed as a non-drug alternative [4]. Regular physical activity improves not only sleep quality [4;14], but also the general physical condition of subjects [15]. Ezati et *al*. 2022 showed that eight weeks of regular aerobic exercise significantly improved sleep quality [16].

In Côte d'Ivoire, despite the positive effects of physical activity as a therapeutic alternative for improving sleep quality, physical condition and health, there is a lack of research highlighting the impact of regular physical activity on sleep quality and general health. The main objective of the present study is to determine the effects of an eight-week fitness program on physical condition, anthropometric parameters and sleep quality in leisure-time physical activity participants.

2. Materials and method

This study was carried out in 2022, in the form of an eight-week physical activity intervention at the Equinox Sport Center in the municipality of Cocody, Abidjan. Twenty-three (23) subjects, including 14 women and 9 men, took part in the study after giving their informed written consent. The ethics committee of the National Institute of Youth and Sports (INJS) in Abidjan approved the study (INJS/ETH/2022-0016). Written informed consent was also obtained from each subject.

2.1. Study protocol

Participants underwent an eight-week program of physical activity. Measurements of physical condition and sleep quality were taken before and after the physical activity program.

A digital scale combined with a graduated measuring rod (Health o meter professional, USA) accurate to 0.1 g and 0.1 cm was used to measure the subjects' body mass and height. To measure height, each subject was stripped of their shoes before stepping onto the scales, facing forwards. The scale was then adjusted to the subject's height. The weight and height readings were immediately displayed in kg and cm respectively. A 2.5 m long tape measure was used to measure hip and waist circumference. The waist circumference was measured at the navel using a tape measure and marked in cm. The hip circumference was measured by placing the tape measure at the crest of the hip bone.

Heart rate and blood pressure were measured using an OMRON blood pressure monitor (OMRON HEALTH CARE CO. Ltd, Kyoto, Japan). Systolic blood pressure was low when it was below 110 mmHg, normal when it was between 110-129 mmHg, and considered high normal when it was between 130-139 mmHg. When the pressure was between 140-149 and 150-159, the subject had grade 1 and grade 2 arterial hypertension (AH) respectively (WHO). Diastolic blood pressure values below 75 mmHg, between 75-79, 80-84, 85-90 and above 90 represented low, normal, high normal, grade 1 and grade 2 hypertension respectively [17].

2.1.1. Physical fitness assessment test

Physical fitness was assessed using the Ruffier-Dickson test according to the method described by Dah (1991) [18].

The Ruffier-Dickson index (RDI) was calculated from the different heart rate measurements using the formula:

$$RDI = (P2 - 70) + 2 (P3 - P1) / 10.$$

P1: Resting heart rate.

P2: Heart rate during exercise

P3: Heart rate after 1 minute of recovery.

Physical fitness was assessed on the basis of RDI values according to the following reference standards: IRD < 0: Excellent physical condition; IRD 0 - 3: Good physical condition; IRD 3 - 6: Average physical condition; IRD > 6: Poor physical condition [18].

2.1.2. Assessment of sleep quality

Sleep quality was assessed using a Spiegel Sleep Scale questionnaire [19]. This questionnaire assesses sleep quality and has six main sections: 1) time to sleep, 2) sleep quality, (3) sleep duration, (4) nocturnal awakenings, (5) dreams, (6) state of the subject on waking in the morning. This subjective scale has an overall score of 30 and is used to classify subjects according to their sleep quality into three broad levels:

- A score > 20 indicates good sleep quality;
- A score [20 - 11] indicates average sleep quality;
- A score < 11 indicates poor sleep quality.

2.1.3. Physical activity program

The physical activity program consisted of four weekly fitness sessions lasting an average of one hour and thirty minutes and performed at 80-85% of HRmax. Each week, the fitness program included a session of African dance (Djembel), two sessions of bicycle pedaling (also known as 'spinning'), and an aerobics session based on the gestures and techniques of combat sports, commonly known as 'cardio-combat'. A 15-minute muscle-strengthening sequence was incorporated into each session. All the sessions began with a 5-minute handover and a 10-minute warm-up, followed by the body of the session itself (30 minutes), a 10-minute relaxation and a 5-minute handover. Subjects were encouraged to hydrate regularly as required.

2.2. Statistical analysis

The data were analysed using STATISTICA version 13 software. The Kolmogorov Smirnov test was used to test the normality of the distributions. The Man Withney U test and the Wilcoxon rank test were performed for paired and independent samples respectively. The significance level was set at $p<0.05$.

3. Results

After 8 weeks, the body mass and BMI of all subjects decreased significantly, from 86.9 kg to 84.2 kg (-2.7 kg) or 3.10% ($p < 0.001$) and from 29.3 kg/m^2 to 28.4 kg/m^2 (-0.9 kg/m^2) or 3.07% ($p < 0.001$) respectively. This loss of body mass was more marked in women (-3.7 kg or 4.05%; $p < 0.01$). In men, the reduction of 0.9 kg (1.12%) was not significant (Table 1).

The waist-to-hip circumference ratio for all participants fell significantly by 9.27%, from 0.97 to 0.88 (- 0.09; $p < 0.001$). This reduction was more marked in men (Table 1), where it was 0.12 (-11.76%; $p < 0.01$). In women, the ratio fell from 0.93 to 0.87, or -0.06 ($p < 0.05$).

Resting heart rate fell significantly in both women (-11 bpm; $p < 0.01$) and men (-11 bpm; $p < 0.05$). Variations in systolic and diastolic blood pressure were not significant in the sample (Table 1).

Table 1 Anthropometric and physiological characteristics of participants before and after the eight weeks of training, by sex (n = 23)

	Men (n = 9)		Wemen (n = 14)		Total sample (n = 23)	
Variables	**Before m ± σ**	**After m ± σ**	**Before m ± σ**	**After m ± σ**	**before m ± σ**	**After m ± σ**
BM (kg)	79.9 ± 9.6	79.0 ± 8.4	91.3 ± 16.1	87.6 ± 16.0**	86.9 ± 14.8	84.2 ± 14.0***
Taille (cm)	1.74 ± 0.05	-	1.71 ± 0.05	-	1.72 ± 0.05	-
IMC (kg/m²)	26.4 ± 2.9	26.0 ± 2.4	31.1 ± 5.1	29.9 ± 5.1**	29.3 ± 4.9	28.4 ± 4.6***
WC (cm)	93.6 ± 10.3	90.1± 8.5*	95.6 ± 13.1	94.0 ± 12.1*	94.8 ± 11.9	92.5 ± 10.8*
HC (cm)	91.3 ± 9.0	98.7 ± 8.5*	102.0 ± 10.4	107.8 ± 12.4**	97.8 ± 11.0	104.3 ± 11.7***
WHR	1.02 ± 0.03	0.9 ± 0.04**	0.93 ± 0.07	0.87 ± 0.07*	0.97 ± 0.07	0.88 ± 0.06***
HR (bpm)	78 ± 11	67 ± 8*	77 ± 8	66 ± 5***	78 ± 9	66 ± 7***
SBP (mmHg)	125.2 ± 14.0	122 .7 ± 13.7	117.2 ± 14.9	117.4 ± 14.0	120.3 ± 14.8	119.5 ± 10.8
DBP (mmHg)	75.0 ± 8.9	79.2 ± 7.9	74.5 ± 8.5	64.8 ± 21.8	74.7 ± 8.4	70.4 ± 18.8

m = mean; **σ** = standard deviation; **BM** = body mass; **BMI** = body mass index; **WC** = waist circumference; **HC** = hip circumference; **WHR** = waist to hip ratio; **HR** = heart rate; **SBP**: systolic blood pressure; **DPB**: Diastolic blood pressure; *: difference with measurements taken before the eight weeks of physical activity, significant at p < 0.05; **: difference with measurements taken before the eight weeks of physical activity, significant at p < 0.01; ***: difference with measurements taken before the eight weeks of physical activity, significant at p < 0.000.

Before the training program (Figure 1), there were four (4) normo-weighted, three (3) overweight and two (2) obese male subjects. At the end of the eight weeks, one overweight subject became normo-weight and one (1) obese subject became overweight, so that there were five (5) normo-weight subjects, three (3) overweight subjects and only one (1) obese subject in the men.

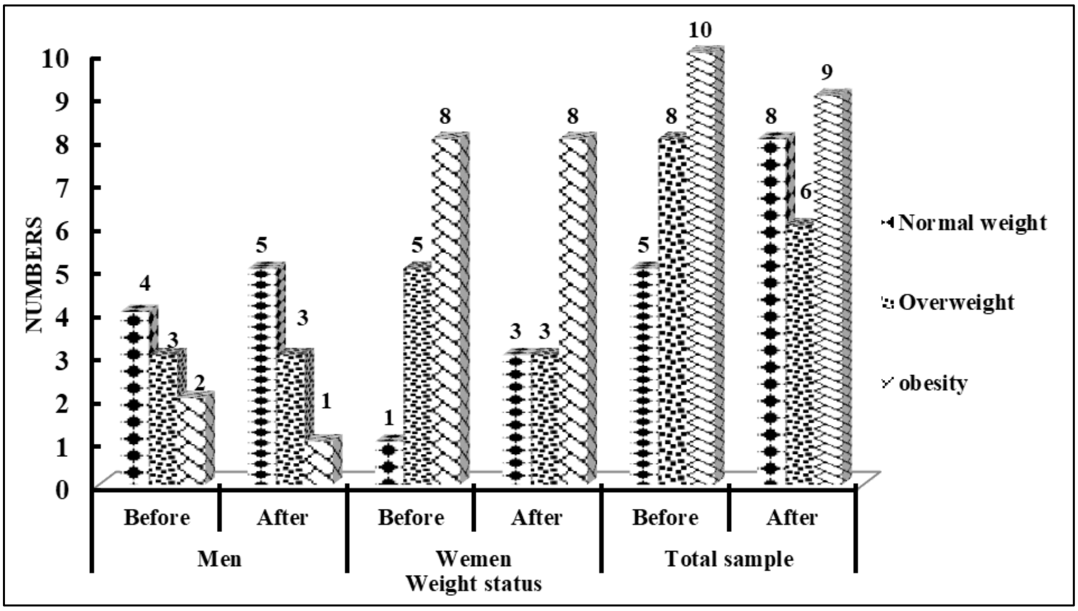

Figure 1 Change in weight status of subjects

Among the women, the initial sample consisted of one (1) normal-weight woman, five (5) overweight women and eight (8) obese women. At the end of the eight weeks, two (2) overweight women became normo-weight. There were 3 normal-weight woman and 3 overweight women. The number of obese women did not change, so there were 8 obese women before and after the training program (Figure 1).

At the end of the eight weeks of fitness, the Ruffier-Dickson index fell significantly, reflecting a significant improvement in physical condition in all subjects (Table 2). At the start of the program, none of the subjects was in good physical condition. After eight weeks, three subjects were found to be in good physical condition. In the sample, all thirteen (13) subjects who were in poor condition achieved fair physical condition. Thus, the proportion of subjects in fair condition was significantly higher than at baseline ($p < 0.05$).

Table 2 Changes in subjects' physical condition in the Ruffier-Dickson flexion test before and after 8 weeks' training (n = 23)

		Men (n = 9)		**Women (n = 14)**		**Total sample (n = 23)**	
Variables		**After**	**Before**	**After**	**Before**	**After**	**Before**
		m ± σ	**m ± σ**	**m ± σ**	**m ± σ**	**m ± σ**	**m ± σ**
Ruffier-Dickson flexion test HR	**P1**	78 ± 11	67 ± 8*	77 ± 8	66±5***	78 ± 9	66 ± 7***
	P2	121±13	111±9*	122 ± 7	116±13	122±10	114±12**
	P3	85 ± 9	67 ±7**	83 ± 8	65±5***	84 ± 9	66 ± 10***
Ruffier-Dickson Index		6,58	4,25**	6,28	4,35**	6,40	4,31***
IRD modalities		**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**
	Good 0 –3	0(0)	2(22)	0(0)	1(7)	0(0)	3(13)
	Fair 4 – 6	4(44)	7(78)	6(43)	13(93) *	12(43)	20(87) *
	Poor > 6	5(56)	0(0) *	8(57)	0(0) **	13(57)	0(0) ***

m = mean; σ = standard deviation; IRD = Ruffier - Dickson Index; HR = Heart Rate; P1: Resting heart rate; P2: Heart rate during exercise; P3: Heart rate after 1 minute of recovery; *: difference with measurements taken before the eight weeks of physical activity, significant at $p < 0.05$; **: difference with measurements taken before the eight weeks of physical activity, significant at $p < 0.01$; ***: difference with measurements taken before the eight weeks of physical activity, significant at $p < 0.000$.

Before the 8 weeks of fitness program, sleep quality was good, fair and poor in nine (39.13%), 13 (56.52%) and 1 (4.37%) subjects respectively (Table 3). After 8 weeks of the fitness program, all thirteen subjects with fair sleep quality showed a significant improvement in sleep quality. Thus, these subjects showed a good quality of sleep. The only subject with poor sleep quality had fair sleep quality ($p < 0.00$). All the other twenty-two subjects (95.65%) had good sleep quality. Thus, the proportion of subjects with good sleep quality was statistically higher ($p < 0.00$) than that of those who had it before the fitness program (Table 3).

Table 3 Changes in sleep quality before and after eight weeks of physical activity

	Men (n = 9)		**Wemen (n = 14)**		**Total sample (n = 23)**	
Quality of sleep	**Before**	**After**	**Before**	**After**	**Before**	**After**
	Number (%)	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**	**Number (%)**
Good SQ ≥ 20	4 (44.44)	9 (100) **	5 (35.71)	13 (92.85)*	9 (39.13)	22 (95.65) ***
Fair SQ=12 -19	5 (55.55)	0 (0) **	8 (57.14)	1 (7. 14)**	13 (56.52)	1 (4.34) ***
Poor	0 (0)	0 (0)	1 (7.14)	0 (0)	1 (4.34)	0 (0)

SQ ≤ 11						

SQ: Sleep quality; *: difference with sleep quality before the eight weeks of physical activity, significant at $p < 0.05$; ***: difference with sleep quality before the eight weeks of physical activity, significant at $p < 0.001$.

4. Discussion

4.1. Validity Reliability

This study was based on the hypothesis that a physical activity program would improve the physical condition and sleep quality of leisure-time physical activity enthusiasts in the municipality of Cocody (Abidjan, Côte d'Ivoire). It is interesting because of its innovative approach. It is one of the first studies carried out in Côte d'Ivoire to simultaneously investigate the effect of physical activity on sleep quality and physical condition. Although the sample size is small, the study is highly reliable and valid thanks to the tools and tests used.

In this study, the physical activity program, based on activities that are accessible and commonly practiced in fitness centers, made it possible to confer reliability on the study. The eight-week duration of the physical activity program also enabled improvements to be obtained, thereby conferring validity on this program for leisure-time physical activity enthusiasts.

The Ruffier-Dickson test, used to assess physical fitness, is a test adapted to assessing the physical fitness of sedentary people [18]. The Spiegel Sleep Quality Scale [19], which takes the form of a questionnaire, is still one of the most reliable tests for assessing subjective sleep quality. The results showed a statistically significant improvement in participants' physical fitness, a drop in body mass index (BMI), a reduction in the number of obese and overweight subjects, and a significant improvement in sleep quality.

4.2. Changes in weight status

At the start of the study, most of the subjects (18/23) were overweight or obese. In Africa, and more particularly in Côte d'Ivoire, regular physical activity is not an established part of people's lifestyles, especially in urban areas. As a result, people do very little physical activity, even though lifestyle habits are tending to change. In fact, manual activities with a high level of physical involvement (working in the fields, walking, fetching water, etc.) used to be the daily routine for Africans.

Today, with mechanization and modernization, and the use of transport vehicles, people's level of activity is declining. The change in African society has given rise to many new occupations (clerks, civil servants, bureaucrats) that do not require a high level of physical commitment. In many professions, people spend the whole day sitting at their workstation. Added to this is the changing eating habits of African societies, which are consuming more and more fatty and sugary foods. All these factors contribute to increasing the risk of overweight or obesity through an excessive accumulation of body fat that can induce health risks [20].

Obesity is increasingly becoming a major public health problem in African countries, particularly Côte d'Ivoire [21], with a gradual rise in the prevalence of overweight and obesity [21; 22]. It is therefore essential for everyone to be active or to take part in regular physical activity and sport to maintain a healthy lifestyle and limit health risks, particularly cardiovascular risks [22].

In the present study, changes in body mass and weight status were observed in those taking part in the physical activity program. The program of aerobic exercise, lasting an average of one hour and thirty minutes, four times a week, was sufficient to bring about an average reduction in the body mass and weight status of the participants. It should be noted that there was no change in the weight status of the women, who remained obese or overweight despite the exercise program. However, a reduction in their BMI was observed. It is therefore to be hoped that if this exercise program is continued, significant weight loss may be observed in these individuals. In this sense, there could be a significant drop in their body mass capable of inducing a change in their weight status.

It is well known that aerobic physical activity enables lipids to be used as energy substrates, resulting in a reduction in body mass [22]. This reduction in lipid reserves is generally essential for the maintenance of good health in overweight and obese subjects such as those in the present study.

Reducing lipid reserves, particularly non-essential ones, is fundamental to maintaining good health. In obese or overweight individuals, even minimal weight loss has beneficial effects on health and can prevent the situation from worsening [22], as was observed in the present study. Significant weight loss (≥ 5% of baseline body weight) has been shown to be effective in reducing cardiovascular risk factors and diabetes [23]. Obesity and overweight are strongly associated with the risk of developing metabolic disorders that can lead to metabolic diseases such as diabetes, hypertension, cancer and related complications [24]. This is why the WHO recommends regular physical activity for everyone [20] in order to improve health and physical condition.

4.3. Changes in physical condition

Participants' physical condition improved at the end of the training program. The majority of subjects experienced a reduction in their Ruffier-Dickson Index and therefore an improvement in their physical condition. It is well known that regular exercise improves physical fitness, which reflects a subject's ability to carry out daily activities and tasks. A number of indices and tests can be used to assess this. One of the most commonly used is the Ruffier-Dickson index [18], used in the present study to assess an individual's cardiovascular endurance and recovery capacity. Without cardiovascular endurance and good recovery capacity, it will be difficult for any individual to carry out their daily tasks. Regular exercise improves physical condition, cardiovascular endurance and lowers the resting heart rate.

One of the markers of good physical condition is resting heart rate [25]. The better the physical condition, the lower the resting heart rate [25]. In the present study, the average resting heart rate (78 bpm) at baseline showed that the participants did not have a high level of physical activity. In fact, their average heart rate was higher than that recorded in sedentary subjects, which averages 70 bpm [26]. A high resting heart rate indicates a high risk of cardiovascular problems [25], a risk that is accentuated in obese or overweight subjects.

The physical activity program resulted in a significant reduction in the participants' resting heart rate to 66 bpm. This heart rate is below the average of 70 bpm. This finding confirms that regular aerobic exercise of at least three sessions a week and lasting at least 30 minutes improves cardiovascular health and lowers resting heart rate [27]. These changes could have a positive impact on their health. For most individuals, increased physical activity leads to improved fitness [28]. As well as improving physical health, regular exercise improves sleep quality, as was observed in the present study.

4.4. Changes in sleep quality

Poor sleep quality can have consequences for physical health, mood, mental health, etc. [10; 9]. Poor sleep quality leads to reduced concentration, memory dysfunction and severe fatigue. Sleep deprivation in particular is known to induce sympathetic overactivity associated with increased heart rate and blood pressure, thereby increasing the risk of cardiovascular and metabolic diseases [10].

In this case, sport can be considered as a means of improving sleep quality and health [29], as was demonstrated in the present study. At the end of the 8 weeks of physical activity, all the participants showed an improvement in sleep quality. In fact, the combination of aerobic exercise and muscle strengthening influenced the participants' subjective sleep quality. Regular physical activity improves sleep quality by promoting well-being [30]. It reduces stress through the secretion of relaxation hormones such as serotonin, which has a positive impact on mood, promoting well-being and regulating sleep quality [31].

Recent results confirm the benefits of regular physical exercise in adolescents (53% girls) who took 30 minutes of moderate exercise. In these girls, an improvement in the quality of their sleep and their mood was observed [32]. In addition, Kline et al (2012) have shown that a six-month program of moderate-intensity physical activity is likely to improve sleep quality and reduce the risk of sleep disorders [33]. The results of the present study corroborate the work of Teheri and Irandoust (2018) [34], who showed that an eight-week program of regular physical activity improved not only sleep quality but also the general physical condition of the subjects.

It is therefore necessary for the subjects in this study to continue practicing physical activity in order to maintain their quality of sleep over the long term, while at the same time improving health-related parameters. It is important to emphasize that regular physical activity improves sleep quality for everyone, even the elderly. Reid et *al*. (2010) [35] showed an improvement in subjective sleep quality and quality of life in elderly insomniacs after taking part in a six-week program of aerobic physical activity. It is therefore necessary to suggest that all those who suffer from sleep disorders engage in regular physical activity, which will not only improve the quality of their sleep but also their general physical condition and state of health.

5. Conclusion

In conclusion, the results of this study showed that the training program had an effect on anthropometric parameters, reducing body mass, BMI, waist circumference and hip circumference. An improvement in cardiovascular parameters was observed through a fall in the subjects' resting heart rate. Sleep quality was improved by the training program. The results showed a change in the participants' physical condition.

In view of these results, it is important to suggest to the general public that physical activity should be associated with the management of sleep disorders. In this context, training at moderate intensity (75-80% of maximum heart rate) will help not only to improve sleep quality but also to improve general fitness and health.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest.

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