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The effects of 4-week of aerobic exercise training on non-athlete male students sleep quality

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Abstract
The purpose of this study was to survey the effects of 4-week of aerobic exercise training on non-athlete male students' sleep quality. 40 non-athlete male students (M_{age}=21) were tested by Pittsburgh Sleep Quality Index (PSQI). The training program was weekly and it was lasted 45 to 65 minutes in 3 sessions. The trainings were a combination of hiking, jogging, Cooper running, Fartlek training, interval running and roping and they were performed with 70 to 85% maximum heart rate intensity. The findings were measured and the data were examined for the natural assumption by Shapiro-Wilk. The hypotheses were analyzed by dependent T-test. The results of this study showed that the sleep quality were significantly increased in 4-week of aerobic exercise training ($P<0.05$). Also, there was a significant difference between the sleep quality, mental sleep quality, sleep latency, habitual sleep efficiency, and daytime dysfunction factors ($P<0.05$). But the results showed that there was no significant difference between the sleep duration and sleep disturbances factors ($P>0.05$). Therefore, the physical activities can be effective on the improvement of students' sleep quality.

Keywords: Aerobic exercise, sleep quality, non-athlete students

1. Introduction

Today, the scientific improvement is a need for growing societies and the young are attracted in this issue. The entrance to university is an important event in every person's life because it will affect on his/her occupation, income, social relationships, and future. The student life is full of new and stressful challenges [1]. The experience of independent life, the variable lifestyle, quick consequences, and residential life are examples of theses challenges. So students change voluntarily the habits of their sleep to meet these requirements. This habits change is included the decreasing of sleep time, the changing of the sleep cycle, the delay in time to fall asleep, the delayed wake up, their sleep deprivation during a week, and the compensation of this lack of sleep on weekends [1]. Thus we should understand the effects of sleep deprivation on a human's performance [2]. The students who have a poor sleep quality have significantly weaker academic performance than students have a good sleep quality [3]. The sleep is one of basic human needs and the sleep disorder is an earliest symptom of mental disorders in most cases [4]. On the other hand, a poor sleep quality has destructive effects on health [5]. The studies show that the sympathetic activity decrease and parasympathetic increase during sleep. These changes decrease heart rate and nocturnal hypertension. Therefore, long term sleep deprivation may affect negatively on cardiovascular system and it will increase the danger of cardiovascular diseases [2]. The problems and long term sleep deprivation have irreparable effects on health. The studies show that the sleep deprivation can lead to negative effects on the health, life quality, and performance [6]. The changes in sleep will begin with the increasing of age in men and women. Most of older men and women sleep soon and they have a short term sleep [7]. The changing in puberty affects on the structure of sleep in the adolescent. It means that there is a decreasing of NREM sleep duration in the school students that this problem occurs mainly in the adolescences [8]. Also the drowsiness increases in the puberty and this shows that increasing of sleep is essential during puberty [9]. The studies about the effects of gender on the sleep quality and quantity showed that gender factor can affect on the sleep quality and quantity. A study showed that older women's sleep duration was more than older men's sleep duration [10]. The studies about the effects of lack of sleep showed that the physical activities are an effective strategy to improve the sleep quality [11]. The researches results show that the physical activity and sport can have useful effects on sleep under a special condition [12]. Kathryn (2011) stated that aerobic activity can be effective on the exhilaration, social performance, and the quality of life mental health in sedentary adults (M_{age}=61.6±4.3) [13]. Montgomery et al, (1988) expressed that the physical exercise has no significant effects on weightlifters' sleep [14]. Also, Frris et al's (2005) study showed that the strength of upper body resistance decreased after the sleep deprivation [15] in the resistance trainings.

Kathryn (2011) stated that aerobic exercise plus sleep hygiene education can be an effective therapy method in older adults with chronic insomnia [13]. Krauchi et al, (1999) examined the effects of exercise on sleep and they expressed that physiology warm feet promote the rapid onset of sleep [16]. The amount and concentration of melatonin that it is the sleep hormone is affected by exercise [17]. According to body reconstruction theory, a high energy that is expended for physical activities should be provided in the rest state of body due to an appropriate balance of energy and the maintaining of body balanced condition so body will be more willing to rest [12]. In addition, the growth hormone secretion during sleep for the construction of anabolic consumes to reserve the missing resources of body [18]. The increasing of a stimulation of growth hormone stimulation is occurred in the NREM sleep state that all these will improve the regulation of sleep and will lead to maintain the energy of body [18]. Wang and Youngstedt (2014) examined the sleep quality improved following a single session of moderate-intensity aerobic exercise in older women [19]. Fifteen healthy, non-obese (body mass index = 24.4 ± 2.1 kg/m2, mean ± SD), sedentary (<20 min of exercise on no more than 3 times/week) older women (66.1 ± 3.9 years) volunteered for the study. Subjects wore a wrist ActiGraph monitor (GT3X+; ActiGraph, Pensacola, FL, USA) 24 h each day for 7 days at baseline, and 48 h after each exercise session [19]. The most interesting findings of this study were that after the moderate-intensity aerobic exercise, wake time after sleep onset, number of awakenings, and total activity counts were significantly lower than those parameters when no exercise was performed. This study showed that the moderate-intensity exercise improved sleep quality, and suggested that performing exercise and increasing the intensity of exercise may influence sleep quality positively in older adults [19]. Giselle Soares et al, (2011) studied the effects of moderate aerobic exercise training on the sleep quality in older adults [20]. This study showed that moderate aerobic exercise training improved sleep pattern in older adults [20]. Only two studies examined the effects of exercise on the sleep quality. It is essential to imply several points in relationship with these two studies. The study was done in the healthy secondary older women in the Wang and Youngstedt's (2014) study. Data were collected by a wrist ActiGraph monitor in one training session [5] and Giselle Soares et al's (2011) examined the effects of training in healthy secondary older adults [20]. Data was collected experimentally in this study. There are differences between the collected methods of data and subjects in these two studies. These studies were done only in older adults since individuals' age can be an important and effective factor on the sleep quality. Therefore, a more detailed research in non-athlete subjects with different age group can present better and more accurate results. The student population should be considered because the numbers of student are increasing and their sleep habits are changing (the decreasing of sleep time, the changing of the sleep cycle, the delay in time to fall asleep, the delayed wake up, their sleep deprivation during a week, and the compensation of this lack of sleep on weekends) so the attention to this issue can be effective help for them. On the other hand, a poor sleep quality has destructive effects on individuals' health [5]. Few studies have examined the relationship between exercises and sleep quality and there is not a comprehensive and specific study about non-athlete students and people who do not have a regular training program. Therefore, this study wants to examine the effects of 4-week of aerobic exercise training on non-athlete male students' sleep quality.

2. Methodology

2.1 Method

The method of research was semi empirical and design of it included pre-test, post test with control group.

2.2 Participants

The statistical population of this study was all non-athlete students of Islamic Azad University Islamic Azad University Lahijan Branch. 40 non-athlete students who had the conditions of this study were randomly selected. The lack of regular sports activities on campus, out of campus, and clubs was one of selected sample conditions in this study.

2.3 Instruments and Tasks

The instrument of this study was Pittsburgh Sleep Quality Index (PSQI). It assesses the sleep quality by measuring seven domains: sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleep mental quality, and daytime dysfunction over the last month.

2.4 Procedure

The subjects were divided control and experimental groups. The experimental group participated in a training program that it was weekly and it was lasted 45 to 65 minutes in 3 sessions. The trainings were a combination of hiking, jogging, Cooper running, Fartlek training, interval running and roping according to American college of sports medicine strategies (1986).

2.5 Data Analysis

The collected data were classified by descriptive statistical methods and were analyzed by dependent T-test. The SPSS software (version 19) was used for data analysis ($\alpha \leq 0.05$).

3. Results

The results of table (1) show that the mean and standard deviation of the subjects' age and time of lack of sports history. The subjects' frequency and percent were presented based on marital status, employment status, and field of study in the table (2). The descriptive information of some sleep quality characteristics was presented on the pre-test and post-test in the table (3).

Table1. The subjects' characteristics

Variable		Mean	SD	Minimum	Maximum
Age	Experimental Group	19.7	1.0311	18	22
	Control Group	20	1.45	18	23
Time of lack of sports history (month)	Experimental Group	24.6	9.91	12	36
	Control Group	20.4	10.13	6	36

Table2. The frequency and percent of marital status, employment status, and field of study

Status / Group	Single		Married		Student		Employee		Self-employed		Civil		Electric		Food industry		Business management	
	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent	N
Experimental Group	80%	16	20%	4	80%	16	20%	4	0%	0	35%	7	25%	5	40%	8	0%	0
Control Group	80%	16	20%	4	75%	15	20%	4	5%	1	20%	4	40%	8	10%	2	30%	6

Table3. The descriptive information of variables on the pre-test and post-test

Group / Variable		Experimental Group	Control Group
Sleep quality	Pre-test	8.1±3.24	6.3±3.39
	Post-test	6±2.45	6.7±3.45
Mental sleep quality	Pre-test	2.05±0.94	1.3±0.57
	Post-test	1.3±0.73	1.35±0.67
Sleep latency	Pre-test	1.45±0.89	1.2±0.52
	Post-test	1±0.73	1.35±0.75
Sleep duration	Pre-test	1.25±0.72	1.2±0.89
	Post-test	1.15±0.67	1.1±0.71
Sleep efficiency	Pre-test	1.2±0.69	0.65±0.81
	Post-test	0.7±0.65	0.65±0.74
sleep disturbances	Pre-test	1.05±0.76	0.95±0.83
	Post-test	1.05±0.69	1.1±0.79
Daytime dysfunction	Pre-test	1.25±0.64	1.05±0.51
	Post-test	0.75±0.55	1.15±0.59

The results of table (3) show:

- The mean of sleep quality has decreased from 8.1 to 6 after the performing of aerobic exercise training in the experimental group (26% improvement) and it has increased from 6.3 to 6.7 after the performing of aerobic exercise training in the control group.
- The mean of mental sleep quality has decreased from 2.05 to 1.3 after the performing of aerobic exercise training in the experimental group (36% improvement) and there was no changing in the control group.
- The mean of sleep latency has decreased from 1.45 to 1 after the performing of aerobic exercise training in the experimental group (31% improvement) and it has increased 12.5% after the performing of aerobic exercise training in the control group.
- The mean of sleep duration has decreased from 1.25 to 1.15 after the performing of aerobic exercise training in the experimental group (8% improvement) and there was an 8% decreasing too.
- The mean of sleep efficiency has decreased from 1.2 to 0.7 after the performing of aerobic exercise training in the experimental group (41% improvement) and there was no changing in the control group.
- The mean of sleep disturbances has not changed decreased after the performing of aerobic exercise training in the experimental group and there was a 16% increasing in the control group.
- The mean of Daytime dysfunction has decreased from 1.25 to 0.75 after the performing of aerobic exercise training in the experimental group (40% improvement) and there was no changing in the control group.

According to the table (4), the results of Shapiro-Wilk test showed that sleep quality data were normally distributed at the independent levels. But mental quality, sleep latency, habitual sleep efficiency, and daytime dysfunction data were not normally distributed at the independent levels.

Table4. The results of Shapiro-Wilk test for the experimental group

	Group	Df	N	p
Sleep quality	Before	0.93	20	0/151
	After	0/938	20	0/224
Mental sleep quality	Before	0/815	20	0/001
	After	0/784	20	**0/00**
Sleep latency	Before	0/884	20	0/021
	After	0/815	20	0/001
Sleep duration	Before	0/795	20	0/001
	After	0/798	20	0/001
Sleep efficiency	Before	0/8	20	0/001
	After	0/78	20	**0/00**
sleep disturbances	Before	0/816	20	0/002
	After	0/807	20	0/001
Daytime dysfunction	Before	0/78	20	**0/00**
	After	0/72	20	**0/00**

According to table (5), the results of dependent T-test show that there is a significant difference between before and after aerobic exercise training in non-athlete male students' sleep quality (P=0.000, t=5.358).

Table5. The results of dependent T-test for data of sleep quality

Variable	t	df	Sig
Sleep quality	0.385	19	0.000

Table6. The results of Wilcoxon test for the data of sleep quality

Variable	Z	Sig
Mental sleep quality	-3.873	0.000
Sleep latency	-2.714	0.007
Sleep duration	-0.707	0.480
Sleep efficiency	-3.162	0.002
sleep disturbances	0.000	1.000
Daytime dysfunction	-2.673	0.008

According to table (6), the results of Wilcoxon show that there is a significant between before and after aerobic exercise training in non-athlete male students' mental sleep quality (P=0.000, z=-3.873), sleep latency (P=0.007, z=-2.714), sleep efficiency (P=0.002, z=-3.162), and daytime dysfunction (P=0.008, z=-2.673).

Also, the results of Wilcoxon show that there is no significant between before and after aerobic exercise training in non-athlete male students' sleep duration (P=0.480, z=-0.707) and sleep disturbances (P=1.000, z=0.000).

4. Discussion

The purpose of this study was to examine the effects of 4-week of aerobic exercise training on non-athlete male students' sleep quality. According to the results of this study, we can conclude that 4-week exercise training had been effective on non-athlete male students' sleep quality. This finding is consistent with the results of Lang, et al, (2013); Wang and Youngstedt (2014); and Giselle et al, (2011); and Erlacher et al,'s (2014) [11, 19, 20, 21]. This finding is consistent with the results of Geber et al's (2014) study in the mental sleep quality domain [22]. Lang et al, (2013) stated that both scientists and the general public assume that physical activity (PA) is an effective, non-pharmacological approach to improvement in sleep quality. However, objective and reliable data on this relationship are scarce, particularly for adolescents [11]. Therefore, the aims of their study were to test the relationship by assessing both physical activity and sleep subjectively and objectively. A total of 56 adolescent vocational school students (Mean age=17.98, SD=1.36; 28 males, 28 females) participated in the study. Sleep and PA were subjectively assessed via questionnaires. Accelerometers objectively assessed PA, while sleep-EEG devices objectively assessed sleep. The data supported our prediction that adolescents with high PA levels would have longer TST, fewer wakening at night (WASO), fewer symptoms of insomnia, and higher sleep quality. However, gender influenced this pattern of results in that significant findings were only found between high self-reported PA levels and shorter perceived sleep onset latency (SOL). Though self-reported PA levels were a better predictor of good sleep than objectively assessed PA levels, gender was associated with sleep complaints; females reported more sleep complaints. Results indicate that among a non-clinical sample of adolescents increased PA is favorably associated with restoring sleep. Therefore, PA seems beneficial not only for physical and mental health, but also for sleep restoration [11]. Wang and Youngstedt (2014) examined the sleep quality improved following a single session of moderate-intensity aerobic exercise in older women [19]. Fifteen healthy, non-obese (body mass index = 24.4 ± 2.1 kg/m2, mean ± SD), sedentary (<20 min of exercise on no more than 3 times/week) older women (66.1 ± 3.9 years) volunteered for the study. Subjects wore a wrist ActiGraph monitor (GT3X+; ActiGraph, Pensacola, FL, USA) 24 h each day for 7 days at baseline, and 48 h after each exercise session [19]. This study showed that a single session of moderate-intensity exercise improved sleep quality in older women [19]. Giselle Soares et al, (2011) studied the effects of moderate aerobic exercise training on the sleep quality and metabolic profile in older adults [20]. This study tested 14 healthy and sedentary older adults. The subjects completed a 3-month exercise training protocol (three day per week). The data was gathered in laboratory methods. The results of this study showed that there was the decreasing in the blood serum and the concentration of insulin and HOMA index was improved. Also, the sleep, wake time, and REM sleep latency were decreased after exercise than baseline line values. This study showed that moderate aerobic exercise training improved sleep pattern in older adults however metabolic adaptation did not continue [20]. Erlacher et al, (2014) studied the effects of exercise on sleep in adults with chronic sleep complaints [21]. The present study reports supplementary analysis of an already described and published study. Data were provided by a nonclinical sample of 98 normal-active adults with chronic initiating and the maintaining of sleep complaints. The results indicate that the number of steps ($p = 0.02$) and the duration of physical activity ($p = 0.01$) is significantly related to the improvement in subjective sleep measures and therefore reveal an independent effect within this combined sleep program. Sleep diary data (recuperation of sleep, number of awakenings after sleep onset, and wake time after sleep onset time) improved significant (all $p < 0.01$) over the intervention program [21]. Geber et al (2014) examined whether objectively assessed vigorous physical activity (VPA) is associated with mental health benefits beyond moderate physical activity (MPA) [22]. Particularly, this study examines whether young adults who accomplish the American College of Sports Medicine's (ACSM) vigorous-intensity exercise recommendations differ from peers below these standards with regard to their level of perceived stress, depressive symptoms, perceived pain, and subjective and objective sleep. A total of 42 undergraduate students (22 women, 20 men; M=21.24years, SD=2.20) volunteered to take part in the study. Stress, pain, depressive symptoms, and subjective sleep were assessed via questionnaire, objective sleep via sleep-EEG assessment, and VPA via actigraphy. Meeting VPA recommendations had mental health benefits beyond MPA. VPA was associated with less stress, pain, subjective sleep complaints and depressive symptoms. Moreover, vigorous exercisers had more favorable objective sleep pattern. Especially, they had increased total sleep time, more stage 4 and REM sleep, slower wave sleep and a lower percentage of light sleep. Vigorous exercisers also reported fewer mental health problems if exposed to high stress. This study provides evidence that meeting the VPA standards of the ACSM is associated with improved mental health and more successful coping among young people, even compared to those who are meeting or exceeding the requirements for MPA [22]. Since the results of this study are consistent with the results of above studies, it seems that the sleep is an active and complex experience and different factors are effective on the sleep quality and quantity [23]. In this regards, we can imply to the reasons such as warm feet promote the rapid onset of sleep [16]. The amount and concentration of melatonin that it is the sleep hormone is affected by exercise [17]. According to body reconstruction theory, a high energy that is expended for physical activities should be provided in the rest state of body due to an appropriate balance of energy and the maintaining of body balanced condition so body will be more willing to rest [12]. On the other hand, the increasing of a stimulation of growth hormone stimulation is occurred in the NREM sleep state that all these will improve the regulation of sleep and will lead to maintain the energy of body [18]. Since the sleep duration is a

subscale of sleep quality and it was significant in this study but the sleep duration factor of falling sleep was not significant and sleep disturbances as a subscale of sleep quality was not significant too so the results of this study is consistent with the results of Souissi's (2003) study [24]. Souissi's (2003) examined the effect of one night's sleep deprivation on anaerobic performance in the morning and afternoon of the following day [24]. The results of this study showed that the sleep deprivation reduced the difference between morning and afternoon in anaerobic power variables. Anaerobic performances were unaffected after 24 h of wakefulness [24]. In this regard the studies suggest that the problems and short sleep duration have irreversible effects on health so that sleep restrictions lead to negative effects on health, quality of life, and performance [6]. We can say about this issue that the sleep duration is affected by the gender and age [25]. So it seems that the lack of changing in the scores mean of sleep duration is affected by gender and age in this study. In addition, the acquired scores in the pre-test and post-test were respectively 1.05±0.75 and 1.05±0.69 in the sleep disturbances. According to the pre-test scores, it can be observed that there have not been the sleep disturbance moreover the effects of age and gender so there was not a significant change in the sleep disturbance in this study.

5. Conclusion

According to the results of this study, we can conclude that the performing of aerobic exercise trainings have a positive effect on the sleep quality due to the decreasing of scores mean in the sleep quality factor with mental sleep quality, sleep latency, sleep efficiency, and daytime dysfunction subscales in this study and with attention to the maintaining body energy and body reconstruction theories and effects of growing and melatonin hormone on the sleep quality. In addition, we can conclude that aerobic exercise trainings were unaffected on the sleep disturbances due to the distribution of scores was normal in the experimental group and subjects have not been sleep disturbances on the pre-test. Also we can conclude that aerobic exercise trainings were unaffected on the sleep disturbances that it can be due to the subjects gender (male) according to Kripke et al's (2002) expressions (the effects of gender differences on the sleep quality and the improvement of sleep quality) [10]. Therefore, we suggest that non-athlete students can participant in the physical activities to improve their sleep quality.

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