THE EFFECT OF A MODERATE-INTENSITY AEROBIC TRAINING PROGRAM ON THE SLEEP QUALITY, BMI, AND WEIGHT IN NON-ACTIVE PEOPLE WITH TYPE 2 DIABETES

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Abstract

Diabetes Mellitus has imposed a large economic burden on society in recent decades. It is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The daily inactivity, poor lifestyle, and prevalence of obesity are important and effectiveness factors in the incidence of type 2 diabetes. The purpose of this study was to examine the effect of a moderate-intensity aerobic training program on the sleep quality, BMI, and weight in non-active people with type 2 diabetes.The method of this study was semi empirical. The statistical population of this study was 30 patients with Type 2 Diabetes. Kolmogorov-Smirnov test was used to determine the data normality. The collected data were classified by descriptive statistical methods and were analyzed by independent and dependent T-test ($\alpha \leq 0.05$). The results of this study showed that there was no significant relationship between the sleep quality and age, duration of diabetes, education, and marital status. But there was a significant relationship between sleep quality and without history of sport, weight, and BMI changes. Diabetes is an effective predictor for the reduction of sleep quality and there is a relationship between the sleep and obesity so that the results of this study showed that a moderate-intensity aerobic training program can be an effective treatment for sleep disorders and obesity in non-active people with type 2 diabetes.

Keywords: *Type 2 diabetes, sleep quality, aerobic training, weight, BMI*

INTRODUCTION

Diabetes Mellitus is a health challenge that it has imposed a large economic burden on society in recent decades (1). It is worth noting diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both (2). The most common types of diabetes are insulin-dependent diabetes (type 1) and non-insulin dependent diabetes (type 2) that type 2 diabetes is increasing at an alarming speed in the world (3). The daily inactivity, poor lifestyle, and prevalence of obesity are important and effectiveness factors in the incidence of type 2 diabetes and its complications (4). As several studies show that the prevalence of type 2 diabetes is increasing quickly due to obesity and the reduction of physical activity in different societies (5, 6). The International Diabetes Federation (IDF) predicts that the number of people with type 2 diabetes will be 40 million (with increases of 80%) in the Middle East in 2025 that this is a very serious warning for health field (7). The fact is that more than three million people have diabetes in Iran and this figure is 3 times every 15 years (8) so that the statistics of IDF shows that the prevalence of diabetes was reported 6% in people aged 20 -79 in 2007 in Iran and it is predicted that this figure rises to 4/8% in 2025 (9). On the other hand, we observe multiple complications of diabetes on people that hypoglycemia is a short-term complication of diabetes and hyperglycemia and chronic hyperglycemia are long-term complications of diabetes (10). So people with diabetes experience numerous problems to perform their daily tasks. Some studies reported that people with type 2 diabetes experience high levels of emotional problems along with physical difficulties. These problems include depression, anxiety, aggression, and so on (11). The high cholesterol, insulin resistance with high blood pressure, the low ability in the blood sugar control, and arteriosclerosis are the other complications in people with type 2 diabetes (12). The systematic control of blood glucose and the adjustment of effective negative factors on the blood sugar are important with the increasing of Diabetes Mellitus. We should consider several factors to control this disease. The appropriate lifestyle plays an important role. The sleep against the physical activity is an important element of human life style and they are two sides of the same coin (13). Today, sleep disturbance is a complication for people with type 2 diabetes so that poor quality sleep can have destructive effects on health (14). A large percentage of the elderly often have poor sleep quality such as frequent waking. The results of the 2003 National Sleep Foundation Sleep in America showed at least among every three people, one person (over 64 years) had one of sleep problems such as sleep late, staying awake at nigh, and waking up too early (15). Other

conditions such as a reduction in hormones, obesity, arthritis, diabetes, diabetes, and metabolic syndrome are associated with aging (16). The aging causes changes in sleep patterns as well as the increasing of the awakening of nightmares, the reduction of REM sleep, frequent waking during sleep, the reduction of sleep duration, and the increasing of sleep disorders such as sleep apnea and insomnia (17). Epidemiologic studies were examined the on the relationship between sleep quality and incidence of type 2 diabetes and exercise in recent years. The studies about the survey of sleep quality in people with type 2 diabetes showed that people who always had sleep disorders had a higher body mass index and fat percentage so that limitations of Sleep increases foods stimuli especially the high-carbohydrate foods that these factors can affect individuals' sleep quality and quantity. The poor sleep quality has a negative effect on insulin. So, the poor sleep quality is an effective predictor facto in the incidence of type 2 diabetes. Thus these factors should be considered as factors in the incidence of type2 diabetes (18). A study examined the relationship between sleep duration and cardio metabolic risk factors among individuals with type 2 diabetes. The results of this study showed that sleep duration is an effective factor on sleep quality in people with type 2 diabetes. Health promotion interventions might highlight the importance of adequate sleep in people with type 2 diabetes (19). We can say about the relationship between sleep and type2 diabetes that the prevalence of diabetes and impaired glucose tolerance during sleep duration increases less than 6 hours sleep or more than 9 hours. People with type 2 diabetes have less sleep duration than normal sleep duration in society (20). A study showed that obesity and its psychological changes can cause sleep disorders. The short sleep duration changes the metabolism of glucose in the body and it increases the risk of diabetes or impaired glucose tolerance (21). We can found that an increasing or decreasing of sleep duration is associated with the increasing of risk and incidence of diabetes or the poor control of blood glucose in people with type diabetes (22). The awareness, knowledge, right diet, medication, and exercise are the basic principles to control diabetes. The low cost and non-pharmacological nature of exercise increases its therapeutic importance (23). Also, the regular exercise plays an important role in the control of type 2 diabetes especially glycemic control and modification of risk factors in cardio – vascular, the increasing insulin sensitivity, reduction of body fat, blood pressure, the decreasing of glycosylated hemoglobin and blood sugar, and the reduction of hyperlipidemia (24). There is a strong relationship between exercise and type2 diabetes (25). Therefore, a moderate-intensity aerobic exercise can have a positive effect on the quality of life in people with peripheral neuropathy and type2 diabetes (26). On the other hand there is a strong correlation between sleep quality and quality of life. Also, the use of exercise is a non-pharmacological approach that can has beneficial effects on sleep (27). Studies have shown that physical activity is one of the most effective daily activities on sleep quality (28, 29, 30). According to the mentioned contents, the role of diabetes in non-active individuals' sleep, and the effectiveness of exercise on sleep quality, this study wants to examine the effect of a moderate-intensity aerobic training program on the sleep quality, BMI, and weight in non-active people with type 2 diabetes to understand that the designing of a moderate-intensity aerobic training program in accordance with the non-active individuals' age and physical condition affects on the sleep quality, BMI, and weight in in non-active people with type 2 diabetes or not.

METHODOLOGY

Method

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

Participants

The statistical population of this study was 30 patients with Type 2 Diabetes (30 to 70 years old) who had the study conditions including the definitive diagnosis of diabetes by an endocrinologist, a doctor's permission to exercise in the experimental group, the lack of structural abnormalities in the spine, a history of type 2 diabetes more than six months and no cardiovascular and Alzheimer disease, without history of sport for one year.

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. The score ranging of this questionnaire is from 0–21. The score 5 or more means poor sleep quality.

Procedure

The subjects were randomly divided to the control group (N=15) and experimental group (N=15). They participated in the pre and post-test. The subjects complete honestly the questionnaires a day before the study conducting. At the beginning of both experimental and control groups were matched in terms of marital status, age, education, duration of diabetes, and history of sports. The purpose and the process of study

were explained to subjects before the training process. They completed a consent form to participant in this study and they attended with the complete satisfaction in this study. Then, the experimental group participated in the designed exercise program every other day at gym. All participants were weighed and recorded their body mass index. Every subject's weight was measured without shoes and with light clothing by the carriage scales with stadiometer seca that had an accuracy of less than 100 grams. Subjects were asked to start an exercise program for 10 minutes with stretching to warm up their muscles in each session. The aerobic training program of walking was included 24 weeks of aerobic training (3 sessions in every week). Subjects' program execution was started with 40-45% of maximal reserved heart rate for 25 minutes in the first week. It increased to 70-80% of maximal reserved heart rate for 45 minutes in the fourth week. This intensity continued until the end of the week (it was increased 5 minutes to the time and 5% to the intensity of training every week). Each session included a 15 minute warm-up with a variety of running, stretching, and a 45-minute walking. The cool down was included the flexibility and stretching exercises for 10 minutes at the end of each session. Maximum heart rate was calculated by (Age - 220) formula. Every subject's training heart rate was calculated by maximum and resting heart rate through Caroni method. Heart Rate was controlled by (maximum heart rate - resting heart rate) × training intensity - resting heart rate of training intensity in each session using Polar heart rate monitor. The subjects were asked to walk 1.600 meters after the warm up. Subjects' heart rate was controlled through Polar heart rate monitor during test and time was recorded with a stopwatch.

Data Analysis

The collected data were classified by descriptive statistical methods and were analyzed by independent and dependent T-test and Pearson correlation coefficient ($\alpha \leq 0.05$).

Results

The results of table (1) show the subjects' individual characteristics. Also the results of table (2) show the mean and standard deviation of subjects' sleep quality, weight, and BMI at the beginning of study and after the exercise protocol.

Table1. Subjects' individual characteristics

Group		Experimental	Control
*without history of sport (month)		4.86±16.745	66.4±23.51
*Age		59.87±5.58	60.0±5.73
* Duration of diabetes (month)		3.13±19.845	3.13±18.837
**Education	High school	4(26.7%)	5(33.3%)
	Diploma	3(0.20%)	6(40.0%)
	Associate	3(0.20%)	2(13.3%)
	Bachelor	5(33.3%)	2(31.3%)
**Marital status	Married	11(73.3%)	12(80.0%)
	Divorced	4(26.7%)	3(20.0%)

N (%) ** Mean ± SD *

Table2. The results of comparison of sleep quality, weight, and BMI before and after test in groups

Variable	Groups	Pre-test	Post-test	P*	The difference between pre and post-test	P**
Sleep quality	Experimental	1.6±11.47	1.42±9.2	†0.000	0.59±2.27	†0.000
	Control	1.65±11	1.5±11.53	†0.006	0.64±-0.53	
BMI	Experimental	1.44±27.98	1.29±27.39	†0.000	0.48±0.598	†0.000
	Control	1.29±28.01	1.14±28.23	†0.004	0.25±-0.22	
Weight	Experimental	4.51 ± 83.27	4.49±80.6	†0.000	1.46±2.67	†0.000
	Control	5.29±83.43	5.27±84.56	†0.000	0.718±-1.13	

‡Mean ± SD, *P<0.05 (paired sample t-test, for changes within the group), ** P<0.05 (independent sample t-test, for the comparison between groups)

According to table (2), aerobic trainings had a significant effect on sleep quality, BMI, and weight changes. The mean of score of sleep quality has decreased from 11.47 to 9.2 after the

aerobic trainings in the experimental group. It means that there was 20% improvement in sleep quality. It has increased from 11 to 11.53 in the control group. It means that there was 5% loss. BMI has decreased 2% in the experimental group and it has increased 1% in the control group. Subjects' weight has decreased 4% in the experimental group and it has increased 1% in the control group.

According to Pearson and Chi Eta tests, there was no significant relationship between sleep quality and age, duration of diabetes, education, and marital status. But there was a significant difference between sleep quality and without history of sport, weight, and BMI changes.

Discussion and conclusion

The results of this study showed that Diabetes is an effective predictor for the reduction of sleep quality and there is a relationship between the sleep and obesity. The prevalence of obesity has increased at a faster rate in the past few years. Most experts agree that the reduction of physical activity and poor food patterns cause multiple effects on people. The reduction of sleep quality and quantity is an important factor for obesity (31). A systematic review reported that there is a high correlation between sleep and obesity in adults and children (32). Today, scientific evidence suggests that the sleep quality and quantity plays an important role in the regulation of ghrelin and leptin levels so that acute and chronic sleep deprivation causes a significant decreasing in the leptin levels and the increasing in ghrelin level. These changes are associated with the increasing of hunger and appetite (33). Studies have also confirmed these changes. For example a study showed Participants with short sleep had reduced leptin and elevated ghrelin than participants with adequate sleep. These differences in leptin and ghrelin are likely to increase appetite, possibly explaining the increased BMI observed with short sleep duration (34). The results of this study showed that the sleep quality score of experimental group (9.2±1.42) were significantly lower than the control group (11.53±1.5). The BMI (27.39±1.29) and weight (80.6±4.49) of experimental group were lower than the BMI (28.23±1.14) and weight (84.56±5.27) of control group. This shows the effect of independent variable on dependent variables. We can state that a moderate-intensity aerobic training program has a good effect on the improvement of sleep quality. The results of study are consistent with the results of Shelley et al,'s (2003) study. They examined effects of a yearlong moderate-intensity exercise and stretching intervention on sleep quality in postmenopausal women. They reported that the effect of moderate-intensity exercise may depend on the amount of exercise and time of day it is performed (35). The improvement of sleep quality results from the aerobic physical activities that may be due to the reduction of period of REM and the increasing of NREM period. Because changes of core body temperature stimulates Preoptic nucleus and anterior hypothalamus by this type of exercise. This process also improves sleep quality (36). The results of this study are consistent with the results of Wang and Youngstedt's (2014) study. They examined the effect of a single session of moderate-intensity aerobic exercise on sleep quality in older women. Their study showed that a single moderate-intensity aerobic exercise session improved sleep quality in older women. We can express that the increasing of activity of sympathetic system during exercise and the reduction of the activity of the parasympathetic system during recovery may lead to deeper sleep and the increasing of sleep duration in active people (37). The results of this study are consistent with the results of Erlacher et al,'s (2014) study. They studied the effect of exercise on self-rated sleep among adults with chronic sleep complaints. The results of this study showed that the number of steps and the duration of sleep were significantly related to individual sleep criteria and those had an independent effect on subjects' sleep program (38, 39). Sleep is an integral part of health. Sleep disturbances and changes in sleep habits may be the reason or the result of other conditions such as obesity, diabetes, and cardiovascular disease. There are mechanisms to overcome the mentioned complications that the regular use of the exercise is one of these mechanisms (39). The regular the exercise is an effective strategy to deal with sleep disorders, obesity, and diabetes so that the use of the aerobic training along with the instruction of sleep health can be an effective treatment for older people with sleep disorders (40). It seems that the idea of the proper functions of sport as an effective treatment of sleep problems in people with type 2 diabetes is the result of the different theories about the sleep function such as heat regulation, revival of body, and energy conservation. For example the recovery theory of the body predicts that the there is a relationship between the energy cost and deeper sleep (i.e. slow wave sleep) or longer sleep in elderly people to regroup (38). Moreover, exercise increases the production and release of neurotransmitters and neurotropic factors that can affect on sleep from neurophysiological aspects (e.g. better mental health) (41). In addition, physical activity is an important factor in prevention of obesity and diabetes and it also is an effective variable on sleep.

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