

Effect of yoga and aerobics exercise on sleep quality in women with Type 2 diabetes: A randomized controlled trial

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ABSTRACT

Objective: The aim of this study was investigating the effect of 12 weeks of yoga and aerobic exercise (running on a treadmill) on the sleep quality in women with Type 2 diabetes. **Materials and Methods:** 39 diabetic women were selected from Semnan city with the mean age of 46.85 ± 3.35 years, weight of 69.79 ± 17.18 kg, height of 155.03 ± 5.00 , BMI of 29.64 ± 5.00 kg/m² who had a background of diabetes for 6.46 ± 2.69 years. They were then randomly divided into yoga exercise (n=15), aerobic exercise (n=13), and control group (n=11). The exercise program was performed for 12 weeks, three sessions per each week. In order to measure the sleep quality, the Pittsburgh Sleep Quality Index (PSQI) was used. The data were analyzed by non-parametric wilcoxon and Kruskal-Wallis Test at significance level of $p < 0.05$. **Results:** Overall score of sleep quality improved after six ($p = 0.001$) and 12 ($p = 0.001$) weeks of yoga exercise. Also, significant effect was observed after 6 weeks of aerobic exercise ($p = 0.039$). However, the positive effect was diminished to under significant levels after 12 weeks of aerobic exercise ($p = 0.154$). Kruskal-Wallis Test showed significant differences between yoga and aerobic groups after 12 weeks of exercise ($p = 0.002$). No significant differences were observed in control groups in all situation. **Conclusions:** It can be concluded that yoga exercise is more effective in improving the sleep quality in comparison with the same course of aerobic exercise in women suffering from diabetes Type 2. Thus, yoga exercise can be suggested to these patients.

Keywords: Yoga; Sleep; Diabetes Mellitus, Type 2; Exercise.

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INTRODUCTION

Diabetes is a chronic hyperglycemia and disordered metabolism of carbohydrates, lipids, and proteins. This disease originates from disruptions in secretion of insulin and performance of insulin receptors or both of these conditions¹. According to statistics presented by WHO in 2016, the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014². Diabetes mellitus has affected millions of people around the world where this figure is increasing with an alarming rate. Estimates reveal that the number of diabetic patients would reach over 366 million people in 2030 all over the world³.

Some research has shown that there is a relationship between the quantity and quality of sleep and diabetes. For example, some studies have reported that sleep disorders can lead to increased risk of diabetes^{4,8}. Resnick et al.⁷ in 692 diabetic patients showed that there is a significant difference between the diabetes and non-diabetes groups in terms of sleep stages and the sleep time. Using the Pittsburgh Sleep Quality Index, Vigg et al.⁸ demonstrated that diabetes Type 2 follows sleep reduction and control of blood sugar is associated with the sleep quality and quantity. Therefore, it seems that sleep and diabetes (one as a physiological behavior and the other as a metabolic disorder) have interactive effects on each other.

On the other hand, previous research has revealed that exercise training (especially aerobic exercise) lead to improved sleep quality in Middle-Aged Non-Athlete Females⁹, men older adults¹⁰, patients with rheumatoid arthritis¹¹ and sedentary overweight men¹². However, although there are very study showing positive effects of Yoga on diabetics patient¹³, effect of yoga on sleep quality is not well investigated. Yoga has been known as one of the effective for overcoming numerous problems including anxiety¹⁴⁻¹⁶. Also, Khalsa¹⁷ suggested that 12 weeks of yoga exercise is effective in reducing insomnia.

To our knowledge, no research was found about the effect of yoga exercises on sleep quality of diabetic women. Therefore, this research has been conducted to investigate first the effect of 12 weeks of yoga and aerobic exercise on sleep quality of women with Type 2 diabetes. Secondly, it compares the effect of yoga and aerobic exercises on sleep quality in diabetic patients. Accordingly, the aim of this study is investigating the effect of 12 weeks of aerobic exercise (running on treadmill) and yoga exercise on the sleep quality in women with diabetes Type 2.

METHODS

Subjects

Subjects were selected among 1700 diabetic Type 2 patients of Semnan diabetes Association who had a medical file in the Semnan Kothar Hospital (Iran). From among this patients, 45 women with diabetes Type 2 with an age range of 38-53 years old were selected as the available sample and volunteer participants in this research (Table 2).

The criteria of subject selection included lack of any diabetic complications (neuropathy, nephropathy, retinopathy),

not being under insulin treatment, no participation in sport activities over 20 min or any kind of regular aerobic exercise and resistance training over the last 6 months, no change in oral hypoglycemic, lipid-lowering, and anti-hypertensive medications over the last two months, no weight loss over 5% over the last two months, no extreme obesity (BMI<40), no consumption of hormonal drugs or hormone-therapy such as thyroid, etc., no consumption of alcohol beverages, cigarette, and other drugs.

This study based on declaration of Helsinki about Ethical Principles for Medical Research Involving Human Subjects and all the subjects signed consent form before participation in study. This study has been approved by Department of Exercise Physiology, Semnan University.

After completion of health questionnaire and consent form, they were then divided into three groups randomly (Regardless of age, weight, and .): aerobics group (treadmill) - 15 patients, yoga exercise group - 15 patients, and the control group - 15 patients. In randomization, for each participant was assigned a code by researcher and then someone else selected 15 code for each group randomly. Nevertheless, with the attrition of some subjects due to personal reasons, the subjects in the aerobics and the control groups dropped to 13 and 11 patients, respectively.

Exercise protocol

The both exercise protocol included 12 weeks, 3 sessions every week. The yoga exercise program included 10 min general warm-up (pawanmuktasana), 30 min asana (principal movements), 20 min surya namaskar, 15 min pranayama (breathing exercise), 10 min shavasana (relaxation), and 5 min Yoga nidra. Yoga program is shown in Table 1.

Aerobic exercise included running on a treadmill. For first four weeks, exercise performed for 25 min with 60-65 % of the maximum heart rate reserve (MHRR). During second four weeks, time of exercise was 30 min with an intensity 60-65% of the MHRR, and for third four weeks, time increased to 35 min and intensity raised up to 70-75% of the MHRR. The calculation of the exercise intensity was done using Karvonen formula.

Measurement of sleep quality

For measuring sleep quality in the subjects, the Pittsburgh Sleep Quality Index was employed. This questionnaire is an instrument with seven components (sleep quality, delay in falling asleep, the sleep duration, the sleep efficiency, sleep disorders, consumption of sleep-inducing medications, and the daily performance) and 18 questions. The score of every item in this questionnaire is between 0 and 3 where the score of every component is at most 3. The sum of the scores means of these seven components accounts for the total score of this instrument ranging from 0 to 21. The higher the obtained score, the worse the sleep quality. A score higher than 6 denotes undesirable sleep quality. The PSQI validity is 0.80 and reliability examined through re-testing has been reported between 0.93 and 0.98¹⁸. The validity and reliability of this questionnaire has

Table 1. Yoga program

Stage	Duration	Exercise type
1	10 min	pawanmuktasana
2	30 min	salabhasana, virabhadrasana, Trikonasana, Upavistha Konasana, vrikshasana, Padahasthasana, uttanasana, vajrasana, vakrasana, gomukhasana, paschimottanasana, uttanpadasana, bhujangasana, salabhasana, dhanurasana, viparita karani
3	20 min	surya namaskar
4	15 min	sitkari and bhrumari pranayama
5	10 min	nadi shodhana, kapalbhati, and Shavasana
6	5 min	Yoga nidra

Table 2. Personal characteristics of the subjects in groups.

	control	aerobic	Yoga
age	48.18±3.45	44.69±3.03	47.93±2.86
Weight	72.05±14.06	72.35±12.79	71.29±14.66
height	151.50±4.82	156.81±4.58	155.63±4.58
BMI	31.28±5.43	29.35±4.57	29.35±5.31

Table 3. Comparison of data in three groups.

	control						
				pre vs. post 1		pre vs. post 2	
	Pre	Post1	Post2	Z value	p value	Z value	p value
Sleep quality	1.82	1.64	1.45	-0.70	0.480	-1.26	0.206
Sleep latency	2.09	2.27	1.82	-1.00	0.317	-1.34	0.180
Sleep duration	2.00	1.82	1.55	-0.81	0.414	-1.40	0.160
Sleep efficiency	2.18	2.18	2.00	0.00	1.000	-0.81	0.414
Sleep disturbances	2.55	2.45	2.55	-0.27	0.785	0.00	1.000
Sleep medications	1.91	2.09	2.09	-0.53	0.593	-0.53	0.59
Daytime dysfunction	1.45	1.91	1.73	-1.51	0.129	-1.13	0.257
Overall score	13.91±5.52	14.45±5.37	13.27±5.58	-0.88	0.375	-0.85	0.394
	aerobic						
	Pre	Post1	Post2	Z value	p value	Z value	p value
	Pre	Post1	Post2	Z value	p value	Z value	p value
Sleep quality	1.77	1.15	1.31	-2.82	0.005**	-1.45	0.145
Sleep latency	1.85	1.38	1.77	-1.40	0.161	-0.05	0.957
Sleep duration	1.85	1.46	1.77	-1.40	0.160	-0.27	0.782
Sleep efficiency	2.23	1.92	1.92	-1.41	0.157	-1.10	0.271
Sleep disturbances	2.85	2.08	2.00	-2.04	0.041*	-2.05	0.040*
Sleep medications	1.69	1.46	1.15	-0.36	0.717	-1.35	0.177
Daytime dysfunction	2.08	1.15	1.38	-2.14	0.032*	-1.49	0.135
Overall score	14.31±4.72	10.54±6.22	11.54±6.39	-2.06	0.039*	-1.42	0.154
	yoga						
	Pre	Post1	Post2	Z value	p value	Z value	p value
	Pre	Post1	Post2	Z value	p value	Z value	p value
Sleep quality	2.07	0.73	0.33	-3.25	0.005**	-3.34	0.001**
Sleep latency	1.80	1.33	0.80	-1.65	0.097	-2.65	0.008**
Sleep duration	2.20	0.87	0.27	-3.40	0.001**	-3.45	0.001**
Sleep efficiency	2.53	1.60	0.73	-2.62	0.009**	-3.22	0.001**
Sleep disturbances	2.40	1.87	0.87	-1.90	0.057	-3.22	0.001**
Sleep medications	1.87	0.93	0.27	-3.12	0.002**	-2.94	0.003**
Daytime dysfunction	1.73	1.00	0.40	-2.11	0.035*	-2.74	0.006**
Overall score	14.40±5.92	8.07±5.45	3.73±3.49	-3.41	0.001**	-3.41	0.001**

*p=0.05; ** p=0.001 within-groups significant differences

also been confirmed in Iran (the Cronbach-alpha coefficient of this questionnaire was obtained between 0.78 and 0.82)¹⁹.

Statistical analysis

The Shapiro -Wilk test was used to assess normality of data distribution for each variable. We used non-parametric Wilcoxon and Kruskal-Wallis test at significance level of $p < 0.05$.

RESULTS

Shapiro -Wilk test showed that the majority of data were not normally distributed. Therefore, we used non-parametric test for analysis of data.

Overall score of sleep quality improved after six ($p=0.001$) and 12 ($p=0.001$) weeks of yoga exercise. Also, significant effect was observed after six weeks of aerobic exercise ($p=0.039$). However, the positive effect was diminished to under significant levels after 12 weeks of aerobic exercise ($p=0.154$). Kruskal-Wallis Test showed significant differences between yoga and aerobic groups after 12 weeks of exercise ($p=0.002$). No significant differences were observed in control groups.

DISCUSSION

Considering the statistical results obtained from this study, it was observed that 6 and 12 weeks of yoga exercise has been effective in improving the sleep quality in diabetic women. Although the sleep quality score improved in this study, at the end of the 6th week of exercise, the PSQI score was still in the undesirable sleep range (questionnaire score higher than 6). However, this score reached the suitable and normal range of sleep quality after 12 weeks of yoga exercise.

On the other hand, although the aerobic exercise resulted in improved sleep quality in diabetic women after 6 weeks, this improvement did not reach to statistically significant levels after 12 weeks. Likewise, between the aerobics and yoga exercise groups, the difference was not statically significant by the 6th week, but after the 12th week, the difference reached to significant level.

It is believed that regular exercise leads to improved sleep quality^{20,21}. In a meta-analysis, it was reported that regular exercise results in increased total sleep time and slow wave of sleep²². The results of this study with respect to the effect of yoga exercise on sleep quality is in accordance with those by Halpern et al.²³ regarding the effect of yoga asanas on the improvement of sleep disorders in the elderly suffering from insomnia and low sleep quality. The results of the study by Hariprasad et al.¹⁵ also indicated that 6 weeks of yoga exercise results in improved physical and mental health, social relations, and considerable amelioration of the total score of sleep quality in the elderly. Manjunath et al.²⁴ reported that 6 weeks of yoga exercise leads to improved delay in sleep, sleep duration, and better feeling in the morning.

Researchers believe that physical activities improve sleep quality through elongating the sleep stage and shortening the latent period (the time between the onset and the first stage of sleep)^{25,26}. Another possible explanation can be the fact that

yoga exercise causes a person to experience a good sleep during the night, have lower levels of stress during the day, be more energetic and happy culminating in reduced disruptions in daily activities²⁷.

People who perform yoga asanas mostly declare that they have higher levels of energy, vivacity, and more balanced feelings²³. It has also been reported that the variations in the hormonal levels caused by physical activities including Growth Hormone Receptor (GHR), melatonin, interleukin-1, prolactin, and prostaglandin D2 have desirable modulating effects on the sleep quality²⁸.

Also numerous studies have shown yoga to have an immediate down-regulating effect on both the sympathetic nervous system (SNS) and hypothalamic-pituitary-adrenal (HPA) axis response to stress²⁹. Also yoga in a relatively short time with a measurable effect, the associated change in GABA levels may increase. The effect of the yoga intervention on GABA levels may be due to the ability of yoga practices to increase parasympathetic nervous system (PNS) activity³⁰.

CONCLUSIONS

The results of this study displayed a significance difference between the effect of yoga and aerobic exercise. The main reason behind this difference could be due to the way activities have been carried out. The aerobic exercise in this research was done in the form of running on a treadmill individually, but yoga was practiced in a group and in an enlivening fashion.

Yoga stimulates production of endorphins and reinforces the feeling of happiness during the day and improves sleep quality during the night. On the other hand, previous studies have reported that aerobic exercise done in the form of running on a treadmill follows reduced levels of anxiety, stress, and depression resulting in improved sleep quality³¹⁻³³.

In addition, Yoga exercises were carried out for 90 min per session, while aerobic exercises lasted 35 min in the longest session. Since according to previous research the optimal intensity of aerobic exercise for reduce blood glucose levels³⁴ and improvement sleep quality¹² is high intensity exercise, in this research we employed this protocol. However, due to high intensity, it was not possible to increase the duration of aerobics sessions because of the physical conditions of the subjects. Based on the nature of the yoga exercises, it is possible to elongate sessions and this can be one of the advantages of this exercise.

As limitations, it was applied only one questionnaire and other parameters associated with diabetes was not measured. Also, the duration of yoga session was different from the aerobic exercise session. This may have influenced the results.

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