Taiwanese Journal of Obstetrics & Gynecology 56 (2017) 204–209

Contents lists available at ScienceDirect

Taiwanese Journal of Obstetrics & Gynecology

journal homepage: www.tjog-online.com

Original Article

Effect of a gymnastics program on sleep characteristics in pregnant women

Ildikó Kocsis [a], Tibor Szilágyi [a, b, *], János Turos [c], Aliz Bakó [d], Attila Frigy [e]

[a] Doctoral School, University of Medicine and Pharmacy Tirgu Mures, Tirgu Mures, Romania
[b] Department of Physiology, University of Medicine and Pharmacy Tirgu Mures, Tirgu Mures, Romania
[c] Department of Obstetrics–Gynecology I, University of Medicine and Pharmacy Tirgu Mures, Tirgu Mures, Romania
[d] Rheum Care Foundation, Tirgu Mures, Romania
[e] Department of Internal Medicine IV, University of Medicine and Pharmacy Tirgu Mures, Tirgu Mures, Romania

ARTICLE INFO

Article history:
Accepted 26 January 2017

Keywords:
gymnastics
pregnancy
sleep

ABSTRACT

Objective: The quality and quantity of sleep represent important health issues in pregnant women. Sleep disturbances could be associated, beyond alteration of quality of life, with poor pregnancy outcome. Our aim was to investigate the effect of a regular, specific, medium-term physical training program on sleep characteristics in healthy pregnant women.

Materials and methods: A total of 132 healthy pregnant women, with gestational age between 18 weeks and 22 weeks, were enrolled in a prospective study. They were allocated into two groups; the first group involved 79 women (average age, 29.4 years) who performed a specific gymnastics program of 10 weeks, and the second group involved 53 pregnant women (average age, 27.9 years) who did not perform gymnastics. All participants completed a comprehensive questionnaire at baseline and after 10 weeks concerning general data, sleep characteristics, and psycho-emotional status. The changes arising within a diverse set of characteristics were followed and compared for the two groups using parametric and nonparametric statistics.

Results: In the control group, we observed significant worsening of 12 out of the 14 studied parameters during the 10-week period. In comparison with the women who did not perform gymnastics, women who performed specific gymnastics showed the following characteristics: (1) significantly less deterioration of psycho-emotional status (stress and anxiety levels); (2) the same general pattern of decrease in sleep quality, which is related to the progression of pregnancy; and (3) a significant attenuation of the worsening of several sleep characteristics, such as restless sleep, snoring, diurnal tiredness, and excessive daytime sleepiness. Nocturnal and diurnal sleep quantity increased significantly in both groups.

Conclusion: The 10-week training program designed for pregnant women has an overall beneficial effect on sleep characteristics, not by improving them but by attenuating their general deterioration related to the progression of pregnancy. Our data strengthen the general recommendation regarding participation of pregnant women in specific exercise programs, mainly for maintaining their psycho-emotional and general well-being.

Introduction

Sleep represents an important health issue in pregnant women [1,2]. Pregnancy is associated with significant changes in sleep architecture and pattern, which could lead to the occurrence of sleep disorders, such as insomnia [3], nocturnal awakenings, restless legs syndrome [4,5], habitual snoring [6,7], and obstructive sleep apnea [6,8] with consecutive excessive daytime sleepiness [1,2,9]. Sleep disorders are the result of hormonal, anatomical, and psychological changes occurring during pregnancy [10].

Up to 25% of pregnant women suffer from sleep disorders in the first trimester and reaches nearly 75% in the third trimester [11]. These sleep disturbances could be associated with poor pregnancy outcomes for both the mother and the fetus [12]: preeclampsia [8,13], gestational diabetes [14–16], intrauterine growth retardation [7], and fetal death and preterm birth [5,11,17–19]. Considering

* Corresponding author. University of Medicine and Pharmacy of Tîrgu Mureş, 38 Gheorghe Marinescu Street, 540139 Tîrgu Mureş, Romania.
E-mail address: szilagyi@umftgm.ro (T. Szilágyi).

http://dx.doi.org/10.1016/j.tjog.2017.02.001

these facts, the prevention, early diagnosis, and safe treatment of sleep disturbances are very important [20,21]. In the general population, physical activity of at least 1 hour/day is associated with a longer sleep duration; both low and high intensity physical training have a positive effect on sleep [22].

Moderate physical activity during pregnancy is safe and could have numerous benefits, including maternal weight control, decreasing the risk of developing gestational diabetes, and strengthening the muscles required for labor and delivery [20]. Currently, we have limited data and understanding regarding the influence of physical training on sleep characteristics during pregnancy.

Our aim was to investigate the effect of a regular, specific (designed for pregnant women) physical training program on sleep characteristics in healthy pregnant women, focusing on sleep patterns, sleeping habits, sleep quality and quantity, and sleep disorders.

Participants and methods

Study population

In total, 132 pregnant women from Mures County, Romania were enrolled in the study, with gestational age between 18 weeks and 22 weeks at inclusion. These women were assigned to two groups.

In the first group (intervention group), 79 pregnant women were included who performed a specific gymnastics regime (see training program below) for 10 weeks and were evaluated before and after the training program. In the second group (control group), 53 healthy pregnant women were included who did not perform the gymnastics regime. They were also evaluated at baseline and after 10 weeks.

All participants were informed about the aim of the survey, and they gave informed consent for their participation. The approval of the Research Ethics Committee of the University of Medicine and Pharmacy of Tirgu Mures was obtained for both anonymous data collection and publication (Approval no. 41-16). The role of the investigators was to monitor prospectively the participants who had already (before any study activity) decided to participate or not in the training program. Control group members were recruited consecutively during routine, follow-up obstetrical examinations in an outpatient clinic. These women were not currently involved in and were not willing to participate in any regular exercise training program. General exclusion criteria for both groups included refusal to participate and any significant medical condition related or not to pregnancy. To make the two groups more comparable, only women aged 18–40 years were included. In addition, women with body mass index >35 kg/m^2 and those with a history of three or more completed pregnancies were not enrolled.

Short description of the physical training program

The intervention group followed a specific exercise program for pregnant women at the Rheum-Care Foundation, Tirgu Mures, Romania, under the strict control of an exercise training specialist. Supervised specific gymnastics designed for pregnant women differ from the generally recommended home-based exercises due to the following: (1) the type of exercises, which are fully adapted for the pregnant body, with the main goal being the maintenance of muscle tone; (2) the duration of the gymnastics session, which is flexible and dependent on the individual's exercise capacity; (3) the association (at the end of session) of respiratory exercises and a period of psycho-somatic relaxation; and (4) the qualified surveillance during the entire training session, which permits continuous interactions both physically (correction of posture and movements) and emotionally.

The structure of the exercise program consisted of 2 hours per training session, twice per week for 10 weeks. The exercises included were for posture correction, preserving muscle tone, and strengthening pelvic and posterior muscles, breathing exercises, and relaxation techniques [23]. The last included the progressive relaxation technique of Jacobson [24], based on the control of muscle contractions and the autogenic training of Schultz [25] that can efficiently reduce stress and psychosomatic symptoms.

Data collection

Data were collected through (face to face) interviews using standard [26,27] and custom-designed questionnaires. All study participants filled a questionnaire at baseline and after 10 weeks. The questionnaire included two main parts: (1) demographic and obstetrical data, such as maternal age, weight, and parity, and (2) specific sleep questionnaires, completed as a custom-based part referring to sleep characteristics and psycho-emotional status.

To ensure a comprehensive assessment of sleep characteristics, the questionnaire included two validated instruments, the Berlin Questionnaire for sleep-disordered breathing (sleep apnea) [26] and the Epworth Sleepiness Scale for excessive daytime sleepiness [27]. The Berlin and Epworth questionnaires were used only at baseline to characterize and compare the two groups regarding the presence of sleep-related breathing disorder.

The custom-designed questionnaire involved sleep quality (general perception) and quantity, number of awakenings, difficulty of falling asleep, insomnia, restless sleep, snoring, diurnal sleep, consequences of inadequate sleep (diurnal tiredness, excessive daytime sleepiness), and characteristics of psycho-emotional status (level of anxiety and stress).

The answers to the questions were quantified using a visual analog scale, the response ranging from 0 to 10, where 0 indicated “not at all or poor quality” and 10 indicated “very frequently or good quality”.

Statistical analysis

For statistical analysis, R: A language and environment for statistical computing was used (R Core Team, R Foundation for Statistical Computing, Vienna, Austria, www.R-project.org). Descriptive statistics were performed first, followed by the analysis of the changes in parameters during the 10-week observational period in each group, and the comparison of changes in the two groups. The median, the first (Q1), and the third (Q3) quartiles were calculated for each dataset. If there was an even number of values in the set, the result was calculated as the average of the two numbers in the middle.

For comparison of parameters we used the chi-square test for categorical variables and parametric (Student's t test) and nonparametric statistics (Wilcoxon rank sum test) for continuous and discrete variables. For non-normal distributions, the Wilcoxon test was used. A value of $\alpha < 0.05$ was considered significant.

Results

The control and intervention groups were comparable at baseline regarding the general and socioeconomic characteristics, although the two groups were not recruited from the same clinic (Table 1). A slight dominance of primipara was observed in the intervention group, but this difference was not significant.

Statistical analysis of the specific characteristics revealed that the studied parameters did not follow a normal distribution. Furthermore, several outliers were identified; thus, nonparametric statistics were used for further analysis. Baseline characteristics of

Table 1
Baseline characteristics of the intervention and control group (general features and socioeconomic satisfaction).

	Intervention group ($n = 79$)	Control group ($n = 53$)	p
Age (y)	29.60 ± 4.04	27.88 ± 5.48	0.6687
Weight (kg)	67.54 ± 7.9	64.76 ± 9.15	0.2192
Primiparity	69 (87.3)	32 (60.4)	0.1136
BMI (kg/m^2)	25.31 ± 0.41	24.53 ± 0.37	0.1892
Working hours (h)	7.7 ± 1.55	7.84 ± 0.24	0.7883
Working in shifts	11 (13.92)	7 (13.20)	0.7498
Satisfied with her financial situation	67 (84.81)	39 (73.58)	0.1236
Satisfied with her support from spouse/family	79 (100)	52 (98.11)	0.4015

Data are presented as n (%) or mean ± SD.
BMI = body mass index.

the specific features (psycho-emotional factors and sleep parameters) are presented in Figures 1 and 2.

There was no significant difference in the Epworth's score between the two groups (8.96 ± 0.43 vs. 8.53 ± 0.55, $p = 0.47$). The number of pregnant women with high likelihood of sleep apnea based on the Berlin questionnaire was seven (8.9%) in the intervention group and two (3.8%) in the control group, and the difference was not significant.

Comparison of the control and intervention groups showed no significant differences in the majority of specific parameters at the beginning of the observational period (Figures 1 and 2). However, the subjective perception of insomnia and the number of awakenings during nighttime were significantly different between the two groups (marked with * in Figures 1 and 2): women in the intervention group reported fewer awakenings, but more insomnia.

Changes in parameters during the 10 weeks' observational period were analyzed in each group. The comparison of changes in parameters between the control and intervention group was performed, too.

When comparing the changes that occurred during the 10 weeks' observational period, no significant differences were found between the two groups for several parameters (Table 2 and Figures 3 and 4). However, significant differences were observed in the magnitude of changes of the psycho-emotional factors (stress and anxiety levels), and of certain sleep characteristics (restless sleep, snoring, diurnal tiredness, and excessive daytime sleepiness), revealing a beneficial effect of the exercise program.

The differences in the changes in parameters observed between the two groups raised the question of whether certain parameters within the intervention group were more stable or that the parameters in the control group worsened more.

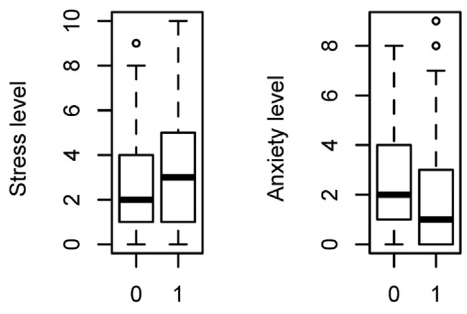

Figure 1. Baseline level of psycho-emotional factors. Column "0" denotes the control group, and Column "1" denotes the intervention group. The thick line represents the median value, the box shows the 25–75% interquartile range (IQR), whiskers show ±1.5*IQR distance from the edges of the boxes (in case of symmetrical distribution this refers to the median ±2*IQR); circles show the outliers.

Comparing the initial values with those recorded at the end of the 10-week observational period, we observed that nocturnal and diurnal sleep quantity increased significantly in both groups. In the control group, with two exceptions (general perception of sleep quality and feeling rested in the morning), all parameters worsened significantly (Table 3). In the intervention group, we observed the same general trend (worsening) but with more exceptions (5): sleep quantity (subjective judgment), snoring, excessive daytime sleepiness, diurnal tiredness, and feeling rested in the morning (Table 4).

Discussion

Only small observational studies have investigated the effect of aerobic exercises on the psycho-emotional status of pregnant women. Robledo–Colonia et al [28] observed a beneficial effect of physical exercises in reducing depressive symptoms and anxiety in pregnant women after 3 months of training (60 minutes of aerobic gymnastics per week). Haakstad et al [29] observed that regular gymnastics (40 minutes aerobic exercises and 20 minutes stretching and relaxation, twice a week for 3 months) contributed to the improvement of psychical well-being. In a systematic review, Shivakumar et al [30] stated that regular training had an antidepressant effect in pregnancy. In another review, Nascimento et al [31] observed the same beneficial effect of physical training on psycho-emotional status. In our study, we found that the level of anxiety and stress increased significantly in pregnant women without physical training, while remained practically unchanged during the intervention period in women participating in the training program, revealing the psycho-protective effect of training.

The incidence of sleep disorders in pregnancy is not exactly known, but almost one-fourth and three-fourth of pregnant women report sleep disturbances in the first and third trimester, respectively [11]. Few studies have investigated the effect of physical training on sleep in pregnant women. Tella et al [32] observed that physical training (6 weeks of an aerobic exercise program) reduced the level of insomnia. The same effect of regular exercise was observed by Goodwin et al [33]. The results of our study reveal the presence of disordered sleep in pregnant women, with a worsening tendency related to the progression of pregnancy, which is consistent with other studies [2]. This trend was attenuated by the 10 weeks' regular exercise training program, with certain sleep (or sleep related) parameters remaining constant in the intervention group.

Sleep quality has been found to be a predictor of depression, anxiety, and stress in pregnant women; its improvement prevents aggravation of these factors [34]. Quality of sleep is an important factor for the outcome of pregnancy. Poor sleep quality can induce premature birth and can influence the birth outcome. Goodwin et al [33] reported the beneficial effects of aerobic exercises on improving sleep quality. In our research, we found that the quality of sleep (general perception) was not influenced positively in the intervention group. The difference between the groups is barely significant ($p = 0.047$). We hypothesize that this deterioration is unrelated to the exercise program; however, further studies are required to clarify this contradiction.

Hedman et al [9] reported that sleep duration is reduced in the third trimester due to frequent nighttime phenomena, such as restless legs syndrome, sensation of back pain, and urination. In our study, we observed that the average sleep duration at baseline was 7–7.5 hours, which was similar in both groups and within the expected range. Regarding the effect of physical activity in women, Borodulin et al [21] reported that there is no clear correlation between physical activity (occupational, recreational, indoor housekeeping) and sleep quantity. In our study, we observed that in

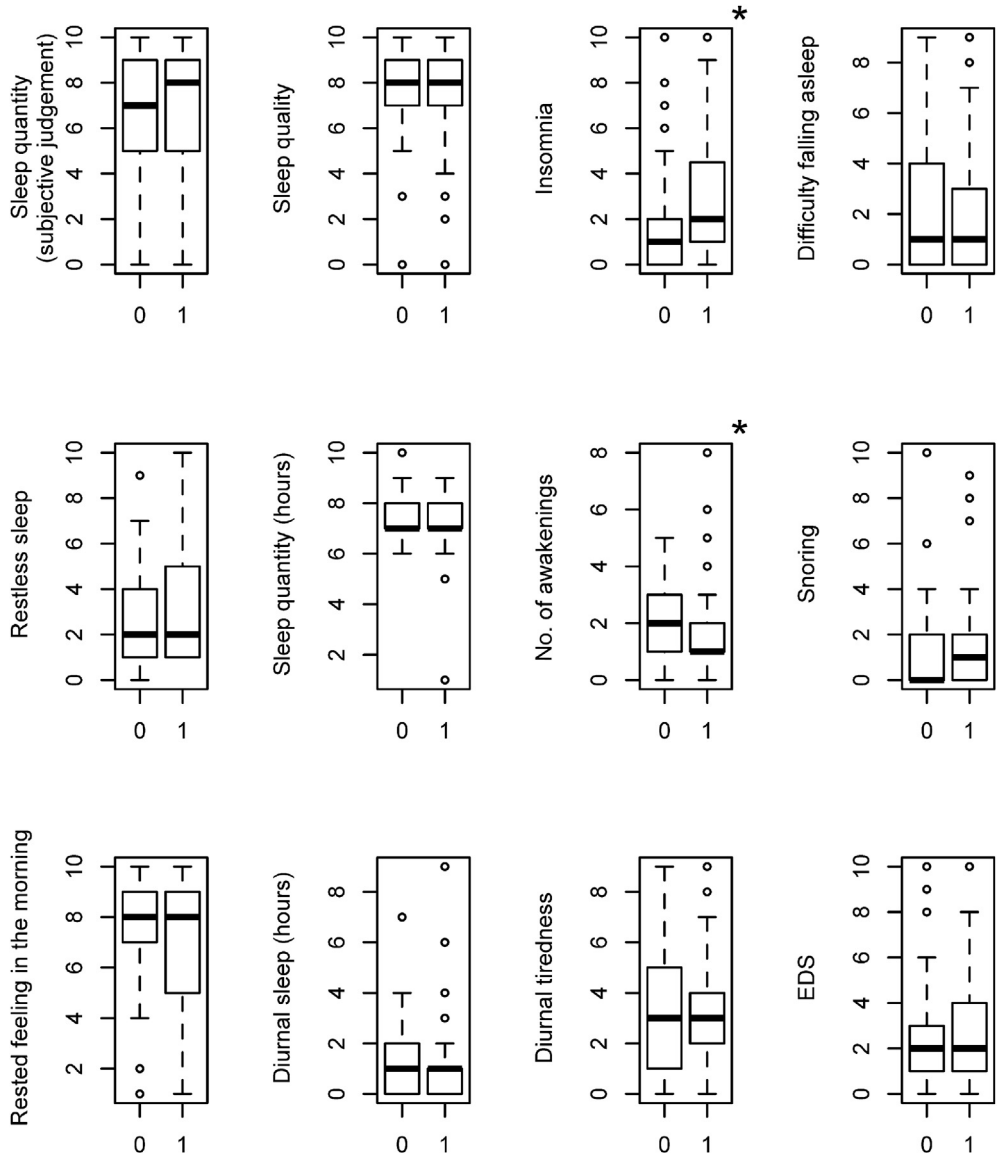

Figure 2. Baseline level of sleep parameters. Box-and-whiskers as in Figure 1 (* denotes significant differences). EDS = excessive daytime sleepiness.

Table 2
Comparison of the two groups regarding the changes of parameters during the observation period (calculated from individual differences – subtracting the initial values from the 10 weeks' values for each participant). See explanation in text.

	p
Psycho-emotional factors	
Stress level	<0.0001
Anxiety level	0.0013
Sleep characteristics	
Sleep quantity (subjective judgment)	0.055
Sleep quality (general perception)	0.047
Insomnia	0.365
Difficulty falling asleep	0.301
Restless sleep	0.0051
Sleep quantity (hours)	0.138
Number of awakenings	0.986
Snoring	0.0002
Rested feeling in the morning	0.962
Quantity of diurnal sleep (hours)	0.514
Diurnal tiredness	<0.0001
Excessive daytime sleepiness	0.0023

both groups, sleep duration increased significantly at the end of the 10 weeks' follow-up period. The fact that a physical training program specially designed for pregnant women did not influence sleep quantity significantly is consistent with Borodulin's observations.

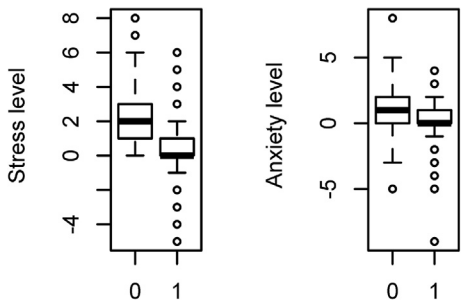

Figure 3. Changes in the level of psycho-emotional factors (calculated from individual differences – subtracting the initial values from the 10 weeks' values). Box-and-whiskers as in Figure 1.

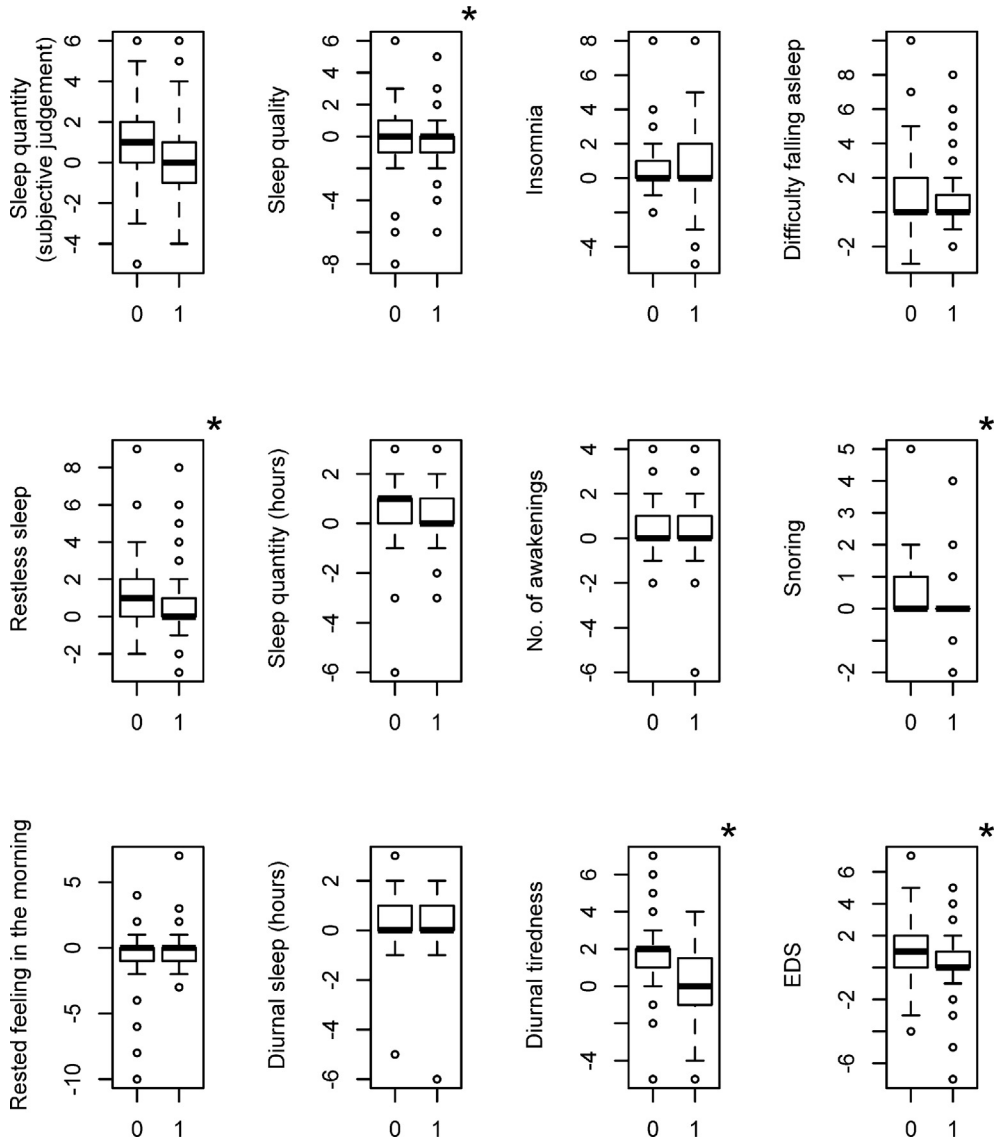

Figure 4. Changes in the levels of sleep parameters (calculated from individual differences − subtracting the initial values from the 10 weeks values). Box-and-whiskers as in Figure 1 (* denotes significant differences). EDS = excessive daytime sleepiness.

Table 3
Variation of parameters in the control group.

	At baseline	After 10 weeks	*p*
Psycho-emotional factors			
Stress level	2 (1–4)	5 (3–7)	<0.0001
Anxiety level	2 (1–4)	3 (1–5)	0.0007
Sleep characteristics			
Sleep quantity (subjective judgment)	7 (5–9)	8 (6–9)	0.0118
Sleep quality (general perception)	8 (7–9)	8 (7–10)	0.891
Insomnia	1 (0–2)	2 (1–4)	<0.0001
Difficulty falling asleep	1 (0–4)	2 (1–5)	0.0003
Restless sleep	2 (1–4)	4 (2–6)	<0.0001
Sleep quantity (hours)	7 (7–8)	8 (7–9)	0.0006
Number of awakenings	2 (1–3)	3 (2–4)	0.039
Snoring	0 (0–2)	0 (0–2)	0.0004
Rested feeling in the morning	8 (7–9)	8 (6–9)	0.434
Quantity of diurnal sleep (hours)	1 (0–2)	1 (0–2)	0.011
Diurnal tiredness	3 (1–5)	5 (2–6)	<0.0001
Excessive daytime sleepiness	2 (1–3)	4 (2–5)	<0.0001

Data are presented as median (Q1–Q3), and *p* values were calculated using Wilcoxon rank sum test.

Table 4
Variation of parameters in the intervention group.

	At baseline	After 10 weeks	*p*
Psycho-emotional factors			
Stress level	3 (1–5)	3 (1–5)	0.623
Anxiety level	1 (0–3)	2 (1–3)	0.863
Sleep characteristics			
Sleep quantity (subjective judgment)	8 (5–9)	8 (6–9)	0.4306
Sleep quality (general perception)	8 (7–9)	7 (6–8)	0.0197
Insomnia	2 (1–4.5)	3 (1–5)	0.0235
Difficulty falling asleep	1 (0–3)	2 (1–4)	0.0003
Restless sleep	2 (1–5)	3 (1.5–6)	0.0074
Sleep quantity (hours)	7 (7–8)	8 (7–9)	0.0005
Number of awakenings	1 (1–2)	2 (1–3)	0.003
Snoring	1 (0–2)	1 (0–2)	0.914
Rested feeling in the morning	8 (5–9)	8 (5–9)	0.845
Quantity of diurnal sleep (hours)	1 (0–1)	1 (1–1.5)	0.0002
Diurnal tiredness	3 (2–4)	3 (2–5)	0.237
Excessive daytime sleepiness	2 (1–4)	3 (2–4)	0.127

Data are presented as median (Q1-Q3), and *p* values were calculated using Wilcoxon rank sum test.

Snoring is a sleep apnea marker [6]; it is often associated with pregnancy and has proven to be a strong risk factor for cesarean delivery and gestational diabetes [14]. Preexisting snoring becomes worse during pregnancy [7]. Our study demonstrated that the training program prevented the worsening of this parameter.

Sleep apnea-related symptoms and the degree of excessive daytime sleepiness increase significantly during pregnancy [1]. Numerous studies reported that daytime sleepiness and diurnal tiredness-fatigue are consequences of the insufficient nighttime sleep and of the frequent awakenings [9], while aerobic exercises have a beneficial effect on the daytime fatigue level [29]. In our study, we found that diurnal tiredness and excessive daytime sleepiness significantly worsened in the control group but did not change significantly in the intervention group. We confirmed a significant tendency of slowing/stopping progression of daytime symptoms in the intervention group.

Women in the two groups were not recruited from the same clinic, which in principle could cause a bias due to the possible differences in the participants' socioeconomic status. We did not find significant differences regarding the participants' satisfaction related to their socioeconomic status; therefore, we consider this confounding factor as a minor limitation of our study.

Conclusion

The results of our study suggest that the 10-week specific training program designed for pregnant women has an overall beneficial effect on sleep characteristics, not necessarily by improving them but by attenuating their general deterioration related to the progression of pregnancy. Furthermore, the training program has a beneficial effect on psycho-emotional status and on the maintenance of daytime well-being of pregnant women.

Overall, our data strengthen the general recommendation regarding participation of pregnant women in specific exercise programs.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

Special thanks to Dr Hanga Gálfalvy for consulting about the statistical analysis.

References

[1] Pien GW, Fife D, Pack AI, Nkwuo JE, Schwab RJ. Changes in symptoms of sleep-disordered breathing during pregnancy. Sleep 2005;28:1299–305.
[2] Facco FL, Kramer J, Ho KH, Zee PC, Grobman WA. Sleep disturbances in pregnancy. Obstet Gynecol 2010;115:77–83.
[3] Okun ML, Buysse DJ, Hall MH. Identifying insomnia in early pregnancy: validation of the insomnia symptoms questionnaire (ISQ) in pregnant women. J Clin Sleep Med 2015;11:645–54.
[4] Gupta R, Dhyani M, Kendzerska T, Pandi-Perumal SR, BaHammam AS, Srivanitchapoom P, et al. Restless legs syndrome and pregnancy: prevalence, possible pathophysiological mechanisms and treatment. Acta Neurol Scand 2016;133:320–9.
[5] Meharaban Z, Yahya S, Sadegniiat K. Restless legs syndrome during pregnancy and preterm birth in women referred to health centers of ardabil. Iran Red Crescent Med J 2015;17:e24438.
[6] Venkata C, Venkateshiah SB. Sleep-disordered breathing during pregnancy. J Am Board Fam Med 2009;22:158–68.
[7] Franklin KA, Holmgren PA, Jonsson F, Poromaa N, Stenlund H, Svanborg E. Snoring, pregnancy-induced hypertension, and growth retardation of the fetus. Chest 2000;117:137–41.
[8] Frederick IO, Qiu C, Sorensen TK, Enquobahrie DA, Williams MA. The prevalence and correlates of habitual snoring during pregnancy. Sleep Breath 2013;17:541–7.
[9] Hedman C, Pohjasvaara T, Tolonen U, Suhonen-Malm AS, Myllyla VV. Effects of pregnancy on mothers' sleep. Sleep Med 2002;3:37–42.
[10] Sharma S, Franco R. Sleep and its disorders in pregnancy. WMJ 2004;103:48–52.
[11] Lee KA, Zaffke ME, McEnany G. Parity and sleep patterns during and after pregnancy. Obstet Gynecol 2000;95:14–8.
[12] Flenady V, Koopmans L, Middleton P, Froen JF, Smith GC, Gibbons K, et al. Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. Lancet 2011;377:1331–40.
[13] Blyton DM, Skilton MR, Edwards N, Hennessy A, Celermajer DS, Sullivan CE. Treatment of sleep disordered breathing reverses low fetal activity levels in preeclampsia. Sleep 2013;36:15–21.
[14] O'Keeffe M, St-Onge MP. Sleep duration and disorders in pregnancy: implications for glucose metabolism and pregnancy outcomes. Int J Obes (Lond) 2013;37:765–70.
[15] O'Brien LM, Bullough AS, Owusu JT, Tremblay KA, Brincat CA, Chames MC, et al. Pregnancy-onset habitual snoring, gestational hypertension, and preeclampsia: prospective cohort study. Am J Obstet Gynecol 2012;207:487.e1–9.
[16] Xiong X, Saunders LD, Wang FL, Demianczuk NN. Gestational diabetes mellitus: prevalence, risk factors, maternal and infant outcomes. Int J Gynaecol Obstet 2001;75:221–8.
[17] Okun ML, Schetter CD, Glynn LM. Poor sleep quality is associated with preterm birth. Sleep 2011;34:1493–8.
[18] Chang JJ, Pien GW, Duntley SP, Macones GA. Sleep deprivation during pregnancy and maternal and fetal outcomes: is there a relationship? Sleep Med Rev 2010;14:107–14.
[19] Hall WA, Stoll K, Hutton EK, Brown H. A prospective study of effects of psychological factors and sleep on obstetric interventions, mode of birth, and neonatal outcomes among low-risk British Columbian women. BMC Pregnancy Childbirth 2012;12:78.
[20] Hollenbach D, Broker R, Herlehy S, Stuber K. Non-pharmacological interventions for sleep quality and insomnia during pregnancy: A systematic review. J Can Chiropr Assoc 2013;57:260–70.
[21] Borodulin K, Evenson KR, Monda K, Wen F, Herring AH, Dole N. Physical activity and sleep among pregnant women. Paediatr Perinat Epidemiol 2010;24:45–52.
[22] Youngstedt SD. Effects of exercise on sleep. Clin Sports Med 2005;24:355–65. xi.
[23] Gleeson PB, Pauls JA. Obstetrical physical therapy. Review of the literature. Phys Ther 1988;68:1699–702.
[24] Urech C, Fink NS, Hoesli I, Wilhelm FH, Bitzer J, Alder J. Effects of relaxation on psychobiological wellbeing during pregnancy: a randomized controlled trial. Psychoneuroendocrinology 2010;35:1348–55.
[25] Piscicelli U. Respiratory autogenic training in preparation for labor (RAT method). Minerva Med 1975;66:3926–39.
[26] Tantrakul V, Sirijanchune P, Panburana P, Pengjam J, Suwansathit W, Boonsarngsuk V, et al. Screening of obstructive sleep apnea during pregnancy: differences in predictive values of questionnaires across trimesters. J Clin Sleep Med 2015;11:157–63.
[27] Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep 1991;14:540–5.
[28] Robledo-Colonia AF, Sandoval-Restrepo N, Mosquera-Valderrama YF, Escobar-Hurtado C, Ramirez-Velez R. Aerobic exercise training during pregnancy reduces depressive symptoms in nulliparous women: a randomised trial. J Physiother 2012;58:9–15.
[29] Haakstad LA, Torset B, Bo K. What is the effect of regular group exercise on maternal psychological outcomes and common pregnancy complaints? An assessor blinded RCT. Midwifery 2016;32:81–6.
[30] Shivakumar G, Brandon AR, Snell PG, Santiago-Munoz P, Johnson NL, Trivedi MH, et al. Antenatal depression: a rationale for studying exercise. Depress Anxiety 2011;28:234–42.
[31] Nascimento SL, Surita FG, Cecatti JG. Physical exercise during pregnancy: a systematic review. Curr Opin Obstet Gynecol 2012;24:387–94.
[32] Tella BA, Sokunbi OG, Akinlami OF, Afolabi B. Effects of aerobic exercises on the level of insomnia and fatigue in pregnant women. Internet Journal of Gynecology and Obstetrics 2011;15(1).
[33] Goodwin A, Astbury J, McMeeken J. Body image and psychological well-being in pregnancy. A comparison of exercisers and non-exercisers. Aust N Z J Obstet Gynaecol 2000;40:442–7.
[34] Lee SY, Hsu HC. Stress and health-related well-being among mothers with a low birth weight infant: the role of sleep. Soc Sci Med 2012;74:958–65.