

## The effect of three-week exercise programme on sleep quality and depression symptoms in female adults

### Háromhetes testmozgás-program hatása az alvásminőségre és a depressziós tünetekre felnőtt nők körében

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**Abstract** - The aim of the study is to examine how a three-week exercise programme with increasing intensity influences sleep quality and symptoms of depression and anxiety. Thirty physically healthy female adults with a sedentary lifestyle participated in the exercise programme. Participants suffer from mild depression and poor sleep; however, they have not been under medical or psychiatric treatments. They were randomly assigned to the exercise group or to the group of waiting-list condition. The experimental group performed a three-week spinning programme of 50 minutes of exercise, 3 times a week. The main programme was to increase intensity gradually from 60-70% maximal heart rate to 70-80% HRmax. Participants of the exercise programme reported better sleep quality, fewer symptoms of depression and anxiety, as well as lower daytime sleepiness at the end of the programme than at baseline. The improvement in sleep quality and depression was simultaneous. The positive changes in sleep quality may already occur after one week of exercise. The effects were prevailed and continued until the end of exercise course. In sum, there were significant effects of exercise on improved sleep quality and decreased depressive symptoms, as well as moderate effects on trait-anxiety in female sedentary adults. Increasing the intensity of exercise and taking into account the initial activity/fitness level played an important role in maintaining motivation to do regular exercise.

**Keywords:** exercise programme, mental health, increasing intensity, sleep quality, sedentary

**Absztrakt** - Vizsgálatunk célja egy háromhetes fokozódó intenzitású testmozgás program alvásminőségre, valamint depressziós és szorongásos tünetekre gyakorolt hatásának vizsgálata. Harminc fizikailag egészséges fiatal felnőtt, inaktív életvitelt folytató nő vett részt a vizsgálatban. A testmozgás-programban résztvevők enyhe depressziós tüneteket és rossz, szegényes alvást mutattak, de egyikük sem állt/áll orvosi vagy pszichiátriai kezelés alatt. A vizsgálatban résztvevő személyeket random módon soroltuk be a kísérleti csoport (testmozgás program) és a kontroll csoport (várólistás feltétel) tagjai közé. A kísérleti csoport három héten keresztül spinning edzést végzett, heti három alkalommal, 50 percben. A fő-program fokozatosan növekedő intenzitású edzést jelentett 60-70% HRmax-tól 70-80% HRmax-ig. A testmozgás-programban résztvevők jobb alvásminőségről, kevesebb depressziós és szorongásos tünetről számoltak be, valamint a nappali álmoság kisebb szintjét mutatták a program harmadik hetére a kezdeti, alapállapothoz képest. Az alvásminőség és a depresszió javulása egyszerre, szimultán valósult meg. Az alvás minőség pozitív változása már egyhetes edzést követően jelentkezhet. A megfigyelt hatások a testmozgás-program végéig folyamatosan fennmaradtak. Összességében a testmozgás-program jelentősen javította az alvás minőségét, és csökkentette a depressziós tünetek jelentkezését, valamint közepes hatással volt a vonásszorongás értékére fiatal, inaktív nők körében. A testmozgás intenzitásának fokozatos növelése és a kezdeti aktivitás/edzetségi szint figyelembevétele döntő szerepet játszhat az életvitelszerűen végzett testmozgás végzésre irányuló motiváció fenntartásában.

**Kulcsszavak:** testmozgás-program, mentális egészség, fokozódó intenzitás, alvásminőség, inaktivitás

## Introduction

Few studies have examined the effects of exercise on symptoms of depression and/or anxiety of adults who have not been under psychiatric treatments. The two most comprehensive meta-analyses which examined the relationship between exercise and subthreshold depression supported the moderate effects of exercise on decreasing depressive symptoms (*McDonald and Hodgdon; 1991; North et al., 1990*). In the past decade, other meta-analyses have become available. According to the results, the effects of exercise on depressive symptoms were moderate – independent from the type of exercise – on the reduction of depressive symptoms (*Conn, 2010; Rethorst et al., 2009*). Finally, the meta-analyses by *Rebar et al. (2015)* also reported a significant, moderate antidepressant effect of exercise.

One of the most comprehensive meta-analytic studies on the relationship between exercise and symptoms of anxiety is that of *Petruzzello et al. (1991)*. This and further meta-analytic studies showed that exercise had a small-moderate effect on the reduction of symptoms of anxiety doing various types of aerobic exercise (*Long and van Stavel, 1995; McDonald and Hodgdon, 1991; Petruzzello et al., 1991*). Questionnaire-based studies report a smaller effect size than the experimental research. However, exercise programme was at least as effective as other anxiety reduction treatment (e.g. relaxation techniques). In spite of the fact that these effects of exercise were generally independent from age, health status and other descriptive characteristics; subjects with a stressful lifestyle benefited more from exercise than those who were not exposed to stress.

In the recent years, meta-analytic studies have been conducted in the relationship between exercise and sleep. *Yang et al. (2012)* examined the effects of exercise on sleep quality, and *Kredlow et al. (2015)* discussed the effects of acute and chronic exercise on subjectively and objectively measured sleep variables. *Yang et al. (2012)* demonstrated a moderate effect of exercise (better sleep quality, decreased sleep onset latency and use of medication) and they concluded physically active subjects do not sleep more, even though they reported better sleep quality. *Kredlow et al. (2015)* revealed that acute exercise had a small effect on total sleep time, increased slow-wave

sleep and subjectively measured sleep efficiency. It also reduced wake after onset latency, sleep onset latency and REM. Similarly, to acute exercise, regular, chronic exercise, had a small-moderate effect on increased total sleep time, sleep efficiency and it reduced sleep onset latency as well. However, exercise had a moderate and robust effect on the variables of sleep quality measured with the Pittsburgh Sleep Quality index (except the use of medication). Age and gender as confounding variables did not have a significant effect; while the fitness level of the subjects did. Participants with a high fitness level showed more changes in increased slow wave sleep. A longer duration of exercise had more a positive effect on the sleep variables, whereas the intensity of exercise did not influence them. In sum, it was concluded that acute and chronic exercise could reduce the prevalence of sleep disturbances. Both have a small-moderate effect on objectively and subjectively measured variables of sleep. These effects are direct and immediate; therefore, regular exercise is recommended for maintaining a better and more restful sleep (*Dolezal et al., 2017; Kelley and Kelley, 2017*).

The aim of this study is to examine how a three-week exercise programme with increasing intensity influences sleep quality and symptoms of depression and anxiety. Subjects of this research only include physically healthy female adults with a sedentary lifestyle, who suffer from mild depression and poor sleep but have not been under any medical or psychiatric treatments.

## Methods

### Participants

Thirty female adults, aged 30-35 years, participated in this study. Participants were physically healthy, sedentary females with normal body mass index and they have not been under any medical or psychiatric treatments. They met criteria for mild depression on Beck Depression Inventory ( $6 \leq BDI \leq 11$ ) and showed sleep complaints on Pittsburgh Sleep Quality Index ( $PSQI \geq 5$ ).

### Assessments

#### Assessments before the exercise programme

Depressive symptoms were evaluated with the

13-item short form Beck Depression Inventory (BDI) (Beck and Beck, 1972; Rózsa et al., 2001), while the Hungarian version of Pittsburgh Sleep Quality Index (PSQI-HUN) was assessed to obtain subjective reports of sleep quality (Buysee et al., 1989; Takács et al., 2016). Daytime sleepiness was measured with Epworth Sleepiness Scale (ESS) (Johns, 1991) and state and trait anxiety with Spielberger State-Trait Anxiety Inventory (STAI-T/S) (Sipos and Sipos, 1978; Spielberger et al., 1970). Body mass index (BMI) was calculated from weight and height. Participants declared the state of health with a standard form about medical or psychiatric treatments, pregnancy, cardiovascular and/or respiratory diseases or any serious illnesses in the previous two years.

#### *Assessments during the three-week exercise programme*

The subjective reports of sleep were assessed with the Hungarian version of Pittsburgh Sleep Quality Index (PSQI-HUN) at baseline as well as at the end of first, second and third week (Buysee et al., 1989; Takács et al., 2016). Depressive and anxiety-related symptoms were measured at baseline and at the end of third week with the 13-item short form Beck Depression Inventory (BDI) (Beck and Beck, 1972; Rózsa et al., 2001) and with Spielberger State-Trait Anxiety Inventory (STAI-T/S) (Sipos and Sipos, 1978; Spielberger et al., 1970).

#### **Study procedures**

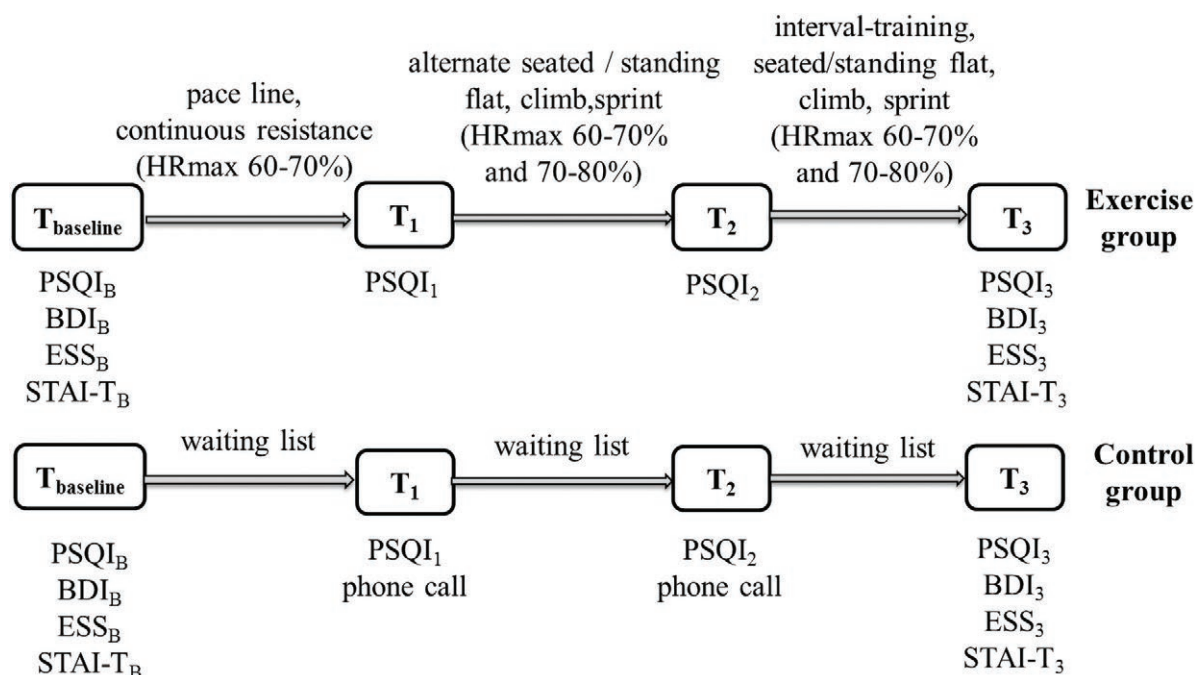
Participants were recruited through invitation, which was published on the websites of three fitness (spinning) instructors and on three internet fora themed 'health and move/fitness'. Participation was confirmed via e-mail.

Assessments before the exercise programme were completed at pre-arranged times. Participants received detailed information about the purpose of the study and about the voluntary basis of their participation. Only physically healthy subjects were allowed to in the three-week exercise programme. Participants who reported medical or psychiatric treatment, acute/chronic illnesses, cardiovascular or respiratory diseases were excluded. Following the assessments before the exercise programme, participants with normal mood, moderate/severe depression, no

sleep complaints, as well as participants who were found to be under/overweight, obese by the body mass index were excluded. This way, participants in the exercise and the control group showed mild depression ( $6 \leq \text{BDI} \leq 11$ ), poor sleep quality ( $\text{PSQI-HUN} \geq 5$ ) and normal body mass index ( $18.5 \leq \text{BMI} \leq 24.99$ ). Informed oral and written consent was obtained from all participants.

There were 15-15 participants randomly assigned to the experimental group (exercise programme) or the control group (waiting list condition). Participants in the control group (waiting list condition) completed the questionnaires in the three-week course of the study. They were called or sent a text message at the end of each week as a reminder. Participants in the control group had the possibility to take part in exercise programme after the experiment. Participants in the experimental group (exercise group) performed a three-week exercise programme which is a spinning course of 50 minutes of exercise, 3 times a week. Participants were informed orally and in writing about the prevention of accidents, injuries and about how to set up the bikes before starting the spinning programme. During the three-week exercise programme participants completed the above assessments too.

Each spinning lesson consists of three sections: warm-up (10 minutes), main programme (30 minutes) and cool-down (10 minutes). The 10-minute warm-up section consisted of spinning with low to medium resistance. The purpose of the main programme is to increase intensity gradually. Intensity is increased throughout three weeks (from 60-70% maximal heart rate [endurance energy zone] to 70-80% HRmax [strength energy zone]). During the first week of the main programme, the exercise was seated flat, same pace lines with continuous low-moderate resistance without rest (endurance energy zone). During the second week of the main program, the exercise was alternate seated/standing flat, climb and sprint (endurance and strength energy zone); while during the third week, interval-training with seated/standing flat, climb and sprint was applied (endurance and strength energy zone combined with interval energy zone). The 10-minute cool-down section included seated spin with low resistance and intensity, as well as stretching exercises.



**Figure 1.** Study design of the three-week exercise programme in the exercise group and waiting list condition in the control group (*PSQIB*: sleep quality at baseline, *BDIB*: depression at baseline, *ESSB*: daytime sleepiness at baseline, *STAI-TB*: trait-anxiety at baseline, *PSQI1,2,3*: sleep quality at first, second, third week, *BDI3*: depression at third week, *ESS3*: daytime sleepiness at third week, *STAI-T3*: trait-anxiety at third week)

### Data analysis

The distribution of relative frequencies and the descriptive analysis with means and standard deviations were calculated to describe the variables in the control and the experimental groups. To examine the differences between the control and the experimental group independent samples *t*-tests were used with Cohen's *d* effect size. To measure the difference between the baseline and the end of the three weeks (T<sub>3</sub>) paired samples *t*-tests were applied with Cohen's *d* effect size. Repeated measures of analysis of variance were performed to measure the difference between the baseline (T<sub>B</sub>), the end of the first (T<sub>1</sub>), the second (T<sub>2</sub>) and the third (T<sub>3</sub>) week with partial eta-squared (effect size). All statistical procedures were calculated using IBM SPSS 25 statistical software (*IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.*).

### Ethical approval

All procedures were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments

or comparable ethical standards [TE-KEB/No25/2019]. Participants received both oral and written information about the study and they signed an informed consent form.

### Results

#### Participants' characteristics at baseline

The sample included 30 sedentary female adults with normal body mass index (range: 18.6-24.8) who fulfilled the criteria for mild depression ( $6 \leq BDI \leq 11$ ) and poor sleep ( $PSQI-HUN \geq 5$ ). The experimental (exercise) group ( $n = 15$ ) participated in the three-week exercise programme (spinning) of increasing intensity. The control group ( $n = 15$ ) participated in the waiting list condition. There were no statistically significant differences between the experimental and the control group in terms of age ( $t(28) = 1.464, p = .154$ ) and body mass index ( $t(28) = 1.658, p = .109$ ) (Table 1).

There were no statistically significant differences between the exercise and the control group at baseline in sleep quality ( $t(28) = 0.205, p = .839$ ), depression ( $t(28) = -.311, p = .758$ ), trait-anxiety ( $t(28) = -.482, p = .634$ ) and daytime sleepiness ( $t(28) = -.057, p = .931$ ) (Table 2).



**Table 1.** Mean and standard deviation of age and body mass index (BMI) in the exercise and the control group

	age (years)		BMI	
	mean	SD	mean	SD
exercise group (n=15)	32.7	1.7	22.7	1.8
control group (n=15)	31.8	1.8	21.5	2.0

**Table 2.** Mean and standard deviation of sleep quality, depression, trait-anxiety and daytime sleepiness in the exercise and the control group at baseline and at T1, T2, T3

		exercise group (n=15)		control group (n=15)		t	p
		mean	SD	mean	SD		
T <sub>B</sub>	PSQI <sub>B</sub>	7.47	1.55	7.33	1.99	0.205	.839
T <sub>1</sub>	PSQI <sub>1</sub>	5.67	2.02	6.93	1.98	-1.732	.094
T <sub>2</sub>	PSQI <sub>2</sub>	4.13	2.03	7.07	2.71	-3.354	.002
T <sub>3</sub>	PSQI <sub>3</sub>	3.20	1.27	6.20	1.90	-5.095	< .001
T <sub>B</sub>	BDI <sub>B</sub>	7.87	2.03	8.07	1.44	-0.311	.758
T <sub>3</sub>	BDI <sub>3</sub>	4.60	1.06	7.27	2.19	-4.254	< .001
T <sub>b</sub>	ESS <sub>B</sub>	6.27	1.83	6.33	2.32	-0.057	.931
T <sub>3</sub>	ESS <sub>3</sub>	5.27	2.22	6.20	1.94	-1.128	.230
T <sub>B</sub>	STAI-T <sub>B</sub>	46.73	5.82	47.93	7.69	-0.482	.634
T <sub>3</sub>	STAI-T <sub>3</sub>	44.87	5.84	48.07	7.74	-1.278	.212

T<sub>B</sub>: baseline, T<sub>1</sub>: first week, T<sub>2</sub>: second week, T<sub>3</sub>: third week, PSQI-HUN: sleep quality, BDI: Beck Depression Inventory, ESS: daytime sleepiness, STAI-T: trait-anxiety, t: t-value, p: significance value, d: Cohen's d (effect size)

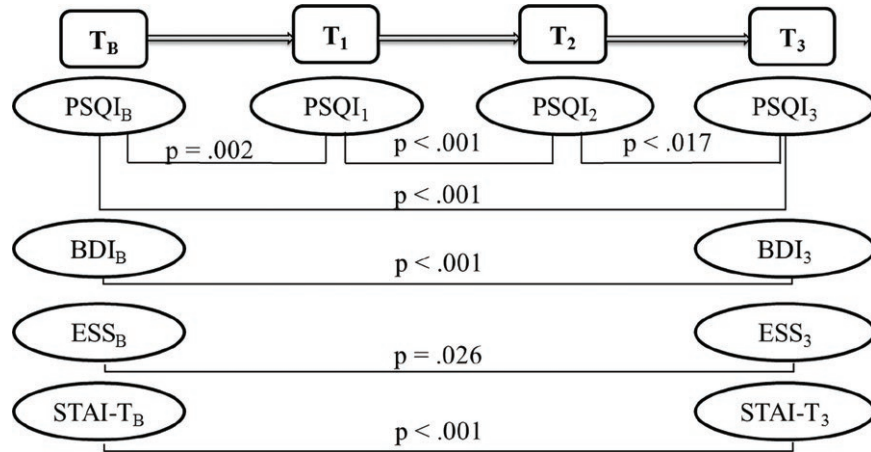
### **Differences between exercise and control group at the end of the third week (T<sub>3</sub>)**

There were significant differences between the exercise and the control group on sleep quality ( $t(28) = -5.095, p < .001, d = 1.86$ ) and depression ( $t(28) = -4.254, p < .001, d = 1.55$ ) at T<sub>3</sub>. Participants in the exercise group showed significantly lower depression scores ( $M = 4.60, SD = 1.06$ ) than those who participated in the control group ( $M = 7.27, SD = 2.19$ ). The exercise group also reported better sleep quality (lower PSQI scores) ( $M = 3.20, SD = 1.27$ ) than the control group ( $M = 6.20, SD = 1.90$ ) (Table 2). Daytime sleepiness ( $t(28) = -1.128, p = .230$ ) and trait-anxiety ( $t(28) = -1.278, p = .212$ ) did not show significant differences between the

exercise and the control group at T<sub>3</sub> (Table 2).

### **Differences between baseline and T<sub>3</sub> in exercise and control group**

Within the exercise group there were significant differences between baseline and T<sub>3</sub> on sleep quality ( $t(14) = 7.557, p < .001, d = 2.56$ ), depression ( $t(14) = 6.507, p < .001, d = 2.19$ ), daytime sleepiness ( $t(14) = 2.485, p = .026, d = 0.73$ ) and trait-anxiety ( $t(14) = 4.525, p < .001, d = 1.46$ ) (Figure 2). Participants of the exercise programme reported better sleep quality, fewer symptoms of depression and anxiety, as well as lower daytime sleepiness at the end of program than at baseline (Table 2).



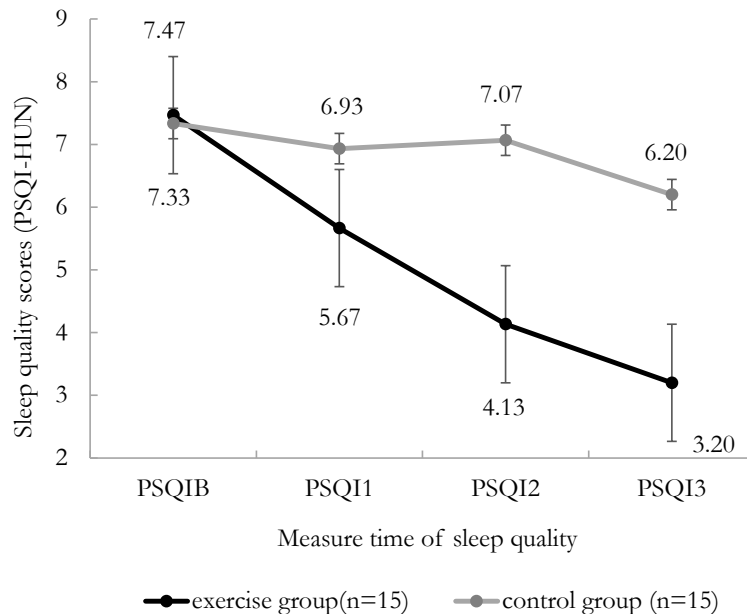
**Figure 2.** Changes in sleep quality (PSQI-HUN), depression (BDI), daytime sleepiness (ESS) and trait-anxiety (STAI-T) in the exercise group during the three-week exercise programme ( $T_B$ : baseline,  $T_1$ : first week,  $T_2$ : second week,  $T_3$ : third week,  $p$ : significance value)

In the control group non-significant differences were revealed between baseline and  $T_3$  on sleep quality ( $t(14) = 1.715, p = .108$ ), depression ( $t(14) = 1.702, p = .111$ ), daytime sleepiness ( $t(14) = .521, p = .610$ ), as well as trait-anxiety ( $t(14) = -.695, p = .499$ ).

**The effects of the three-week exercise programme on sleep quality**

To measure the effects of exercise on sleep quality at baseline and Time ( $T_1, T_2, T_3$ ) between the

control and the exercise groups, repeated measures of ANOVA were performed with between-subject factor (Group: control vs. exercise). There was a significant Time main effect on sleep quality ( $F(3,84) = 15.831, p < .001, \eta^2_{partial} = .361$ ). The Group main effect was also found significant ( $F(1,28) = 11.506, p = .002, \eta^2_{partial} = .291$ ). The Time x Group interaction also showed a significant effect ( $F(3,84) = 6.842, p < .001, \eta^2_{partial} = .196$ ) (Figure 3).



**Figure 3.** Changes in sleep quality in the exercise and the control group during the three-week study design (decreased PSQI scores indicate improving sleep quality) ( $PSQI_B$ : sleep quality at baseline,  $PSQI_1$ : sleep quality at first week,  $PSQI_2$ : sleep quality at second week,  $PSQI_3$ : sleep quality at third week, error bar: standard error)

PSQI-HUN scores significantly decreased which means improving sleep quality in the exercise group, and this decrease already occurred after one week of exercise. Furthermore, sleep quality was significantly lower in the exercise group than in the control group at the end of the second week. In the control group sleep quality remained statistically unchanged during the three-week exercise programme (Table 2).

## Discussion

The present study demonstrates that participating in a three-week exercise programme with increasing intensity resulted in better sleep quality and decreased symptoms of depression. At the baseline of the study all participants (100%) showed poor sleep quality both in the exercise and in the control groups. However, at the end of the third week in the exercise group only one person (6.7%) showed poor sleep quality, whereas in the control group 86.7% still reported poor sleep quality. A similar trend was seen with the symptoms of depression. At the baseline, all participants (100%) showed mild depression, while at the end of the third week only 13.3% of the exercise group and 73.3% of the control group were characterized with mild depression.

It is important to highlight that the ‘improvement’ in sleep quality and depression was experienced simultaneously. This means that 80% of the participants in the exercise group showed not only increased sleep quality but also decreased symptoms of depression, while 60% of the participants in the control group showed no changes in either sleep quality or depression. In addition, there were not any significant differences between the exercise and the control group at the end of the third week on daytime sleepiness and trait-anxiety. On the other hand, in the exercise group itself, showed lower daytime sleepiness and trait-anxiety at the end of the third week than at baseline. Based on a previous study (Petruzzello *et al.*, 1991) high-intensity exercise had no positive effect on trait-anxiety compared to low- or moderate-intensity exercise, which may explain our results.

Recent randomized-controlled trials examining the effect of exercise programme on the symptoms of depression, anxiety, and sleep complaints in non-clinical population showed that exercise had moderate antidepressant effects (Rebar *et al.*,

2015; Stanton and Reaburn, 2014), which was experienced after a few weeks (4-8 weeks), while the anxiolytic effects were small (Rebar *et al.*, 2015; Wegner *et al.*, 2014). Exercise had small to moderate effects on sleep (Kredlow *et al.*, 2015); however, it had significant positive effects on subjectively measured sleep quality. The positive effects of exercise on sleep are direct and immediate. Presumably, these direct effects may be a source of a strong motivation to maintain the activity and also reduce the risk of demotivation at a later stage (Lattal, 2010). It is important to emphasise that most randomized-controlled trials focusing on the associations between exercise and sleep quality examined elderly or clinical subjects. Consequently, it is difficult to generalise their results. The only study examining young, healthy subjects without sleep complaints supported the associations between exercise and sleep quality, although only with marginal effects (Youngstedt *et al.*, 2003).

Compared to previous studies, the result of the present study show that the positive effects of exercise could already be experienced after a three-week long exercise programme, at least regarding improved sleep quality and decreased depressive symptoms. Improvement of sleep quality may already occur after one week of exercise, which underpins previous studies demonstrating that the positive effects of exercise on sleep quality are direct and immediate (Lattal, 2010). The effects of exercise in the present study prevailed and continued. It is assumed that this is attributable to choosing the adequate initial intensity of exercise, as well as the increasing intensity of exercise throughout the programme.

## Limitations of the study

The present study had certain notable limitations. First, the sample was relatively small and was limited to only female subjects. At the same time, the required sample size was calculated using the G\*Power 3.1 software (Faul *et al.*, 2007), considering an effect size of 0.5,  $\alpha$  of 0.05 and  $1-\beta$  of 0.8. Secondly, a subjective sleep measurement (PSQI-HUN) was used to evaluate changes in sleep quality during and after the exercise programme. PSQI-HUN assessed subjective sleep quality over a one-month period, but it may also be used to measure weekly changes in sleep quality (Lai, 2005; Harmat *et al.*, 2008). There is a poor correlation

between subjective and objective sleep measures (Buysse *et al.*, 1989); however, PSQI shows a strong correlation with depression, measured by CES-D scale, as well as subjective sleep complaints (Grandner *et al.*, 2006). Finally, it is important to note that the waiting-list control condition may overestimate treatment effects, although the extent of any such bias is likely to vary among study populations (Cunningham *et al.*, 2013).

## Conclusions

In sum, even considering these limitations, the present study demonstrates significant effects of exercise on improved sleep and decreased depressive symptoms, as well as moderate effects on trait-anxiety in physically healthy, non-clinical female adults. It is important to highlight two factors: first, the present study used an increasing intensity of exercise as opposed to maintaining a moderate-intensity exercise throughout a longer period. Secondly, the exercise programme took into account the individual initial activity/fitness level when planning the intensity of the exercise programme. Previous studies also indicated the importance of intensity of exercise on its antidepressant effects (Cooney *et al.*, 2013; Hallgren *et al.*, 2016). Our results support the fact that with these conditions (increasing intensity and considering the initial activity/fitness level) of an exercise programme may improve sleep quality and decrease the symptoms of depression significantly after three weeks.

It is also highlighted that the effects of exercise become more prominent over time both on the symptoms of depression and anxiety, as well as on sleep complaints. This may be a consequence of the inter-relationship between exercise and somatic changes such as decrease of body weight, increase in cardiovascular fitness etc. However, the positive effects of exercise do not only come from exercise itself, but also from psychological (increased self-efficacy, self-confidence, self-control, and coping skills, etc.) and neurophysiological processes (hippocampal neurogenesis, regulation of HPA-activity, and neurotransmitter synthesis, etc.) (Wegner *et al.*, 2014). Based on the results of the present study, it is important to emphasise that the positive changes in sleep quality and depression occurred simultaneously, influencing and strengthening each other. These results are in line with the circular relationship between insomnia disorder/symptoms

and mood disorders/symptoms (Riemann *et al.*, 2001).

In the present exercise programme there were no dropouts. Increasing the intensity of exercise and taking into account the initial activity/fitness level (sedentary participants) played an important role in maintaining motivation. Maintaining motivation is high of priority; in the transtheoretical model which is the best-known model of behavioural change. Based on this model, it is assumed that performing physical activity/regular exercise will gradually provide more and more experience in the long-term positive effects of exercise. All this experience adds and creates motivation to keep doing exercise regularly and also results in internal motivation to continue living an active lifestyle, which helps to sustain good mental health. "Motivation is what gets you started. Habit is what keeps you going" (Jim Ryun).

## Highlights

- We examined the effects of a three-week exercise programme in female adults with mild depression and poor sleep
- Increasing intensity of exercise in a three-week exercise programme was as effective as a moderate-intensity exercise throughout a longer period
- Positive changes in sleep quality and depression occurred simultaneously, influencing and strengthening each other
- An exercise programme with increasing intensity that takes also into account the initial activity level could maintain motivation to do regular exercise

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