



State anxiety and subjective well-being responses to acute bouts of aerobic exercise in patients with depressive and anxiety disorders

J Knapen, E Sommerijns, D Vancampfort, P Sienaert, G Pieters, P Haake, M Probst and J Peuskens

Br. J. Sports Med. 2009;43;756-759; originally published online 19 Nov 2008; doi:10.1136/bjsm.2008.052654

Updated information and services can be found at:
<http://bjsm.bmj.com/cgi/content/full/43/10/756>

These include:

References

This article cites 14 articles, 4 of which can be accessed free at:
<http://bjsm.bmj.com/cgi/content/full/43/10/756#BIBL>

Rapid responses

You can respond to this article at:
<http://bjsm.bmj.com/cgi/eletter-submit/43/10/756>

Email alerting service

Receive free email alerts when new articles cite this article - sign up in the box at the top right corner of the article

Notes

To order reprints of this article go to:
<http://journals.bmj.com/cgi/reprintform>

To subscribe to *British Journal of Sports Medicine* go to:
<http://journals.bmj.com/subscriptions/>

State anxiety and subjective well-being responses to acute bouts of aerobic exercise in patients with depressive and anxiety disorders

J Knapen,^{1,2} E Sommerijns,¹ D Vancampfort,^{1,2} P Sienaert,² G Pieters,^{2,3} P Haake,² M Probst,^{1,2} J Peuskens^{2,3}

¹ Faculty of Kinesiology and Rehabilitation Sciences, Katholieke Universiteit Leuven, Leuven, Belgium; ² University Psychiatric Centre KU Leuven, Campus Sint-Jozef Kortenberg, Kortenberg, Belgium; ³ Faculty of Medicine, Katholieke Universiteit Leuven, Leuven, Belgium

Correspondence to:
Dr Jan Knapen, Universitair Psychiatrisch Centrum KU Leuven, Campus Kortenberg, Leuvensesteenweg S17, 3070 Kortenberg, Belgium

Accepted 24 October 2008
Published Online First
16 November 2008

ABSTRACT

Objective: Acute aerobic exercise is associated with a reduction in state anxiety and an improvement in subjective well-being. The objective of the present study was to contrast the effects of aerobic exercise at self-selected intensity versus prescribed intensity on state anxiety and subjective well-being (negative affect, positive well-being and fatigue) in patients with depressive and/or anxiety disorders. In addition, the potential impact of heart rate feedback was assessed.

Methods: Nineteen men and 29 women performed three test conditions on a bicycle ergometer during 20 minutes: two tests at self-selected intensity; one with and another without heart rate feedback, and a third test at the prescribed intensity of 50% of the maximal heart rate reserve according to Karvonen. Tests were executed in random order. State anxiety and subjective well-being were evaluated using the state anxiety inventory and the subjective exercise experiences scale.

Results: After 20 minutes cycling, patients showed significantly decreased state anxiety and negative affect in the three conditions. The magnitude of the reduction did not differ significantly between the three conditions. Only cycling at self-selected intensity enhanced positive well-being. Cycling at 50% of the maximal heart rate reserve decreased fatigue, whereas cycling at self-selected intensity increased fatigue.

Conclusions: The response in state anxiety and negative affect was unaffected by the type of aerobic exercise. Self-selected intensity influenced exercise-induced changes in positive well-being and fatigue in a positive and negative way, respectively.

Research indicates that acute bouts of exercise are associated with reductions in state anxiety. Taylor¹ evaluated in a narrative review of 24 studies the effects of single exercise sessions on state anxiety. In 21 (87%) of the studies, acute exercise resulted in a significant reduction in state anxiety. It appears that acute aerobic exercise is more effective than weight training.¹⁻⁴ In acute bouts of aerobic exercise, state anxiety reductions last for 2–4 h after cessation of activity.² Individuals with high state anxiety and unfit subjects show the greatest improvement post-exercise. Generally, a reduction in anxiety will be observed after following moderate intense aerobic exercise. Several investigators noted that high-intensity physical activity (ie, 80% of maximum oxygen consumption; $\dot{V}O_{2max}$) is associated with significant elevations in state anxiety.¹ A study by Raglin and Wilson⁵ using healthy subjects indicated that state anxiety

increased immediately following 20 minutes of cycling performed at 70% of $\dot{V}O_{2max}$, whereas reductions were observed immediately after exercise at 40% and 60% of $\dot{V}O_{2max}$.

The first objective of the present study was to compare the changes in state anxiety and subjective well-being after a single aerobic exercise session at self-selected versus prescribed intensity in a sample group of patients with depressive and/or anxiety disorders. Several authors⁶⁻⁹ assume that exercise at preferred intensity is more effective in improving state anxiety and subjective well-being than exercise at prescribed intensity.

The second objective was to investigate the potential impact of heart rate feedback during an aerobic exercise session on changes in anxiety and subjective well-being. Patients with panic disorders are more sensitive to bodily changes during physical activity than non-anxious individuals. They associate normal physiological reactions during effort such as tachycardia, hyperventilation and sweating with symptoms that are typical for panic attacks.¹⁰⁻¹³ In these patients heart rate feedback during aerobic exercise has a negative impact on changes in anxiety and subjective well-being. We investigated whether heart rate feedback influences response in anxiety and subjective well-being in a sample group of patients with other anxiety disorders (eg, generalised anxiety disorder, posttraumatic stress disorder, social anxiety disorder, obsessive compulsive disorder) and/or depressive disorders.

METHODS

Subjects

Nineteen male patients (mean age 40.68 years, SD 13.18; mean body weight 75.71 kg, (12.78); mean body mass index 24.43, (4.45); mean resting heart rate 71.26, (9.67)) and 29 female patients (mean age 34.61 years, (11.8); mean body weight 67.69 kg, (16.49); mean body mass index 24.13, (6.06); mean resting heart rate 71.34, (14.43)) took part in the study. The patients were diagnosed by psychiatrists according to the Diagnostic and Statistical Manual for Mental Disorders, 4th edn.¹⁴ They had anxiety disorders and/or depressive disorders or a mixed diagnosis, adjustment disorder with mixed anxiety and depressed mood. Most of them (90%) received two diagnoses. The symptoms of depression and anxiety often overlap as most patients diagnosed as having depression have co-morbid symptoms of anxiety disorders. Similarly, it is common that patients diagnosed

as having an anxiety disorder also receive a diagnosis of depression.¹⁵ Therefore, we made no distinction between patients with depressive or anxiety disorders. The diagnoses are represented in table 1. All patients were hospitalised in a cognitive-behavioural treatment unit of a university psychiatric hospital in Belgium. Patients were excluded if they had panic disorder, bipolar disorder or psychosis. The somatic exclusion criteria were treatment with beta-blockers and severe cardiopulmonary diseases.

Instruments and procedures

Patients carried out three submaximal exercise tests on an electronically braked bicycle ergometer (Ergo 2000, Ergo-Fit, The Netherlands), with 3 days between tests. The tests order was randomly assigned, to control for the influence of previous test(s). The randomisation lists were generated by an independent statistician using the SAS Ranuni random number generator.¹⁶

The first test (test condition A) consisted of cycling during 20 minutes at an intensity of 50% of the estimated maximal heart rate reserve according to Karvonen.¹⁷ The maximal heart rate was estimated using the formula (220 – age). The work load was automatically adapted to the heart rate, which corresponds to 50% of the estimated maximal heart rate reserve. During this test, the patient received heart rate feedback. The heart rate was visible on a screen during the whole test. The experimenter asked the individual for heart rate readings at baseline and at 2-minute intervals during the test.

The second test (test condition B) involved cycling for 20 minutes at a self-selected intensity. The patient could vary the workload, while he/she got heart rate feedback.

The third test (test condition C) consisted of cycling for 20 minutes at a self-selected intensity without heart rate feedback. During this test, the heart rate on the screen of the bicycle ergometer was covered.

The testing took place at the same time of day in standardised conditions. Before examination, heart rate at rest was assessed after the subject had relaxed on a mat for 5 minutes. The pedal frequency was free.

State anxiety was assessed by the state anxiety inventory (SAI) of Spielberger.¹⁸ The range of possible total scores is 20 to 80. Higher scores indicate higher levels of anxiety. The SAI has been extensively validated and is the most widely used measure of anxiety in exercise research.² The internal consistency

assessed by Cronbach's alpha coefficients in the present study was 0.96.

Subjective well-being was measured using the subjective exercise experiences scale (SEES).¹⁸ It consists of three subscales: negative affect, positive well-being and fatigue. Each subscale contains four items, which are scored on a scale from 0 (not at all) to 7 (entirely). Higher scores on a subscale indicate a higher perception for this factor. The SEES represents one of the most reliable and valid instruments for assessing subjective well-being in exercise settings.¹⁹ The internal consistency in the present study was 0.90 for the subscales negative stress and positive well-being and 0.87 for the subscale fatigue.

The SAI and the SEES were assessed 5 minutes before the exercise session and 10 minutes after the completion of the session.

The study procedure was approved by the Ethical Committee of the Faculty of Medicine of the Katholieke Universiteit Leuven in accordance with the principles of the Declaration of Helsinki. All participants gave the research coordinator their informed consent.

Statistical analysis

A 3 × 2 (condition × time) within-participants repeated-measures analysis of variance (ANOVA) was conducted using the SAS procedure MIXED²⁰ to test the significance of the pre-post differences between the means. The significance level was set at 0.05 (two-tailed).

RESULTS

Changes in state anxiety and subjective well-being

The means before and after exercise sessions are presented in table 2 and figs 1 and 2.

State anxiety

A 3 × 2 (condition × time) within-participants repeated-measures ANOVA revealed a significant time main effect, with decreased scores over time ($F_{1,47} = 19.59, p < 0.001$).

In each test condition, SAI scores after exercise were significantly lower than before exercise (F and p values ranged from $F_{1,92} = 21.81, p < 0.001$ to $F_{1,92} = 7.44, p < 0.001$). There were no significant differences in response between the three conditions.

Subjective well-being

Negative affect

The repeated-measures ANOVA revealed a significant time main effect ($F_{1,47} = 13.16, p < 0.001$). In each test condition, post-scores were significantly lower than pre-scores (F and

Table 1 Diagnoses

	N
Anxiety disorders	
Generalised anxiety disorder	15
Posttraumatic stress disorder	7
Social anxiety disorder	6
Obsessive compulsive disorder	6
Acute stress disorder	3
Anxiety disorder not otherwise specified	8
Depressive disorders	
Major depressive disorder recurrent	
Moderate	8
Severe	21
Major depressive disorder single episode	
Moderate	3
Severe	7
Dysthymic disorder	5
Depressive disorder not otherwise specified	3
Adjustment disorder with mixed anxiety and depressed mood	6

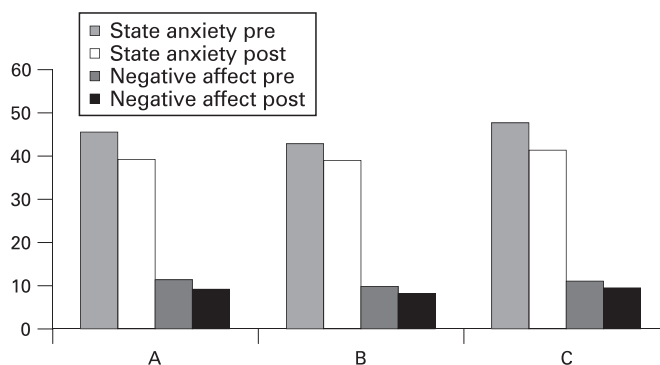


Figure 1 State anxiety and negative affect before and after the exercise sessions.

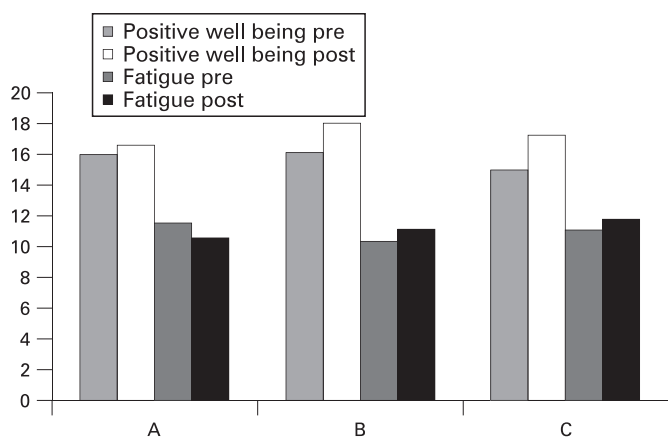


Figure 2 Positive well-being and fatigue before and after the exercise sessions.

p values ranged from $F_{1,93} = 10.11$, $p = 0.002$ up to $F_{1,93} = 6.59$, $p = 0.0119$. There were no significant differences in response between the three conditions.

Positive well-being

The repeated-measures ANOVA showed a significant time main effect, with higher scores after exercise bouts ($F_{1,47} = 9.30$, $p = 0.0038$). We observed a significant condition-by-time interaction effect ($F_{2,93} = 3.14$, $p = 0.0479$). The interaction effect indicates that the type of exercise condition influenced positive well-being responses. In conditions B and C, post-scores were significantly higher than pre-scores ($F_{1,93} = 9.31$, $p = 0.003$; $F_{1,93} = 15.31$, $p < 0.001$). There was no significant change in condition A.

Fatigue

Repeated-measures ANOVA revealed no significant time main effect. However, the condition-by-time interaction effect was significant ($F_{2,93} = 3.87$, $p = 0.0242$). In condition A, the fatigue scores after exercise sessions were lower than the scores before exercise. In contrast to conditions B and C, the level of fatigue increased after exercise.

Comparisons of heart rate at rest, maximal heart and average work load

The heart rate at rest (condition A 71.26, (9.67); condition B 71.34, (7.43); condition C 70.73, (7.86)) and maximal heart rate (condition A 134.93, (10.89); condition B 141.83, (21.07); condition C 140.34, (22.62)) did not differ significantly across the three test conditions. The average work load under condition A, B and C was 57.54 (20.03), 65.86 (28.67) and 63.88 (26.34) Watts, respectively. Patients performed a higher

work load in conditions B and C than in condition A ($t = -2.49$, $p = 0.0139$; $t = -2.05$, $p = 0.0423$).

DISCUSSION

Main findings

Results indicated that self-selected and prescribed exercise intensity at 50% of maximal heart rate reserve are equally effective in decreasing state anxiety and negative affect. In contrast to the study of Schmidt *et al.*,¹¹ exclusively using patients with panic disorders, heart rate feedback did not influence the response in state anxiety and negative affect.

Only self-selected exercise intensity, with or without heart rate feedback, improved positive well-being. According to other investigators,⁶⁻⁸ it was expected that self-determination of exercise intensity is associated with positive well-being. Our findings are in accordance with Ekkekakis *et al.*²¹ and Raedeke.²² Those authors indicated that at preferred intensity (self-determination) the dominant response will be pleasure, in contrast to prescribed intensity (no or less self-determination).

Exercising at 50% of maximal heart rate reserve decreased fatigue, whereas exercising at self-selected intensity increased fatigue. A plausible explanation for this interaction effect is that patients performed a higher average work load at self-selected intensity than at prescribed intensity of 50% of the maximal heart rate reserve.

Limitations of the study

In spite of the positive results, the findings of the present study must be interpreted with caution because of some methodological limitations. The major limitation was the absence of a no-exercise control condition. A future study to contrast the effects of an acute bout of aerobic exercise with an anxiety-reducing relaxation or yoga session will be planned. A second limitation was the lack of repeated measures post-exercise. Despite state anxiety reductions lasting for 2–4 h after cessation of activity,¹ only the response 10 minutes after the completion of the session was assessed. This study did not examine potential physiological (eg, increased norepinephrine, serotonin and beta-endorphins, increased parasympathetic activity) and/or psychological mechanisms (eg, increased self-efficacy, distraction, a sense of mastery) that are responsible for the reduced state anxiety and improved subjective well-being.²³ Further research will be needed to examine putative underlying mechanisms. A final limitation was that the maximal heart rate was not measured but estimated by means the formula $220 - \text{age}$.¹⁷

CONCLUSIONS

In summary, the results indicate that the response in state anxiety and negative affect is unaffected by self-selected intensity compared with prescribed intensity, and by heart rate feedback in a sample group of patients with depressive and/or

Table 2 Means and standard deviations of state anxiety, negative affect, positive well-being and fatigue before and after the exercise sessions

	Condition A n = 48		Condition B n = 48		Condition C n = 48	
	Before	After	Before	After	Before	After
State anxiety	45.54 (14.16)	39.23 (16.18)	42.91 (131)	38.98 (11.97)	47.72 (13.22)	41.30 (12.46)
Negative affect	11.25 (6.46)	9.08 (6.43)	9.83 (6.15)	8.10 (5.61)	10.87 (6.13)	9.36 (5.29)
Positive well-being	16.00 (6.2)	16.60 (6.99)	16.13 (6.19)	18.04 (5.99)	15.00 (5.62)	17.23 (5.75)
Fatigue	11.58 (5.75)	10.56 (6.02)	10.31 (5.49)	11.13 (5.29)	11.06 (5.45)	11.77 (4.84)

Results are means (SD). Condition A: 50% of the maximal heart rate reserve. Condition B: self-selected intensity with heart rate feedback. Condition C: self-selected intensity without heart rate feedback.

What is already known on this topic

There is growing evidence to show that acute aerobic exercise is associated with a decrease in state anxiety and an improvement in subjective well-being (negative affect, positive well-being and fatigue) in patients with depressive and/or anxiety disorders.

What this study adds

The reduction in state anxiety and negative affect is unaffected by self-selected intensity compared with prescribed intensity, and by heart rate feedback during aerobic exercise. However, self-selected intensity compared with prescribed intensity influences exercise-induced changes in positive well-being and fatigue in a positive and negative way, respectively.

anxiety disorders. However, self-selected intensity compared with prescribed intensity influences exercise-induced changes in positive well-being and fatigue in a positive and negative way, respectively. Heart rate feedback did not play an essential role in improving psychological states. These findings have implications for exercise therapy in patients with depressive and anxiety disorders. Patients and therapists are free to choose a preferred intensity during aerobic exercise, and they do not need to focus on a specific target range of the maximal heart reserve. However, exercise programmes should be under the guidance of a physician and an exercise specialist. The exercise therapists should monitor the exercise intensity following the guidelines for exercise prescription for sedentary individuals at risk of premature chronic disease.¹⁷ The rate of perceived exertion, rated by the Borg category ratio 10 scale, is a valuable aid in teaching patients to monitor exercise tolerance taking account of their own level of fatigue, rate of breathing and muscular sensations.¹⁷ This rating scale is especially usefully for patients with extreme fatigue complaints who do not exceed 50% of the maximal heart rate reserve due to an increase of fatigue after more vigorous exercise.

Acknowledgements: The authors thank the patients who participated in the study and the psychomotor therapists for the examinations.

Competing interests: None.

Ethics approval: The study procedure was approved by the Ethical Committee of the Faculty of Medicine of the Katholieke Universiteit Leuven in accordance with the principles of the Declaration of Helsinki.

Patient consent: Obtained.

REFERENCES

1. **Taylor A.** Physical activity, anxiety and stress. In: Biddle S, Fox K, Boutcher S, eds. *Physical activity and psychological well-being*. London: Routledge, 2000:10–45.
2. **Hale B, Koch K, Raglin J.** State anxiety responses to 60 minutes of cross training. *Br J Sports Med* 2002;**36**:105–7.
3. **Knubben K, Reischies F, Adli M, et al.** A randomised, controlled study on the effects of a short-term endurance training programme in patients with major depression. *Br J Sports Med* 2007;**41**:29–33.
4. **Dimeo F, Bauer M, Varahram I, et al.** Benefits from aerobic exercise in patients with major depression: a pilot study. *Br J Sports Med* 2001;**35**:114–17.
5. **Raglin J, Wilson M.** State anxiety following 20-min of leg ergometry at differing intensities. *Int J Sports Med* 1996;**17**:467–71.
6. **Morgan W.** Conclusion: state of the field and future research. In: Morgan W, ed. *Physical activity and mental health*. Washington: Taylor and Francis, 1997:227–32.
7. **Ryan R, Deci E.** Self-regulation and the problem of human autonomy: does psychology need choice, self-determination, and will? *J Pers* 2006;**74**:1557–85.
8. **Biddle S, Mutrie N.** *Psychology of physical activity. Determinants, well-being and interventions*. London: Routledge, 2001.
9. **Scully D, Kremer J, Meade M, et al.** Physical exercise and psychological well being: a critical review. *Br J Sports Med* 1998;**32**:111–20.
10. **Broocks A, Meyer T, Bandelow B, et al.** Exercise avoidance and impaired endurance capacity in patients with panic disorders. *Neuropsychobiology* 1997;**36**:182–7.
11. **Schmidt N, Lerew D, Santiago H, et al.** Effects of heart-rate feedback on estimated cardiovascular fitness in patients with panic disorder. *Depress Anxiety* 2000;**12**:59–66.
12. **Knapen J, Van de Vliet P, Van Coppenolle H, et al.** Evaluation of cardio-respiratory fitness and perceived exertion for patients with depressive and anxiety disorders: a study on reliability. *Disabil Rehabil* 2003;**25**:1312–15.
13. **Meyer T, Broocks A.** Therapeutic impact of exercise on psychiatric diseases: guidelines for exercise testing and prescription. *Sports Med* 2000;**30**:269–79.
14. **American Psychiatric Association.** *Diagnostic and statistical manual of mental disorders, 4th edn (DSM-IV-TR)*. Washington: American Psychiatric Association Press, 2000.
15. **Kaplan H, Sadock B.** *Kaplan and Sadock's synopsis of psychiatry: behavioral sciences/clinical psychiatry*, 9th edn. Philadelphia: Lippincott Williams and Wilkins, 2005.
16. **SAS Institute.** SAS language and procedures: usage 2, version 6 (computer program). Cary: SAS Institute Inc, 1991.
17. **American College of Sports Medicine.** *ACSM's health/fitness facility standards and guidelines*, 6th edn. Champaign: Human Kinetics, 2006.
18. **Spielberger C.** *Manual for the state-trait anxiety inventory*. Palo Alto: Consulting Psychologists Press, 1983.
19. **McAuley E, Courneya K.** The subjective exercise experiences scale: development and preliminary validation. *J Sport Exerc Psychol* 1994;**16**:163–77.
20. **Littell R, Milliken G, Stroup W, et al.** *SAS system for mixed models*. Cary: SAS Institute Inc, 1996.
21. **Ekkekakis P, Hall E, Petruzzello S.** Variation and homogeneity in affective responses to physical activity of varying intensities: an alternative perspective on dose-response based on evolutionary considerations. *J Sports Sci* 2005;**23**:477–500.
22. **Raedeke T.** The relationship between enjoyment and affective responses to exercise. *J Appl Sport Psychol* 2007;**19**:105–15.
23. **Ströhle A.** Physical activity, exercise, depression and anxiety disorders. *J Neural Transm* 2009;**116**:777–84.