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Research report

Bright-light exposure combined with physical exercise elevates mood

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Abstract

Background: Physical exercise alleviates depressive symptoms, as does exposure to bright light, especially in those with seasonal variation. Our objective was to compare the effect of exercise alone or combined with morning bright light on mood and the health-related quality of life in healthy subjects. *Methods:* Study subjects were working-age adults, randomized in two groups ($n = 80$): exercise in bright light (group A), or exercise in normal indoor illumination (group B). Intervention lasted for 8 weeks and questionnaire data on mood and the health-related quality of life were collected at study entry, and at weeks 4 and 8. *Results:* Physical exercise both in normal indoor illumination and in bright light was effective at alleviating depressive symptoms. The exercise was significantly more effective at alleviating so-called atypical depressive symptoms when combined with bright-light exposure. *Limitations:* There was no active placebo condition, but a comparative, randomized trial was executed. *Conclusions:* Physical exercise in bright light had a positive effect on mood and health-related quality of life in a sample of healthy, working-age people. Further research is needed to explore the mechanisms of the apparent additive effect of exercise and light.

Keywords: Light; Exercise; Mood; Quality of life; Sub-syndromal seasonal depression

1. Introduction

Exposure to bright light (> 2500 lx at eye-level) is a relatively safe, well-tolerated treatment which, in controlled trials, has proved effective in 40–80% of patients with the winter-subtype of seasonal affective disorder (Partonen and Lönnqvist, 1998). According to a recent report (Kripke, 1998), bright light treatment of non-seasonal depressive disorders is also beneficial. It has not until recently, however, been shown to improve mood in non-depressed individuals (Partonen and Lönnqvist, 2000).

Regular exercise, both aerobic and non-aerobic, alleviates negative mood states and relieves the symptoms of mild to moderate depression (Byrne and Byrne, 1993). Regular exercise may also help to

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diminish the deterioration of mood observed during the winter (Suter et al., 1991). Exposure to bright light and physical exercise seem hence to produce similar effects, but interactions between these two may bear positive, or negative, net influence on mood.

We set out to test the hypothesis that the addition of bright-light exposure to physical exercise would benefit mood and the health-related quality of life in healthy subjects more than exercise alone.

2. Methods

2.1. Subjects

The subjects were enrolled through occupational health care centres on a voluntary basis. The recruiting letter invited those who felt they routinely experienced difficulties during the dark winter months, and were interested in a study of physical exercise, to contact the staff of their centre. Administration of bright light was not mentioned in the letter. The study protocol was explained to the volunteers in a face-to-face meeting with a health professional, and the chief physician of each centre gave their opinion on the eligibility of each subject. The exclusion criteria were progressive retinal disorders, severe general medical conditions and major psychiatric disorders. Block randomisation was applied by the staff of each centre according to the lists provided to them. The 160 eligible subjects were randomized into two groups: exercise in bright (2500–4000 lx) light (group A, $n = 80$), or exercise in normal room illumination 400–600 lx (group B, $n = 80$). The study was conducted in two parts with 80 subjects each.

2.2. Settings

The trial was carried out during two consecutive winters in Helsinki, Finland, from 25 November 1996 to 25 January 1997 and 25 November 1997 to 25 January 1998, each intervention thus lasting for 8 weeks. The length of day in Helsinki on these dates was 6′46″, 7′24″, 6′48″ and 7′23″, respectively. The exercise took place in a gym, to the ceiling of which was attached 30 extra light fixtures with cool-white (6000 K) fluorescent lamps (F58W/186, Sylvania, Germany), which were turned on for group A subjects. The intensity of light was regularly checked to be at least 2500 lx at eye-level. The subjects were instructed not to stare directly at the lamps. For group B subjects, the gym was normally lit with regular lamps (F36W/186) emitting cool-white (6000 K) fluorescent light. During the first winter the exercise consisted of aerobic fitness training tailored by a physiotherapist individually for each subject, using the gym equipment, two or three times a week, in the morning or early afternoon (Partonen et al., 1998). During the second winter there were group aerobics training sessions led by a physiotherapist twice a week. The group sessions started at 07:30 or 08:30 h from Monday to Friday, and at 10:00 or 11:00 h on Saturdays. The exercise sessions lasted approximately 1 h, of which 15 min was reserved for stretching and warm-up to avoid injuries. On both winters, the physiotherapists regularly controlled the subjects' attendance and the intensity of the training. Before and after the study period all subjects underwent a fitness test, and were weighed to calculate the body-mass index (BMI).

2.3. Clinical assessment

At baseline, the subjects filled in the Seasonal Pattern Assessment Questionnaire (SPAQ; Rosenthal et al., 1987), the Structured Interview Guide for the Hamilton Depression Rating Scale — Seasonal Affective Disorders Version Self-Rating Format (SIGH-SAD-SR; Williams et al., 1991), and the RAND 36-Item Health Survey 1.0 (RAND; Hays et al., 1993). At 4 and 8 weeks, the participants were asked to fill in the SIGH-SAD-SR and the RAND. The SPAQ measures seasonal mood and behavioural changes, and the sum of its six-item scale gives the Global Seasonality Score (GSS). The SIGH-SAD-SR includes the Hamilton Depression Rating Scale (HDRS), plus an eight-item addendum for measuring the atypical depression symptoms (ATYP). The RAND creates eight different dimensions of functioning, which reflect the health-related quality of life. The scoring system used gives relative values on an interval scale, ranging from 0 to 100%. All the questionnaires had been translated into Finnish and then back into English to check their linguistic accuracy.

2.4. Statistics

Statistics were calculated using the SPSS 8.0 for Windows. Outcome measures were the absolute scores of the SIGH-SAD-SR and the RAND as well as the changes in these scores from baseline to week 4 and to week 8, and from week 4 to week 8. One-way analysis of variance (ANOVA) and independent samples t-test were performed. The Levene test was used to control the equality of variances. The data were also evaluated by examining the mean and 95% confidence interval (CI) of each outcome measure.

2.5. Ethics

The study was approved by the ethics committee of the institution. All subjects gave their written informed consent prior to participation.

3. Results

Seventy-eight (98%) subjects in group A and 71 (89%) in group B started the study. Their age ranged from 22 to 63 years, with a mean (S.D.) of 41.0 (9.8). We excluded from the analysis the 13 group A and four group B subjects who scored 19 or more on the HDRS at baseline. Of the 132 subjects, 115 (87%) were women and 17 (13%) men. Group A had 56 women and nine men, and group B 59 women and eight men. At baseline, the groups did not differ significantly in the HDRS, ATYP or RAND scores, nor in age, sex, BMI, GSS or fitness test results. The overall mean (S.D.) HDRS score was 9.4 (4.6), the ATYP score 5.6 (4.2) and the GSS 10.9 (4.9). The mean (S.D.) scores in groups A and B are shown in Table 1. Fifty-one (78%) subjects in group A and 55 (82%) in group B completed the 8-week trial. They did not differ in the HDRS, ATYP, or RAND scores, nor in age, sex, GSS or fitness test results at baseline from those who dropped out. The BMI, however, was slightly higher in the latter group (mean 25.7 (95% CI 23.9–27.5) versus 24.1 (23.4–24.7); $F = 4.549$, df $= 1$, $P = 0.04$).

At week 8, both the HDRS and ATYP scores were significantly lowered in both groups. All the eight RAND dimensions were improved in group A, but in group B three scales, those of perceived pain, role limitation caused by emotional problems, and general health perception, failed to improve. At week 4, a significant reduction in the HDRS score was already

Table 1
Mean (S.D.) values at baseline and at weeks 4 and 8 of the intervention

	Baseline		Week 4		Week 8	
	Group A ($n = 65$)	Group B ($n = 67$)	Group A ($n = 55$)	Group B ($n = 57$)	Group A ($n = 51$)	Group B ($n = 55$)
SIGH-SAD-SR						
ATYP	6.4 (4.5)	4.9 (3.7)	4.2 (3.5)	4.0 (3.7)	2.7 (3.5)	3.1 (2.7)
HDRS	10.0 (5.0)	8.9 (4.3)	6.8 (5.6)	7.1 (4.6)	5.1 (4.8)	6.1 (4.0)
RAND						
Physical functioning	91.9 (11.8)	91.9 (9.2)	91.3 (15.8)	93.6 (8.1)	94.7 (9.3)	94.1 (7.4)
Physical problems	82.6 (27.3)	87.3 (25.5)	84.1 (27.4)	86.8 (28.8)	92.6 (18.9)	88.3 (24.6)
Pain	79.7 (20.4)	78.6 (20.8)	83.2 (16.5)	82.9 (17.1)	87.5 (18.5)	83.1 (16.8)
General mental health	68.6 (17.5)	71.3 (13.9)	75.9 (17.6)	77.5 (13.1)	79.3 (15.8)	79.0 (11.3)
Emotional problems	60.3 (36.3)	76.6 (29.6)	71.5 (36.5)	86.5 (23.5)	88.9 (24.6)	89.1 (19.3)
Social functioning	77.7 (20.9)	82.8 (15.8)	85.0 (20.5)	89.7 (14.6)	91.7 (14.3)	92.5 (11.9)
Vitality	51.0 (23.2)	58.8 (20.2)	62.1 (21.8)	65.3 (18.8)	70.9 (19.3)	69.6 (16.2)
General health	71.0 (20.3)	71.9 (18.3)	75.3 (19.0)	76.7 (17.9)	78.7 (19.1)	75.7 (15.7)
GSS	11.3 (5.2)	10.5 (4.7)				

SIGH-SAD-SR, Structured Interview Guide for the Hamilton Depression Rating Scale — Seasonal Affective Disorders Version Self-Rating Format; ATYP, atypical symptom score; HDRS, depression score; RAND, the RAND 36-Item Health Survey; GSS, Global Seasonality Score.

notable in both groups, whereas the ATYP rating had significantly decreased in group A ($t = 4.2$, df = 54, $P < 0.01$) but not in group B ($t = 1.3$, df = 56, $P = 0.2$).

After 8 weeks, the scores on the ATYP ($F = 8.95$, df = 1, $P = 0.003$) and HDRS ($F = 4.44$, df = 1, $P = 0.04$) had decreased significantly more in group A, and the reduction in the ATYP score differed already after 4 weeks ($F = 6.73$, df = 1, $P = 0.01$). The improvement in the RAND score of vitality was significantly more extensive in group A than in group B at week 4 ($F = 4.88$, df = 1, $P = 0.03$) and at week 8 ($F = 5.65$, df = 1, $P = 0.02$).

A 50% reduction in the HDRS score is used as a marker of clinical response in depressive patients. Although our study groups did not include subjects with major depression, we used this criterion to examine the change in depressive symptoms and response to the interventions. At week 4, there were no significant differences between the groups, but at week 8, the HDRS scores had decreased by 50% or more in 31 subjects in group A and 20 subjects in group B ($\chi^2 = 6.32$, df = 1, $P = 0.01$).

There was no marked change in the BMI of the participants during the trial. The fitness test results improved in both groups, showing that the exercise was effective and that compliance was adequate, but there was no significant difference between the groups.

4. Discussion

Our major finding was that both physical exercise alone and combined with bright light exposure were effective at alleviating depressive symptoms and improving certain aspects of the health-related quality of life. The reduction in depressive symptoms was significantly greater in the group allocated to exercise in bright light. This reduction was most marked in the so-called atypical depressive symptoms (carbohydrate craving, increased appetite, morning fatigue, increased need for sleep). The positive effect on atypical depressive symptoms in group A was already apparent after the first 4 weeks of the study, and improved still further during the second half.

4.1. Subsyndromal seasonal symptoms

Although the concept of subsyndromal or subthreshold depression suffers from varying definitions used and lack of clear diagnostic criteria (Pincus et al., 1999), subsyndromal depressive symptoms are common and considered to be an important public health problem. They can lead to increased physical limitations, social irritability, diminished role function, and suicidal ideation. A history of subthreshold depressive symptoms also presents a significant risk factor for future major depressive episodes (Judd et al., 1997).

Our study groups consisted of employees who were healthy during the intervention, as none was suffering from a medical or psychiatric condition severe enough to prevent them from attending work. Nevertheless, a number of subjects reported high scores for depressive symptoms. Self-report questionnaires used to assess the mood states of subjects are, without a concurrent psychiatric interview, highly sensitive in this kind of study setting, possibly yielding too high scores. On the other hand, the subjects enrolled voluntarily, and some pre-selection occurred in the sense that those invited were suffering, to a certain extent, from problems associated with wintertime. However, we excluded from the analysis those scoring over 19 on the HDRS at the study entry to rule out possible cases of major depression (Philipp et al., 1992).

It seems that persons suffering from even only mild, subsyndromal seasonal symptoms may benefit from exercise alone, or more markedly from physical exercise combined with bright light, during the wintertime. We suggest that physical exercise in bright light could be an effective and well-tolerated measure for treating these symptoms and preventing the emergence of season-dependent depressive episodes.

4.2. Mechanisms of action

Single and repetitive exposure to light has an influence on the human circadian rhythms, including core body temperature, the sleep–wake cycle and melatonin secretion. Single activity pulses do not seem to change the period of the circadian pacemaker (Beersma and Hiddinga, 1998), but regular and long-term exercise resets the circadian clock (Van Someren et al., 1997).

Circadian disturbances have been reported in major depressive disorders, both with and without seasonal pattern. In patients with seasonal affective disorder, for instance, the circadian rest-activity rhythm seems to be both phase-delayed and poorly entrained to the 24-h day (Teicher et al., 1997), possibly due to behavioural patterns such as physical inactivity in the morning and carbohydrate craving in the evening. As both exercise and bright light can help with entrainment of the disturbed circadian clockwork, this might partly explain their additive effect on mood observed in our study.

Tryptophan depletion studies and the efficacy of selective serotonin reuptake inhibitors support the view of disturbed central serotonergic activity in major depressive disorders. Physical exercise seems to be linked with serotonin metabolism, since acute exercise increases brain 5-hydroxytryptamine content, at least in rats (Chaouloff, 1997), and there is also some evidence that exposure to light modifies the processing of serotonergic stimuli in the circadian system (Penev et al., 1997). Instability of circadian rhythms may be secondary to impaired serotoninergic function in the afferent pathways to the suprachiasmatic nuclei (Thompson et al., 1997). However, we measured neither circadian rhythms nor serotonin metabolism in this study, so more research with new approaches is needed to verify these hypotheses.

4.3. Psychological view

Physical exercise improves psychological well-being and feelings of self-control and self-confidence (Weyerer and Kupfer, 1994). Administration of bright light also induces positive expectations in many individuals, but the clinical efficacy cannot be solely attributed to the level of pre-treatment expectations (Eastman et al., 1998). Many bright-light studies are however compromised by lack of an adequate control, and a marked placebo effect cannot definitely be ruled out in our study either.

There was a notable preponderance of women in our study. This is probably not a confounding factor, since menstrual-cycle stage and menopausal state do not seem to have a marked effect on symptom reporting (Schwartz et al., 1997; Slaven and Lee, 1997).

4.4. Implications

Most previous studies on exposure to bright light in the treatment of season-bound symptoms recommend daily use of 0.5–2 h. Our results now show that bright light exposure limited to three times a week can, at least when in combination with physical exercise, have a positive effect on mood and the health-related quality of life among working-age people. The effect is most pronounced on atypical depressive symptoms. We propose that a combination of bright-light exposure and physical exercise may prove to be an effective and useful preventive measure against subsequent episodes of depressive disorders. More studies are needed to examine the mechanisms of the additive effect of exercise and light that was observed in this study.

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