

Acute effects of outdoor physical activity on affect and psychological well-being in depressed patients – A preliminary study



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ABSTRACT

Introduction: Physical activity (PA) is well established in the treatment of people with depressive symptoms. Most of this activity is done in an indoor setting. There is growing evidence that PA outdoors shows larger positive effects on affective states than PA indoors. The aim of the present study was to compare the affective experience of an acute outdoor exercise bout with indoor and sedentary equivalents for individuals with clinical depression.

Method: 14 in-patients with mild to moderate depression were recruited during treatment in a mental health center. In a within-subjects experimental study, all participants completed three 60-min sessions: a sedentary control condition (SC), an indoor PA condition (IC), and an outdoor PA condition (OC). Mood, valence and activation were assessed throughout each session using the Mood Survey Scale (MSS), Feeling Scale and Felt Arousal Scale.

Results: Concerning the MSS subscales, whilst patients in the SC exhibited minimal changes, significantly lower “excitement” scores and higher “activation” scores were reported following the OC. Affective activation also differed significantly between OC and IC.

Conclusion: A single outdoor exercise bout showed greater affective improvements compared to indoor and sedentary equivalents for self-reported excitement and activation. As patients felt more active, an outdoor setting might be useful in overcoming listlessness during depression treatment. Due to methodological limitations associated with the pragmatic nature of the trial, findings must be interpreted with caution. Further trials should focus on wider feasibility and acceptability of outdoor exercise in depressive patients.

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1. Introduction

Depression is one of the most common reasons for consulting the health system and its economic burden has grown considerably within recent decades (Choi, Lee, Matejkowski, & Baek, 2014). Although anti-depressants are the primary treatment option, many patients and healthcare professionals would like other options to be available as an alternative or adjunct to drug therapy (Biddle, Fox, & Boutcher, 2000; Cooney et al., 2013). Some evidence shows that physical activity (PA) might be an effective treatment for

depression (Blumenthal et al., 2007) and PA has been recommended as part of the latest guidelines on depression from the National Institute for Health and Care Excellence (National Collaborating Centre for Mental Health, 2010). Robertson, Robertson, Jepson, and Maxwell (2012) reviewed 8 papers with over 300 patients in their meta-analysis and reported a large effect of moderate-intensity walking on depressive symptoms. The authors concluded that further studies comparing different types of walking interventions are needed. A recent Cochrane report concludes that, despite some methodological weaknesses, exercise seems to improve depressive symptoms in people with depression when compared with no treatment or control conditions (Cooney et al., 2013). When PA was compared with conventional treatment the authors could not find a statistically significant difference between the treatment approaches. However, Ekkekakis (2015)

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critically appraised this review and after correcting several errors, stated a significant large sized effect in favor of PA compared to control treatments.

More knowledge about acute effects of exercise is important from at least 4 perspectives: First, single bouts of exercise may improve well-being and vigor in people suffering from major depressive disorder (Bartholomew, Morrison, & Ciccolo, 2005). Second, acute exercise effects may lead to a better clinical response to anti-depressive drug regimens by helping to bridge the time until pharmacological effects are reached (Knubben et al., 2007; Stark, Schöny, & Kopp, 2012). Third, affect seems to be one major factor in human decision-making (Ekkekakis, Hall, & Petruzzello, 2004). It has been shown that the affective components of pleasure and activation during exercise might be crucial for bridging the intention – behavior gap at the beginning of exercise engagement (Ekkekakis et al., 2004; Ekkekakis, Lind, & Vazou, 2010; Hall, Ekkekakis, & Petruzzello, 2002). Regular participation in PA, in the long-term, may be mediated by the pleasure or displeasure people feel during exercise (Ekkekakis, Parfitt, & Petruzzello, 2011; Rhodes & Kates, 2015).

Additionally, active exposure to natural environments elicits positive effects on mental well-being (Bowler, Buyung-Ali, Knight, & Pullin, 2010). Therefore it could be argued that the setting of exercise has substantial implications for mental well-being. Another systematic review reported larger mood enhancing effects after PA in an outdoor environment than in an indoor setting (Thompson Coon et al., 2011). Eleven studies were included measuring mental well-being in single episodes of exercise such as walking or running which were performed indoors and outdoors at the same duration. Participating outdoors was associated with greater feelings of revitalization and positive engagement, decreases in tension, confusion, anger and depression, and increased energy. Furthermore, greater enjoyment and satisfaction with the outdoor activity was observed, as well as a greater willingness to repeat the activity in the future. Because only healthy subjects were included in this review, we cannot be sure whether PA shows similar effects in patients with depressive symptoms.

For a person with clinical depression who experiences mood problems, listlessness and fatigue, it would be valuable to know if (1) PA can immediately improve affect and/or help an individual to feel more energetic and if (2) PA in an outdoor environment elicits greater affective benefits than PA in an indoor environment. To the best of our knowledge, no studies exist which compare the affective benefits of PA in different environments for individuals suffering from clinical depression.

2. Materials and methods

2.1. Patients

In a mental health-center, 28 in-patients were approached after obtaining ethical approval from the Board for Ethical Issues of the University of Innsbruck. 22 in-patients with mild to moderate depression assessed by a clinician, who was not involved in the study, were recruited. Informed consent was obtained prior to their involvement in the study. 8 patients dropped out due to acute sickness (4), early release (2), incomplete questionnaires (1), or different disease pattern (1) and were therefore excluded from the data-analyses. 14 patients with mild to moderate depression (8 female, 6 male; mean age: 32.7 ± 10.8 years, mean Beck Depression Inventory II score: 17.9 ± 9.6) completed the study. To ensure a homogenous population for this study, only in-patients in the day-unit who exhibit depressive symptoms and who were free from any other acute illnesses were included.

2.2. Design and procedure

The assessment took place during two survey periods (July and October 2014). Prior to each survey period, an information session was held for the patients including the data collection of the Beck Depression Inventory II (Beck, Steer, & Brown, 1996). In a within-subjects experimental study, all participants performed three conditions: sedentary control condition (SC), indoor condition (IC), and outdoor condition (OC) within 2 weeks. The order of the conditions was decided by the physiotherapist, who was not a member of the research team, on the basis of the weather. This resulted in the IC consistently being the final condition, with the OC and SC always taking place in the first week of measurement. The IC and the OC took place at the same time of the day one week apart. All conditions (60 min each) were carried out as a group. To avoid between-patient group dynamics the groups were identical to the hospital treatment groups and stayed the same throughout the conditions. The number of patients within each condition was up to eight people. To minimize influences on regular treatment, the exercise conditions took place during the regular PA program, which was included in their psychiatric treatment and happened twice a week.

2.3. Sedentary control condition

The sedentary control condition involved sitting with the group with access to reading materials and board games.

2.4. Outdoor condition

After a short warm-up, participants walked outdoors using the Nordic walking technique. The patients were familiar with the Nordic walking technique since they practiced it sometimes in their regular PA program. Their regular physiotherapist led the group along a path outside the hospital area through a green, natural environment. Participants walked at a self-regulated pace corresponding approximately to 11–14 on Rating of Perceived Exertion (RPE). If their walking pace was faster than the physiotherapist, they were told to overtake and turn around at a known position to stay within a certain distance of the group. Patients were allowed to drink water during the condition.

2.5. Indoor condition

After a short warm-up, patients had to cycle on a cycle ergometer, located in the gym inside the hospital. The patients were acquainted with the cycle ergometer because they occasionally used it during their regular PA program. The same measurement times and instruments as in the outdoor condition were also used in the indoor condition. Although patients were allowed to use the toilet while performing the task, they were instructed to maintain the same range of perceived exercise intensity as in the outdoor condition (11–14 RPE). Patients were allowed to drink water during the condition.

2.6. Measures

Affective valence was assessed by the Feeling Scale (FS) (Hardy & Rejeski, 1989). The FS is a single-item rating scale with anchors at zero (“Neutral”) and at all odd integers, ranging from “Very good” (+5) to “Very bad” (–5). Convergent validity for the FS has been established previously (Hardy & Rejeski, 1989; Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). Perceived activation was assessed by the Felt Arousal Scale (FAS) (Svebak & Murgatroyd,

1985). This single-item rating scale ranges from 1 (“low arousal”) to 6 (“high arousal”). The FAS has been used in previous physical activity studies, demonstrating convergent validity with other measures of perceived activation (Van Landuyt et al., 2000). FS and FAS were administered five times per condition: immediately before the condition, every 15 min during the condition and immediately after termination of the condition (see Fig. 1). Patients responded verbally to the questions while exercising. The questions were administered by a member of the research team in all conditions.

The Mood Survey Scale (MSS) assesses mood states with 8 subscales (activation, elation, calmness, contemplativeness, excitation, anger, fatigue, depression) and consists of a total of 40 items answered in 5-point Likert-type scales (Abele-Brehm & Brehm, 1986). The MSS was developed on the principle of the circumplex model. Thereby the mood scale “activation” measures the high arousal, positive quadrant and the mood scale “excitation” the high arousal, negative quadrant of the circumplex. Information about validity and reliability for using the MSS in physical activity has been provided by Abele-Brehm and Brehm (1986). The MSS was used in depressive patients previously (Stark et al., 2012). MSS was self-assessed immediately before and after all conditions.

To determine exercise intensity, RPE (Borg, 1998) was recorded every 15 min during the conditions by a member of the research team. The scale ranges from 6 (“no exertion”) to 20 (“maximal exertion”). The RPE scale has demonstrated satisfactory reliability and validity previously (Borg, 1998).

2.7. Data analysis

For statistical analysis, 3 (condition: SC, IC, OC) by 5 (timepoint: pre-treatment, 15 min s, 30 min s, 45 min s, post-treatment) repeated measures ANOVAs were employed for analyzing affective valence and perceived activation. Greenhouse-Geisser corrections were applied where assumptions of sphericity were not met. 3 (condition: SC, IC, OC) by 2 (timepoint: pre-treatment, post-treatment) repeated measures ANOVAs were used for analyzing each mood state defined by the MSS subscales. To answer our first research question, whether PA influences affective valence, perceived activation and specific mood states compared to being sedentary, pre-planned simple contrasts were performed with the SC and “pre-treatment” timepoint as reference categories.

To answer our second research question, whether PA in an outdoor environment elicits greater affective benefits than PA in an indoor environment, simple contrasts were performed comparing the IC and OC with repeated contrasts used to determine differences from timepoint to timepoint. Additionally, Cohen's *d* effect size was calculated for the contrast calculations with the formula of Cohen (1988). Data are presented as mean \pm standard deviation.

3. Results

3.1. Preliminary analysis

Mean RPE was similar in the IC (13.84 ± 1.59) and OC (13.33 ± 1.78), $p = .198$. Additionally, changes in RPE across timepoints were not significantly different between conditions, $p = .413$. There were no pre-treatment baseline differences between the OC, IC and SC in terms of affective valence (OC: $.92 \pm 2.21$, IC: $.85 \pm 2.70$, SC: 1.54 ± 2.60 , $p = .732$) and perceived activation (OC: 3.46 ± 1.81 , IC: 4.08 ± 1.50 , SC: 3.92 ± 1.93 , $p = .557$). MSS subscales did not show baseline differences, except the subscale activation, $p = .012$. See Table 1 for means and standard deviations of the MSS.

3.2. Affective valence and perceived activation

Fig. 2 shows affective valence and perceived activation over time within the three conditions. For affective valence, there was no significant interaction, $p = .103$. However, a higher effect size was found for PA in the OC ($d = 1.44$) compared to the IC ($d = .64$).

For perceived activation, a significant interaction was found, $p = .015$. Perceived activation was significantly higher in the OC

Table 1
MSS subscales over time in all conditions.

Subscale	Condition	Pre treatment	Post treatment	<i>p</i>
		Mean (SD)	Mean (SD)	
Anger	SC	.67 (.77)	.70 (.90)	.087
	OC	.96 (.88)	.85 (.95)	
	IC	.89 (.92)	.51 (.67)	
Excitement	SC	1.17 (.89)	1.22 (.86)	.026*
	OC	1.47 (.98)	1.04 (.88)	
	IC	1.10 (.84)	.97 (.86)	
Activation	SC	1.90 (1.00)	1.74 (1.07)	.001***
	OC	1.35 (.72)	2.16 (.84)	
	IC	1.87 (1.01)	2.05 (.89)	
Calmness	SC	1.86 (1.08)	1.90 (1.03)	n.s.
	OC	1.71 (.95)	2.07 (.87)	
	IC	1.81 (1.10)	1.94 (1.17)	
Elation	SC	1.88 (.99)	2.02 (1.13)	n.s.
	OC	1.51 (.67)	2.03 (.93)	
	IC	1.70 (1.12)	2.03 (1.27)	
Contemplation	SC	1.61 (.93)	1.60 (.87)	n.s.
	OC	1.79 (.84)	1.70 (1.06)	
	IC	1.64 (.93)	1.60 (.96)	
Fatigue	SC	1.16 (.92)	1.13 (.92)	.056
	OC	1.49 (1.18)	.89 (.87)	
	IC	1.04 (.87)	.97 (.89)	
Depression	SC	1.17 (1.12)	1.13 (1.12)	.098
	OC	1.59 (1.05)	1.17 (1.10)	
	IC	1.46 (1.18)	1.14 (1.31)	

SC: sedentary control condition, IC: indoor condition, OC: outdoor condition, *: $p \leq .05$, **: $p \leq .01$, ***: $p \leq .001$.

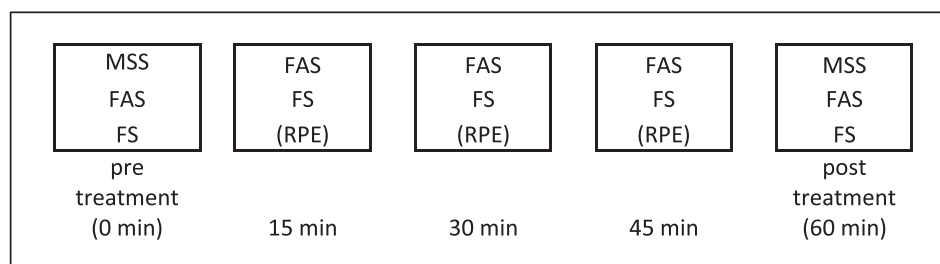


Fig. 1. Measurements in all conditions. MSS: Mood Survey Scale, FS: Feeling Scale, FAS: Felt Arousal Scale, RPE: Rating of Perceived Exertion. RPE was only assessed during indoor and outdoor condition.

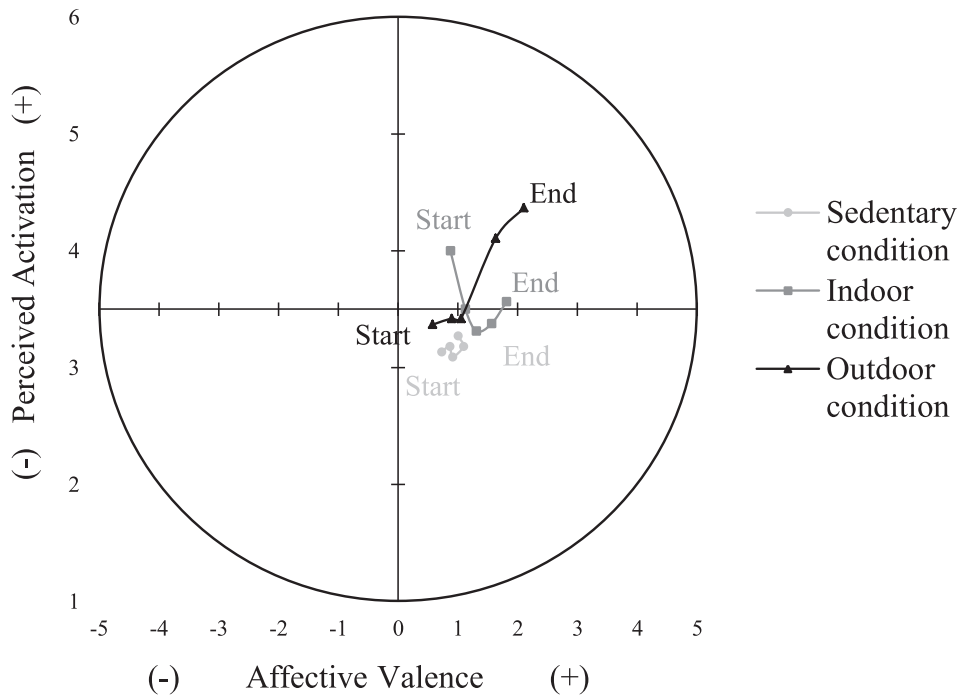


Fig. 2. Change in valence and activation within the three conditions over time.

compared to the SC after 45 min, $p = .037$, $d = 1.35$ and post exercise, $p = .045$, $d = 1.29$. The IC did not show a significant change in perceived activation, $p > .132$, $d < .93$. Repeated contrasts across timepoints showed a significantly higher rise in perceived activation in the OC between 30 and 45 min compared to the IC, $p = .025$, $d = 1.22$.

3.3. MSS subscales

Table 1 shows the MSS subscales before and after the treatment for each condition.

Significant interactions for the MSS subscales activation, $p < .001$, and excitement, $p = .026$, were found. Activation was significantly higher in the OC compared to the SC after exercise, $p = .003$, $d = 2.04$. The IC did not elicit significant changes in activation, $p = .104$, $d = .09$. Excitement was significantly lower in the OC compared to the SC after exercise, $p = .022$, $d = 1.45$, whereas the IC did not elicit significant changes in excitement, $p = .207$, $d = .74$. Contrast calculations between the IC and the OC showed a significantly higher rise in activation from before until after the OC compared to the IC, $p = .014$, $d = 1.57$. However, no such differences were found for excitement, $p = .113$, $d = .94$.

A tendency for an overall interaction effect was shown in the MSS subscales anger ($p = .087$, $d = .91$), depression ($p = .098$, $d = .89$) and fatigue ($p = .056$, $d = .99$). Following up the marginal interactions, the IC tended to reduce anger more than the SC ($p = .058$, $d = 1.16$). The OC reduced depression more than the SC ($p = .042$, $d = 1.08$). Lastly, the OC tended to reduce fatigue more than the SC ($p = .056$, $d = 1.16$).

4. Discussion

4.1. Main findings

This study showed that an acute exercise bout in in-patients with mild to moderate depression had effects on valence,

activation and specific mood states. Our first research question concerned whether PA can immediately improve affect and/or help an individual to feel more energetic. Our analysis showed that outdoor PA (but not indoor PA) resulted in higher perceived activation and lower excitement after 45 min compared to being sedentary. Our second research question concerned whether outdoor PA elicits greater affective benefits than indoor PA. When undertaking the OC, patients reported significantly higher post-exercise ratings on the MSS subscale activation and the FAS, suggesting that outdoor PA does elicit greater affective benefits.

4.2. Implications

4.2.1. PA and depressive patients

It has been shown previously, that PA results in decreased symptoms of depression with a medium- (Cooney et al., 2013) to large-sized (Ekkekakis, 2015; Robertson et al., 2012) effect. However, these outcomes are only possible with a high compliance and acceptance rate in the patients. It is known that the pleasure or displeasure people feel during exercise predicts future participation in exercise (Ekkekakis et al., 2011). Therefore, positive acute effects of PA on affect and mood such as those demonstrated in the present study are essential to increase patient compliance. Even though in the present study the OC and IC did not show comparable effects, the effects exhibited in the OC are in the line with the results of Bartholomew et al. (2005) who compared quiet rest to moderate exercise in subjects diagnosed with major depressive disorder and found increases in positive mood states like well-being and vigor for the exercise condition only. Bartholomew et al. (2005) observed significant effects with PA indoors whereas the present study only detected similar differences with PA outdoors. However, it has to be considered that the sample size of Bartholomew et al. (2005) was 40 patients in comparison to 14 patients in the present study and that the control situations were quite different (solitary quiet rest versus sedentary group activity in the present study).

Hansen, Stevens, and Coast (2001) discovered mood

improvements after just 10 min of moderate PA in healthy subjects with additional benefits after 20 min but no further improvements after 30 min. However, in the present study, significant improvements in perceived activation were only seen after 45 min in the OC compared to SC. This suggests that depressive subjects might need a longer dose of moderate exercise to experience comparable changes in mood. This suggestion is supported by the findings of (Stark et al., 2012), who were only able to detect mood changes after 60 min of outdoor walking with depressive patients albeit in an uncontrolled design.

4.2.2. PA in an outdoor environment

In healthy persons, Pasanen, Tyrväinen, and Korpela (2014) concluded that both indoor and outdoor exercise was related to general health but only exercise in an outdoor environment was connected with positive mental well-being. Thompson Coon et al. (2011) concluded that healthy subjects report increased energy and greater feelings of revitalization after PA outdoors; findings which have been generally corroborated previously (Bowler et al., 2010).

To the best of our knowledge no study has examined the affective outcomes of outdoor and indoor exercise in depressive subjects thus far. This study found that depressive patients felt more active after outdoor PA compared to indoor PA with tendencies to feel less depressed and fatigued. As listlessness is a common symptom in depression, promoting outdoor activity could mitigate some of the negative consequences associated with it. Furthermore, there was a steep rise in perceived activation between 30 and 45 min in the OC which was not present during the IC. Variations in the gradient of the outdoor terrain could explain this finding, although there were no observed differences in perceived exertion.

The results of this study may have implications for promoting PA in individuals with depression because there is some evidence of multi-dimensional benefits of moderate exercise as an adjunct treatment for depressive patients: exercise interventions may be used more intensively at the start of pharmacological treatment to bridge the phase of the pharmacological action latency (Knubben et al., 2007). In addition, moderate exercise could be used for the prevention of relapse (Hoffman et al., 2011). The effects between PA indoors and outdoors seem to be different and potentially, the patients benefit more from PA outdoors. Due to the low power of the study ($n = 14$), effect sizes lower than large effects (i.e. $d < .80$) could not be detected as statistically significant, and thus type 2 errors are possible. Future research with depressed populations should therefore consider a range of affective states that may be altered by exercise, rather than exclusively those which are significantly altered in the present study. To integrate the results of this study into good clinical practice, further research about the longer term effects, feasibility and acceptability of PA outdoors is needed.

4.3. Strengths and limitations

The major strength of this study is the pragmatic approach. There were only minor changes in the daily life of the patients and their treatment regimens (e.g. filling in the questionnaires before and after the conditions, answering questions during PA). Thus, external disturbances for the patients due to the study were kept as small as possible. It is also the first study which evaluates affective differences between outdoor and indoor PA in depressive patients.

Due to the pragmatic nature of the trial, of integrating the interventions in the patient's treatment regimen and minimizing disturbances of the daily ward's operations, some limitations have

to be noted. One limitation concerns the different types of PA in the OC (walking) and the IC (cycling) as well as the non-randomization of our 3 conditions. There were a number of reasons that these decisions were taken. Firstly, we expected low compliance for outdoor walking in inclement weather. Secondly, we wanted to minimize interruptions to the patients' treatment regimen as little as possible and so opted for activities that were already part of their treatment program. Furthermore, indoor walking exercises, or outdoor cycling exercises, which would have served as more comparable alternatives, were not feasible for this population in this clinical setting. One could argue that observed differences are not caused by environment type but by different exercise types or the order of conditions. Indeed, in comparable studies, the most frequently used PA type was walking (Pretty et al., 2007). But, whenever cycling was used as an intervention, cycling and walking showed comparable effect sizes on mood states (Barton & Pretty, 2010). We realize that as all patients experienced the IC last, it may have biased the affective measures. However, none of the conditions were unfamiliar to the patients, as they practiced similar exercises as part of their treatment regimens. Also, group factors might have influenced results. To minimize these, groups stayed similar throughout the study, but structured group physical activity is part of the latest NICE guidelines on depression treatment anyway (National Collaborating Centre for Mental Health, 2010). The BDI II scores did not consistently correspond to clinician assessments of mild to moderate depression, however we consider the clinician's assessments to be superior to our BDI II measurements. Even though nearly all of the parameters did not show baseline differences, the subscale activation did, which could have influenced the results. Due to the fact that prior expectations can influence the participant's commitment (Rosa et al., 2015), affect and mood could change differently through dissimilar baseline scores. Nonetheless, the OC's activation scores increased the most out of all three conditions and the fact that this finding is substantiated by comparable changes in the more domain-general FAS measure demonstrates that this finding is unlikely due to a floor effect.

Although the present study was focused on acute effects of exercise on self-reported measures of affect and mood, future studies could include follow-up assessments and integrate physiological measures (such as salivary cortisol concentrations (Ida et al., 2013)) to corroborate and extend the present findings. Future research could also examine the perceived usefulness of outdoor exercise programs amongst mental health service providers.

5. Conclusion

In conclusion this study shows that there is some evidence that PA outdoors is potentially more beneficial for depressive patients than PA indoors. Compared to a sedentary control condition, outdoor PA elicited greater changes in ratings of excitement and activation (both perceived activation and the MSS subscale activation). Higher effect sizes were also found for anger, fatigue and depression. Additionally, the patients felt more active after outdoor PA compared to indoor PA. Nevertheless, further randomized controlled trials are needed to compare the same kind of activity indoors and outdoors and to focus on the feasibility and acceptability of outdoor PA programs amongst depressive patients.

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