

# **A Review of the Beneficial Mental Health Effects of Exercise and Recommendations for Future Research**

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The present paper presents a comprehensive review of the empirical literature regarding the beneficial effects of physical exercise based interventions for the alleviation of anxiety and mood disorders. Anxiety and depressive disorders affect a significant proportion of the world's population and are associated with substantial personal and societal cost. The research data indicates that physical exercise is an efficacious treatment method for depression, with evidence also supporting its use as a treatment for anxiety conditions. Exercise has been demonstrated to be at least as effective as pharmacotherapy for depressive and anxiety disorders, and preliminary evidence suggests that it is equally effective as CBT treatments. Exercise therefore appears to be a highly efficacious, cost-effective, and widely available method of alleviating depressive and anxiety symptomology. Research findings are also discussed in light of recent discoveries in the field of positive psychology and recommendations are made for future research.

The role of exercise in the physical health and wellbeing of an individual has been long established. Physical exercise has been well demonstrated to be associated with a range of physiological health benefits while absence of physical exercise is associated with a wide plethora of common causes of mortality including coronary heart disease, certain forms of cancer, obesity, hypertension, and diabetes (Centre for Disease Control, 1996). Recently a great deal of research effort has been focused on identifying the possible beneficial effects of physical exercise on mental health and psychological wellbeing.

## **Prevalence of Anxiety Disorders**

Psychological disorders are extremely common in current society and exert an enormous burden of suffering on individuals afflicted with these conditions. Anxiety disorders appear to be the most common mental health problems (Kessler, Chiu, Demler, & Walters, 2005) with various large scale epidemiological surveys in the United States suggesting a lifetime prevalence rate of between 25-30% for at least one anxiety disorder (see Kessler, McGonagle, Zhao, Nelson, Hughes, & Eshleman, 1994; Kessler, Berglund, Demler, Robertson, & Walters, 2005; Kessler et al., 2005). Large scale nationally representative surveys in other Western developed nations such as Canada, Australia, and Great Britain identify similar patterns of anxiety prevalence (Canadian Community Health Survey, 2003; Jenkins et al., 1997; Andrews, Henderson, & Hall, 2001). Anxiety was also identified as the most common mental health disorder by the World Health Organisation's (WHO) World Mental Health Survey Initiative in each country surveyed (with the single exception of Ukraine) with 1-year prevalence rates as

low as 2.4% in Shanghai, China to 18.2% in the United States (WHO World Mental Health Survey Consortium, 2004).

In addition to the very high prevalence of diagnosed anxiety disorders, a substantial proportion of the general population experience various symptoms of anxiety that do not reach the level of clinical diagnosis but still contribute to a substantial degree of suffering for the individual. Worry is a central cognitive feature of Generalized Anxiety Disorder and is found to be present in the majority of the non-clinical general population and these worries tend to relate to areas of work, school, family, relationships, finances and other general daily concerns (Borkovec, Shadick, & Hopkins, 1991; Dupuy, Beaudoin, Rheume, Ladouceur, & Dugas, 2001; Tallis, Eysenck, & Matthews, 1992; Wells & Morrison, 1994). Moreover, various studies in different community settings have shown that between 11-33% of the general population have experienced at minimum a single panic attack in the previous year (Malan, Norton, & Cox, 1990; Salge, J. G. Beck, & Logan, 1998; Wilson, Sandler, Asmundson, Ediger, Larsen, & Walker, 1992). Sleep disturbances which are also a very common feature of anxiety and mood disorders are extremely widespread among the general population; in Britain 27% of women, and 20% of men report serious sleep problems (Jenkins et al., 1997) while according to the United States National Sleep Foundation Survey conducted in 1991, 36% of the general population experience mild to severe insomnia (Ancoli-Israel & Roth, 1999).

### **Prevalence of Depressive Disorders**

Mood disorders including depression and dysthymia are frequent occurrences in modern society. In the National Comorbidity Survey-Replication study conducted in the United States, mood disorders were found to have a lifetime prevalence rate of 20.8% while the 12 month prevalence rate was 9.5% (Kessler et al., 2005). The Canadian Community Health Survey (2003) reported that the lifetime prevalence of major depressive episodes among the general population was 12.2% and similar findings have been reported in European wide studies (Alonso et al., 2004). However, a more recent nationally representative Canadian study has suggested that the lifetime prevalence of major depressive episodes could be substantially higher. The National Population Health Survey (see Patten, 2009) employed a more methodologically sound longitudinal measurement approach and found lifetime prevalence rates to be 19.7% which is nearly twice as high as commonly believed.

While anxiety disorders are presently accepted as the most prevalent of the psychological conditions, depression appears to exert the greatest degree of suffering among the world population. The WHO found that in 1990 depression was the fourth leading cause of major ill-health worldwide and by 2020 depression is projected to be the second leading cause of suffering worldwide (Murray & Lopez, 1996). The worldwide prevalence of depression has been estimated to be as high as 10.4% (Ustun & Satorius, 1995). Depression not only exerts a major burden of suffering to a great many people, it also has substantial negative economic effects on society. The National Institute of Mental Health (NIMH) in the United States estimates that it costs \$26billion per year to treat depression, and more worryingly, it appears that only about half of all people suffering from depression seek out treatment (Andrews, Sanderson, Corry, & Lapsley, 2000).

Anxiety and depressive disorders tend to present co-morbidly. Approximately 55% of patients who receive a diagnosis of an anxiety or depressive disorder will also be diagnosed with a further depressive or anxiety disorder. The lifetime co-morbid diagnosis is as high as 76% (Brown & Barlow, 2002). In the United States anxiolytic and mood stabilising medications are the third most widely prescribed class of medications (IMS, 2004). All of these figures serve to amply demonstrate that a substantially large proportion of the world's population experience a daily struggle against the problems of depression and anxiety.

### **The Role of Positive Affect in Mental Health**

The field of psychology has undergone somewhat of a revolution in the past decade with the development of the field of 'Positive Psychology'. Traditionally, the field of psychology has primarily been concerned with understanding and alleviating the psychological suffering of human beings. Positive psychology is a scientific approach to understanding the positive aspects of human psychology including positive emotions, positive character traits, and interventions that can increase levels of positive emotions (see Seligman & Csikszentmihalyi, 2000 for a more detailed discussion). In the past decade great strides have been made in formulating a rigorous scientific investigation of the positive emotions of human experience, most prominently 'happiness'. In addition, positive psychologists have developed a range of scientifically validated therapeutic intervention methods for increasing psychological wellbeing collectively encapsulated under the domain of 'Positive Psychotherapy' (Seligman, Steen, Park, & Peterson, 2005; Seligman, Rashid, & Parks, 2006).

The continued study of positive psychology appears crucially important as what has emerged from this body of research is that happiness is not merely an epiphenomenon but rather happiness is a critical causal factor in a wide range of important life areas. In an extensive review of the relevant literature on positive emotions, Lyubomirsky, King, and Diener (2006) drawing on cross-sectional, longitudinal, and experimental studies produced strong empirical support for the causal pathway between positive emotion (happiness) and a multitude of desirable and successful outcomes across a wide variety of life domains. For example, strong positive associations were discovered between happiness and physical and mental health, immune functioning, success in work, and success in romantic and social relationships. Strong positive associations were also discovered between positive emotions and a range of positive personal attributes and characteristics including favourable evaluations of the self and others, prosocial behaviour, sociability, coping, creativity, and likeability.

Longitudinal data supported the findings of the cross-sectional studies revealing that long-term happiness and short-term positive affect preceded the above mentioned positive and successful outcomes. More importantly, a large body of experimental data conclusively demonstrates that positive affect gives rise to greater altruism, a positive view of the self and of others, sociability, activity, conflict resolution skills, original thinking and creativity, and substantially greater physical and mental health and general immune functioning.

Given the wide range of beneficial mental health effects that emerge as a consequence of increasing levels of happiness, positive psychologists have been investigating and successfully identified a variety of methods that can effectively enhance levels of happiness and which persist over time (see Seligman et al., 2005). Curiously, to date no

research has been undertaken in order to determine whether regular engagement in physical exercise could serve as an efficacious method of increasing levels of happiness. This is an especially surprising oversight when considered in light of the empirical evidence regarding the beneficial effects that physical exercise offers for the alleviation of depressive and anxiety symptomology.

### **The role of Exercise in the Development and Prevention of Depression and Anxiety**

A large body of empirical evidence exists with respect to: i) the role of physical exercise in the development and prevention of both anxiety depression and ii) the effectiveness of physical exercise in the alleviation of depressive and anxious symptomology and disorders.

Numerous correlational studies have suggested a high degree of association between regular physical exercise and positive psychological wellbeing. Among a sample of 5,061 participants, Steptoe and Butler (1996) reported a strong, positive, statistically significant correlation between regular strong physical exercise and emotional wellbeing while controlling for social status and current health. Subsequently Steptoe and colleagues (1997) found a strong, inverse association between regular vigorous exercise and levels of depression among a large sample (n = 16,483) of undergraduate students after controlling for the effects of gender and age. Stephens (1988) carried out a large scale study of 55,000 Canadian and American participants and found a similar negative correlation between regular physical activity and symptoms of depression and anxiety which remained when sociodemographic status, physical illness, sex, and age were statistically controlled for. Abu-Omar, Rutten, and Lethenin (2004) conducted an equivalent large scale study (n = 16,230) among participants from 15 European countries and again a statistically significant negative relationship was discovered between physical exercise and presence of depression and anxiety. Goodwin (2003) analysed data from the United States National Comorbidity Survey and found that a diagnosis of major depression, social phobia, agoraphobia, and specific phobia were all associated with very low levels of physical exercise.

Correlational data obtained from these studies are generally unsurprising as reduced physical activity, sedentary lifestyle, and motivational deficits are all central symptoms of depression. Moreover such findings provide no insight into the causal or preventative effects of physical exercise in depression and anxiety. Longitudinal studies provide greater insight into the causal and preventative role of exercise in depression and anxiety and numerous studies support the findings obtained in the cross-sectional literature. Strohle et al. (2007) followed a sample of 2,458 participants over a four year period and found that those individuals who engaged in regular physical exertion experienced substantially lower levels of depression and anxiety as compared to those sedentary individuals. Results from Motl, Birnbaum, Kubik, and Dishman (2004) found that fluctuating changes in physical activity in adolescents over time inversely correlated with onset of depressive symptomology. Farmer and co-workers studied 1,900 people over an eight year period and were able demonstrate that regular exercise contributed to the prevention of depression. These findings were replicated by Strawbridge, Deleger, Roberts, & Kaplan (2002) among older adult participants. Paffenberger, Lee, and Leung (1994) followed 10,201 men over an extensive period of time and found that absence of physical exercise predicted depression 25 years later.

Camacho, Roberts, Lazarus, Kaplan, and Cohen (1991) identified a negative relationship between exercise and depression at two separate nine year observation periods.

The evidence obtained from these longitudinal studies, in conjunction with data obtained from well controlled cross-sectional studies, provide good empirical support that engagement in regular physical activity can prevent the onset of depressive and anxiety symptoms and lead to substantially greater psychological health.

### **Physical Exercise as a Treatment for Depression**

The role of physical exercise as an effective method of intervention for depression among clinical and nonclinical populations has enjoyed a good deal of rigorous empirical validation. Given the volume of experimental studies that have been performed testing the efficacy and effectiveness of physical exercise as a treatment for depression, a large body of meta-analytic data exists. It is necessary to note at this point that the empirical evidence indicates a clear dose-response relationship for the anti-depressant effect of physical exercise. An energy expenditure output of at least 17.5kcal/kg per week is necessary for physical exercise to bring about a clinically significant reduction in depression (Pate et al., 1995). It is to these recommendations that standardized measures of physical activity have been developed such as the widely employed International Physical Activity Questionnaire (Craig et al., 1993) which allows for the calculation of weekly metabolic expenditure regardless of the method of physical activity (weight training, aerobic exercise, walking, sports etc.).

An early meta-analysis was conducted by North, Mucullagh, and Tran (1990) which included 80 studies. Among non-clinical populations an effect size (ES) of -0.53 was identified while and an ES of -0.94 was found among the clinical populations. Using much stricter inclusion criteria Lawlor and Hopker (2001) carried out a meta-analysis of 14 methodologically sound randomized controlled trials (RTC's) and found a large effect size of -1.1 among those groups who engaged in physical exercise when compared to the no-exercise control groups. In an attempt to discover the clinical utility of exercise as a treatment for depression, Craft and Perna (2004) converted results from a series of meta-analyses into a binomial ES. Their results indicated a clinical success rate of between 67-74%. This provides extremely strong support for the clinical utility of exercise in the treatment of depression as an improvement rate of 50% is generally considered as a treatment response (see Strohel, 2009).

A recent large scale meta-analysis was carried out by Rethorst, Wipfli, and Landers (2009) which has provided evidence that exercise is a level 1, Grade A treatment for depression. Their study included 58 RTC's (N = 2982) examining the effects of exercise on depressive symptoms. An overall effect size of -0.80 was discovered demonstrating that participants receiving exercise as a treatment for depression experienced a greater than three-quarters of a standard deviation reduction in their symptomology as compared to the participants within the control groups. Population characteristics were found to moderate the effectiveness of exercise on depression. Forty studies (N = 2408) were included which examined the effects of exercise on depression among non-clinical samples drawn from the general population and an ES of -0.59 was identified whereas an ES of -1.03 was discovered among seventeen (N = 574) studies conducted within clinical populations.

While many individual studies have shown no differences in exercise form (aerobic based or resistance based) in producing an antidepressant effect (see Doyne, Ossip-Klein, Bowman, Osborn, McDougall-Wilson, & Neimeyer, 1987; Sexton, Maere, & Dahl, 1989; Martinsen, Hoffart, & Solberg, 1989) exercise type was found to moderate treatment effects but only for the non-clinical populations. A combination of aerobic and resistance training produced statistically greater effects than either aerobic or resistance training alone.

### **Exercise Compared to Established Treatments of Depression**

Currently the most efficacious psychotherapeutic intervention for the treatment of depression is cognitive therapy (or commonly described as 'Cognitive Behaviour Therapy' or 'CBT'). CBT is widely recognised as the 'gold standard' treatment for depression (see Butler, Chapman, Forman, & Beck, 2006 for a detailed review of the meta-analytic data regarding the efficacy of cognitive therapy). Multiple RCT's have been conducted which have evaluated the efficacy of exercise as a treatment for depression when compared to general psychotherapy and results from these studies generally indicate that exercise is as effective as general psychotherapy (Greist, et al. 1979; Klein, Greist, Gurman, & Neiberyer, 1985; Harris, 1987). In their meta-analysis Rethorst et al. (2009) identified four relevant studies and although exercise produced better outcomes than psychotherapy (ES -0.26), the difference between the treatments did not reach statistical significance. A better comparison would be studies that have directly evaluated exercise as compared to cognitive therapy. In the few studies in which the treatments have been systematically compared exercise emerged as an equally effective treatment for depression as the current gold standard psychotherapy (e.g. Freemont & Craighead, 1987).

Use of anti-depressant medication is recommended as the first line treatment for moderate-to-severe depression according to the American Psychiatric Association's Practice Guidelines (American Psychiatric Association [APA], 2000). Anti-depressant medications have proved to be efficacious in the treatment of depression (see Thase & Kupfer, 1996) and are the most common means of treating depressive symptoms (Olfson & Klerman, 1993). A number of studies have scrupulously compared exercise to medication as a treatment for depression. For example, Blumenthal and colleagues (1999) compared these treatments in a cohort of older adults and reported that although those receiving medication improved at a quicker rate than the exercise group, by the end of the intervention at twelve weeks exercise proved as effective as medication in reducing depression. More impressive was the fact that the exercise group had maintained their gains to a significantly greater degree than did the medication group at a ten months post-test (Babyak et al., 2000). Later, Blumenthal et al. (2007) compared an individual home-based and a supervised group-based exercise intervention consisting of three exercise regimes, three times per week, with an anti-depressant and a placebo intervention. Again, both exercise groups proved as effective as medication in reducing symptoms of depression.

Based on the empirical evidence, exercise appears to be a highly effective treatment for depression, comparable with the efficacy of anti-depressant medications, general psychotherapy, and possibly cognitive therapy, however in the latter case more data is required for a more reliable determination to be made.

## **Mechanisms of Change in Exercise for Depression**

It has been hypothesised that exercise yields its anti-depressant effects through a series of complex and interacting biopsychosocial factors. Ernst, Olson, Pinel, Lam, & Christie (2006) suggest that exercise increases hippocampal neurogenesis by increasing levels of  $\beta$ -endorphins which are linked to neurogenesis (Persson et al., 2003); increasing levels of vascular endothelial growth factor which have also been linked to neurogenesis (Pereira et al., 2007; Jin et al., 2003; Fabel et al., 2003) and are known to increase during exercise (Schobersberger et al., 2000); promoting production of brain-derived neurotrophic factor which is also crucial for neuronal development and survival (Wozniak, 1993); and by generating greater levels of serotonin in the brain through the production of tryptophan hydroxylase which is generated during exercise (Chaouloff, Laude, & Elghozi, 1989) and is necessary for the synthesis of serotonin. Serotonin regulation may also be effected by exercise induced improvements in sleep patterns. Regular exercise leads to increases in total sleep time, along with an increased amount of time in slow-wave sleep and decreased time in REM sleep where serotonin output is substantially lower (Kubitz, Landers, Petruzzello, & Han, 1996; Youngstedt, O'Connor, & Dishman, 1997; McGinty & Harper, 1976).

Biologically, exercise may also produce an anti-depressant effect by increasing levels of noradrenalin (Dishman, 1997) as low levels of noradrenalin are known to be implicated in the dysregulation of mood (Beyer, Boikess, Luo, & Dawson, 2002).

The beneficial effects of exercise may also be mediated by a number of positive psychological changes. Ossip-Klein et al. (1989) demonstrated that among women who were diagnosed with major depressive disorder, engagement in exercise led to significant improvements in their levels of self-esteem, a greater sense of self-efficacy, and a more positive view of the self. With respect to the cognitive theory of depression (A. T. Beck, Rush, Shaw, & Emery, 1979; Disner, Beevers, Haigh, & A. T. Beck, 2011) it is likely that successful engagement in regular exercise serves as good behavioural evidence which undermines the depressed individual's dysfunctional, negative schemas regarding themselves, their future, and their current state.

## **Physical Exercise as a Treatment for Anxiety**

Although the quantity of empirical data regarding the efficacy of physical exercise as a treatment for anxiety is not as extensive as that which exists with regards to depression, physical exercise has enjoyed a good deal of empirical support as a method of alleviating symptoms of anxiety.

Orwin (1984) first demonstrated the anxiolytic effect that exercise can exert among healthy participants. More recently, a large scale meta-analysis of forty studies examining the effect of exercise training on anxiety levels among the general population found that there was a weak-to-moderate positive effect (.36) for those who engaged in exercise as compared to control groups or various other alternative intervention methods (Long & van Stavel, 1995).

The majority of studies with highly anxious populations have examined the differential effects that exercise training has on state and/or trait anxiety levels. Petruzzello et al. (1991) conducted a meta-analysis of 11 studies among participants with high levels of

trait anxiety, and reported a mean ES of 0.47 for the reduction in trait anxiety in the exercise groups compared to the control groups. This data demonstrates that engagement in regular exercise has a moderately positive effect in reducing trait anxiety among highly anxious individuals. Stich (1999) carried out another meta-analysis of eleven studies involving both clinical and non-clinical samples, all of whom however were highly anxious individuals. Among these eleven RCT's, exercise was demonstrated to be significantly better in reducing anxiety symptoms than wait-list controls (ES = .94). Seven of these trials were carried out with participants who had received a diagnosis of a particular anxiety disorder and results for these groups were comparable (ES = .99).

Merom and colleagues (2007) recently demonstrated that a combination of exercise and group-based CBT was a significantly more effective treatment of anxiety symptomology among patients diagnosed with panic disorder, generalized anxiety disorder, or social anxiety than a nutritional and educational intervention. There is also emerging evidence that exercise may be an efficacious intervention for the treatment of Posttraumatic Stress Disorder (PTSD) (see Manger 2000; Manger & Motta, 2005) however larger scale RCT's are required in order to better establish the efficacy of physical exercise as a treatment for PTSD.

### **Exercise Compared to Established Treatments of Anxiety**

Cognitive-Behavioural therapies are well established as the most efficacious psychological intervention for the myriad of anxiety disorders (see Butler et al., 2006). Only one study could be identified that directly compared exercise to CBT as a treatment for anxiety with outcomes reaching comparable levels (McEntee & Halgin, 1999).

Broocks et al. (1998) carried out a randomized controlled trial in which clomipramine, exercise, and a pill placebo were compared in the treatment of panic disorder. Although the pharmacological intervention exerted its anxiolytic effect more rapidly than did the exercise intervention, at post-test there was no statistically significant difference between the two interventions in the reduction of panic symptomology, and both yielded significantly better results than the placebo group.

While the evidence supporting the use of exercise for reducing symptoms of anxiety is certainly not as extensive as that which exists with respect to depression, the research literature does indicate that exercise can produce a substantial anxiolytic effect, particularly for those without an anxiety disorder diagnosis. There is also evidence, although scant, that exercise may be as effective as CBT and pharmacotherapy which represent the two most commonly used and empirically supported treatments for anxiety.

### **Conclusion and Future Directions**

Depressive and anxiety disorders are extremely common within the general population, while the distressing and inhibiting symptoms of these conditions are experienced almost universally. These psychological maladies therefore bring with them major individual and social costs. Although effective psychotherapeutic and pharmacological treatments have been developed to tackle these psychological problems, they are not



without their drawbacks. Among both therapies approximately 30-40% of patients do not respond to the respective treatments, the treatments themselves incur a significant financial cost, and are not widely accessible. Moreover, in the case of pharmacological interventions, a wide range of particularly unpleasant side-effects can occur (Antonuccio, Danton, & DeNelsky, 1995; David, Szentagotai, Lupu, & Cosman, 2008; Sava, Yates, Lupu, David, & Szentagotai, 2009).

The empirical data reviewed in the current paper suggests that engagement in regular physical exercise over a relatively short period of time can bring about highly beneficial results in depression and anxiety symptomology. Additionally, in the case of depression these improvements are at least equal to those observed in pharmacotherapy treatments, and there is tentative evidence that exercise-based interventions may also produce clinical improvements in both anxiety and depressive symptoms equal to those observed in CBT-based interventions. Greater research is now required to evaluate the efficacy of physical exercise based interventions for depression and anxiety against cognitive-behavioural therapeutic interventions. As the gold-standard treatment method for both depressive and anxiety disorders, identifying clearly how effective exercise-based therapies can be against CBT-based therapies is extremely important. Fortunately, the nature of the two therapies means that they are highly compatible and can be applied simultaneously. Undoubtedly future treatment protocols for depressive and anxiety disorders will include a combination approach of not just psychotherapeutic and pharmacological approaches, but also exercise based interventions.

A critical factor that is often ignored in the treatment of psychological maladies relates to the fact that the alleviation of unhealthy negative emotions such as depression and anxiety does not axiomatically lead to a simultaneous increase in positive functional emotions. One of the primary goals of the field of positive psychology has been to develop and validate intervention methods which can supplement conventional treatments such that the eradication of distressing negative emotions can occur along with the development of functional positive emotions. As noted by Seligman et al. (2005), conventional practice in clinical psychology and psychiatry has focused on reducing suffering, without any direct focus on building happiness. Given the volume of empirical data demonstrating the beneficial psychological, physiological, and societal effects of increasing levels of happiness this is a trend that will likely change in the near future. With increasingly effective methods of reducing negative emotions, there is now a growing trend within conventional psychological treatments to focus on the positive aspects of the individual that can foster the development of positive emotions (see Beck, 2011 for how this changing in the area of CBT). What makes physical exercise based treatments so exciting is that they offer a highly effective alternative to conventional treatment methods for both anxiety and depressive disorders, while being fully accessible to practically all individuals, with few, if any, associated financial costs, and no known or obvious side-effects. An even more exciting prospect is that in addition to being an efficacious method of alleviating depression and anxiety, physical-exercise based interventions hold the very real possibility of also being an efficacious method of increasing positive emotions. Sadly this possibility has not been investigated but we eagerly await research which attempts to test this possibility.

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