



Dr Stuart Jones

Exercise and Mental Health (Depression)



Aims of the Lecture

- To discuss depression prevalence rates and the cost of depression in the United States.
- To explore research (from a variety of approaches) that has looked at the relationship between exercise and depression.
- To provide a discussion on the possible explanations as to how much and why exercise could treat depression.
- To discuss runner's high and exercise addiction.

Depression Prevalence Rates

- Lopez et al (2006) – Depression among the 10 leading risk factor of disability-adjusted life expectancy in high income nations in 2001.
- Mathers and Loncar (2006) – projected to rank 1st leading risk factor of disability-adjusted life expectancy by 2030.
- Gradual increase of rates of major depression in the US since the 1940's (Buckworth et al, 2012).



Greenberg et al (2003)

- Cost of depression in the United States (2000).
 - \$26.1 billion – medical costs direct.
 - \$51.5 billion lost productivity in workplace.
- 2009 – Antidepressants 4th highest prescribed medication in the US - \$9.9 billion in 2009 alone.
 - Cited in Buckworth et al (2012).

What about free treatments...

- Freeman et al (2010) study suggested the self-help treatment and alternative treatments can have a major impact on reducing major depressive disorders.
- Therefore, what about exercise.
 - Remember the lecture on exercise and cognitive function.
 - Remember the discussion on exercise and increases in self-worth, self-esteem
 - And the relationship between self-esteem and depression.



Early Thoughts and Research

- Hippocrates prescribed exercise for his patients who had melancholia...
 - 2,500 years ago.
- Franz and Hamilton (1905)
 - Mood and Reaction Times of 2 depressed males.
 - Improvements following 2 hours of exercise compared to days where they didn't exercise.
- Morgan et al (1970) –
 - Experimental Study
 - Self ratings of depression reduced in men after an exercise training program
 - Many flaws – not a randomised control study.





Cross Sectional Studies (Depression and Exercise)

- A number of cross-sectional studies have suggested a link between increased leisure time activity and reduced symptoms of depression (Buckworth et al, 2012).
- US National Comorbidity Survey (Goodwin, 2003).
 - N = 5,877 – ages 15-54 (United States).
 - Representative Sample
 - People who participated in exercise (either for recreation or at work) had ↓ 25% of being diagnosed of major depression within the last 12 months.
 - » After adjusting for age, sex, race, education, marital status, income, education, physical illness and other mental disorders.

Goodwin (2003)

- In addition – reported a significant reduction in the odds of being diagnosed with dysthymia if you partake in exercise.
 - Dysthymia = Chronic Depression, longer term but considered less severe than major depression
- Although smaller, there was also a significant reduction in the odds of being diagnosed with biopolar disorder if you partake in exercise.
- In the main there was also evidence for a Dose-Response Relationship.
 - More you exercise, less likely you were in obtaining a major depression, dysthymia and biopolar disorder diagnosis.



Goodwin (2003; cited in Buckworth et al, 2012)

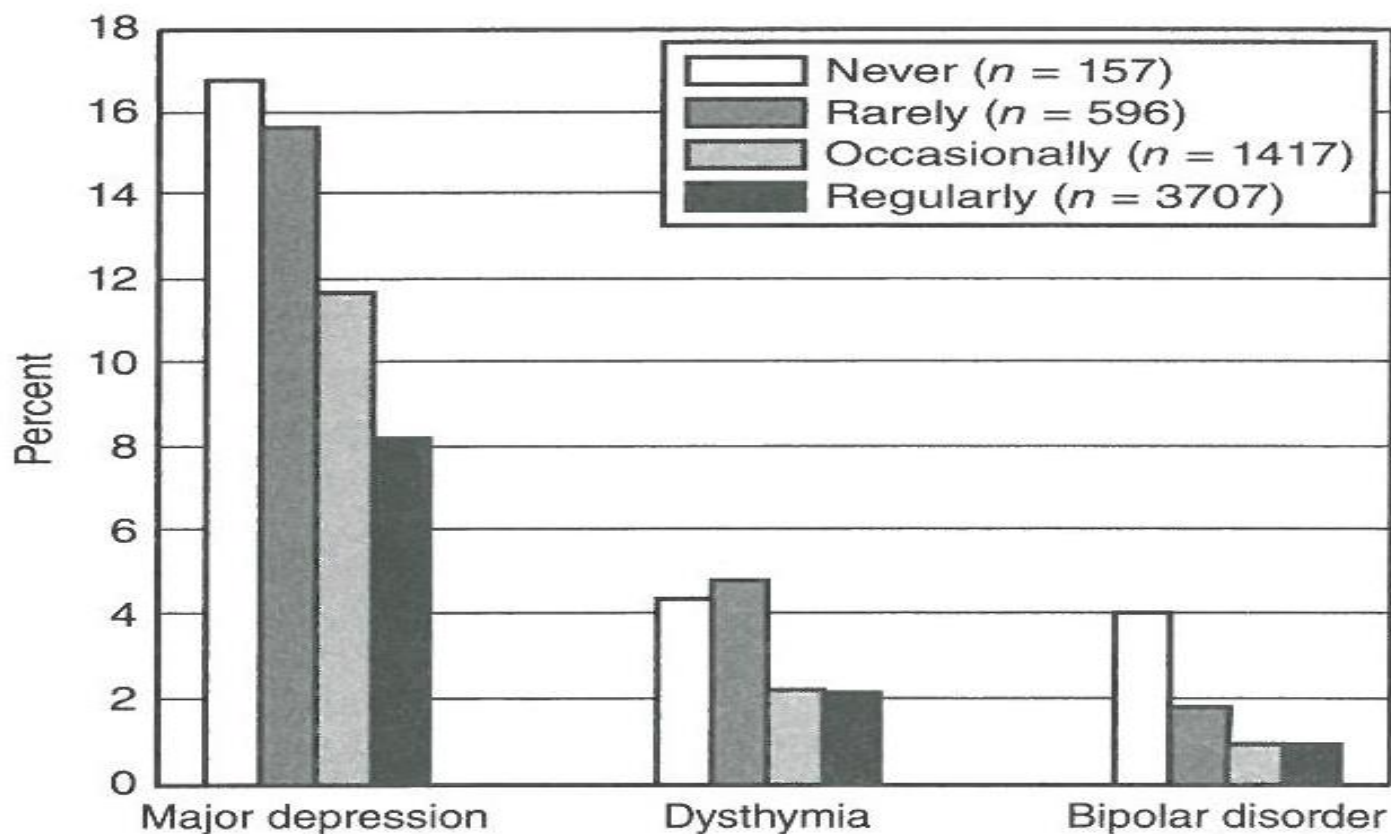


Figure 7.5 Twelve-month prevalence rates of mood disorders according to the frequency of physical activity in the U.S. National Comorbidity Survey.

Data from Goodwin 2003.



Medical Expenditure Panel Survey

- National representative survey of 23,283 US adults in 2003 (published by Morrato et al, 2007).
- Information of socio-demographics, medical conditions (mental and physical health) – which included major depression.
- Findings – Depression = 40% lower in people who were physically active.



Medical Expenditure Panel Survey

- Findings suggested a link between depression and exercise even after data was adjusted to consider gender, age, ethnicity, education, income, BMI, cardiovascular history, blood pressure, hyperlipidemia (high levels of lipids in the blood) and physical disability.
- Critique of study.
 - Not much (it is considered very detailed with an excellent sample size) however they did base their definition of major depression using the International Classification of Diseases (9) as opposed to the DSM-IV.



2006 – Behavioural Risk Factor Surveillance Survey (Strine et al, 2008).

- Survey – random digit dialled telephone survey
- 217,379 participants – USA (38 states), Columbia, Puerto Rico and Virgin Island.
- Patient Health Questionnaire (based on DSM-IV) was used to measure symptoms of depression.



2006 – Behavioural Risk Factor Surveillance Survey (Strine et al, 2008).

- Findings...
- 24% of sample considered themselves inactive.... Regardless of age, these participants were 50% more likely to have suffered a diagnosis in lifetime of depression.
- When adjusting for age, gender, ethnicity, education, smoking, job status, marital status, education, chronic medical conditions, smoking, obesity, and alcohol intake.
 - Those inactive 20% more likely to have suffered a diagnosis in lifetime of depression.



Netherlands Twin Registry (De Moor et al, 2006).

- 12,450 Participants (age 10+ at time of first data collection).
- Longitudinal Looking at lifestyle and health from 1991 to 2002.
- Symptoms of Depression 17%↓ amongst exercisers.
 - However, exercisers were also more extrovert and emotional stable than non-exercisers.
 - Chicken and Egg scenario.



Netherlands Twin Registry (De Moor et al, 2006).

- The twin aspect of their study also revealed some interesting findings.
- 479 male and 943 female identical twins aged 18-50.
- No significant difference between exercise participation and depression.
 - Similar findings in the follow up.
 - Increases in exercise participation did not decrease depression symptoms.



Prospective longitudinal studies.

- The studies noted previously have large samples size across a large cross-section of a representative sample.
- However, their findings are looking at the relationship retrospectively.
 - E.g. Looking at participants who had been or currently diagnosed with depression symptoms and exploring the physical activity level.
 - But what about studies who might explore the predictiveness of exercise on depressive symptoms.
 - E.g. Looking at it prospectively.....



Copenhagen City Heart Study (Mikkelsen et al, 2010).

- 18, 146 residents of Copenhagen
- Leisure Activity and other variables measured at three different points.
 - 1976-1978, 1981-183, 1991-1994.
- Depression risk at each of the follow up assessments was PREDICTED by physical activity levels.
 - Compared to high physical activity level, women with a moderate level of physical activity had a 7% increased risk of depression.
 - Women with low level physical activity – 80% risk.
 - Not quite a strong but similar for men.

Copenhagen City Heart Study (Mikkelsen et al, 2010, cited in Buckworth et al, 2012).

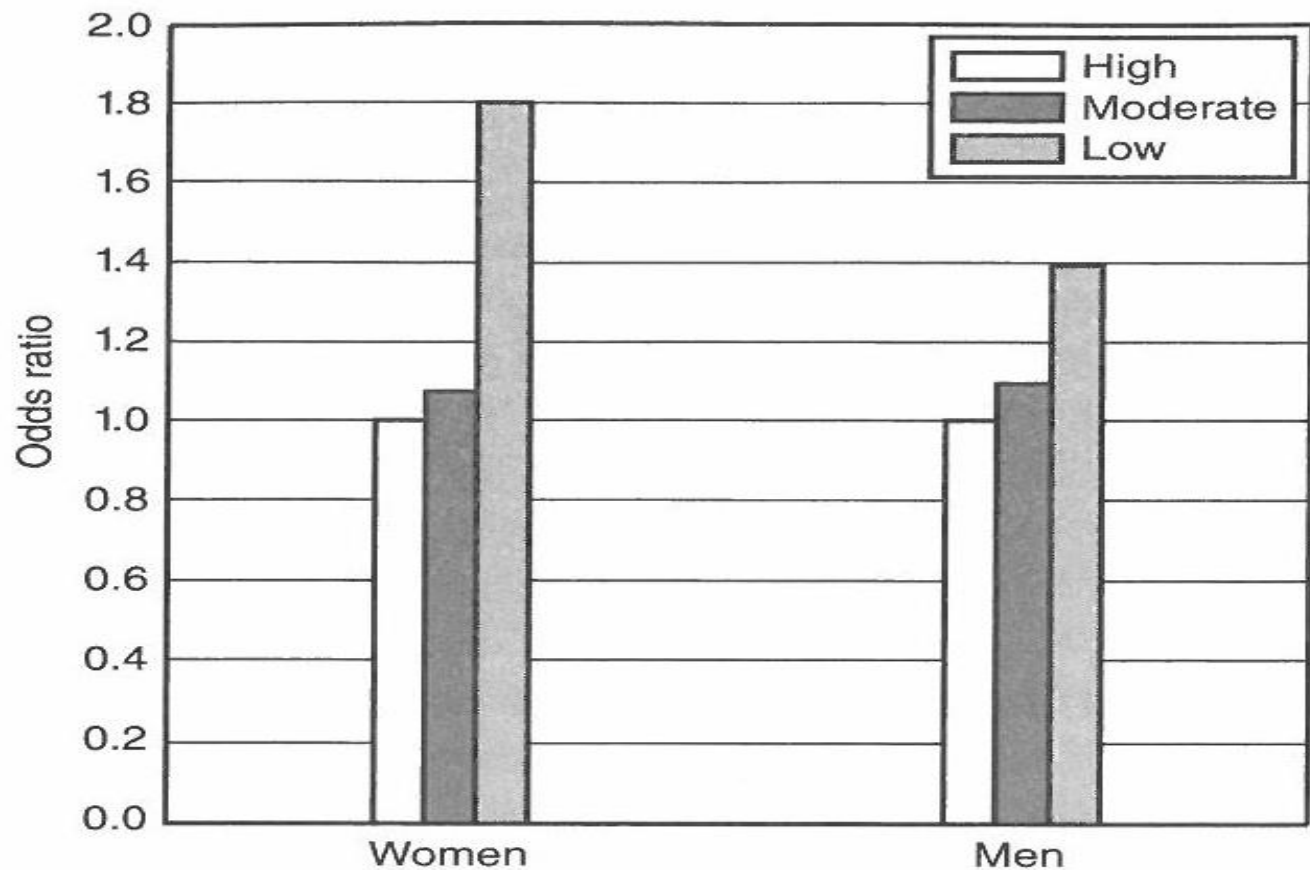


Figure 7.8 Copenhagen City Heart Study of incident depression in inactive women and men

Data from Mikkelsen et al. 2010.



Issues with Longitudinal Survey Based Approaches.

- Measures of physical activity exposure limited.
 - Type of physical activity reported can be limited.
 - What about the difference between Aerobic and Anaerobic exercise, what about Weight Training vs Swimming.
 - Training alone or playing a team game.
 - Measured at a set time, what about previously.
 - E.g. Participant might not have been exercising a great deal for last 6 months, but for previous 4 years may have been a fitness fanatic.
- Self-Report Measures.



Treating Depression – Experimental Studies.

- Mead et al (2009) – Meta Analysis of Existing Material.
- 23 studies (a total 907 adult patients) – all patients diagnosed with depression but avoiding post-natal depression.
- Found a strong relationship between exercise as a treatment for reducing studies.
 - However, some caution as relationship was not nearly as strong for studies in which participants were given alternative treatments (e.g. double blind randomised control studies) or not aware of positive impact of exercise on depression beforehand.
 - Also, what about drop out rate – effect size not so great if they are included as part of the analysis.



Rethorst et al (2009) – Meta Analysis.

- 17 studies, 574 participants with clinical depression diagnoses.
- Studies which had a control condition – clinical depressed participants in exercise treatment had lower depression scores (BDI score change of 10).
- Training programme length – largest effect size = those last 10-16 weeks, better than 4-9 weeks and also +16 weeks.



Issues with such Meta Analysis

- Whilst such meta analysis of existing studies are an EXCELLENT method of exploring the impact of exercise on a large population, still some aspects need clarity....
- For example, did the meta analysis break down the type of exercise and also the exercise environment (which might be pivotal to the impact of exercise on depression).

Treating Depression – Individual Experimental Studies.

- School of thought that Aerobic exercise would have a greater impact of reducing depression than Anaerobic / Weight based training.
- Greater increase in Oxygen Uptake (VO2 max)
- Studies that looked at Exercise and Cognition (see Lecture 2) reported that Aerobic Exercise was more beneficial in relation to cognitive functioning.



Treating Depression – Individual Experimental Studies.

- Martinsen et al (1985 + 1989 follow up).
- Study 1 (1985)
- Effects of exercise programme on hospitalised psychiatric patients diagnosed with depression.
 - Randomised Control Study of 43 patients 1) Exercise Group 2) Occupational Therapy group.
 - Group 1 – Significant larger reduction in self-reported symptoms compared to group 2.

Martinsen et al (1989)

- Martinsen et al (1989) – Follow up.
- 99 inpatients diagnosed with unipolar depressive disorders.
 - Major depression, chronic depression and atypical depression.
- Randomised Controlled Study – Group 1) = Aerobic Exercise 2) Non-Aerobic Exercise.
 - 8 Weeks of Training – BOTH groups = Reduction in Depressive Symptoms Scores.
 - NO significant differences BETWEEN the groups.
 - Although differences in VO2 max scores – Aerobic group improved more.

Doyne et al (1987)

- Compared effectiveness of two types of exercise in 40 females (age range 18-35) diagnosed with depression.
 - Aerobic exercise (e.g. Running on Treadmill)
 - Resistance exercise (e.g. Weights).
- 8 weeks of exercise in both conditions.
- Both groups = reduction in depression scored compared to a waiting list control.
 - Results similar for both groups.



Singh et al (1997)

- 10 week progressive resistance exercise training among elderly participants diagnosed with major depression or chronic depression.
- Compared to a control group who were given a health education intervention.
- Exercisers had less depressive symptoms on Beck Depression Inventory and Interview feedback post programme than control group.

Fremont and Craighead (1987)

- Compared exercise to traditional psychotherapy treatment.
- 49 participants all reporting mild to moderate depression (19-62 years age range).
- 3 groups (randomly assigned).
 - Supervised Running Group.
 - Psychotherapy group
 - Combined Running and Psychotherapy group.



Fremont and Craighead (1987)

- Findings
- 10 Weeks of Treatment.
 - Both Exercise and Psychotherapy group exhibited significant reductions in depression scores.
 - No significant difference between these two groups.
 - Conclusion Exercise as an effective treatment as psychotherapy.
 - In fact although not significant – Exercise group fared better in terms of reduced symptoms after 10 weeks and 8 weeks post treatment.
 - However, an addition benefit for group 3 – the exercise AND psychotherapy group.

Fremont and Craighead (1987, cited in Buckworth et al, 2012)

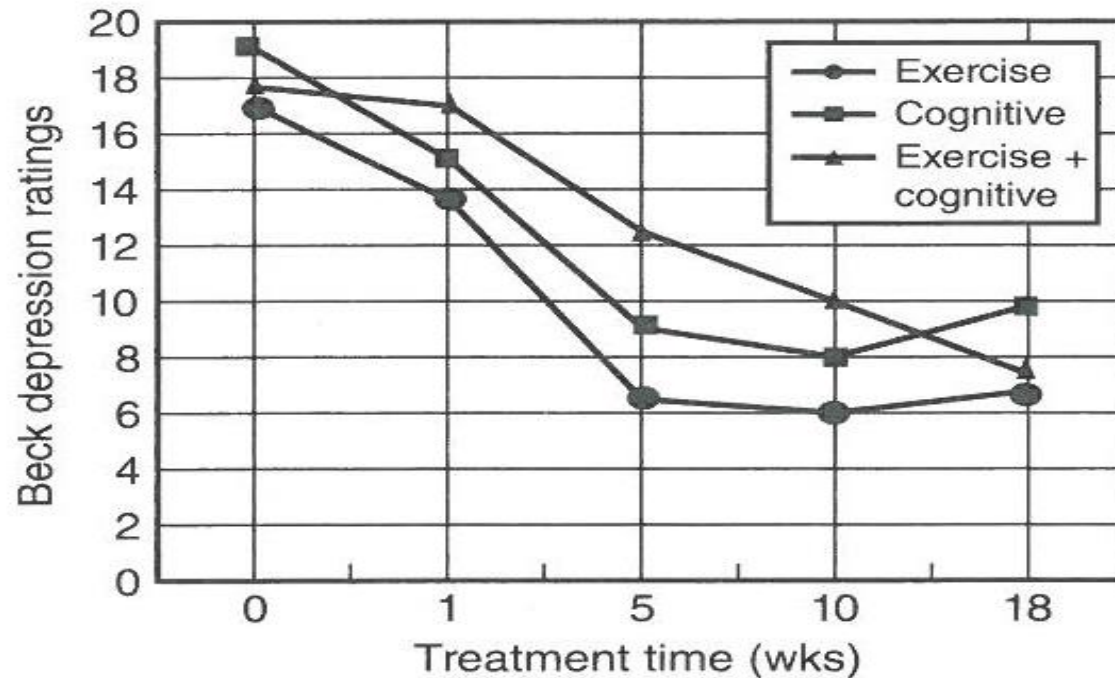


Figure 7.10 Changes in self-reported symptoms of depression for men and women randomly assigned to supervised running, individual cognitive psychotherapy, or running plus psychotherapy.

Data from Fremont and Craighead 1987.

Blumenthal et al (1999)

- Compared Aerobic exercise and medication (antidepressants).
- 156 older patients diagnosed with major depressive disorder.
- Randomised assigned to one of 3 groups.
 - Aerobic exercise group
 - Antidepressants groups
 - Combined exercise and antidepressants group.



Blumenthal et al (1999)

- 16 week program.
- All three demonstrated similar decreases in depression scores – statistically and clinically significant.
- Medication only – fastest initial response.
- By end of the programme, very little difference between each group (next slide).
- However, follow up (Babyak et al 2000) exercise group less likely to relapse into depression than EITHER group with drug treatment involved.



Blumenthal et al (1999, cited in Buckworth et al 2012)

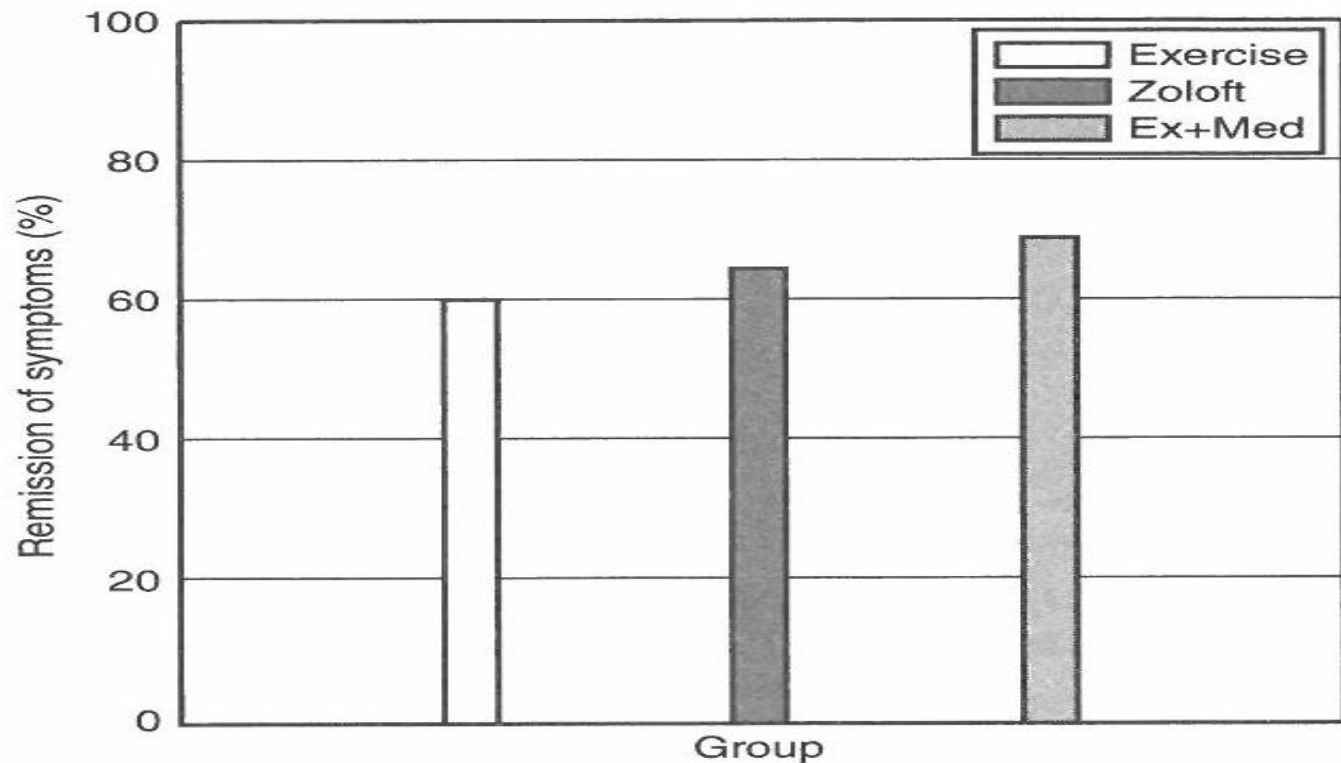


Figure 7.11 Remission rates after 16 weeks for groups of older men and women clinically diagnosed with major depressive disorder randomly assigned to groups receiving antidepressant medication, aerobic exercise, or aerobic exercise plus medication.

Data from Blumenthal et al. 1999.

Treating Depression – Experimental Studies.

- Dimeo et al (2001) – Exploring short term effects on Aerobic Training Programmes.
- Sample – 12 Adults – 5 male, 7 female diagnosed with a major depressive disorder (DSM IV)
- Procedure – Training Programme - Walking on a treadmill following an interval training pattern - 30 minutes a day for 10 days.
- Results—Statistically significant reduction in self-reported depression scores (using Hamilton rating scale) after training programme, in addition to intensity of depression bouts.
- Subjective (attitudes) and objective – results of the scale view on depression reduction correlated significantly. Led authors to conclude the a short term Aerobic training programme can produce significant improvements in mood in patients diagnosed with major depressive disorders.



How much is enough.

- Canada Fitness Survey (Stephens, 1988)
- People protected from symptoms of depression from a low level of daily activity (e.g. equivalent of 20 minutes of walking).
- Havard Alumni Study (Paffenbarger et al, 1994).
 - Dose Dependent Reduction....
 - Decreased risk of depression the more the person exercised.

Paffenbarger et al, 1994, cited in Buckworth et al, 2012).

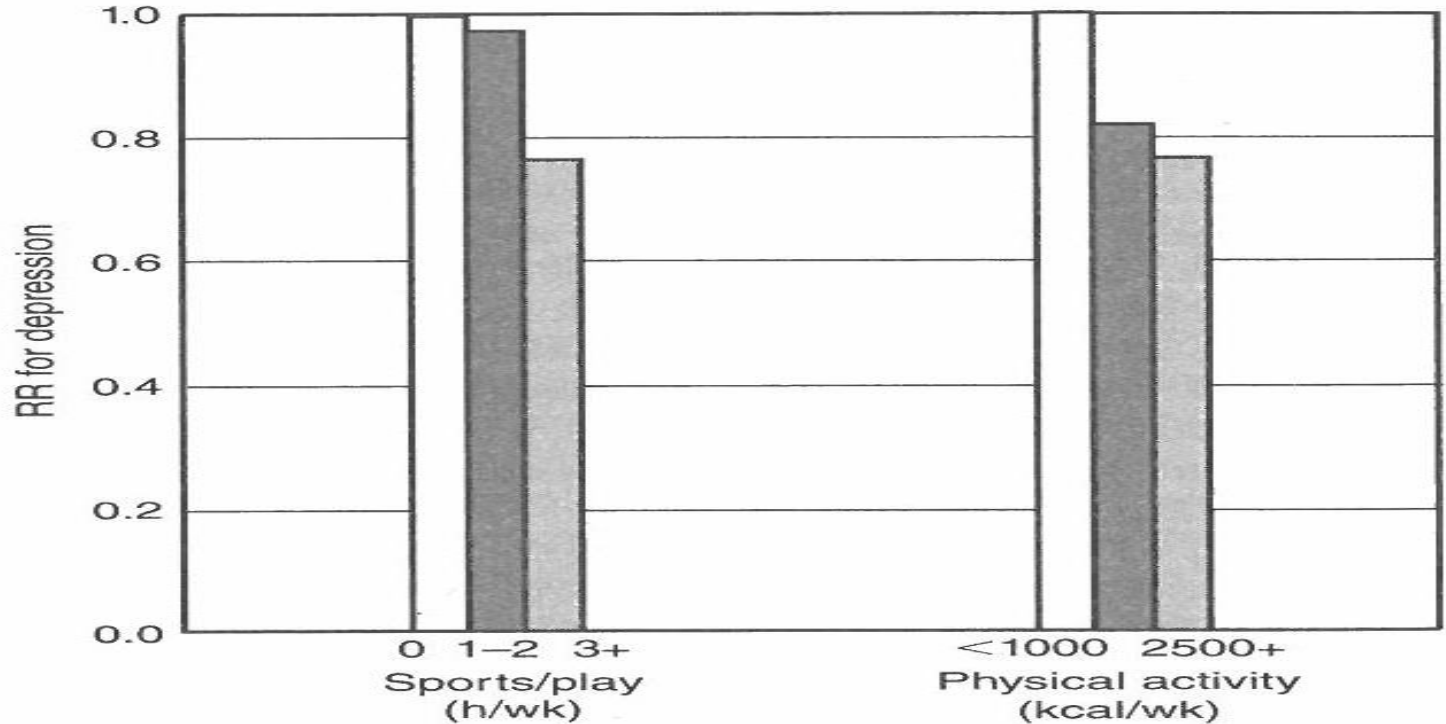


Figure 7.12 The analysis of activity habits from 1962 through 1966 and the incidence of depression during 23- to 27-year follow-ups among Harvard alumni ($n = 10,201$ males) shows that relative risk (RR) for depression was improved with some regular activity.

Data from Paffenbarger, Lee, and Leung 1994.



However....

- Whilst these findings were from a very strong study, there is one major issue.....
- Fewer than 1 in 10 adults in the US expend this much energy in leisure-time physical activity (Buckworth et al, 2012).



Buckworth et al (2012) – Review.

- Although the authors concede that there is inconsistency in the research and still more research is needed in relation to the type and location of the exercise. Their extensive review provided the following exercise recommendations to treat depression.
- 3 to 5 days a week
- 20-60 minutes each session
- 55%-90% of maximal heart rate.
 - Appropriate for a reduction of symptoms for people diagnosed with depression.



So why....

- Still discovering the reasons why.... As highlighted in the lecture on exercise on cognitive function – we are learning more and more about the biological impact of exercise.
- Typical explanations have been based upon.
 - Social
 - Cognitive
 - Biological Mechanisms (Buckworth et al, 2012).
 - Combined elements of these.



Social Cognitive Explanations

- Ernst et al (1998)
- Social elements of exercise associated with...
 - Diversion from stressful stimuli
 - Improved self-image
 - Feelings of control
 - Social Interaction
 - Positive attention
 - Subjective expectations
 - Social Support.
- However, the empirical studies exploring these aspects not very well designed (O'Neal et al, 2000).

However...

- McNeil et al (1991)
- 30 Mildly depressed ELDERLY male and women.
 - Three conditions (randomly assignment)
 - 20 minutes of outdoor walking with a student
 - 20 minutes of social interaction (no exercise) with a student.
 - Wait-List Control

Findings (cited in Buckworth et al, 2012).

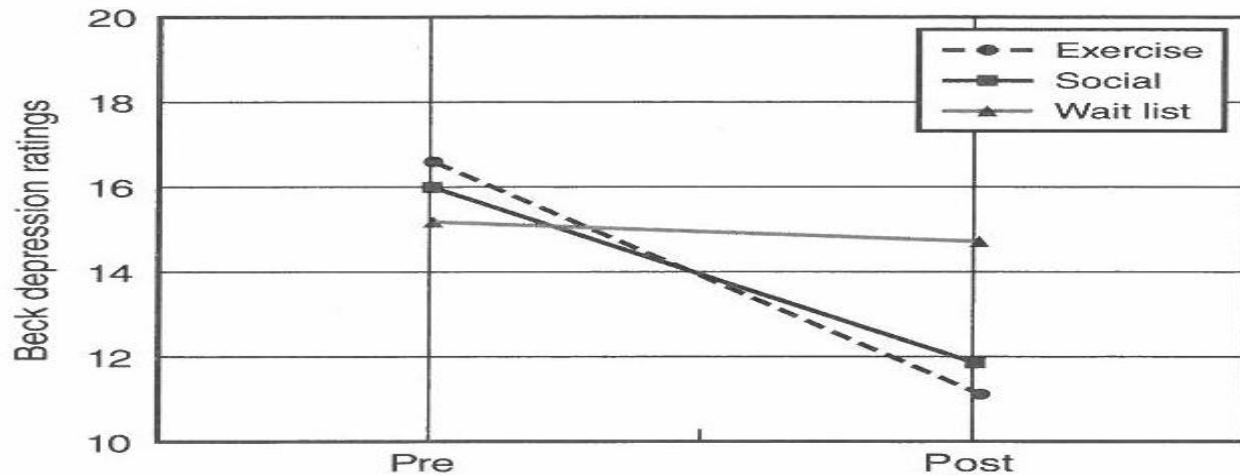


Figure 7.14 Reduction of depression after an exercise program (walking) versus regularly scheduled social contact with another person.

Reprinted, by permission, J.K. McNeil, E.M. LeBlanc, and M. Joyner, 1991, "The effect of exercise on depressive symptoms in the moderately depressed elderly," *Psychology and Aging* 6(3): 487-488.

- Therefore, could it be just the social contact that might have been response for depression reduction.
 - Many confounding variables.
 - Social life of participants.
 - Some might not have enjoyed the company.



Biological Explanations

- May offer more potential in terms of a cause and effect relationship between exercise and depression reduction.
- However, some caution because there is so many variables to consider.
 - E.g. Buckworth et al (2012) – Bright light treatment can reduce some depression.
 - Therefore if exercising in daylight it might be due to the light exposure as much as exercising.



Aetiology of depression...

- Aetiology = study of causes.
- Monoamine Depletion Hypothesis.
- Suggested (by accident) when exploring the side effects of prescribed medication for physical illness.
 - Reserpine (used to treat Blood pressure) – linked with Depressive symptoms – for those not known to have depression previously.
 - 15% increased risk.



Aetiology of depression...

- Resperine works by inactivating cells that contain noradrenaline and serotonin (5Ht).
- Consequently, depleting the activation of noradrenaline and serotonin.
- Resperine can cross the blood brain barrier, so can impact on serotonergic and noradrenergic cells in the brain.
 - Monoamine depletion hypothesis of depression.

Monoamine depletion hypothesis of depression.

- Depression is caused by a deficiency of noradrenaline at central adrenergic receptors OR a deficiency of serotonin.
- The Monoamine depletion hypothesis has formed the basis of anti-depressant medication
 - E.g. Prozac, Zoloft = SSRI's (Selective Serotonin Re-uptake inhibitors)
 - Significantly more effective than placebo (Williams et al, 2000).



Research involving exercise

- Animal studies –
- A variety of studies have suggested changeable increases in brain serotonin (5HT) and Noradrenaline levels following acute exercise in rats
 - (Dishman et al, 2000; Dunn et al, 1996, Dunn and Dishman, 1991)
 - Similar findings for longer term exercise of moderate intensity (Yoo et al, 1999; 2000).



Dishman et al (1997)

- A classic behaviour symptom of depression in humans is that of “learned helplessness” which can often come as a consequence of repeated exposure to inescapable stress.
- First study (Dishman et al, 1997) demonstrated that rats exposed to an inescapable stress had lower 5HT and Noradrenaline levels.
 - However, rats in exercise group – exposed to same stress, impact on 5HT and Noradrenaline was less.



Dishman et al (1997)

- What study follow up suggested was that for rats exposed also to aerobic (wheel running) exercise when they were exposed to a CONTROLLABLE stress (e.g. shock treatment but with an escape root) they were able to escape quicker than the sedentary rats.
- Reducing Learned Helplessness (Greenwood et al, 2003).



However.....

- Findings have not been as conclusive for humans.
- For example – animal studies have also suggested that treadmill running can also increase dopamine release in rats.
- Such findings not as conclusive in Humans.... Yet.... (Dishman et al, 2006; Wang et al, 2000 Knab and Lightfoot, 2010).



Nevertheless

- Despite the mixed findings in relation to dopamine levels, there is still a school of thought that these inconsistencies are in the main due to inconsistencies in the research methodologies (Lin and Kuo, 2013).
- E.g. Studies exploring the role of exercise in reducing ADHD symptoms would still suggest this is due to increases in dopamine levels.
 - Although again limited in relation to humans (Robinson et al, 2011)



Endorphins....

- Endorphins are our bodies natural pain killers.
- Prime function is to stop the transmission of pain signals.
- Also heightened feelings of Euphoria.
- Endorphins are opioids and recreational drugs that have similar chemical structure and responses.
 - E.g. Heroin.



The Runner's High.....

- Runner's high = sense of heightened alertness and awareness, feeling of euphoria, increase positive feelings spiritually, psychologically and spiritually. A feeling of liberation, suppressed pain, a sense of ease and exhilaration (Weinberg and Gould, 2012).
- Very common among runners – 30% claim they experience it on daily runs (Weinberg and Gould, 2012).



Defining Runner's High

- Sachs (1984) and Berger (1996) – Several key words to define runner's high including “euphoria, spirituality, power, gracefulness, effortless movement, a glimpse of perfection, spinning out” (Weinberg and Gould, 2012 p410).
- Linked with peak performance and flow (Jackson and Csikszentmihalyi, 1999).

Boecker et al 2008

- Very well known study that explored the Runner's high phenomenon using PET scan.
- PET Scan of 10 Endurance Athletes (used as runner's high is reported most often in long distance running). Scanned twice in random order at rest and after a 2 hour endurance run.
- Also given rating scales to report their euphoric feelings at these two points.



Boecker et al, 2008

- Reduction in opioid receptor AVAILABILITY was reported after the 2 hour run.... Conclusion, more opioid receptors were already bound to an endorphin neurotransmitter.
- Prefrontal and limbic regions.
- In addition, the self-reported level of euphoria was significantly increased after running.
- Quite strong evidence that running may result in an increase in Endorphin release.



RUNNERS HIGH

AFTER MANY MILES, LONG DISTANCE RUNNERS OFTEN
EXPERIENCE A PRONOUNCED FEELING OF EUPHORIA
I SMOKE AND DRINK. ONE FLIGHT OF STAIRS. SAME THING

motifake.com



Could this be the link with exercise addiction....

- Major school of thought.
- Opioids such as Heroin which leaves feelings of heightened euphoria are very addictive.
- In addition, dopamine (in which there have been links in Animal studies) is a major aspect in relation to rewards, drives and motivation.
 - Research in other areas (such as gambling addiction) have suggested that heightened levels of dopamine, endorphins and serotonin associated with addicted gamblers.



Issues with Exercise Addiction Research

- Unlike some other “addictive” behaviours, such as smoking, there are also health benefits to exercise.
- Therefore, early research and schools of thought so being addictive to exercise as a “positive” thing (Glaser, 1976).
 - Therefore, exercisers desired to be addictive to exercise.
 - Consequently athletes (and research participants) would describe themselves as addicted to exercise.



Griffiths (1997, 2002)

- Components of Exercise Addiction....(as with any type of addiction)
- Salience
 - Becomes the most important thing in the person's life.
- Mood modification
 - Positive or Negative Mood as a consequence of engaging in exercise.
- Tolerance
 - Increasing amounts of the activity are required to achieve former effects.
 - Increase exercise to get the same euphoric feeling.



Griffiths (1997, 2002)

- Withdrawal Symptoms
 - Unpleasant feeling states and/or physical effects which occur when the activity is discontinued or suddenly reduced
- Conflict
 - Between those around them, other activities (e.g. job) and with themselves.
- Relapse
 - Repeat behaviours after days, months or years of abstinence.



Pierce et al (1993)

- Examined Endorphin response to endurance exercise (aerobic dance)
- 8 women trained in dance.
- Plasma Endorphin levels prior and post a 45 minute dance routine + participant answered a exercise-dependence scale.



Pierce et al (1993)

- Findings
- Plasma Endorphin Levels greater post exercise.
- However, no correlation (either way) between Endorphin levels and exercise dependence scale.
 - Any issues with such studies?



Critique

- Low Sample Size.
- Remember back to Griffiths (1997, 2002) criteria of an addiction.
 - Greater effort needed to attain previous feelings of euphoria (so we would not necessarily expect those addicted to have the same response).
 - However, remember Pierce reported NO correlation at all....
- However, unlike with gambling – with exercise you also build a physical tolerance to training effects (oxygen uptake, sweat response).
 - It is not necessarily those who scored high in the exercise-dependence scale were physically fitter.



Leuenberger (2006)

- Review of literature that reports inconsistency evidence for a rise in endorphin release in humans.
- Difficult to simply deduct the endorphins released due to exercise are the cause of euphoric feelings.
- Remember the primary role of endorphins (pain suppression) – Exercise can hurt, particularly long distance running with an end goal.
 - (Farrell, 1985)



Lecture Conclusion

- Depression rates and cost of treatment highlight the reason to research alternative treatments.
- Widespread cross sectional studies have highlighted the impact of exercise as a predictor of positive well being and a decrease likelihood of obtaining depression.
- However, such studies look at this relationship retrospectively, so issues.



Lecture Conclusion

- Prospective Longitudinal have provided us with insight into being able to examine how exercise behaviours might predict future depression. However, the survey nature of such research provides with many issues.
- E.g.
 - Type of Exercise
 - Intensity and Frequency of Exercise
 - Measure of Depression.



Lecture Conclusion

- Individual experimental studies have further highlighted how exercise can be used as treatment against depression
- So how have researchers explained the impact of exercise as a treatment on exercise?
 - Social
 - Cognitive
 - Biological Mechanisms (Buckworth et al, 2012).
 - Combined elements of these

Lecture Conclusion

- Whilst there are much research demonstrating social and cognitive explanations for the effects of exercise as a treatment of depression, many confounding variables so cause and effect issues.
- Biological explanations may provide a more direct answer and address the cause and effect concerns of other explanations.





Lecture Conclusion

- Biological Explanations
 - Effects of Exercise on Serotonin, Noradrenaline, Dopamine and Endorphin levels.
- Promising Findings on Animals.
- However, findings on human less clear.
- Endorphin levels may provide some insight into exercise addictions.