Exercise and the possibilities of it being used to treat Drug Addictions

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Pass with Merit

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ABSTRACT

Currently there are over 23 million people are addicted to alcohol and drugs in America and addiction is the number one public health threat in the United States. Therefore it is essential that we find a way of effectively allowing an addict to withdraw and stopping more people becoming addicted to the drug. This research focuses on BDNF produced in exercise and how it can help addicts recover as well as making it less likely for people to become addicted in the first place. The possibility of prescriptions for cardiac exercise in the form of fitness classes has been discussed and the financial implication considered. Despite localizing this paper to just alcohol and cannabis addiction the reasoning is exactly the same for every type of drug addiction and if exercise was initiated our society would have much less addiction and drug related health problems.

INTRODUCTION

Parkinson’s disease is a completely neurological condition with physical symptoms such as trembling and slowness of movement despite these muscles showing no sign of damage (1). This vivid example of how the mind can affect the body in a negative way led us to believe that the body can affect the mind in both negative and positive ways. This has been demonstrated by many cases of which the placebo effect is the greatest and most widely recognized in science and modern medicine and has been shown in a number of drug trials. One of these trials in 2010 carried out by researchers in the Program of Placebo Studies at Harvard Medical School on patients with irritable bowel syndrome found that even if the patients were told that the pills they were taking were placebos they still benefited significantly compared to the patients who were not given pills (12). As exercise is considered one of the best things for the human body it is possible that it could affect the mind in a positive way. Exercising for only 30 minutes increases adrenaline, serotonin, dopamine and endorphin levels in the blood can create feelings of euphoria and act as natural painkillers(2).

Research has shown that exercise raises BDNF (Brain Derived Neutrophic Factor) protein levels directly which as well as having the “feel good” factor can also have some positive affects for the brain. BDNF is one of the most active neurotrophins1 and when it comes into contact with the neurons in the brain it causes the number of dendrites on the neuron and the dendritic complexity of the arbors2 to be increased therefore increasing connections in the brain and synaptic plasticity as well as stimulating neurogenesis from the neural stem cells. This therefore disproves the theory that once a human being has reached maturity they have all the brain cells that they will ever have as exercise in all ages will increase BDNF levels and therefore stimulate neurogenesis throughout a lifetime. The “feel good” factor created in BDNF is because it restores each neuron to the balanced chemical levels that it works best at. Low levels of BDNF have been suggested as causes for Alzheimer’s disease, Rett Syndrome, Dementia, anorexia, Huntington’s disease and many others (7). Due to the “feel good” feeling produced by BDNF it could be proved as a replacement for addictive drugs which create a similar effect and minimize the effects of withdrawing from a certain drug.

Not enough properly regulated trials have been done to determine whether or not exercise decreases the chance of relapsing in former drug addicts however other trials seem to indicate that exercise has an affect that makes creatures less dependent on drugs. However, this

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1 Neurotrophins are chemicals that help to stimulate and control neurogenesis

2 Neuron Arbors are the collection of the branching parts of the neuron
phenomenon was demonstrated in Barcelona, Spain at the Charles River Laboratories Inc whereAdult male Sprague-Dawley rats were separated into two groups; one group was given exercise training and the other group wasn't. When the rats had been conditioned to know which compartment gave amphetamines and which one gave saline, a higher proportion of the rats that had undertaken the exercise program stayed in the saline compartment than the non exercised rats that spent little time in the saline compartment (11). These results suggest that previous regular exercise over a long period of time makes a creature much less susceptible to addictive drugs.

DISCUSSION

In order to help drug addicts to get over their addictions any triggers that could cause an addict to revert must be controlled or minimized. These triggers can vary between different drugs but some main triggers that are general reasons for reverting are depression, stress, lack of support and lots of free time. The research into BDNF has been used by scientists to find a more natural treatment for depression as at the moment the medication is designed to raise serotonin levels as depression is thought to be due to a chemical imbalance in the brain caused by a lack of serotonin. However, as we cannot measure serotonin levels in the brain it is only a theory and little is known about how antidepressants actually work. Antidepressants are generally SSRIs (Selective Serotonin Reuptake Inhibitors) which are thought to increase the activity of neurotransmitters Serotonin and Noradrenalin. Only around 60% of people on antidepressants see any improvement after 3 months, which is generally the time the antidepressants start to really show an affect. As this is quite a long time period and there is no guarantee that the antidepressants will actually work, we need to find a drug which gives results much faster and the key to that may be in the chemicals produced in the brain by exercise.

In Schmidt & Duman's paper "Peripheral BDNF Produces Antidepressant-Like Effects in Cellular and Behavioral Models" they reveal the antidepressant effects that BDNF has on mice in a number of different tests. However, in spite of working much quicker than the SSRI Antidepressants the tests carried out are so sensitive that the results could be due to lots of confounding factors. Also BDNF has a really short activity period and so doesn't work as a daily pill or injection but there is the possibility that a BDNF osmotic minipump could be used to maintain BDNF levels allowing neurogenesis to create more serotonin neurotransmitters allowing the brain to balance out the chemicals itself (Duman & Schmidt, 13th December 2010). However, the best way to get BDNF into the brain is to inject it into the hippocampus, a part of the brain which is associated with learning, memory and depression, which is obviously is a very risky procedure to do on a human being and could cause even worse neurological problems or be fatal if the procedure went wrong. Despite the results on the mice being slightly better than no treatment at all there could be other confounding factors that were the reason the tests showed an antidepressant effect for BDNF. As the results for BDNF being put into the body at another point were much less than BDNF being put into the brain fitting a human with an osmotic minipump may do no more than the current antidepressant treatments do already. It would be much better to stimulate the brain to produce more BDNF itself by prescribing exercise or doing something else to help stimulate the production of

3 Amphetamines are addictive drugs which work by activating the brain’s reward pathways
4 Saline is the liquid part of the blood and has no addictive affect at all.
BDNF. Unfortunately as with antidepressants when we try and help improve that balance by raising a certain drug it is possible that the levels could be raised too much and harmful neurological side effects could occur.

As depression is common among individuals during withdrawal from drugs or alcohol (3), regular exercise could prevent an individual becoming so depressed and therefore making them less likely to revert back to the drug addict or alcoholic that they were. Withdrawal Symptoms can also play a major part in whether or not an addict can give up an addictive substance. Withdrawal symptoms will affect each person differently and for each individual they will have different amounts of both physical and emotional withdrawal symptoms. For example-Marijuana, which is the most popular recreational drug (4). After inhalation of marijuana smoke all the chemicals in the smoke are distributed throughout the body (5). One of these chemicals THC (tetrahydrocannabinol) is a very potent chemical with one mg of THC producing serious psychological and mental effects and reaches the brain within a few seconds of being inhaled producing an instantly relaxing effect for the user(5). The way THC works is that it is a cannabinoid\(^5\) chemical and mimics another cannabinoid chemical anandamine\(^6\) which means that THC binds with the cannabinoid receptors that anandamine normally would resulting in neurons being activated to produce a “high” feeling. As exercise causes a release of endorphins and endocannabinoids(3) which produce the same “high” feeling as THC in Cannabis does but has none of the adverse affects on health exercise could be considered as a replacement for the drug minimizing the affect of an withdrawal symptoms as the brain is still getting its supply of cannabinoids.

Exercise becoming a replacement for addictive drugs would not only stop the person from reverting back but could also start to repair any damage done to the body such as making the lungs bigger and more elastic and counteracting the negative effects of smoking Marijuana on the lungs such as coughing, wheezing and an increased chance of respiratory diseases(6). This of course is dependent on the age of the person, how long they have been an addict and how much of the drug they were taking before they stopped. Unfortunately BDNF protein is secreted by the BDNF gene on chromosome 11 of our DNA which means that some people will be affected by exercise a lot more than others and therefore a standard amount of exercise that each person should do to combat their addiction varies from person to person (7). Also the amount of exercise needed would also depend on how regularly the addict had been taking the drug so that the pattern of regularity didn’t change during the transition stage from drug to exercise. There is also the problem that just because a GP prescribes you exercise doesn’t mean people will actually do it and if a heavy drug user wants to give up they will have to do a lot of exercise whilst cutting down on the drug use which they may not do as exercise isn’t rewarding at first. However, long term exercise over 6 months has the possibility of producing functional neuroadaptations which influence an individual’s susceptibility to developing a substance disorder(8) and could actually give people increased willpower.

This was demonstrated at Charles River Laboratories Inc.\(^7\) where they found that exercise made the rats less dependent on these types of drugs suggests that this could be the same for

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\(^{5}\) Cannabinoids are a class of chemical compounds that activate cannabinoid receptors. These can include anandamine, THC and endocannabinoids.(9)

\(^{6}\) Anandamine is a neurotransmitter which binds with a cannabinoid receptor activating the neuron and causing a sensation of “bliss”. Hence why it is called the “bliss” molecule (10)

\(^{7}\) See Introduction, Page 3 of paper
humans as the basic chemical balance in rats’ brains works exactly the same as in humans. Therefore cardiac exercise before any addiction has occurred could also have the effect of making humans less susceptible to addictive drugs once they’ve tried them and so perhaps more people exercising from an early age would decrease the number of addicts in later life. If schools perhaps made it compulsory for there to be an hour of cardiac exercise before school, then our society would hopefully see the benefits in 20 years time with much less addiction and depression. Before this happens though there would need to be much more evidence and research done on this area with lengthy clinical trials before this is considered.

Another reason relapses back to drug addictions can be so common is due to the everyday stresses of daily life and drug abuse can be used as a form of escape. Often the reason for drug taking is either to number painful emotions, to calm down after an argument, or to forget about any problems. This inability to deal with certain problems and stress therefore increases the likelihood of dependence on drugs. During exercise a chemical called galanin is produced in the brain which seems to diminish stress-related thoughts and cravings and therefore it’s likely that exercise reduces stress (3). Therefore implementing regular exercise may decrease lots of stress related disorders as well as helping drug addicts rehabilitate by helping them to deal with stress.

However, there are many problems with this theory; firstly an addict may not be very healthy as they used their time and money on drugs instead of aerobic exercise and therefore the idea of doing lots of cardiac exercise isn’t very appealing to them and could make the process of rehabilitation a whole lot harder, secondly there is no current way of monitoring exercise. One way of monitoring exercise would be though blood chemical monitors, the latter of which being the most useful as it could measure how much BDNF was being produced by the exercise and not just how much exercise was being done. The problem with these monitors would be that they would monitor 24/7 and therefore lots of addicts wouldn’t accept them as any drugs they took would show up and it would feel like the doctor was trying to catch them out and tell them they’d failed undermining the trust they had for the doctor.

With addiction to Cannabis and other drugs which don’t have particularly strong physical withdrawal symptoms going straight off it and onto exercise is fine. Unfortunately certain drugs such as alcohol and tranquilizers can have some very dangerous withdrawal symptoms which include Strokes, Heart attacks, Grand mal seizures and delirium tremens\(^8\). For these drugs a slightly different process would be needed because of the extra risk involved but the theory is still the same as with the cannabis drug addiction.

One of the things about when someone goes “cold turkey” on a drug is that the space in their life where that drug went seems to block out everything making addicts think about the drug more causing relapses. If exercise was to replace that drug then the feeling of loss wouldn’t be so great, especially as the endocannabinoids produced in exercise give the person a “high” and self satisfied feeling. Some drug treatment and rehabilitation centers already use exercise as part of a program to help addicts develop a healthier lifestyle however this is more as stated earlier due to focusing them on something other than their withdrawal symptoms and cravings.

Alcohol abuse has also been found to disrupt the circadian rhythm\(^9\) our bodies follow which explains why when recovering from alcoholism the person’s sleeping patterns and eating habits

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8 Delirium tremens, otherwise called DT’s, are the most severe alcohol withdrawals.

9 Circadian Rhythm is the daily (24 hour) cycle of the body’s biological processes which is influenced by external conditions such as light.
often change. This can cause a lot of stress for a recovering alcoholic if they have to go to work after two hours sleep and cannot concentrate as they are too tired and could trigger a relapse due to the strain of doing too much on not enough sleep. Exercise is a recognized way of regulating the circadian rhythm and can allow normal sleeping and eating routines to continue avoiding unnecessary strain being put on the body by being tired and helping in the other ways discussed earlier.

As the amount of BDNF produced by each person with the same amount of exercise is different for everyone due to genetic factors exercise couldn't be relied upon as being the only thing to treat these addictions. Instead it would be only one component of a wide detoxification plan to give the individual more chance of not reverting back to their original state. This means if you were a heavy drinker or had been drinking frequently for a long time and your GP thought you may be likely to get severe withdrawal symptoms then they would prescribe a benzodiazepine medicine such as chlordiazepoxide for the first couple of days to suppress any violent reactions from lack of alcohol and then an exercise routine could be suggested to distract the recovering alcoholic as well as giving them a substitute for alcohol would also fill their time so they have less time to drink. As alcohol is often a depressant would allow them to be more relaxed and feel good about themselves because of the increased BDNF in their system. Once started on the exercise routine regular cardiac exercise would be needed for at least a couple of months to ensure that the person was completely recovered however the amount of exercise required would drop the longer they had been off the alcohol depending on how the GP decided the recovering alcoholic was doing.

As stated previously monitoring the exercise done by a patient is very hard and what they consider was a lengthy run or a hard workout may not be to the standard that others expect and so figuring out how much BDNF your producing and whether or not its sufficient to stop relapses is very difficult. One way of controlling the minimum amount of exercise someone dies would be to prescribe someone cardiac exercise in the forms of a certain number of fitness sessions a week. Attendance could be recorded and at the session and the fitness instructor would also be able to monitor how hard the body was working by measuring heart rate allowing a later translation into BDNF which could be given to the recovering person showing them how much less likely they were to relapse and alert the doctor if medication was needed due to withdrawal symptoms appearing alarmingly or a relapse was expected. Unfortunately currently the NHS doesn’t have the budget to pay for exercise sessions for the amount of people that would need them so that they could be free for people with prescriptions to attend. As with alcoholics anonymous and all other support groups being around other people with similar problems to you and the sense of fellowship can make a person much stronger if they know other people are going though the same thing and have struggled with the same things you have. This of course raises issues with equality as people who have never be addicted to any substance or drug feel that they are being disadvantaged as they have to pay to do the same classes as the recovering drug addicts and alcoholics who would get them for free. There could be problems with perfectly healthy people abusing the system to get prescriptions for free gym use and this may put unnecessary strain on GP Practices and overfill classes meaning the people who actually need help would have less time spent on them and vital signs that something is wrong could be missed. However, this risk is taken whenever a new drug is allowed to be prescribed and at least, instead of stockpiling antibiotics or drug dealers getting
hold of Opioid analgesics\textsuperscript{10} to sell on to dependent people, the person taking the classes isn’t going to have any adverse affects to the exercise or be able to sell the classes to another person as easily.

CONCLUSION

Despite there being not enough evidence yet from clinical trials there is a very high probability that exercise could be a major factor in helping an addict quit a drug due to other trials on very similar things. Exercise is very good for recovering drug addicts as it can minimize the triggers making addicts less likely to revert and has been proven to improve people’s restraint on addictive substances. All the chemicals produced in cardiac exercise by the brain, most notably BDNF, create a euphoric feeling similar to that of marijuana and other addictive drugs which can trick your brain into thinking that you’ve had your weekly fix of that drug reducing withdrawal symptoms and allowing less strain to be put on the body. Exercise reducing stress also helps by minimizing the trigger and exercise can be a way of dealing with stress whereas before drug taking may have been a way of avoiding problems. As BDNF pumps aren’t very efficient and actually would get the same amount of BDNF into your brain as a quick jog up and down a flight of stairs would, I conclude that it would be much better to consider using cardiac exercise. However, the monitoring of cardiac exercise is very difficult as privacy is considered an important part of people’s lives. The blood chemical monitors despite giving a very good measure of how much exercise had been done would be considered as an infringement on privacy. This is as they would show any drug taking recently which despite showing information on relapses would make the person feel as if they weren’t trusted to stay away from that drug. This loss in trust would be a massive negative for the person and may make them more likely to relapse. In spite of the problems prescribing exercise classes it seems the best way of keeping track of the minimum amount of exercise that the recovering addicts were doing and the feeling of fellowship may also help a lot. Due to the financial costs of running the classes the health service probably wouldn’t be able to afford all of the costs. However, if a charity was set up, similar to support groups, and provided these classes with support from the government in the form of grants it may be possible that the classes would be viable. Compulsory cardiac exercise for an hour at school before lessons would mean that the children would be much less susceptible to drug addiction in later life and would also mean our society would have fewer addicts and less depression in the future.

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\textsuperscript{10} Opioid Analgesics are prescribed for moderate or severe pain. Dependence can occur with regular use and therefore these medications are big business for drug dealers.

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