Assessing the Effectiveness of Physical Activity Interventions in the Treatment of Substance Use Disorders

Ben Jiang, 1/14/2024

Introduction

Drug addiction has become a severe issue in recent years. In 2021, the number of people who suffer from drug use disorders experienced an explosion. The sum skyrocketed to 39.5 million, which is a 45 percent increase over the past 10 years[1]. With such a booming incline of drug abusers suffering, treatments for drug addictions are yet scarce. There are treatments using substances such as methadone or buprenorphine to replace drugs and minimize the harm to the brain[2]. However, they hold the risk of addiction and cause drug-drug interactions, a phenomenon when drugs interact with drugs or food taken while can cause unwanted side effects[3]. Under the hardship of investigating and inventing medical treatments for drug addictions, exercise emerged as a novel solution to this dilemma. To examine the efficacy of exercise when curing drug use disorders, the effectiveness of exercise is explored during three separate phases based on the different neurobiology changes drug addiction triggers[4]. This report discusses the positive effect of exercising on substance abuse as a possible clinical trial for all phases.

Early stage: Bingeing

Exercising is a beneficial treatment for bingeing during the first couple months of drug use (the early phase). When drug use is initiated, the reward pathway is utilized for dopamine signaling[5]. Research shows that physical activity increases the dopamine (DA) concentrations and activates DA receptors D3, D2, and D1 to bind[6]. The formation of these DA receptors stimulates the same reward pathway as drug addiction[7]. The shared reward pathway and similar DA secreting stimulation between exercise of use of drugs makes physical activity a plausible natural substitutional treatment of drug use. Increases in DA concentrations and binding DA receptors are also proven by multiple studies that they are advantageous at reducing the initial vulnerability

---

[1] UNITED NATIONS O

FFICE ON DRUGS AND CRIME, *World Drug Report 2023* (United Nations publication, 2023), 12-13.

[2] Dongshi Wang, "Impact of Physical Exercise on Substance Use Disorders: A Meta-Analysis," *PLOS*. October 16, 2014, https://journals.plos.org/plosone/article/authors?id=10.1371/journal.pone.0110728. (Jan 14, 2024).

[3] HIVinfo authors, "What is a Drug Interaction?" *HIVinfo*. National Institute of Health, August 4, 2021, https://hivinfo.nih.gov/understanding-hiv/fact-sheets/what-drug-interaction. (Jan 14, 2024).

[4] Wendy J. Lynch, "Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis," *Neuroscience & Biobehavioral Reviews* 37, no.8 (2013): 1623-1624.

[5] Lynch, "Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis," 1625.

[6] Stephen M. Stahl, "Dazzled by the dominions of dopamine: clinical roles of D3, D2, and D1 receptors," *CNS Spectrums (2017)*, no.22, 305–307.

[7] Rui Zhang, "Dopamine D1 and D2 receptors are distinctly associated with rest-activity rhythms and drug reward," *The Journal of Clinical Investigation*, 131 no.18 (2021): e149722.

of drug use, serving its secondary purpose of decreasing the harm previous drug bingeing might do to the addict's body health[8].

Late stage: Chronic use

During later stages of addiction when addicts are exposed to chronic use of drugs, the glutamatergic signalizing pathway gets activated. Glutamates are the most abundant excitatory neurotransmitter in the brain. It is crucial to learning and memory. Study shows that chronic drug use overstimulates glutamatergic receptors (GR) causing damage to the memory[9]. A study on Chronic morphine exposure has demonstrated the connection between changes in the neural circuit plasticity with chronic drug abuse[10]. Exercising has a protective use in the damaging GRs. Research indicates that exercising can decrease glutamate in the striatum, which protects the receptors against chronic drug use[11]. This decrease contributes to brain health and the recovery of memory. Exposure to certain drugs also changes the neural circuit plasticity, which accounts for skill learning and quick recovery from brain injuries[12]. To mitigate this harm, exercise can recover brain plasticity by remodeling the chromatin at regions that were implicated and damaged during drug addiction[13]. In this sense, exercise is an extremely beneficial treatment for the second phase as it cures and recovers both GR overstimulation and changing brain plasticity.

Withdraw stage: craving and withdrawal symptoms.

After chronic abuse of drugs, drug addicts develop severe dependence on drug use. When drugs are suddenly snatched from their lives, broken consistency will cause the drug user to experience withdrawal symptoms. According to information provided by the National Institutes of Health (NIH), nausea, vomiting, diarrhea, anxiety, and insomnia are all possible to occur after withdrawing the drug of abuse[14]. As mentioned in the introduction, replacements and mitigations of such are restricted by drug-drug interactions. Meanwhile, multiple studies has solidified the mitigating effect of exercising. A Meta-analysis of 22 randomized control trials shows that aerobic exercise mitigated withdrawal symptoms, anxiety, and depression in adult abusers[15]. Methamphetamine-dependent individuals also suggested that moderate exercise significantly reduced depression symptom scores[16]. Research focusing on whether exercising time was a factor of its effectiveness concluded that even short-term exercise modifies behaviors related to

---

[8] Wendy J. Lynch, “Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis,” 1623.
[9] Cleveland Clinic authors, “Glutamate,” *Cleveland Clinic*. August 25, 2022, https://my.clevelandclinic.org/health/articles/22839-glutamate. (Jan 14, 2024).
[10] V. Beltrán-Camposa, “Effects of morphine on brain plasticity,” *Neurología*. 30, no.3 (2015):176—180.
[11] Lynch, “Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis,” 1623.
[12] Michael V. Johnston, “Plasticity and Injury in the Developing Brain,” *Brain Dev.* 31 no.1, (2009): 1–10.
[13] Lynch, “Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis,” 1625.
[14] World Health Organization Regional Office of the Western Pacific, *Clinical guidelines for withdrawal management and treatment of drug dependence in closed settings* (World Health Organization, 2009), Page 32.
[15] Lisa S. Robison, “Exercise Reduces Dopamine D1R and Increases D2R in Rats: Implications for Addiction,” *Medicine & Science in Sports and Exercise*, Publish Ahead of Print, May 23, 2018, (accessed: Jan 14, 2024).
[16] Sucharita S. Somkuwar, “Evaluating Exercise as a Therapeutic Intervention for Methamphetamine Addiction-Like Behavior,” *Brain plasticity*, 1 (2015): 63–81.

drug withdrawal[17]. Positive effects are also confirmed by animal experiments. A study discovered that wheel-running can ease withdrawal behavior in morphine-addicted mice[18]. Furthermore, exercise reduced the craving for cannabis in marijuana-dependent adults, and enhanced the healing effect on substance use disorder[19]. Studies already assures the effectiveness of exercise in this phase.

Suggestion

Different from other pharmacology methods, exercising is an easier, and a profitable approach. Low cost and ease of implementation make exercise therapy lucrative as a potential treatment for drug abusers. Moreover, exercise benefits in all phases of addiction, making it a universal treatment that is easy to implement. Yet, more research still needs to be conducted to look into the details of exercises to maximize the effectiveness of implementing them. Based on the research findings in those researches, careful designs on the type of exercise, the intensity of exercise, and the frequency of exercise can be made to develop a system of effective exercise treatment for drug addicts.

---

[17] H.Z. Rosa, "Physical exercise modifies behavioral and molecular parameters related to opioid addiction regardless of training time," *European Neuropsychopharmacology*, Volume 32, (2020) Pages 25-35.
[18] Dongshi Wang, "Impact of Physical Exercise on Substance Use Disorders: A Meta-Analysis," https://journals.plos.org/plosone/article/authors?id=10.1371/journal.pone.0110728 (Jan 14, 2024).
[19] Maciej S. Buchowski, "Aerobic Exercise Training Reduces Cannabis Craving and Use in Non-Treatment Seeking Cannabis-Dependent," *PLOS*. March 8, 2011, https://journals.plos.org/plosone/article/authors?id=10.1371/journal.pone.0110728. (Jan 14, 2024).

Bibliography

UNITED NATIONS OFFICE ON DRUGS AND CRIME. *World Drug Report 2023*. United Nations publication, 2023.

Lynch, Wendy. "Exercise as a novel treatment for drug addiction: A neurobiological and stage-dependent hypothesis." *Neuroscience & Biobehavioral Reviews* 37, no.8 (2013): 1623-1624.

Stahl, Stephen. "Dazzled by the dominions of dopamine: clinical roles of D3, D2, and D1 receptors." *CNS Spectrums (2017)*, no.22, 305–311.

Wang, Dongshi. "Impact of Physical Exercise on Substance Use Disorders: A Meta-Analysis." *PLOS*. October 16, 2014. https://journals.plos.org/plosone/article/authors?id=10.1371/journal.pone.0110728. (Jan 14, 2024).

HIVinfo authors. "What is a Drug Interaction?" *HIVinfo*. National Institute of Health, August 4, 2021. https://hivinfo.nih.gov/understanding-hiv/fact-sheets/what-drug-interaction. (Jan 14, 2024).

Zhang, Rui. "Dopamine D1 and D2 receptors are distinctly associated with rest-activity rhythms and drug reward." *The Journal of Clinical Investigation*, 131 no.18 (2021): e149722.

Cleveland Clinic authors. "Glutamate," *Cleveland Clinic*. August 25, 2022. https://my.clevelandclinic.org/health/articles/22839-glutamate. (Jan 14, 2024).

Beltrán-Camposa. "Effects of morphine on brain plasticity." *Neurología*. 30, no.3 (2015):176—180.

Johnston, Michael. "Plasticity and Injury in the Developing Brain." *Brain Dev.* 31 no.1, (2009): 1–10.

World Health Organization Regional Office of the Western Pacific, *Clinical guidelines for withdrawal management and treatment of drug dependence in closed settings*. World Health Organization, 2009.

Robison, Lisa. "Exercise Reduces Dopamine D1R and Increases D2R in Rats: Implications for Addiction." *Medicine & Science in Sports and Exercise*, Publish Ahead of Print, May 23, 2018, (accessed: Jan 14, 2024).

Somkuwar, Sucharita. "Evaluating Exercise as a Therapeutic Intervention for Methamphetamine Addiction-Like Behavior." *Brain plasticity*, 1 (2015): 63–81.