The Neuroscience of Addiction

Addition is a common disease across the globe. The World Drug Report 2019 reported that 35 million people were using drugs globally (UNODC, 2019). Addiction shapes the fundamental structure and functioning of the brain. Addiction associated with use of drugs or alcohol significantly alters the structure and chemistry of the brain. The effects of addiction alter and disrupt brain processes associated with memory, motivation, and reward (Volkow et al., 2019). The effects also drive compulsive behavior and substance use, often worsening the addictive behavior or substance use. This review is based on the premise that changes in brain structure and brain function due to substance use develop and maintain addiction. The extended exposure to drugs or substances is associated with neuroadaptation that contribute to addiction. Addiction is the outcome of changes in neural pathways that lead to a chronic and relapsing cycle of substance use.

Neurobiological Changes in Addiction

a.Changes in Brain Structure

Chronic substance abuse profoundly affects the development and maintenance of addiction. The changes associated with persistent drug use include reduction in volume of gray matter in the prefrontal cortex, insula, and amygdala. Gray matter contains cell bodies and is crucial for processing information. Studies have shown that individuals with substance use disorders have decreased gray matter volume in the prefrontal cortex (Ceceli et al., 2021; Huang et al., 2020). The reduced volume impairs executive function, impulse control and decision making. Research has also observed reductions in the volume of gray matter in the insula for different substance abuse addictions (Ceceli et al., 2021). The alterations potentially lead to changes in interoceptive awareness and drug craving. Further, Perini et al. (2023) suggest that structural changes in the amygdala could increase stress reactivity and emotional dysregulation in individuals with addiction.

Substance abuse has a negative influence on brain connectivity because it damages the myelin sheath. The protective covering helps increase the speed of information transfer between neurons. Studies have observed that the demyelination of white matter reduces its integrity in the corpus callosum in individuals with substance abuse disorders (Ceceli et al., 2021). The reduced integrity potentially affects interhemispheric communication. Pando-Naude et al. (2021) suggests that disruption of white matter tracts impairs cognitive control, which might increase compulsivity of drug-seeking behavior.

Substance abuse also increased the rate of decline of neural density. The decrease in number of neurons hinders the ability to form new memories (Uhl et al., 2019). Studies have also shown that a low neuronal density due to substance use impairs executive function, including the ability to make decision (Pasqualitto et al., 2023).