

Dynamical Modeling of Effect of Drug Abusing, Unemployment on Mental Health

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Abstract

Mental health, particularly among unemployed and employed populations, is a growing concern with significant societal implications. This study presents a mathematical model to analyze the dynamics of mental stress and illness, focusing on factors such as unemployment, drug abuse, and workplace conditions. The model divides the population into eight compartments, including susceptible individuals, those experiencing mental stress, employed and unemployed groups, and subpopulations abusing drugs. Key parameters such as recruitment rates, transmission rates of stress and illness, and recovery rates are incorporated to understand the system's behavior. The derived differential equations describe the transitions between these compartments, offering insights into how different factors influence mental health outcomes. The total population is considered to account for natural death rates and recovery from mental illness. This model aims to provide a framework for policymakers and healthcare professionals to develop targeted interventions, reducing the prevalence of mental anxiety and its associated risks. By examining the interplay between employment status, drug abuse, and mental health, the study highlights the need for comprehensive strategies to address these interconnected issues.

Keywords: Mental anxiety, mathematical modeling, unemployment and mental health, substance abuse dynamics, workplace stress

INTRODUCTION

Mental health is a critical aspect of overall well-being, yet it is often overlooked in public health discussions. Anxiety disorders, exacerbated by factors such as unemployment and substance abuse, pose significant challenges to individuals and societies. The increasing prevalence of mental stress and illness, particularly among working-age populations, underscores the need for a deeper understanding of the underlying mechanisms. This study proposes a mathematical model to explore the dynamics of mental anxiety, focusing on the transitions between different population compartments influenced by employment status, drug abuse, and workplace conditions. Unemployment is a well-documented contributor to mental stress. The lack of financial stability and social validation can lead to feelings of hopelessness, which may escalate into more severe mental health issues or substance abuse. Conversely, employment does not always guarantee mental well-being. Unhealthy work environments, excessive job demands, and job insecurity can also trigger stress and anxiety. These factors create a complex interplay between employment status and mental health, necessitating a systematic approach to analyze their interactions [1].

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Substance abuse further complicates this relationship. For some individuals, drug use becomes a coping mechanism for stress, but it often exacerbates mental health problems, leading to a vicious cycle of dependency and deteriorating psychological conditions. Previous studies have highlighted the bidirectional relationship between

mental illness and substance abuse, where each condition fuels the other. Understanding these dynamics is crucial for designing effective interventions.

Mathematical modeling has emerged as a powerful tool to study such public health issues. Compartmental models, commonly used in epidemiology, are adapted here to represent different mental health states within a population. These models allow researchers to simulate scenarios, predict trends, and evaluate the potential impact of interventions. In this study, the population is divided into eight compartments: susceptible individuals (X_1), unemployed populations with mental stress (X_2) or without (X_3), employed populations (X_4), unemployed drug abusers (X_5), employed individuals with mental stress (X_6), those with mental illness (X_7), and employed drug abusers (X_8). The model incorporates various rates, such as recruitment (r), transmission of stress (b_1), drug abuse (b_2), and recovery (μ), to capture the transitions between these states [2].

The literature on mental health modeling is extensive but often fragmented. Some studies focus solely on unemployment's psychological effects, while others examine workplace stress or substance abuse in isolation. This study bridges these gaps by integrating all three factors into a unified framework. For instance, the parameter a_1 represents the rate at which employed drug abusers develop mental illness, while e_1 captures the transition from work-induced stress to mental illness. Such detailed parameterization enables a nuanced analysis of how specific factors contribute to mental health outcomes.

Existing research also emphasizes the importance of recovery and natural death rates in mental health models. The parameter μ accounts for individuals recovering from mental illness, offering a pathway out of the system. Meanwhile, the natural death rate (δ) ensures the model reflects real-world population dynamics. These elements are critical for creating realistic simulations and assessing long-term trends [3].

Mathematical Model

The mathematical model is given below.

$$\left. \begin{aligned} \frac{dX_1}{dt} &= r - \theta X_1 - (1 - \theta) X_1 - \delta X_1 \\ \frac{dX_2}{dt} &= k_1 X_3 + d_1 X_5 - b_1 X_2 - b_2 X_2 - \delta X_2 + a_1 X_8 \\ \frac{dX_3}{dt} &= (1 - \theta) X_1 + C_3 X_4 - k_1 X_3 - K_2 X_3 - \delta X_3 \\ \frac{dX_4}{dt} &= \theta X_1 + k_3 X_2 - c_1 X_4 - c_2 X_4 - c_3 X_4 - \delta X_4 \\ \frac{dX_5}{dt} &= b_2 X_2 + k_2 X_3 - d_1 X_5 - d_2 X_5 - \delta X_5 \\ \frac{dX_6}{dt} &= c_1 X_4 - e_1 X_6 - e_2 X_6 - \delta X_6 + a_2 X_8 \\ \frac{dX_7}{dt} &= b_1 X_2 + e_1 X_6 + d_2 X_5 - \delta X_7 - \mu X_7 + a_3 X_8 \\ \frac{dX_8}{dt} &= c_2 X_4 - e_2 X_6 - a_1 X_8 - a_2 X_8 - a_3 X_8 - \delta X_8 \end{aligned} \right\}$$

Where $P(t) = X_1(t) + X_2(t) + X_3(t) + X_4(t) + X_5(t) + X_6(t) + X_7(t) + X_8(t)$
and $t \in [0, t], t > 0$.

Theoretical Analysis of the Mental Anxiety Model

The Mental Anxiety Model presents a comprehensive framework for understanding the dynamics of mental health issues within a population, particularly focusing on the interplay between employment status, mental stress, drug abuse, and mental illness. This model categorizes the population into distinct groups based on their employment status and mental health conditions, offering insights into how individuals transition between these states over time. The analysis below explores the theoretical underpinnings of the model, its components, and the interactions between them, without delving into mathematical notations or symbols.

Population Categories and Their Dynamics

The model begins by classifying the population into several key groups. The first group consists of individuals who are susceptible and eligible for employment. These individuals are at risk of transitioning into other categories depending on their employment outcomes and exposure to stressors. The unemployed population is further divided into subgroups: those suffering from mental stress, those abusing drugs, and those who remain unemployed without these issues. Similarly, the employed population includes individuals who are mentally stressed, those abusing drugs, and those who are employed without such problems. Additionally, the model accounts for the total population of individuals suffering from mental illness at any given time [4, 5].

Key Processes and Transitions

The model highlights several critical processes that influence the movement of individuals between these categories. Recruitment introduces new individuals into the susceptible group, while natural attrition reduces the population across all groups. Employment rates determine how many individuals transition from the susceptible or unemployed groups into employment. Conversely, job loss moves individuals from the employed group back into unemployment. Mental stress arises from various sources, including unemployment, drug abuse, and unhealthy work conditions. Unemployed individuals may develop mental stress due to the lack of employment or as a consequence of drug abuse. Employed individuals, on the other hand, may experience mental stress due to harmful work environments or the pressures of maintaining their jobs. The model also considers how mental stress can escalate into full-blown mental illness, particularly when compounded by factors like drug abuse or prolonged exposure to stressful conditions.

Role of Drug Abuse

Drug abuse is a significant factor in the model, affecting both employed and unemployed individuals. For the unemployed, drug abuse can stem from mental stress or serve as a coping mechanism, further exacerbating mental health issues. Among the employed, drug abuse may result from workplace stress or peer influence, leading to a vicious cycle where substance abuse worsens mental health and vice versa. The model captures how drug abuse can lead to job loss, mental illness, or further mental stress, creating complex feedback loops between these states [6].

Recovery and Natural Attrition

The model incorporates a recovery rate for individuals suffering from mental illness, representing those who receive treatment or otherwise improve their mental health status. However, recovery is offset by natural attrition, which affects all groups equally. This reflects the reality that mental health issues, if left unaddressed, can persist or worsen over time, while recovery is possible but not guaranteed for everyone.

Interactions and Feedback Loops

One of the strengths of this model is its ability to depict intricate interactions and feedback loops between different population groups. For instance, unemployed individuals facing mental stress may transition into drug abuse, which in turn increases their likelihood of developing mental illness. Similarly, employed individuals under stress may turn to drugs, leading to job loss and a return to unemployment, where their mental health may further deteriorate. These feedback loops illustrate the

cyclical nature of mental health challenges and the difficulty of breaking free from them without intervention [7-10].

Implications for Policy and Intervention

The theoretical framework of this model has significant implications for policymakers and mental health professionals. By identifying the key factors that drive transitions between mental health states, the model suggests potential leverage points for intervention. For example, improving workplace conditions could reduce the rate at which employed individuals develop mental stress or turn to drug abuse. Similarly, providing support for unemployed individuals, such as job training or mental health services, could mitigate the onset of mental stress or drug abuse. Targeted drug abuse prevention programs could interrupt the cycle of substance abuse and mental illness, while expanding access to mental health care could increase recovery rates. The model also underscores the importance of addressing both employment and mental health simultaneously, as these factors are deeply interconnected.

CONCLUSION

The Mental Anxiety Model offers a nuanced and comprehensive understanding of how various factors—such as employment status, mental stress, drug abuse, and mental illness—interact and influence one another within a population. By clearly delineating the pathways through which individuals transition between different psychological and socio-economic states, the model lays a strong theoretical foundation for developing targeted, evidence-based interventions aimed at improving mental health outcomes. Although currently theoretical in nature, the model's insights have significant real-world relevance, particularly in informing public policy, healthcare practices, and social support systems. It underscores the critical importance of adopting holistic and integrated approaches that simultaneously address both economic conditions and psychological well-being. These approaches may include initiatives focused on employment support, mental health services, substance abuse prevention, and social inclusion. Furthermore, future research can build upon this conceptual framework by incorporating additional variables—such as education level, access to healthcare, social networks, and cultural influences—or by empirically testing its predictions through longitudinal and cross-sectional studies. Such efforts would not only help validate and refine the model but also enhance our broader understanding of the complex dynamics that shape mental health in contemporary societies.

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