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Alcohol Use Disorder in Adolescents from Network Theory Perspective

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ABSTRACT

Alcohol use disorders in adolescents has been a major health and social concern across the globe demanding timely intervention in order to prevent the great deal of morbidity and mortality that are often associated with maladaptive pattern of substance use. Understanding the causation, maintenance and progression of alcohol use disorder is of utmost importance in formulating strategies for its treatment and prevention. There has been a major paradigm shift in understanding of the complex phenomenon of alcohol use in the form of application of concept of network theory. In this review a sincere attempt has been made to give insight into the various issues related to alcohol use disorders in adolescents.

Key Words: Social network, Alcohol dependence, Drinking habit

INTRODUCTION

There have been a tremendous progress in the field of network- which is viewed as the science of connectivity,interactions and interdependence over last few decades[1]. It is an interdisciplinary field covering many areas including telecommunications, computer, biological and social networks. [2,3]. Goh et.al illustrated that a human disease network comprises of human disorder and diseases and two diseases are linked if they share at least one associated gene [4].Recently the studies related to network analysis of various disorders have gained popularity amongst the researchers and scholars. Construction and analysis of complex network has been the area of interest and research in many fields dealing with complex organizations of interacting entities[5]. One such complex area is the substance use disorder in which symptoms in diagnostic criteria, behavioural, psychological and social factors and consequences do show a complex interaction. Thus making it a potential area for application of network analysis.

Alcohol consumption is a major social and health issue of this era and has been regarded as an important contributor to death and disability. Alcohol has been one of the major contributor of many diseases like oesophageal cancer, liver can- cer, cirrhosis of the liver, homicide, epilepsy, and has been linked to various adverse foetal and maternal outcomes such as sudden infant death syndrome, fetal alcohol syndrome, malnutrition, sexually transmitted diseases and many more. Alcohol has been estimated to be associated with as many as 1.8 million deaths each year across the globe and has been ranked as the fourth leading cause of disability adjusted life years (DALY) lost.[6,7,8]

International Classification of Diseases and Related Health Problems 10th edition (ICD10) and Diagnostic and Statistical Manual edition 5 (DSM5) have recognised alcohol use disorders as valid psychiatric diagnosis. Though Alcohol abuse and alcohol dependence were classified as two different entities in DSM IV, DSM 5 has integrated them into a single disorder called Alcohol Use disorder [9]. Apart from the nosological change there is definitely a need to change our approach in understanding the cause, effect and progress of this major health and social concern in order to deal effectively with the menace of alcohol use. One of such approach may be application of network theory. Network theory helps in revealing alcohol related problem and also their relations. This review is an attempt to look into the complex problem of alcohol use disorder in terms of network theory in general and social network in particular.

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Basics of network theory and social network

NETWORK is a collection of points joined together in pairs by lines. The points are referred to as vertices or nodes and the lines are referred to as edges. Vertices and edges carries different information s such as names or strengths, to capture more details of the system [10]. Networks describe not only components connection, interactions but also their pattern of connections[1].Network theory utilizes the concept of graph theory and become essential to uncovering the deeper inter-dependencies found in many complex systems.[2,3]

Social network Analysis

Social network Analysis is multidisciplinary area covering social psychology,mathematics,statistics, anthropology, biology, communication studies, economics, geography, information science, organizational studies andcomputer sciences[11,12]

A social network is a social structure comprises of nodes or actors (individuals or organizations) and edges among them. Edge indicates their different relations such as friendship, kinship, common interest, financial exchange, dislike, sexual relationships or relationships of beliefs, knowledge or prestige [12,13].

Nodes contain different sizes. They may represent individual, groups, organizations or societies. Relations among nodes indicate level of analysis. Some relation may be individual to individual and some are individual to group[13]. Social network is network of human society,where several people are linked by acquaintance or social interactions[10]. Network study illustrates different aspects of individuals and their nature. It indicates the pattern of connections results in big effect in behaviour of the system. In social network,pattern shows how one person affect the next one, form opinion, gather news, which node affect mostly the others and so on. To understand one system fully, it is necessary to know the structure of the system. Network reduces a system to an abstract structure capturing only the basics of connection patterns and little else [10].Social networks operate on many levels, from families up to the level of nations. In simple language social network is the map of individuals and their relations [12]

Social network can be broadly classified as whole network or sociocentric network and personal network or egocentric network. Sociocentric network specifies the relationship among the defined population whereas egocentric network ties specify people such as their "personal communities [12].

Egocentric network can provide individual information, social support, access to resources, sense-making, normative pressures, influence and these factors affect Ego's behaviour and this kind of network is formed based on selection and influence. Individual taking alcohol tends to select his friends who also takes alcohol and thereby forms an ego centric network where he is the ego and his friends are the alters.This kind of network is dominated by the people with particular views [14].

Matrices and measures of social network analysis

SNA can provide a platform for better understanding in terms of which actors are involved in a network, their links, how influential each actor is; what their motivations are and how the network is structured (15) .Measures and matrices are needed in network analysis in order to understand fundamental concepts. Centrality is considered to be an important network measure. Other measures of network analysis are-robustness, efficiency, effectiveness and diversity [16].

Centrality: Centrality indicates the most important or central nodes in a network. There are four basic concepts of centrality. The simplest form of network measure is degree centrality. Degree centrality indicates the number of connections a node has [10].

A second approach of centrality measure is closeness centrality. It indicates the length of the shortest paths to all other actors in the network [17].

Betweenness centrality: The extent to which an actor lies on path between other actors is the betweenness centrality. In social network, messages and news are being passed from one person to another.Messages, news always take the shortest (geodesic) path though the network or one such path, chosen at random, if there are several.Betweenness centrality measures the influence of an actor over all others within the network which implies higher the betweenness centrality, higher is the influence of the actor within the network. [10]

A third approach of centrality measure is eigenvector centrality. It is an extension of degree centrality. In a network, all nodes are not equivalent .Some are more relevant than others. Eigenvector centrality refers to the importance of a node if it is linked to by other important nodes. Itdoes notindicates the nodes with high degree but indicates node that connected with other important nodes[17]

Network Density is the measure of the connectedness in a network.

Robustness is defined as the tendency of the individual nodes in a social network to form local clusters. The robustness is the measure of how fragmented a network will be if the fraction of nodes is removed from it.

Network efficiency measures how one actor is effectively connected with other actors. This indicates efficient node or actor can easily access information, knowledge and status through minimum connections [16].

Effectiveness measures the cluster of nodes that can be reached by efficient nodes. Efficient nodes can easily gain information without much effort.

Diversity: Social Network maps the social interactions and these interactions can be established by observing different factors. One of the factor is the history of the individual actors. Social network analysis focuses mainly on this aspect i.e. diversity of each nodes [17]

Alcohol use disorders and network

Alcohol use disorder is the maladaptive patterns of alcohol use. Alcohol isone of the most commonly misused drugs in both developed and underdeveloped Countries. Practice of drinking causes multiple medical conditions. Alcohol has been attributed to the direct and indirect causation of more than 60 diseases including HIV/AIDS infection and unintended pregnancy[8]. According to National House Hold Survey, 21.4% of adult males are current user of alcohol and 43.9% of treatment seeking person at any Drug de addiction Centre in India are Alcohol Dependent[19]. A number of factors are contributed to alcohol addiction and alcohol dependence. The genesis of most alcohol and drug problems rests with a complex interaction between biological, psychological and environmental factors [20]. Understanding of social network can be helpful in understanding and identification of alcohol use behaviour and to develop better prevention and intervention programs to reduce alcohol-related harm [21]. The problem of alcohol dependence is often associated with various physical and mental comorbidities. Alcohol use disorders are often known to cause physical, mental, social, legal, financial and familial harms and the levels of harm are dependent on levels of use, patterns of use, Individual and social factors. Thus making it a potential ground for application of network theory with numerous hubs. Adolescents being the period of stress and storm is often the most crucial phase of human life and most of the psychiatric illnesses including alcohol use disorder have onset traced back to this stage. Most of the patients with alcohol use disorder often reported to have their first drink during adolescents and nowadays much focus has been given on adolescents' alcohol use.

Social network analysis helps in understanding the influence of friendship ties among adolescents alcohol use[18]. S R Sznitman (2013) in his paper , Peer social network and adolescent alcohol use reviewed the influence of social networks in adolescent alcohol use and concluded that peer selection is important in development of substance use disorders in adolescents. This knowledge may be proved important in formulating preventive strategies in a broader public health perspective. [21]

Adolescent can adopt others behaviour very easily as they are very good observer and learner. Earlier literature demonstrate that, adolescent drinking behaviour was highly influential by friends or friendship networks as they are easily inspired by friends and other social groups outside their own family member.Social network is the interactions among individuals. Network centrality, density and efficiency are the key measuring factor of adolescent and their friendship network. Centrality indicates the number of connections a person has i.e how influential the person is. The ties among adolescent shows the node which lies on the shortest paths linking other adolescents. Utilizing the concept of network theory, researchers can examine the connections or the set-up of the network, their density, connections efficiency and its influence upon adolescents' risky behaviours. [18].

The national Youth Risk Behavior Survey (YRBS) of USA has documented that 9th–12th grade students in high school have engaged in many risky health behaviours and identified age, out degree and betweenness as important factors associated with risky behaviours like sexual intercourse, drinking alcohol and other substance abuse (Jeon KC et al). In this context following network measures need to be defined –

- Degree: It is defined as the number of connections an actor has. The degree is of two types: In degree and out degree. The in degree is the number of connections an ego responds while out degree is the number of connections the ego receives
- Density is the ratio of the number of actual connections divided by the total possible connections in the network.

According to Youth Risk Behavior Survey (YRBS) data

- 70.8% of teenagers reported having consumed at least one alcoholic drink(Centers for Disease Control and Prevention, 2012a)
- 47.4% of adolescents had engaged in sexual intercourse(Centers for Disease Control and Prevention, 2012c).
- 44.7% engaged with tobacco use (Centers for Disease Control and Prevention, 2012d)
- 39.9% marijuana use (Centers for Disease Control and Prevention, 2012b).
- 22.1% drink alcohol or use drug before had sexual intercourse last time

In their experiment with two schools, one with smaller sample size but with a denser friendship network than the other, demonstrated that more dense the friendship network higher the incidence of risk behaviour suggesting that larger network have less risk behaviours depending on how densely the actors are connected.(Jeon KC et al). Like in all other networks various centrality measures have been identified in adolescent substance use network. Betweenness centrality allows us to identify the individuals in the network that are likely exert control over others. This centrality measures indicates that individuals in the network are likely to be influenced by the risky behaviours of others as they are connected by a greater number of geodesic paths. Adolescent with higher betweenness in the network control or influence others easily. Ennett et al. (2008) , have found significant

correlation between friend's cigarette use and betweenness centrality. Higher betweenness centrality was related to an increased risk for engaging in smoking behaviour also. Another centrality measure is Bonacich centrality which measures not only a function of how many friends an individual has but also the number of friends one's friends have.[18]

Parenting style and its effect on network

One of the major causes of adolescent alcohol use behaviour is the style of parenting. Parental control, warmth and negligence affect highly on adolescent alcohol use behaviour. Parenting style means the way of upbringing the child and is mainly governed by two factors namely warmth and control. Based on the levels of parental warmth and control there are four different styles of parenting which are summarized in table 1.

Parenting style	Parental warmth &Parental control
Authoritative	Warmth + control
Authoritarian	↓Warmth + ↑control
Neglectful	↓Warmth + ↓control
Permissive	↑Warmth +↓ control

Authoritative parenting is proved to be optimal and children of such parents are less likely to have delinquent peer network and lower level of substance abuse (Fletcher et al 1995 and Sharley et al 2012)

Adolescent behaviour of substance use is determined by two factors –

  a) behaviour of the friend
  b) parenting style of friends mother

a. Influence of substance use habit on adolescent behaviour

It was estimated that probability of drinking to the point of drunkenness increases by 32% if he has a friend who has the habit of doing so. Similarly having a friend with history of binge drinking increases in adolescent by 47%.

b. Parenting style of friends mother

The strong contributing factor towards the network behaviour of alcohol use disorder in adolescent is the parenting style. Shaley et al 2012 demonstrated that parenting style of friends mother is the determining factor of adolescent substance abuse and concluded that " the adolescent who do not engage in substance abuse are often connected to authoritative parents via their friends even if their own parents are not authoritative. Having a friend of whose mother is authoritative decreases the likely hood of drinking to point of darkness and binge drinking by 40% and 38% respectively. [22]

Interactions among symptoms of SUD form psychopathological networks

It includes interactions such as a strong predictive relation between tolerance and more-than-planned substance use. Network theory helps in analyzing symptoms and their associations to achieve new insight into the mechanisms of SUD[23]. Rheumtulla et al(2017) applied the concept of network analysis in substance use disorder by using Diagnostic and Statistical Manual 4th Edition (DSM IV)Abuse and dependence criteria in twins with life time drug use(mainly cannabis, sedatives, stimulants, cocaine, opioids and hallucinogens) and concluded that three different types of network analysis can be performed

  I.   Individual substance class network
  II. Cross substance class network
  III. Cross substance class variability network

Cross substance class network analysis revealedthat using a substance more than planned is the most central symptom indicating its status as a gateway symptom: losing control over how much or how long one takes drug,leading to host of other abuse and dependence symptoms. Different symptoms were found to be central to different substance network which indicates that different symptoms have specifically in triggering other symptoms and predicting negative clinical outcome across different class of substance. Association between various symptoms do predict the existence of a particular pathway common to all substances. Individual class network was formed by using this model to estimate one network for each substances. Some notable similarities like association between unable stop and hazardous use is present across the substances were noted apart from some striking differences in the form that edges between hazardous use and legal consequences are absent for opium, cocaine and hallucinogens while it is strong for the sedative use indicating the importance of context in which these substances. Mundt et al(2011) while systematically examining the impact of peer social network concluded that adolescents are at higher risk of alcohol use owing to their relative position in the social network comprising of friends and friends of their friends. Peer social network impacts onset of alcohol use in adolescent .Most of the studies revelled that friends alcohol use and adolescent social network characteristics exerts an independent effects on adolescent alcohol initiation. Having friends with more friends regardless of their drinking status increases the likelihood of initiation of alcohol use. Moreover for every additional friend with high in degree (likelihood of being nominated as friend), initiation of alcohol use in adolescent increases by 13%.[24]

Social network revels the spreading of behaviours of adolescent through social ties. Adolescents are more attracted towards similar people. Mundt et al(2012) illustrated about an analytical approach for social network analysis was ac-

tor based model. It is a powerful tool for agent's selection of friends based on alcohol use and changes in alcohol use behaviour over time.Influence and selection are two key factor for adolescent alcohol use behaviour. This model can disentangle selection and influence and determinetheir relative contribution to similarities in alcoholuse behaviour among friends. Study have found that selection is the strongest factor of alcohol use in early adolescent while selection and influence are the two factors effecting alcohol use behaviour on later adolescent. This model comprises of two parts:Friendship network evolution and alcohol use behaviour evolution.Friendship network evolution is formed by friendship ties depending on a list of friendship choice variables. Three variables effect on this part:

1. Adolescent alcohol use behaviour on the number of friendship selection (ego and their alters)
2. Probability of being influenced by alters drinking habits
3. Similarities of alcohol use between Ego and alters.

Other control variables are connectedness of friendship ties within the network (density), reciprocity, transitive triplets, 3 cycles, in degree and out degree popularity. Reciprocity is the likelihood to reciprocate friendship nomination while transitive triplets mean the tendency for the friends to be friends and the propensity for closure in three-person friendships is defined as 3-cycles. Age, gender, race/ethnicity, parental drinking, family bonding, alcohol use similaritywerealso shaped network structure of adolescent alcohol use. Family bonding was one of the main protective factors for adolescent alcohol use behaviour.

Alcohol use behaviour evolution part contains friendship-related influence Component. This component indicates the tendency for alcohol use to change based on the average drinking of immediate friends. Other control variables are age, gender, race/ethnicity, parental drinking, family bonding and linear and quadratic shape effects modelling average drinking across the network. The network selection pattern in adolescent alcohol use provides the much needed platform to understand the dynamics of initiation and maintaining of alcohol abuse in adolescents which can be proved to be pivotal in formulating intervention strategies of the global epidemic of alcohol use disorder [25]

CONCLUSION

Thus social network analysis can give an insight into various factors determining the initiation, progress and maintenance of alcohol use disorders in adolescents. Without clear guidance on the causal pathway between peers and alcohol use, interventions aimed at tackling alcohol use disorders in adolescents may not be effective. Network analysis approach can be an effective alternate measure in understanding the complex nature of the problem and thereby may be considered as a path breaking approach to preventive strategies.

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