Research Article

Exploring the Link between Alcohol Use and Physical Illnesses and Harms Using Network Analysis: A Cross-Sectional Study

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ABSTRACT

Prolonged use of alcohol is linked to a wide array of adverse health consequences, which are dependent on two factors namely volume and pattern of drinking and the direct biochemical effect of alcohol. In this study, we intended to explore the association between alcohol use and physical illnesses and complications by using a graph-theoretical approach in a population of patients attending drug deaddiction services of two tertiary care hospitals. A total of 180 patients selected randomly were interviewed using specially designed semi-structured proforma. Analysis of data showed regular use and drinking of alcohol once and twice a week have weighted degrees of 360 and 120 respectively and are the most influential factors in the network model and are found to be associated with multiple physical complications like weakness (node strength 108), diabetes (node strength 84) and hypertension (node strength 68). Having "No Problem" is also a common node in all the clusters under examination but the relationship is very weak, suggesting that individuals who drink alcohol might not have any physical consequences. Although this is more likely to be an exceptional discovery than a common one. The main finding of this study was that frequency of drinking is crucial to the physical illnesses and complications associated with alcohol use, so advocating for not drinking regularly or spacing out drinking days can be an ideal strategy to lessen the harms of alcohol use in situations where the ideal scenario of total abstinence may not be feasible.

Keywords: Alcohol use, Node, Centrality measures, Weighted degree.

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INTRODUCTION

Alcohol abuse and dependence are considered public health concerns affecting almost all classes of people of all ages.[1] There has been a steep rise in the prevalence of alcohol use disorders across the globe and India is also no exception with the prevalence of alcohol consumption in India ranging from 22.7 to 65.8% as estimated in various studies.[2-5] In a rural area of Tamil Nadu, Kumar S. *et al.* carried out a community-based, cross-sectional study. They found that male alcohol usage is more prevalent than female alcohol use.[2] The most frequent justification for drinking, according to Lakshmi A. *et al.*, was to deal with stress or fatigue. They also found that diabetes and hypertension are the most common conditions in these patients.[3] Furthermore, alcohol consumption is found associated with many physical complications like weakness, loss of appetite and weight, cirrhosis, hypertension, diabetes, various types of cancers, etc. and many deaths have been directly or indirectly linked to the conditions arising due to alcohol use.[4,5] There have been various approaches to understanding the causal association between alcohol use and these physical complications and network analysis is also one of them which helps in understanding the genesis and spread of alcohol use disorders and various complications related to it. Network

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science has become an integral tool in understanding various complex phenomena and has been applied extensively in understanding the causal relationship of various medical illnesses.[6,7] In fact network analysis is regarded as a powerful tool in revealing the pattern of complex interactions amongst various factors which can be beneficial in understanding the causation and formulating therapeutic and preventive interventions. Existing literature shows that the application of the network theory in the field of various mental illnesses including substance use disorders has gained popularity among researchers in examining the key factors in the causation and spread of such illnesses as well as understanding the various comorbidities associated with them.[8-11] Many researchers have used network theory in various substance use disorders and have attempted to examine the influence of peers in progression of the disorders as well as treatment of the same but studies related to complications and alcohol use particularly in adults are limited. Alcohol use is common in India[12] and people have systematically examined various factors related to alcohol use. But to our knowledge a very few have attempted to use network theory in the field of alcohol use disorders and their complications especially physical illness, particularly in India. Therefore, this study was undertaken with an aim to systematically explore the relationship between the various parameters of drinking such as frequency and pattern of drinking, and various physical illnesses encountered in this population by using the concepts of network theory.

MATERIALS AND METHODS

This was a descriptive-analytical and cross-sectional study over one year.

Sample and Sampling Method

Our study population consisted of patients attending the DDC of Assam Medical College, Dibrugarh, and the Substance Use Treatment Unit (SUTU) of Indian Oil Corporation Limited (IOCL) Hospital, Tinsukia for 1 year wherein every third patient attending DDC on a specified day fulfilling the inclusion and exclusion criteria and after obtaining the informed consent were recruited for the study. For patients attending the DDC services at Assam Medical College, Dibrugarh the cases were collected every 2nd Saturday of the month and for SUTU at IOCL Hospital it was done on the 1st Sunday of the month. A total of 180 patients were recruited for the study for one year and data were collected by using a specially designed semi-structured proforma. For this study, only patients 18 years and above diagnosed with alcohol use disorder by a consultant psychiatrist were considered critically ill patients, and those not willing to participate in the study were excluded. This study received permission from the institutional ethics committee and data collection was done after obtaining informed consent from the participants.

Questionnaire

A total of 180 individuals were interviewed and their responses related to their pattern of drinking and related illnesses and complications were recorded by using a specially designed questionnaire. The pattern of drinking was categorized into four type's namely Regular Use (REGU) which included the use of alcohol for at least 5 days a week, Once or Twice a Week (ONE-TWIC/W), Once or Twice in a Month (ONE-TWIC/M) and Occasional Use (OCCU). For the physical complications and illnesses, individuals were interviewed and their medical records whenever available were verified and responses were categorized into no problem, diabetes, hypertension, chronic liver disease, weakness, heart disease, stroke, epilepsy, chronic kidney disease, chronic asthma, body aches, respiratory problems, overdose, loss of appetite and weight, injury due to road traffic accident and other problems. Data were thus collected and plotted in MS excel and the network model was designed by Gephi 0.9.2. Statistical analysis was carried out by Gephi 0.9.2 and R package. A sample of the overall dataset is shown in Table 1.

Software

Gephi 0.9.2. and R package. Both are open-source software. Gephi is a software package written in Java on

Table 1: Sample of Overall Data.

Person Number	Drinking pattern	Diabetes	Hypertension	Chronic Liver disease	Weakness	Injury due to road accident
Person 1	Occasional	No	Yes	No	Yes	No
Person 2	Regular	Yes	Yes	No	Yes	No
Person 13	Once or twice a week	Yes	No	No	Yes	No
Person 20	Regular	Yes	Yes	No	No	Yes
Person 175	Once or twice a month	No	No	No	No	No

the Net Beans platform for analyzing, visualization, and exploration of all kinds of graphs and networks.[13,14]

Measures

The network assessment was done by calculating different network measures such as degree, weighted degree, diameter, graph density, modularity, etc. One of the most used network measurements is centrality measures which consist of degree centrality, betweenness centrality, closeness, and eigenvector centrality. Here we have shown the correlation between weighted degree and authority and degree and authority. A scatter matrix was formed to observe the correlation among these measures.

RESULTS

Alcohol Use and Physical Harm Network Model

The alcohol use and physical harm network model was constructed based on the responses obtained from the participants. Figure 1 depicts a unidirectional network of 20 nodes and 40 edges wherein the frequency of alcohol use and physical illnesses and complications were the two types of nodes defining the pattern of drinking and physical illnesses and complications mentioned by the participants respectively. The connections were established between the frequency of alcohol use and physical illnesses and complications but there was no scope of any such connections within the nodes.

Based on the presence of physical illness and complications in an individual with a particular type of drinking habit, a network was established between these complications and patterns of alcohol use. For example, individuals with regular use of alcohol were observed to have complications like weakness, diabetes, kidney disease, liver disease, hypertension, overdose, loss of appetite and weight as well as an injury due to road traffic accidents; hence a link between these complications can be established with regular drinking of alcohol. The edges in this network represent the strength of connectedness of physical illness and harmwith the frequency of alcohol use.

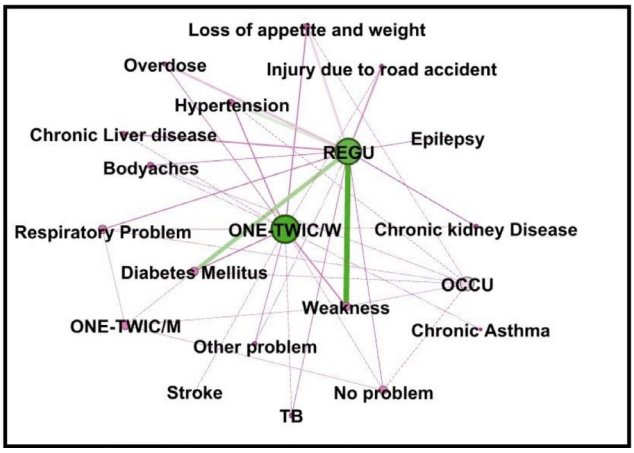

Figure 1: Alcohol Use and Physical Harm Network Model. (REGU = Regular Use of Alcohol, ONE-TWIC/W = Drinking Once–Twice/Week, ONE-TWIC/M = Drinking Once-Twice/Month, OCCU = Occasional User).

The edge strength between the frequency of alcohol use and different complications is visible in the proposed network model and it reflects the influence of alcohol use on one's physical health which can be described in Table 2.

Table 2 clearly shows how the pattern of alcohol use affects on physical health. As evident from Table 2 regular alcohol use was strongly connected to many physical complications like weakness, diabetes etc. whereas occasional use was seen to be connected to fewer complications as described by the clusters of the proposed alcohol use and physical harm network model mentioned below.

Figure 2 shows the cluster of associated health problems namely (respiratory problems, diabetes mellitus, weakness and no problem) with the habit of drinking once or twice a month wherein these health problems are seen to be weakly connected to the central node i.e. drinking once or twice a month. Individuals with the habit of drinking once or twice a month have fewer physical illnesses and complications.

Fourteen out of twenty health problems enumerated in the study population are associated with regular drinking of alcohol as shown in Figure 3. Edge strength in Figure 3 showed how strongly a regular drinking pattern is connected to different physical problems such as weakness, diabetes mellitus, hypertension, loss of appetite, and weight. From the proposed network model, it is apparent that most of the individuals with regular use of alcohol have been suffering from multiple diseases such as weakness, diabetes, hypertension, loss of appetite and weight.

Figure 4 represents respondents having occasionally use alcohol have very weak connections with less number of illnesses/complications. (Edge strength = 4). This is because of the observation that only in few occasional users of alcohol reported having some physical diseases and complications.

Individuals with the habit of drinking once or twice a week like those using regularly have also been suffering from many diseases and complications such as weakness, hypertension, diabetes, low appetite and weights shown in Figure 3 and Figure 5.

Table 2: Weighted Degree of the Edges of the Symptoms.

Frequency of alcohol use	Physical harms	Weight
Occasional User	Hypertension	4
Occasional User	Weakness	4
Occasional User	Bodyaches	4
Occasional User	Respiratory problem	4
Occasional User	Loss of appetite and weight	4
Occasional User	Diabetes	4
Occasional User	No problem	4
Regular user	Diabetes	60
Regular user	Hypertension	48
Regular user	Chronic Kidney Disease	12
Regular user	Weakness	80
Regular user	Respiratory problem	12
Regular user	Loss of appetite and weight	36
Regular user	Chronic liver disease	20
Regular use	Overdose	32
Regular use	TB	8
Regular use	Epilepsy	8
Regular use	Injury due to Road accident	24
Regular use	No problem	8
Regular use	Bodyache	8
Regular use	Other problem	4
Drinking Once-twice/week	TB	4
Drinking Once-twice/week	Weakness	20
Drinking Once-twice/week	Diabetes mellitus	16
Drinking Once-twice/week	Hypertension	16
Drinking Once-twice/week	Other problems	4
Drinking Once-twice/week	Bodyache	4
Drinking Once-twice/week	No problem	4
Drinking Once-twice/week	Chronic Liver disease	4
Drinking Once-twice/week	Loss of appetite and weight	16
Drinking Once-twice/week	Stroke	4
Drinking Once-twice/week	Injury due to road accident	4
Drinking Once-twice/week	Overdose	8
Drinking Once-twice/week	Chronic Asthma	4
Drinking Once-twice/week	Other problem	4
Drinking Once-twice/week	Chronic kidney disease	4
Drinking Once-twice/week	Respiratory problem	4
Drinking Once-Twice/month	Diabetes mellitus	4
Drinking Once-Twice/month	Respiratory problem	4
Drinking Once-Twice/month	Weakness	4
Drinking Once-Twice/month	No problem	4

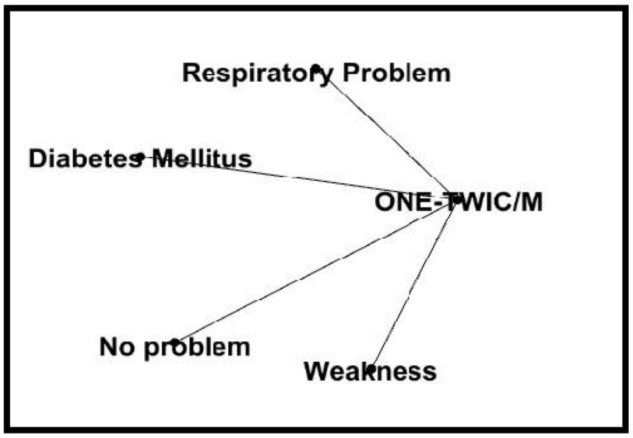

Figure 2: Cluster of Physical Problems Associated with Once or Twice Per Month Drinking Habit.

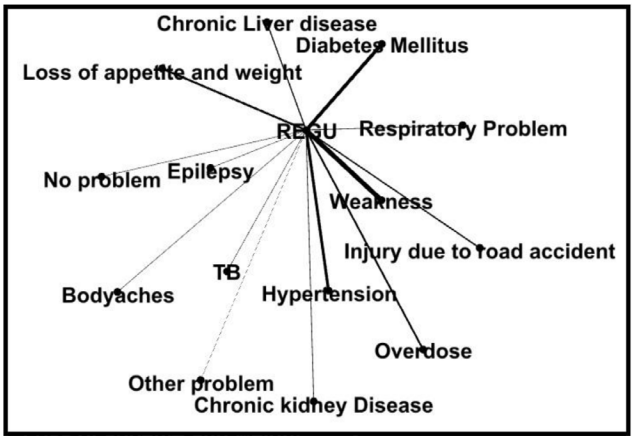

Figure 3: Cluster of Physical Problems Associated with Regular Drinking.

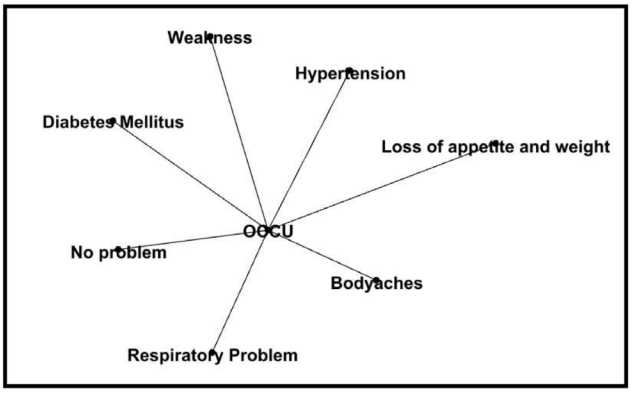

Figure 4: Cluster of Physical Problems Associated with Occasional User (OCCU) of Alcohol.

The strength of the nodes indicates how strongly a pair of symptoms (pattern of alcohol use and physical illness) can influence each other which can be derived from the weighted degree of the symptoms. The weighted degree of the symptoms is the weight assigned to a node and is indicative of the importance of that node with the entire

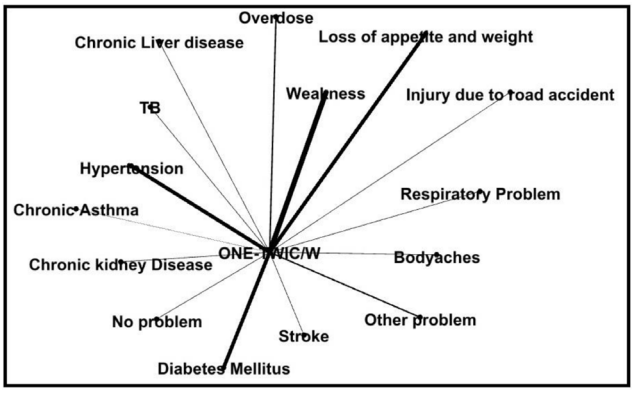

Figure 5: Cluster of Physical Problems Associated with Drinking Once or Twice A Week (ONE-TWIC/W).

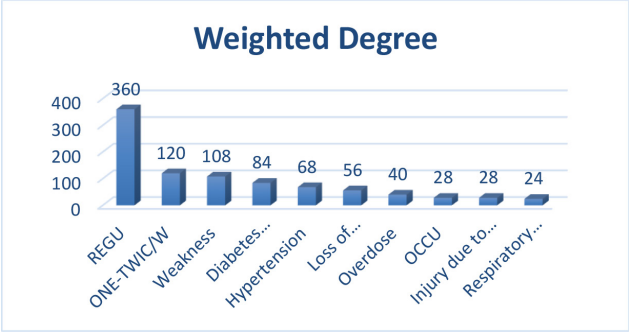

Figure 6: Weighted Degree of Symptoms. (Reg: Drinking Regularly, One-Twic/W: Once or twice in a week, Loss of Loss of appetite and weight, Occu: Occasional User).

network connection. In the proposed network model, a regular pattern of drinking (weighted degree = 360) has the highest weighted degree as many physical illnesses and complications were noted in individuals who use alcohol regularly, on the other hand, the occasional user (weighted degree = 28) and using once or twice a month (weighted degree = 16) have a lesser weighted degree. This indicates that the more regular the drinking more is the risk of having physical illnesses and complications. Among the physical illnesses and complications weakness (weighted degree = 108), diabetes (weighted degree = 84) and hypertension (weighted degree = 68) are the most encountered problems in individuals with alcohol use and regularity in consumption of alcohol is the most influential factor (34.35%) followed by drinking once or twice in a week (11.45%) in this network.

Statistical Analysis

The proposed network model has an average degree of 4, an average weighted degree of 52.4, a diameter of 4, a density of 0.211, a modularity of 0.057and an average path length of 1.937.

Centrality measures were estimated, and they indicate how influential the frequency of drinking is causing the physical complications under study and are depicted in Figure 6.

Closeness centrality defines the importance of a node in a graph as measured by how close it is to all other nodes in the graph. It is an important measure as it decides how quickly a particular node influences the entire network. This centrality measure showed that regular drinking habits and drinking once or twice a week have higher and significant closeness centrality whereas occasional user and drinking once or twice a month have lower closeness centrality. It was observed that some diseases are central to our network model as most of the alcohol use patients have these diseases. Among them weakness, respiratory problems, and diabetes mellitus have high and equal closeness centrality (Closeness centrality = 0.5589); Injury due to road accidents has also significant (Closeness centrality = 0.5) closeness centrality.

Betweenness centrality is a graph centrality measure based on the shortest path which is useful in detecting the amount of influence of a symptom over the flow. We consider this measure as it decides the degree to which nodes stand between each other. Patients drinking regularly and drinking once or twice a week have the highest and most significant betweenness centrality. Among the physical illnesses' hypertension, body aches, loss of appetite and weight have the highest and equal betweenness centrality. Injury due to road accidents has also significant between centrality.

Eigenvector centrality indicates how influential a particular node is that affects the overall functions of the network. Once or twice-per-week drinking habits and regular drinking habits have higher centrality (1 and 0.9676 respectively). On the other hand weakness, respiratory problems, and diabetes have an equal centrality value of 0.50376. Different network measures are shown in Table 3.

The graphical plots and results have given fruitful and interesting results. Later the results from Table 3 are plotted for visual representation and description by using MS Excel and R programming. The Figure wise interpretations are put forward below along with the Figure references. Figure 6: Represents the Bar-Plot of the major ten symptoms along with their weight sharing.

From Figure 6, it is again observed that regularly taking a drink is the most significant factor whereas taking drinks once or twice per week is also a significant and relevant factor in the network. It was observed that 34.35% were influenced by regularly taking alcohol, 11.45% were due to a drinking pattern of once or twice a week whereas weakness is responsible for 10.30% of the overall network.

Table 3: Network Measures of Different Symptoms.

Symptoms	Degree	Weighted Degree	Eccentricity	Closeness centrality	Betweenness centrality	Authority	Hub	Modularity class	Eigen Centrality
Occasional User	7	28	3	0.475	7.5	0.33747	0.165452	0	0.579807
Hypertension	3	68	3	0.527778	2.032967	0.126026	0.257055	1	0.442564
Weakness	4	108	2	0.558824	5.782967	0.143364	0.292418	1	0.503769
Body ache	3	16	3	0.527778	2.032967	0.126026	0.257055	0	0.442564
Respiratory Problem	4	24	2	0.558824	5.782967	0.143364	0.292418	0	0.503769
Loss of appetite and weight	3	56	3	0.527778	2.032967	0.126026	0.257055	1	0.442564
Regular User	14	360	3	0.730769	60	0.561406	0.27524	1	0.967637
Diabetes Mellitus	4	84	2	0.558824	5.782967	0.143364	0.292418	1	0.503769
Chronic kidney Disease	2	16	3	0.5	0.461538	0.097257	0.198375	1	0.3422
Chronic Liver disease	2	24	3	0.5	0.461538	0.097257	0.198375	1	0.3422
Drinking Once or Twice/a week	15	120	3	0.791667	77	0.579473	0.284097	1	1
TB	2	12	3	0.5	0.461538	0.097257	0.198375	1	0.3422
Overdose	2	40	3	0.5	0.461538	0.097257	0.198375	1	0.3422
Other problem	2	12	3	0.5	0.461538	0.097257	0.198375	1	0.3422
No problem	4	20	2	0.558824	5.782967	0.143364	0.292418	0	0.503769
Epilepsy	1	8	4	0.431818	0	0.047858	0.097617	1	0.168058
Injury due to road accident	2	28	3	0.5	0.461538	0.097257	0.198375	1	0.3422
Drinking Once-Twice/Month	4	16	3	0.413043	1.5	0.203381	0.099713	0	0.349778
Stroke	1	4	4	0.452381	0	0.049398	0.100758	1	0.174142
Chronic Asthma	1	4	4	0.452381	0	0.049398	0.100758	1	0.174142

Apart from that, we have checked the scatter plots of modularity classes along with the weighted degree. A Scatter plot is a visual plotting technique to determine whether or not two variables have a relationship between them directly from the visual plot. From the scatter plot, it was observed that some of the major symptoms have modularity 1 whereas some of the symptoms having minimum contribution towards the network also do have modularity 1. We can interpret that the symptoms having minimum effect as well as the maximum effect on the network do have modularity 1 as they are the nodes with more connections in the network which is true in graph theory perspectives. The results obtained in Figure 7 and Figure 8 justify the interpretation.

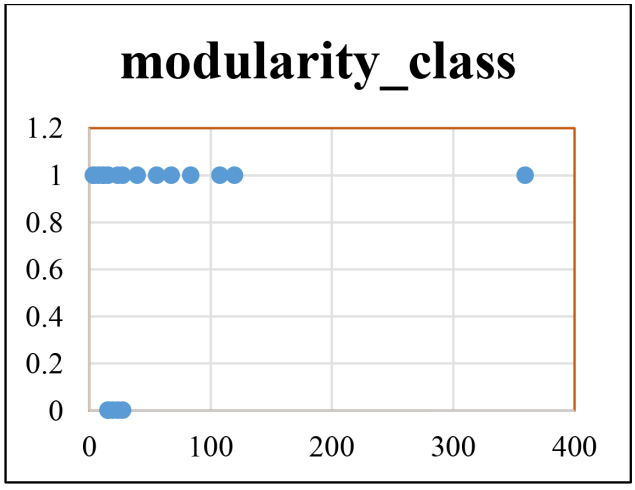

Figure 7: Scatter Plot of Modularity Class vs. Weighted Degree.

The Scatter plot Matrix (Figure 8) was generated for studying the relationships among degree, weighted degree, authority, and modularity classes. Like Scatter Plot, the Scatter matrix helps us to determine the relationship among different variables under study and draw a conclusion based on the diagram. Authority indicates the node's influence within a network.We observed a positive correlation between weighted degree and authority with 0.7541108 and degree and authority with 0.9917986. Positive correlation with 0.7541108 and 0.9917986 gives significant and positive relationships between weighted degree and authority and degree and authority respectively. It indicates most of the nodes

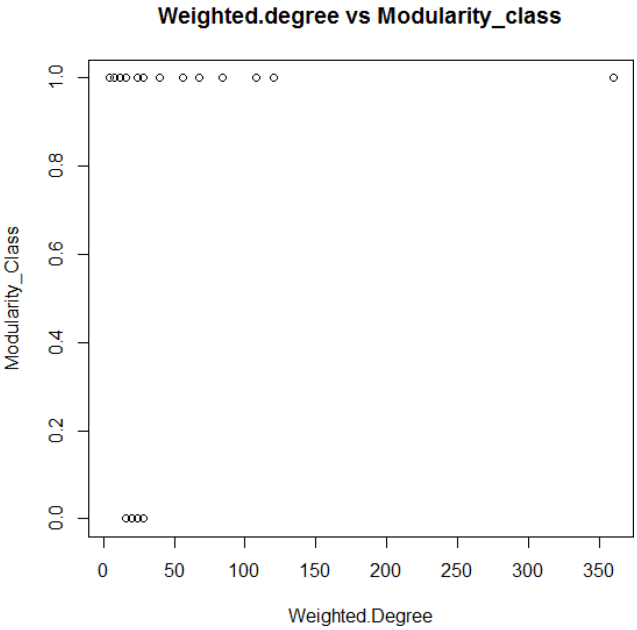

Figure 8: Scatter Plot of Modularity Class vs Weighted Degree.

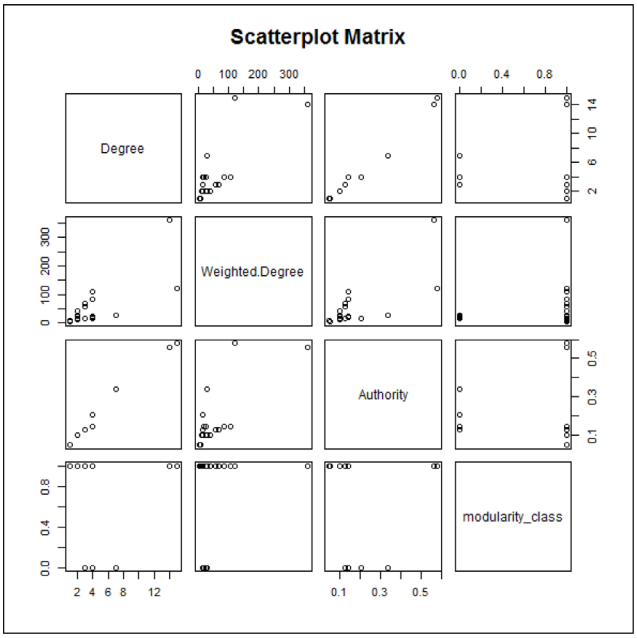

Figure 9: Scatterplot Matrix of Network Variables.

with high degrees and weighted degrees have high node influnce within the network. Whereas Figure 9 represent a Scatterplot Matrix of network variables.

Another important point was observed from Table 3 that degree and authority not only have a positively perfect correlation but also bear a linear relationship. The Box- Plot technique may be used to visually study the linearity between two variables and find outliers in the observation. The linearity of degree and authority is shown in Figure 10. Figure 10 also represents the linearity

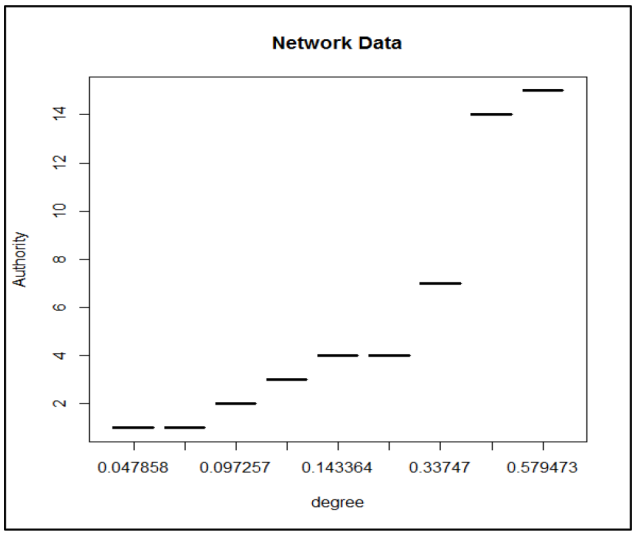

Figure 10: Linearity of Degree and Authority.

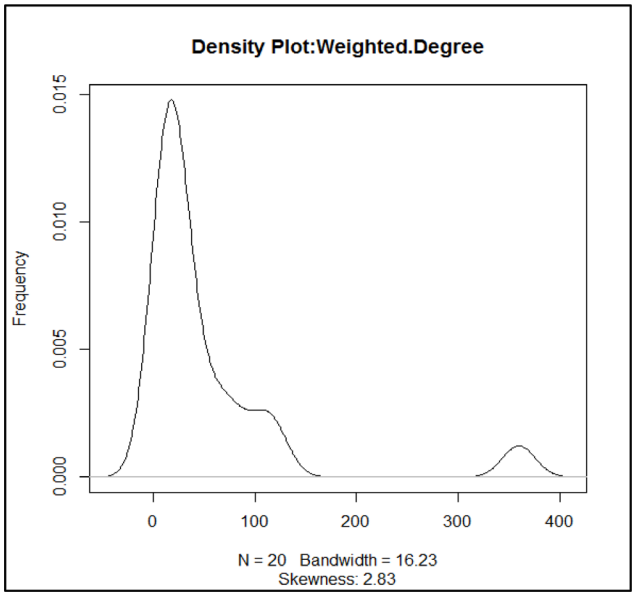

Figure 11: Density Plot of Weighted Degree.

of degree and authority which can be seen in the Scatter Plot Matrix. That is, in graph theory, whenever a node's degree tends to assume high values in a graph structure, the authority of the node also tends to be high as well, and vice versa. Furthermore, the relationship between degree and authority may indeed be represented by a straight line, which is also applicable to our network.

Since weighted degrees of different factors in the networks were studied, that is why we performed the density analysis of weighted degrees. Density charts are used to see how a variable in a dataset is distributed. The curve is plotted on a continuous interval or timeperiod. Figure 11 represents the density plot of the weighted degree.

Figure 11 represents the density diagram with a curve bandwidth of 16.23 which is relatively a big band width that over smooths the density curve but represents a comparatively good fit for the weighted degrees of all 20 different symptoms. We observed a skewness measure of 2.83 in the density plot of the weighted degrees. It was observed that most of the weights lie below the range of 100 whereas very few were observed above 200 from the density plot as well as from the result dataset. Finally, we can claim that in our network study, all of the results derived utilizing statistical approaches yield productive and fascinating outcomes.

DISCUSSION

The relationship between alcohol use and different illnesses and complications has been described by many researchers[15-17] and ours was an attempt to investigate the relationship from a network theory perspective and to identify the association between the frequency of alcohol use and the various physical illnesses. Individuals with regular use of alcohol were observed to have complications like weakness, diabetes, kidney disease, liver disease, hypertension, overdose, loss of appetite and weight as well as an injury due to road traffic accidents which is similar to Lakshmi A *et al*.[5] who reported that hypertension, diabetes and gastritis were more commonly encountered physical complications in individuals with alcohol use disorders. However, their approach was just an observational one but not based on network analysis. Consistent with the literature, alcohol use has been associated with various co-morbidities and complications.[18] The result of the present study showed that those who drink more frequently i.e., regularly have more physical complications than those drink once or twice in a month or occasionally. Individuals with regular drinking habits and drinking once or twice a week are the central and most influential factors of the proposed network model. This is in accordance with the findings of Huth *et al*.[19] who studied the various network parameters and found that time spent in drinking was strongly associated with dependence, dangerous behaviours and other complications. But they studied the social and emotional harms but not the physical one.

The proposed model showed that individual who use alcohol regularly have the most health-related issues. Weakness, respiratory problems and diabetes mellitus are the major illnesses that are strongly associated with excessive alcohol consumption. Our study furthermore justifies the negative impact of alcohol use on physical health. It was observed through the node strength and edge strength of the proposed network model. Our study revealed that, regular pattern of drinking habit has the highest node strength as well as edge strength. This is due to regular user of alcohol has been suffering from multiple diseases like diabetes, hypertension, weakness, overdose, etc.

Strength and Limitations of Study

This study has some limitations such as it is a cross-sectional hospital-based study, hence study results should be generalized with caution. In spite of these limitations this study involved the primary data collected from tertiary care hospital and has not relied on secondary data and diagnosis were verified by qualified psychiatrists. Nonetheless this is the first of its kind in this part of the country where network analysis has been employed to investigate into the relationship between alcohol use and various physical harms.

CONCLUSION AND IMPLICATIONS

This study provides new insight into the association of alcohol use and physical complications. Regularity of drinking in terms of drinking daily has been identified as the determining factor for various physical complications attributable to alcohol. The management of alcohol use disorder has followed three-pronged approach of demand reduction, supply reduction and harm reduction. Hence the findings of the study can be utilized in creating awareness among general public about the harms of alcohol use. It is to be noted that in situations where ideal scenario of total abstinence may not be feasible, advocating for not drinking regularly or spacing out drinking days can be an ideal harm reduction strategy for alcohol use disorders.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

TB: Tuberculosis; **DDC:** Drug Deaddiction Centre.

SUMMARY

Our study was an effort to investigate the relationship between the frequency of alcohol use and the various physical illnesses from a network theory perspective. From our study we can inferred that people who drink more frequently—that is, drinking regularly and drinking once or twice a week—have greater bodily issues than those who drink occasionally or once or twice a month. This finding reinterates the need to advise not to drink regularly in those where total abstinence is not possible as a measure harm reduction stretagies in alcohol use disorder.

REFERENCES

1. World Health Organization. Global statusreport on alcohol and health2014[cited Jul012018]. Availablefrom:http://www.who.int/substance_abuse/publications/global_.AlcoholReport/msb_gsr_2014_1.pdf?ua=1.
2. Girish N, Kavita R, Gururaj G, Benegal V.Alcohol use and implications for public health: patterns of use in four communities. Indian J Community Med. 2010;35(2):238-44. (PMCFree article). doi: 10.4103/0970-0218.66875, PMID 20922099, Google Scholar.
3. Ghosh S, Samanta A, Mukherjee S. Patterns of alcohol consumption among male adults at a slum in Kolkata, India. J Health PopulNutr. 2012;30(1):73-81. (PMCFree article). doi: 10.3329/jhpn.v30i1.11279, PMID 22524122, Google Scholar.
4. Kumar S G, K C P, L S, E S, Vinayagamoorthy, Kumar V. Prevalence and pattern of alcohol consumption using Alcohol Use Disorders Identification Test (AUDIT) in rural Tamil Nadu, India. J Clin DiagnRes. 2013;7(8):1637-9. (PMCFree article). doi: 10.7860/JCDR/2013/5521.3216, PMID 24086861, Google Scholar.
5. Lakshmi A, Daisy D, DuttaguptaLJ, Padmanaban. Drinking habits, health, social and behaviouralaspects of alcoholusers in A semi urban population in Chennai. IOSRJDMS. 2014;13:20-2. Google Scholar.
6. SayamaH, Cramer C, Porter MA, Sheetz L, Uzzo S. What are essential concepts about networks? JComplex Netw.2016;4(3):457-74. doi:10.1093/comnet/cnv028.
7. Newmann MEJ. Network: an introduction.New York:Oxford University Press;2010.
8. Johnson K, Quanbeck A, Maus A, Gustafson DH, Dearing JW. Influence networks among substance abuse treatment clinics: implications for the dissemination of innovations. Transl Behav Med. 2015;5(3):260-8. doi:10.1007/s13142-015-0327-y, PMID 26327931.
9. Rhemtulla M, Fried EI, Aggen SH, Tuerlinckx F, Kendler KS, Borsboom D. Network analysis of substance abuse and dependence symptoms. Drug Alcohol Depend. 2016;161:230-7. doi: 10.1016/j.drugalcdep.2016.02.005. PMID26898186, PMCIDPMC4861635.
10. Anker JJ, Forbes MK, Almquist ZW, Menk JS, Thuras P, Unruh AS, *et al*. A Network approach to modeling comorbid internalizing and alcohol use disorders. J AbnormPsychol.2017;126(3):325-39. doi:10.1037/abn0000257, PMID 28182444.
11. Anker JJ, Kummerfeld E, Rix A, Burwell SJ, Kushner MG.Causal network modeling of the determinants of drinking behavior in comorbid alcoholuse and anxiety disorder. Alcohol Clin Exp Res. 2019;43(1):91-7. doi: 10.1111/acer.13914, PMID 30371947.
12. BastianM, HeymannS, Jacomy M. Gephi: an open source software for exploring and manipulating networks. ICWSM Third international AAAI conference on weblogs and social media. 2009;3(1):361-2. doi: 10.1609/icwsm.v3i1.13937.
13. Hawe P, Webster C, Shiell A. A glossary of terms for navigating the field of social network analysis. JEpidemiolCommunityHealth. 2004;58(12):971-5. doi: 10.1136/jech.2003.014530, PMID 15547054.
14. Baliunas DO, Taylor BJ, Irving H, Roerecke M, Patra J, Mohapatra S, *et al*. Alcohol as a risk factor for type 2 diabetes: A systematic review and meta-analysis. Diabetes Care. 2009;32(11):2123-32. doi: 10.2337/dc09-0227, PMID19875607.
15. Boffetta P, Hashibe M. Alcohol and cancer. Lancet Oncol. 2006;7(2):149-56. PMID: 16455479. doi: 10.1016/S1470-2045(06)70577-0, PMID 16455479.
16. Corrao G, Bagnardi V, Zambon A, La Vecchia C. A meta-analysis of alcohol consumption and the risk of 15 diseases. PrevMed. 2004;38(5):613-9. doi: 10.1016/j.ypmed.2003.11.027, PMID15066364. [PubMed:15066364].
17. Jakkaew N, Pinyopornpanish K, Jiraporncharoen W, Wisetborisut A, Jiraniramai S, Hashmi A, *et al*. Risk of harm from alcohol use and heavy alcohol consumption: its association with other NCD risk factors in Thailand. Sci Rep. 2019;9(1):16343. doi: 10.1038/s41598-019-52754-w, PMID 31704967.
18. Jakkaew N, Pinyopornpanish K, Jiraporncharoen W, Wisetborisut A, Jiraniramai S, Hashmi A, *et al*. Risk of harm from alcohol use and heavy alcohol consumption: its association with other NCD risk factors in Thailand. Sci Rep.2019;9(1):16343. doi: 10.1038/s41598-019-52754-w, PMID 31704967.
19. Huth KBS, Luigjes J, Marsman M, Goudriaan A E, van Holst R J, Modeling alcohol use disorder as a set of interconnected symptoms – Assessing differences between clinical and population samples and across external factors. Addictive Behaviors. 2022;125:107-28.

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