



## Application of Social Network Analysis in Diverse Health and Allied Disciplines –A Review of Existing Research Literature

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### Abstract

*Social network analysis is the study of social structure which connects individuals. This paper reviews the scopes and use of social network analysis as a tool for health research and interventions for improving the health status of population. We review diverse health conditions or diseases which were explored or intervened through social network based research across the world so far and present a summary of the findings. We found that Social network has widely applicability in addressing various health and diseases condition including communicable and non-communicable diseases mainly HIV, STI's, cancer, obesity, Tuberculosis, Flu etc. We also found that it has been used in assessing health seeking behaviors from different perspectives including tribal and rural population. Program implementation and biomedical research also have found the applicability of social network analysis.*

**Keywords:** Social Network, health, research, diseases, structure, tool.

### Background

Social network has been conventionally used to denote the peer social network or social relationships in general in the research literature. But social network as a unique discipline has three sub components, which are i) the network relationships which means the characteristics or attributes of the individuals, ii) network structures which denotes the positions of individuals within the network, and iii) the network functions which are the influence of network members between each other (Hawe et al, 2004). Social network uses quantifiable metrics to measure the structure of network and the functions of its.

This paper reviews the scopes and use of social network analysis as a tool for health research and interventions for improving the health status of population. This review paper assesses the diverse

health conditions or diseases which are explored or intervened through social network based research across the world. In this paper we aim to review the so far implemented social network studies across world which were either unique in nature, novel in its conception, larger in scale, and have the potential to be replicated in other settings. We aim to make a review so that this paper provides a summary of all the social network based interventions and how their methods and findings could help conceptualizing and developing social network based research and interventions in diverse other settings.

### Method

We utilized internet search of keywords “social network”, “diseases” “health” which yielded us hundreds of research papers from Google scholar,

pub med and endnotes. We have read and selected research studies which have used social network analysis for different domains. We included studies which have used social network metrics and also which have used conventional social network approach without any metrics. We selected our review papers based on the novelty of the problem which social network analysis addressed and the quality of the method. We found more studies understanding and using “social network “ as mere social relationship and characteristics or social media networks like face book and twitter. We have shortlisted a total of 29 social network research articles which have used social network in exploring the network structures along with the functions and characteristics of the network members in different contexts and life situations. The studies which have been included in this review have been conducted between the time periods of 2000 to 2016.

## Results

### **Social Network of Key populations at risk of HIV/STI**

Social network has been widely used to explore the key populations who are at the risk of transmitting and getting infected HIV/STIs like Men who had sex with men, Injecting Drug Users and Female sex workers.

Drug using male sex workers in Houston Texas were assessed using social network analysis to know the effect of relationship dynamics on their knowledge and perception of a sex partners HIV status. The study identified six relationship dimensions which were intimate relationship, committed relationship, social relationships, financial relationships, trusted relationship and honest relationship. The study found that commitment was found to be correctly addressing wrong misperceptions but trust was not having the same effect on misperception. (Fujimoto K et al., 2015). A study in China assessed the social networks of low-income female sex workers and peer educators in the context of condom use behaviors and STI/HIV. The study identified a

unique category of FSWs called “laoxiang” who were exhibiting collective agency and power than the FSWs who were without such relationship in the same sex work setting. (Tucker JD et al., 2011)

A mixed method study utilizing ethnographic and social network tools assessed the contextual risk factors, situations and the networking patterns among MSM in India. It found that behavioral factors influencing HIV prevalence among MSM were diverse and unique across different MSM networks. (Lorway R et al., 2010.). A study among the Black Men Who have sex with Men (BSMS) and their family network, found that those who had more number of social networks were having less chance to have risky behaviors like group sex and having sex along with drug use. (Schneider J et al., 2012). MSM related networking studies were widely available when compared to other key populations like FSWs, IDUs and Transgender. (Nelson LE et al., 2015, Hurt CB et al., 2012, Schneider JA, et al., 2013, Latkin C, et al., 2011, Peterson JL et al., 2009)

Truck drivers who are vulnerable to HIV/STI were assessed of their social networks in an South Indian city and it was found that acceptability of rapid HIV testing was associated with social network characteristics like; having intimate friends, having a very intimate friend, making day to day communication with friends, perceiving that friend advice is important and also having discussion with the friends about sexual issues. (Schneider J et al., 2012)

### **Social Network for assessing substance and smoking use**

Adolescent population in six European counties was assessed to know their friendship networks and their smoking behavior. The study found that that adolescents were choosing their friends preferentially based on smoking behavior similar to their own but not merely by influence of a friend. (Merckena L et al., 2009) Similarly another study assessed the substance use among migrant and non migrant adolescents in six

European cities, using social network methods. The study found that migrant adolescents were at relatively lower risk of using smoke, alcohol and substance than their counterpart non-migrant adolescents. (Lorant V et al., 2016)

Framingham Heart Study used a densely interconnected social network of 12,06 between 1971 to 2003 for assessing how the smoking behavior spreads through close and distant social ties like spouses, siblings, and co workers. The study found that groups of networked people stop smoking in concert. It also found that smokers are increasingly marginalized socially means they were at the fringe of their social network without many connections to others...(Christakis NA et al., 2008)

### **Social Network for psycho social health**

This study conducted among elementary school on their social network and rated their Attention Deficit/Hyperactivity disorder.

The results highlighted that there were significant group differences between the high-risk students and normal students in terms of three network metrics: (degree, centrality and closeness). Findings highlighted that high-risk group were having significantly lower values of degree and closeness compared to normal students. (Kim JW, 2015)

### **Social Network for assessing Non Communicable diseases**

Framingham Heart Study used a three decade old dynamic cohort data to understand the social network determinants of obesity using social network analysis between 1971 to 2003. It was found that obese persons formed clusters and these clusters were separated by three degrees .It was found that a network members possibility of becoming obese increased that network member had a friend who turned obese in a particular time period but not solely by forming relationship with a obese person preferentially. (Christakis NA 2007)

A study used article social network tool monitoring how social ties and social structure influence the obesity intervention program. The study collected social network measurements at specific intervention time points to assess whether group cohesion is evolving during the course of the intervention thus helped the group leader to guide implementation process. The study identified that network Density, (number of network ties among people in the network expressed as a percentage of all possible ties) increased significantly in the advice network, and also in the discussion network. (Geseel et al., 2013) With regard to cancer, a study examined the association between network diversity and health behaviors among cancer patients. It showed that low network diversity was significantly associated with sedentary and risky health behaviors like lack of physical exercise, increased weight & obesity, smoking, and alcohol intake. (Kroenke CH et al., 2016). Social network analysis exploring that drug discovery process for cancer highlighted the power law with preferential interactions between successful peers and selected establishments involved in cancer research. The study highlights that the probability of discovering cancer treatments was directly co related to the diversity of social interactions between researchers (Tsalatsanis A et al., 2011)

### **Social Network for assessing communicable diseases**

With regard to Tuberculosis transmission a study in Manitoba, Canada had utilized social network analysis for identifying the social structure which underpinned and contextualized the TB transmission. The study identified that members in the network who were exposed to 7 or more TB group members had increased probability of getting infected with TB and these group members lived in crowded houses , and were socially connected to multiple other TB patients (Al-Azem, 2016)

Another study assessed the predictors of tuberculosis (TB) cluster cases and their sizes to

evaluate the impact of cluster investigation using social network analysis. The study led to the identification of additional TB contacts and cases of active and latent TB and highlighted that social network data for TB cases would improve contact tracing and thus help in reducing transmissions. (Munang ML et al., 2016)

A flu outbreak at Harvard College was assessed using social network analysis by longitudinally following up 744 students. These students were who were either randomly sampled from the college or they were sampled purposively from an index students who were already infected and are friends each other. Based on clinical diagnostic follow up, it was found that the epidemic progression in the friend group occurred much earlier when compared to the other randomly chosen group. (Christakis NA et al., 2010). A study on the transmission dynamics of HCV highlighted that social network had played a major role in determining the rate and pattern of HCV transmission within the network. (Romano CM et al., 2010)

With regard to epidemic transmission, a study explained a theoretical model which highlighted that how the differences between the communities' networks impacts disease progression transmission and its underlying dynamics. The study explained how infections happen in certain communities, the process of epidemic transmission and the contextual network properties which determine whether that infectious disease will be sustained in the community or disappear over a short period of time. (Kitchovitch S et al., 2011)

### **Social Network for rural and Tribal health settings**

A study in Ethiopia utilized data which included use of modern contraception among rural residents and assessed the duration of adoption of modern contraception. It was found that the of person-to-person contact through either friendship or spatial networks is minimal in influencing contraception use. (Alvergne A et al., 2011). A

study was conducted among aboriginal communities on their patterns of social interactions in receiving health information and awareness. Social network analysis showed that specific community members were having higher betweenness, degree and closeness centrality and were thus were facilitating flow of health information to other members of the social network. (Winch S et al., 2016)

### **Social Network for program implementation and biomedical research partnerships**

From a programmatic perspective a study assessed the use of social network model in a four stage model\_which involves successive steps like exploration, adoption, implementation, and sustainment in the implementation process. The paper explained how the network measures can be used to monitor, intervene, and improve the implementations of project. (Thomas W. Valente et al., 2015)

To identify global networking patterns in biomedical research a social network analysis used 771 net work meta data from 336 published journals fro, 3459 authors and 1258 institutions in 49 countries between 1997–2015. This analysis identified overall, 43 clusters of authors and 21 clusters of institutions and yet the collaborations were found weak. (Li L, Catalá-López F et al. 2016)

Similarly Social network analysis (SNA) was used to study relationships between treatment regimens in randomized control trials for multiple myeloma a rare case of cancer. The results found that inspire of being a relatively small and closed domain, Multiple myeloma research has been decentralized with a lack of connectivity among various research partners. (Helen Mahony et al. 2014)

### **Social Network for assessing oral health behavior**

A Japanese study examined social network diversity as an influencing factor of oral health and found that irrespective of demographic and

health status, the diversity of social network was associated with more teeth among elders. The study highlighted that social networking among people from diverse backgrounds could improve information diffusion on oral health and improve oral health. (Yamamoto et al., 2016)

### **Social Network for assessing poverty**

The role of social networks play in the context of urban poverty and its aggravation was assessed in two Brazilian metropolitan cities. Findings highlighted that the people's networks are diverse but still less diversified than middle-class networks and explained the social conditions in influencing the labor supply and demand markets and, income generation (Marques et al 2010).

### **Social Network principles and underlying theory**

There was one study which explained the basic principles and metrics which underlie the social network analysis and methodology in general. It's a descriptive study which lists out the important operational definitions and indicators used in the social network analysis. (Hawe et al, 2004)

Overall there was only one theoretical study which provided a theoretical perspective on the individual and network level factors in the HIV prevention setting. The network Individual Resource model explained by this study predicts the sustainability of behavior change in any prevention settings. (Johnson BT et al., 2010)

### **Discussion**

Social network as a novel research discipline has been utilized for diverse purposes in the health research settings. Social network provides us an unconventional data which throws insights into the relationship dynamics between members of a social group. While social network has been widely understood and used as a term for explaining the nature of social relationship in terms of relationship status, duration, frequency, closeness etc, still social network as a quantitative

discipline which explains the position of various network members has not been much understood. Social network has been utilized to understand a variety of health issues with its exploratory metrics, which is not otherwise possible with the descriptive or inferential statistics which normally is used to test associations. The Birmingham heart study which has been reviewed here uniquely highlights how Obesity temporally spreads across a social group which otherwise would not have captured by an observational, analytic or an experimental study design. Another study also had explored how cancer patient's health behaviors are impacted by their social network properties. Non communicable diseases thus could be well addressed from a prevention aspect using social network analysis of their relationships.

A novel study in Japan shows that how the diffusion of innovation among Japanese have impacted their oral health. Oral health which is determined by a healthy and hygienic behavior which in turn is learned from and impacted by behavior the social network of individuals. The potential of social network which contextualize the diffusion of useful information helps to spread message and information on health lifestyle habits which would be of immense use in developing countries like India which suffer with massive sanitation and hygiene crisis.

Social Networks studies involving key population (MSM, IDUs FSWs) highlights that understanding of HIV epidemic has been critical to the success in the prevention of HIV/STIs so far. Social network analysis of key populations provided a clear understanding of their cultural dynamics The social and cultural context varies across settings and hence one standard programme may not be effective in terms of key populations and hence, it is important that network approaches were effective in understanding the social and sexual networks of key populations and helped in identifying novel strategies for intervention. Tracing patterns of social and sexual networks and strategizing to intervene at key points in the network could be a useful. Among key populat-

ions, access to essential HIV-related services remains invariably low; especially in settings where stigma, discrimination, and criminalization exist and social network based interventions could address this gap.

Infectious diseases like Flu, Tuberculosis and Hepatitis C have also been assessed from the social network perspective. Such information would be of great help in terms of a community outbreak and would immensely help in containing the epidemic within a short period of time... The transmission dynamics captured by these studies have highlighted that social network tools could be cost effective in predicting and identifying the vulnerable individuals who could be affected during an epidemic or pandemic.

Social network related studies in rural and tribal settings could give us so far unexplored dynamics of social relations among rural and tribal populations who have been more conventionally assessed through from ethnographic and anthropological perspective.

The Framingham study and the European study on smoking behaviors from the perspective of social network underlines how important the role of peers adolescent member influencing this harmful behavior. Social network has also explored the structural determinant of health status like poverty and how they impact the income earning among them. There were some out of box methods which have also used application of social network analysis in assessing the research partnerships in bio medical research, drug developments for cancer and programme implementations in the real life settings.

In addition to the studies on the application part of social network analysis, there were very few studies which have assessed on the theoretical frameworks and the basic principle of social network research as a discipline. We found only three studies falling in such categories and thus deserve more focus in future.

## Conclusion

Social network principles have opened up new avenues for social network research and its applications for wider domains related of health which included communicable \* communicable diseases including HIV, STI's, cancer, obesity, Tuberculosis , Flu etc. We also found that it has been used in assessing health seeking behaviors from different perspectives including tribal and rural population. Program implementation and biomedical research also have found the applicability of social network analysis.

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