Usefulness of Geographic Information Systems (GIS) in mental health research

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Abstract
Role of environment on mental health cannot be ignored. Computer based mapping technology called Geographical Information Systems (GIS) has presented mental health researchers with many new possibilities to explore these relationships. The main aim of this literature review is to identify the emerging applications of GIS in mental health research. The use of GIS in mental health has faltered compared to other health care sectors and has started gaining momentum only in the recent years. There is great scope for GIS to be applied in mental health epidemiology, evaluating inequalities in health care access, determining spatial variation in service utilisation and planning health care delivery and community integration. The technology is bound to find many more innovative applications in the mental health care sector in the coming years.

Key words: Mental health, computer based mapping, geographical information system

Introduction
The union between Health and Environment is not a recent happening. In his treatise On Airs waters and Places, Hippocrates described health as a product of different environmental variables. The social and physical environment we live in can have a significant impact on our mental health outcome. Though widely recognised, this relationship still remains relatively unexplored in the field of mental health research and planning. Earlier work in mental health geography involved the use of cumbersome cartographic methods combined with statistical analysis. With the development of computer aided mapping technologies called Geographic Information Systems (GIS), the potential for depicting and analysing these environment related health questions has increased considerably. GIS based spatial mapping and analysis can provide a better insight into the disease patterns, causes, interactions and service needs. This can in turn aid us in evaluating interventions and guide evidence based health care policies.

The global mental health care landscape has undergone tremendous changes in recent years owing to rising costs, increased demand and new modes of service delivery. Many countries are opting for a more consumer led approach to mental health care and planning. In this context, the role of the environment on mental health cannot be ignored and GIS presents us with many new possibilities. In this paper, we will discuss the opportunities and the usefulness of GIS in mental health research, planning and delivery.

Definition and History of GIS
GIS are computer information platforms capable of storing, analysing, retrieving and displaying spatial data and information. The Canada Geographic

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Information System, often referred to as the ‘first true’ GIS was developed by the Department of Forestry and Rural development of Canada in the 1960’s with the objective of classifying and mapping the land resources of the country. Since then the technology has undergone tremendous changes owing to the advancement in software technology, graphics and computer based mathematical modelling. The scope of GIS is not just limited to mapping, although maps are a sought after end product. GIS makes it possible to attach attributes or qualities to spatial data and to combine, analyse and present them in numerous combinations. For example, different aspects of mental health data can be combined with geographic, economic, social and environmental variables. This data integration and spatial visualisation power of GIS make it suitable for a myriad of applications in the mental health sector.

GIS in Public Health
GIS has been successfully employed for studying various health care issues worldwide such as disease spread, health care needs, spatial organisation of health services and ease of service accessibility. Geographically linked health databases and interactive web based Spatial Decision Support Systems (SDSS) are becoming popular throughout the world. GIS based clinical systems and electronic health records are being used in many countries including United Kingdom and the United States. These allow the stakeholders and decision makers to pose queries, find solutions and explore alternatives in an interactive and computer based setting. One such example is the Primary Care Service Area Project (PCSA) in the United States. This web based system provides information on demographic and health details of the population and health resources for small areas throughout the United States.

GIS in Mental Health
GIS technology has been used in mental health research in areas such as epidemiology, service utilisation and neighbourhood impact analysis. However, the use of GIS in mental health research has faltered compared to other health care sectors. The United States, in particular New York, is one of the few places which has extensively used GIS in mental health research and planning. A few studies have examined mental health epidemiology using GIS. Geographic patterns of frequent mental distress among US adults were studied to identify areas of consistently high and low prevalence. A common theme in GIS based mental health research is the relationship between environmental features and prevalence of mental illness. A recent example is the study on the neighbourhood racial composition, racial discrimination and depressive symptoms in African Americans. Researchers have also looked at the impact of urbanisation on mental health. These studies are often found to confirm the so called ‘Breeder – drift hypothesis’ of mental illness, which seeks to explain why the prevalence of mental illness is higher in lower socioeconomic areas. GIS was also used to analyse depression among Twitter users in the United States. A Canadian study explored the relationship between mental health service utilisation and factors which may influence health care utilisation decisions, such as availability of health services, distance, travel time and costs involved in reaching a health care facility. In England, GIS was used to determine the mental health expenditure of local health authorities.

There are also examples of GIS being applied along with participatory mapping. Participatory mapping is a qualitative research technique that helps to capture the individual or community perception and local knowledge of an issue or event along with actual data which brings the diversity component into the decision making framework. One such study measured the community integration of people with serious mental illness. Increasingly GIS have also been employed to study stress reactions after a natural disaster or terrorist attack. A good example is the DiMaggio study which analysed the risk of psychopathology after the 9/11 terrorist attack. In an Australian study, a GIS was employed to explore the relationship between environmental degradation (dryland salinity) and mental health in rural Western Australia. Bayesian spatial analysis indicated the growing rate of mental ill health along with environmental degradation. More recently, the spatial patterns of suicide across metropolitan,
regional and rural Australia was studied using demographic and postcode data\textsuperscript{19}.

**Conclusion**

The adoption of GIS in mental health research is gaining momentum. Many researchers still consider GIS primarily as quantitative mapping tools. This view only covers a fragment of what the technology has to offer. GIS are capable of dealing with quantitative as well as qualitative data with high accuracy and have great potential in behavioural science research. More work is needed in the development of geographically linked mental health databases and psychiatric SDSS. There is further scope for GIS application in mental health epidemiology, evaluating inequalities in health care access, determining spatial variation in service utilisation and planning health care delivery and community integration. The effect of climate change, chemical pollutants or food habits on mental illness have great potential to be explored using GIS. The combination of GIS and mental health information presents us with many opportunities in the areas of mental health research, planning, delivery and management of the mental health care sector. With the technology becoming more user friendly and accessible and with initiatives like participatory GIS, the utilisation of GIS will facilitate greater participation and contribution by all stakeholders. As the technology further develops and becomes more commonplace, it is bound to find many more innovative applications in the mental health arena.

**References**


