Review

Application of geographical sciences and technologies to investigate health problems in the Eastern Mediterranean Region

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تطبيق العلوم والتكنولوجيا الجغرافية لدراسة المشكلات الصحية في إقليم شرق المتوسط

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الخلاصة: إن التطورات الحديثة في العلوم والتكنولوجيا الجغرافية، ولاسيّما الوبائيات الجغرافية، ونظم المعلومات الجغرافية، ونظم تحديد المواقع العالمية، وتحليل المعطيات الفراغية توفر فرصة فريدة لدراسة دور "المكان" على صحة الإنسان بطريقة علمية. وتهدف هذه الورقة للبدء بمناقشة حول تطبيق هذه التطورات في دراسة جغرافيا المشكلات الصحية العمومية ضمن إقليم شرق المتوسط لمنظمة الصحة العالمية.

ABSTRACT Recent developments in the geographical sciences and technologies, namely geographical epidemiology, geographical information systems, global positioning systems and spatial data analysis brings about a unique opportunity to investigate the role of “place” in human health in a scientific manner. The aim of the present communication is to open a discussion about the application of these advances to study the geography of public health problems within the Eastern Mediterranean Region of the World Health Organization.

Application des sciences et technologies géographiques à l’étude des problèmes de santé dans la Région de la Méditerranée orientale

RÉSUMÉ Les récents progrès des sciences et technologies géographiques, à savoir l’épidémiologie géographique, les systèmes d’information géographique, les systèmes mondiaux de localisation et l’analyse des données spatiales offrent une occasion unique d’étudier de façon scientifique le rôle du « lieu » dans la santé humaine. Cette communication a pour but d’ouvrir le débat sur l’application de ces avancées à l’étude de la géographie des problèmes de santé publique dans la Région de la Méditerranée orientale de l’Organisation mondiale de la santé.

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Introduction

Despite the important connections between location and health, the role of geography has not been the recent focus of the public health research agenda [*1*]. However, a revival of interest has accompanied major advances in the geographical sciences and technologies such as geographical epidemiology, spatial data analysis, geographical information systems (GIS) and global positioning systems (GPS), that make it possible for public health researchers to more easily investigate their spatial data [*2*] and consequently to understand the role of "place" in community health in a scientific manner [*3*]. The increasing use of these advances in public heath can be illustrated by the example that in 2003 the term "geographic information systems" was inserted into Medical Subject Headings (MeSH) by the US National Library of Medicine [*4*].

The chief aim of this review is to open up a discussion about the application of these progresses in the Eastern Mediterranean Region (EMR) of the World Health Organization (WHO). It starts by introducing each of the geographical-related sciences and technologies and then moves on to provide an example of how the combination of geographical information sciences and technologies could work to manage a public health problem. Finally, it discusses some of fundamental issues in the application of these advances within the EMR.

Geographical epidemiology

Geographical epidemiology, which is part of descriptive epidemiological studies, is the description of spatial patterns in health-related phenomena, such as diseases, injuries and disasters, and health-related behaviours, such as drug abuse [*5*]. One of the most important branches is disease mapping, which helps researchers to precisely describe spatial variations in disease morbidity and mortality in order to formulate etiological hypotheses; to identify possible clusters; and to properly allocate public health resources [*6*].

Despite the important role of geographical epidemiology in public health, it was a neglected area of epidemiological study until the mid-20th century [*7*]. However, in recent years, 2 important reasons, among others, bring geographical epidemiology to the front line of epidemiological studies: first, an increase in the number of public health databases in which the case information is geo-coded; and second, the developments in geographical information technologies, including GIS and GPS. It is likely, therefore, that more scientists throughout the world will seek to use geographical epidemiology to investigate the geographical aspects of public health problems [*3*].

Geographical information systems (GIS)

GIS are computer software that automatically store, analyse and display spatial data in the form of high resolutions maps and charts. The development of GIS technologies dates back to the 1960s and since then they have revolutionized the capability of researchers to easily handle large volumes of data related to geography [*8*]. One of the advantages of GIS are that they permit simultaneous display and analysis of various databases in an interactive computer environment [*9*]. Therefore, they provide a scientific ground for valuable applications in many fields including public health [*10*].

Through creating informative maps, GIS have been applied to study the patterns of morbidity and mortality and contributing risk factors, to analyse environmental health

hazards, to determine access to health care services and also to locate new health services [*11*]. They have also been applied to design population-based interventions and resource allocations [*9*], to educate public health specialists [*12*] and even to study the spiritual dimension of health [*4*].

The capturing of spatial data—that is, the exact location of a place such as a health centre, or an event such as a traffic accident—comprises the backbone of any GIS project. There are a number of ways to help the researcher to fulfil this demand. These include using geo-referenced data sets, data from aerial photography of the earth's surface, satellite imageries and other geographical information technologies such as GPS [*6*]. This paper draws the attention of readers to the easy integration of data captured by GPS into the GIS.

Global positioning systems

GPS are a constellation of at least 24 and up to 32 solar-powered satellites, with ground-based stations and receivers. The satellites, which circle the earth every 12 hours, transmit radio pulses at very accurate time periods [*13*] that are used by a hand-held receiver to determine the latitude, longitude and altitude of a given position [*14*]. The radio waves can pass through clouds and vegetation but not through the earth, metal, steel and dense tree cover [*15*].

Although at first GPS were designed for military purposes, they have now become a standard method for data capture in all the human sciences, including geographical epidemiology [*11*]. One of the advantages of this method is that many GPS receivers permit storage of the coordinates of the measured locations and therefore, the captured data could be entered directly into GIS and displayed [*11*]. Moreover, some of the other GPS receivers allow users to place their antenna on top of a car whilst connecting them to a portable computer inside the same car. Therefore, the user can record and display the path of the vehicle while driving [*16*].

Spatial data analysis

Spatial data analysis aims to visualize, explore and applying the best statistical model which fit the spatial data [*2*] and it offers a means to use positional information to identify and quantify geographical patterns in public health investigations [*17*]. Unlike conventional statistical analysis, there is an important assumption in spatial analysis: that spatial data gathered from nearby areas are dependent on each other [*18*]. At first glance this makes spatial analysis a daunting task to perform.

Recent advances in more user-friendly and functionally integrated GIS, however, will expand the use of spatial analysis in public health studies [*19*]. For instance, *ArcGIS*, one of the best known GIS desktop packages, consists of 3 different components—*ArcView*, *ArcEditor* and *ArcInfo*. *ArcView* is a fully-featured GIS software application for managing, processing, visualising and analysing geographical data, whilst *ArcEditor* inserts more GIS editing tools into *ArcView*, and *ArcInfo* inserts more advanced conversion and geo-processing capacities into *ArcEditor* [*10*].

Combinations of geographical information sciences and technologies

Geographical information sciences and technologies can perform better if they are linked. Evidence suggests that this combination provides a powerful tool for studying the geographical aspects of public health problems.

Take disasters, which are one of the most important public health problems, as an example. We have realized that the frequency of disasters, both natural and man-made, has increased alarmingly during past decades at both global and EMR levels [*20,21*]. Therefore, we increasingly need technologies which help us to manage a disaster as quickly and efficiently as possible [*22*].

To do this, we need access to timely and precise information from the affected populations. At the same time we have to be able to connect the data collection and analysis process to make managerial decision as soon as possible [*23*]. Given that GPS receivers work efficiently even under severe weather situations such as sandstorms, torrential rain and high temperature, they can play a key role in capturing information about the exact location of the affected population. Then the captured data can be directly entered into the GIS for display purposes. At the final stage, using newly developed spatial statistical techniques, it will be possible to have relatively precise information about the number of people affected [*24*].

Fundamental issues in applying geographical information sciences and technologies

Fortunately, within the EMR there are a number of ongoing projects which have applied geographical information sciences and technologies to investigate the geography side of public health problems. For instance, in one project, satellite images and GIS are used in conjunction to recognize natural hazards in the context of populations exposed to risk [*25*]. In another project, GIS are applied to better monitor health trends in areas influenced by conflicts [*25*]. Therefore the final part of this paper focuses on some of the fundamental issues to consider when designing a relevant project. These include:

- Implementation of geographical information sciences and technologies requires a significant commitment in money, time, training and effort by the relevant organizations, that is, the ministries of health and also the individuals within these organizations [*11*]. While the adoption of these techniques will be supported by the responsible bodies in the developed world, it might not be the same for the developing world, including some countries within the EMR, in which scarce resources need to be invested elsewhere. It seems therefore, that international organizations such as WHO and its regional offices, including the Eastern Mediterranean Regional Office, have to play a more active role to facilitate the application of these techniques in the developing world.
- In order to apply these techniques we need to have public health geo-coded data with clear criteria. It should be noted that public health databases often come from different sources and it might be possible that in designing a database the variables that are surrogates for the place, such as the postcode or the x and y coordinates, have been forgotten or not correctly recorded [*26*]. Therefore, as with all data analysis, it is crucial to take into account the issue of quality of data recording whenever a study is designed. It is also vital to provide the user or reader with a commentary on the quality of the data [*27*]. This is more important for developing countries, including the countries within the EMR, in which existing databases may be of poorer quality.
- It is also necessary to design new public health databases in a way that, if needed, the place of residence of the cases, such as patients with cancer, or place of occurrence of events, such as the exact location of a traffic accident,

will be recorded. At the same time, appropriate measures should be employed to preserve the confidentiality and anonymity of the data [*28*]. Necessary training should also be provided so that those who gather the data or who enter them on forms or computer spreadsheets record the data precisely.

- We should also remember that the geographical information sciences and technologies can generate attractive output, such as maps, which might be misleading if proper scientific methods are not followed when producing them [*29*]. Hence, both the users and the readers of need to study them critically and judge whether the rules of good data management, analysis, presentation and interpretation were followed [*30*].

To fulfil all the above issues, it seems that larger organizations, such as health ministries within the EMR, should hire a geographical-related science and technology expert and the smaller organizations, such as provincial health centres, a trained technician. Furthermore, workshops should be conducted for existing health professionals to inform them about the capabilities of geographical information sciences and technologies. Evidence suggests that the great majority of problems faced by health organizations are essentially geographical and local in nature [*31*]. Therefore, health organizations within the EMR should welcome any new technologies and sciences which help them to better investigate the geographical foundations of their problems. Finally, teaching geographical-related sciences and technologies should be included in the curriculum of all health schools.

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