Applications of Geographical Information System (GIS) in Planning of Health Services in Erbil City, Kurdistan Region

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ABSTRACT

Background and Objectives: Geographic Information System (GIS) is a system for solving complex planning and management problems. GIS provides an excellent means of visualizing and spatial analyzing health data. The aim of this study was to highlight the valuable uses of GIS in planning of health services in Erbil city.

Methods: This is a cross-sectional study, conducted in Erbil city during the period between (1/2/2009-1/5/2009). Data on number of health centers and hospitals, health manpower and health services of 2008 were collected & analyzed spatially and presented in appropriate maps, figures and tables. Health services data was linked to the population data for computing health indicators like doctor- population ratio and nurse -population ratio. Bed occupancy rate (BOR) and average patients stay for all hospitals of year 2008 is calculated and analyzed spatially.

Results: Total number of health centers(HCs) which provide all types of health services to the community were (15), (12) of them have one or more of these health services. There are (13) quarters without health centers. Most of physicians (80.6%) & assistant physicians (Medical assistants) (79%) are working in hospitals, while only (19.4%) of physicians & (21%) of medical assistant are working in HC. The highest number of doctor-population ratio was in (Shahid Najdee Haidar) HC (14588) while the lowest was in (Mala Afandi) HC (1635). Maximum bed occupancy rate was in (Hawler teaching) hospital (66.7%), while the minimum was in (Amal) Hospital (11%).

Conclusions: GIS is a promising tool for evaluating health facility distribution and planning of equitable distribution health services in Erbil city.

Key words: Geographical Information System, Spatial analysis, Bed occupancy rate, Erbil, Health planning.

INTRODUCTION:

Medical geography is a very active subdiscipline of geography which has traditionally focused on the spatial aspects of disease ecology and health care delivery by using maps and visual images as well as new technologies including geographical information[1,2]. GIS as a system of hardware, software and procedures designed to support the capture, management, manipulation, analysis, modeling and display of spatially referenced data for solving complex planning and management problems [3,4]. Nowadays GIS is applied in many fields like: Transportation, Agriculture, Facilities Management, Telecommunications, Petroleum, Military, Risk Management and Web GIS[5]. GIS have numerous applications in human health. GIS is gradually being accepted & used by public health administrators & professionals, including policy makers, statisticians, Health planners, epidemiologists, regional & district medical officers. Some of its potential applications in public health are: determine the geographical distribution & & temporal trends of diseases, identify gaps in immunizations, map populations at risk & stratify risk factors and forest epidemics [6]. Maps produced by a GIS

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can also be used by health officials as a monitoring and evaluation tool, showing the spatial distribution and differential evolution of diseases. Monitoring and evaluation are essential parts of health programs[7]. The Ministry of Health is responsible for all the issues concerning the health of the population in Kurdistan Region, including both the private and public health sectors. The health system is principally based on providing partially free national health services for all population [8]. The health services in Kurdistan region are delivered to the population at three levels: Ministry of health, directorate of health in each governorate, and the district health offices at the district level. The Health services in Erbil city is run by General Directorate of Health (DOH)-Erbil. The development and continuous monitoring of health status indicators reflects one of the key infrastructure services at the core of primary health care [9]. In WHO'S definition they are variables which help to measure changes. Often they are used particularly when these changes cannot be measured directly. Health care delivery indicators are the frequently used indicators for availability and evaluation of health services, these indicators reflect the equity of distribution of health resources in different parts of the country, and of the provision of health care [10]. The special importance of this study involves the evaluation of health services situation in Erbil city. Other importance is computing the physician - population ratio, nurse-population ratio and bed occupancy rates as indicators for delivery of health services in Erbil city.

METHODS:

This is a cross-sectional study, conducted in Erbil city during the period between (1/2/2009-1/5/2009). The data was analyzed spatially and presented in the appropriate maps, figures and tables. Erbil governorate is the capital of Kurdistan-Northern Iraq. It is a commercial, agricultural and administrative center. The population is a mixture of a majority of Kurds (87%-89%), Arabs (6.1%) and a minority of Turkoman (1.5%) and others (9.4%). Majority of the peoples are Muslims (97.9%), while Christians (2%) and others constitute (0.04%). The population of Erbil governorate is estimated to be (1,370,000) in 2002, constituting (18.8%) in comparing to all Kurdistan populations and (4.7%) to all Iraq populations (25,000,000). The population density is about (53%) [11]. The list of Erbil city Quarters with their population in hard copy of 2009 was obtained from the Directorate of Erbil Statistics and was disaggregated by city quarters [12]. Satellite image of Erbil city 2005 (which obtained from GIS center) used to prepare a map of Erbil city by converting it to a vector format (shape files) by using ArcGIS Version 9.2, this map became the base for all other map files throughout the study. The boundary of city quarters was plotted according to these shape files [13]. Health data was collected from Directorate of Health (DOH), all health data obtained was in software format, but separately from different departments. For the purpose of simplicity, the data collected and unified in one table [12]. The population data of 2009 was estimated from 2004 population census. Some of the quarters were previously occupied by peoples, but at the time of the study, they were emptied, for instance, Qalat Quarter, their peoples are re-occupied in Sarwaran Quarter, therefore the number of peoples are added to Sarwaran quarter, with the help of Directorate of Municipality, population data of quarters (especially new quarters) are fixed on the map. Population data were used as a denominator for calculating population catchments area of each HC. Data on number of health centers and hospitals, health manpower and health services of 2008 were collected & analyzed spatially and presented in appropriate maps, figures and tables. Health data linked to population data for computing health indicators like doctor- population ratio and nurse -population ratio. Bed occupancy rate (BOR) and average patients stay for all hospitals of year 2008 is

calculated according to the following formulae [14]:

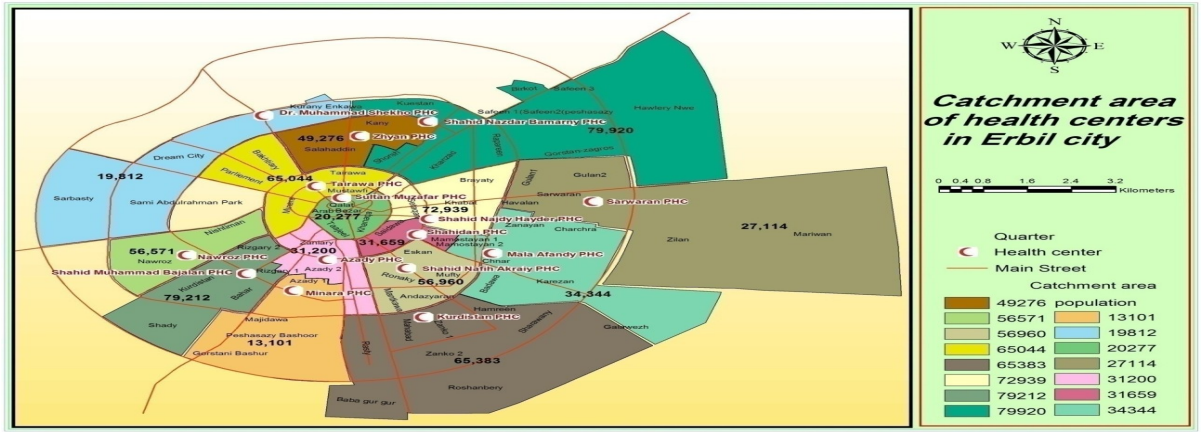
$$Bed\ occupancy\ rate = \frac{Total\ no.of\ days\ of\ staying\ patients\ in\ one\ year}{No.Beds \times No.days\ in\ one\ year} \times 100$$

$$Average\ one\ patient\ stay\ in\ hospital = \frac{Total\ no.of\ days\ of\ staying\ patients\ in\ one\ year}{Total\ no.of\ patient'sadmission\ in\ one\ year}$$

RESULT:

Total numbers of health care facilities are as followings: Number of hospitals (8), primary health centers (27), emergency clinics (3), public clinics (11) and specialized health (medical) centers (11). There were (2) general teaching hospitals in Erbil city: (Rzgary) teaching hospital and (Hawler) teaching hospital, (2) emergency hospitals, (1) hospital of blood disease, (1) cardiothoracic surgery hospital, (1) Raparin hospital for children diseases and (1) maternity hospital. Total number of health centers which provide most of health services to all community are (15) health centers, another (12) health centers provide specific health services. Map (1) shows the catchments areas of 15 health centers which provide health services in Erbil city. According to this map, (Shahid Nazdar Bamarnee) health center covered the maximum population density (79,920) followed by (Shahid Mohammad Bajellan) HC (79,212), while (Minara) HC had the minimum population density (13,101). Total number of physicians in hospitals and health centers in Erbil city was (754) (including specialists, general practitioners), nurses (1 ,(231,dentists (88) and assistant physicians (1,253). Most of physicians (80.6%) & assistant physician (Medical assistants) (79%) were working in hospitals, while only (19.4%) of physicians & (21%) of medical assistants were working in HC, (Figure 1).

Regarding the doctor-population ratio of HCs, the highest number of doctor-population ratio found in (Shahid Najdee Haidar) HC (14,588) while the lowest found in (Mala Afandi) HC (1,635). (Map 2) illustrate doctor-population ratio per HCs in Erbil city. Maximum numbers (6 (631,of nurse -population ratio was recorded in (Shahid Najdee Haidar) HC and minimum ratio (1,145 (in (Mala Afandy) HC, (Map 3).
Maximum bed occupancy rate observed in (Hawler Teaching) hospital (66.7%), while the minimum rate was in (Amal) hospital (11%), (Map 4-A).
The higher number of average patient stay was in the Nanakalee Hospital (6.8) days followed by Rzgary teaching hospital (4.6) days, the lowest number in Mala Afandi HC (0.5) day, (Map 4-B).



Map (1): Catchments area of health centers in Erbil city.

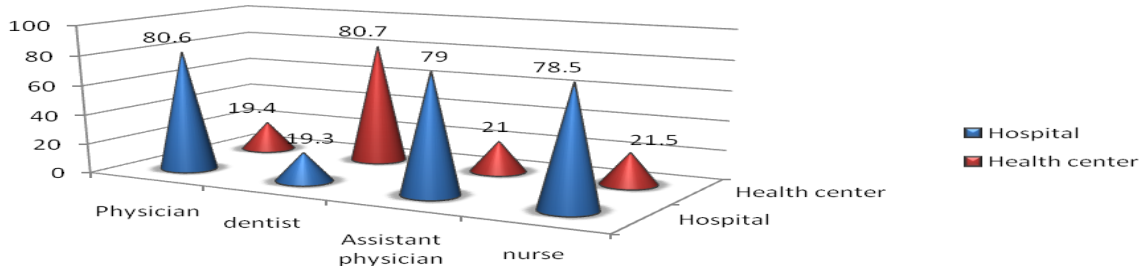
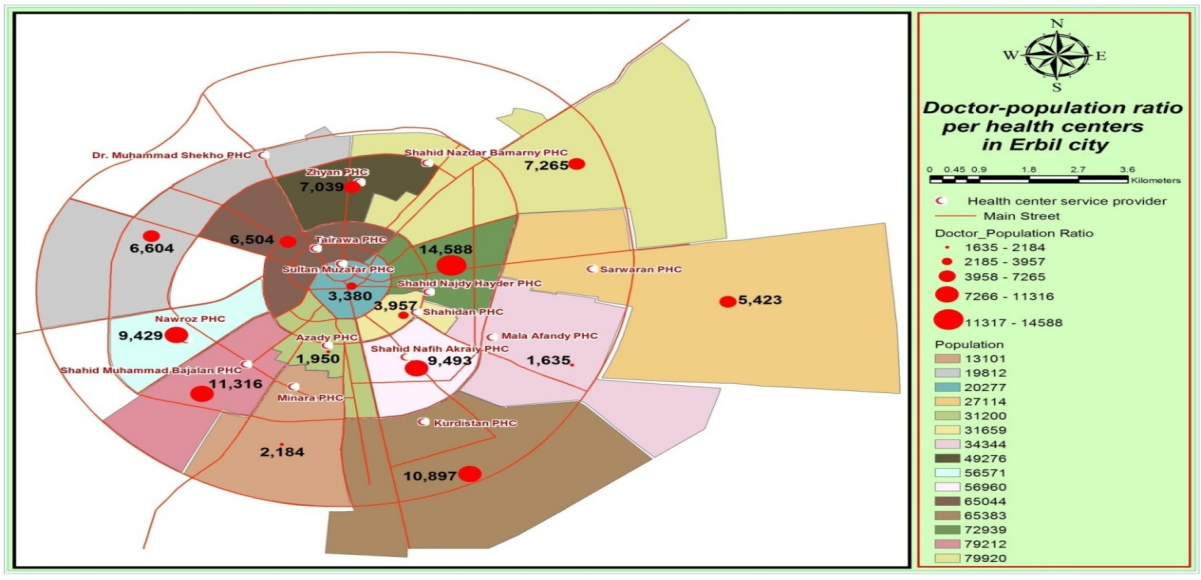
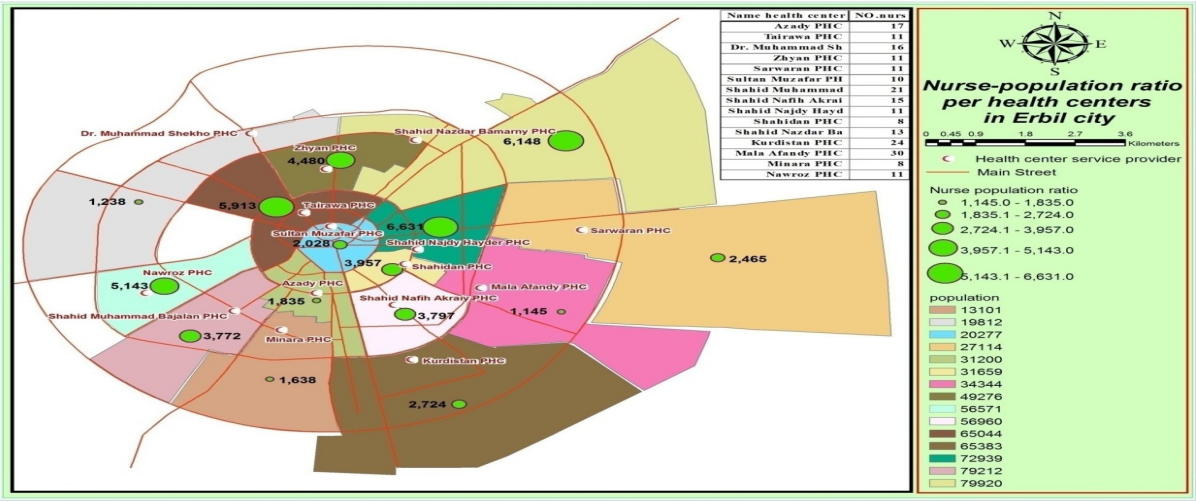


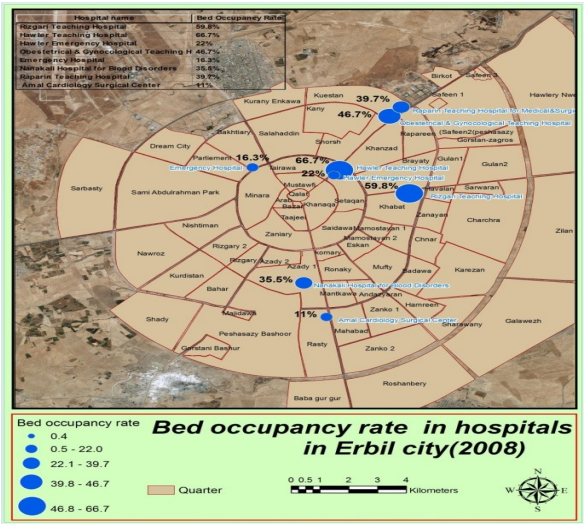
Figure (1): Distribution of health manpower in hospitals and HC in Erbil city.



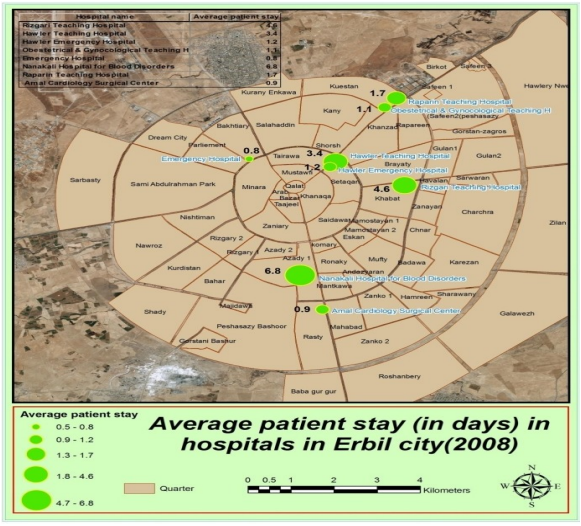
Map (2): Doctor Population ratio per health center in Erbil city.



Map (3): Nurse Population ratio per health center in Erbil city.



Map (4-A): Bed occupancy rate in hospitals.



Map (4-A): Average patient stay in hospitals.

DISCUSSION:

The overlay technique allowed the health planner to provide a health situational map that could be shown with specific themes (city quarter, population density, Health facilities and manpower) and with composites of the themes. This became a key part of GIS-based analysis by visualization of values and rates [15]. In this study it was found that all the health facilities (health centers & hospitals) located and concentrated mainly near the center of the city, and (11) buildings were used to do two jobs, first in the morning serve as primary health center, and in the afternoon as poly clinics. This is because the center of Erbil was the main site of inhabitants & the re-planning of new quarters was started after the year of 2000. Erbil city contains (8) hospitals with different specializations, which are introducing secondary and tertiary health services. Most of these hospitals provide both emergency and elective cares, including

surgery, medicine, obstetrics and gynecology, and pediatrics. It is recognized that there are no HCs in seven most highly density population quarters (more than 10,000 people), these quarters are (Khanzad, Rapareen, Brayaty, Nishtiman, Bahar, Parliement, Sharawany). These shortages reflect the absence of new establishment of HCs for long time to face this population growth and new establishing quarters in Erbil city. This population density is explaining the high doctor-population ratio and high number of outpatient in hospitals and HCs which is illustrated in the previous chapter. A number of factors are found governing the size of catchments area of health services like travelling time, type of medical services, type of illness [16]. Highest population catchments area showed in (Shahid Nazdar Bamarnee) (79,920) followed by (Shahid Mohammad Bajellan) HC (79,212), this might be due to the population density and lacking of HCs in new quarters. One HC in Erbil city provides services to (46,852) persons. According to WHO report of 2005, each centre is responsible for providing primary care services to a population of about 35,000 [17]. In a study in Costa Rica, it is found that Half of Costa Ricans resides less than 1 km away from an outpatient care outlet and 5 km away from a hospital. In equity terms, 12–14% of populations are underserved according to indicators: having an outpatient outlet within 4 km and a hospital within 25 km [18]. The greatest natural resource of all countries is its manpower [19]. There was an imbalance in distribution of health manpower between hospitals and health centers. Most of physicians and assistant physician are working in hospitals, this is reflect the curative mind of doctors & medical assistant, which is mainly present in hospitals, while HCs are introducing mainly the preventive services. Doctor-population ratio considers the frequently used indicators for health care delivery which reflect the equity of distribution of health resources [20]. The highest number of doctor-population ratio found in (Shahid Najdee Haidar) HC (14,588). The doctor population ratio in Erbil city is (1.1per 1000). This is lower than some developed country standards like: 2.3 per 1000 in Ireland. The European average currently stands at 3.5 per 1,000, and 2.56 per 1000 in USA, while it is higher than some developing countries like Ghana which was 1:13 per 683 in 2007 [21-23]. The reason behind this high number of doctor-population ratio in Erbil is due to low number of doctors in the city (608) in hospital & (146) in HCs. HCs are not established according to population density. Regarding nurse population ratio, maximum number found in)Shahid Najdee Haidar) HC (6631 ,((Map 3.11). The overall nurse-population ratio in Erbil city is (1: .(556 Comparing this number with some country like Singapore (1:210) and Nurses per 1000 populations is 3.16 in Muscat Governorate; we have found some shortage or less normality in these ranges [24,25]. The most important health indicator is the bed occupancy rate. High rate of bed occupancy refers to the overcrowding in the hospital or shortage in the number of beds in the hospital [14]. The numbers of beds present in (Mala Afandi) HC are not used for admission but used for daily routine treatment and for childbirth. Maximum bed occupancy rate observed in (Hawler teaching) hospital (66.7%), average bed occupancy rate in hospitals in Erbil city is (48.4%). This number refers to less than what is present in some countries like: Jordan (63.3%) in 2004, Latvia (80.44%) and Islamic Republic of Iran (57.44%) [26-28]. Average patient stay in the hospital is an indicator refers to length of period staying patient in hospital because of certain diseases or certain reasons [25]. The majority of hospitals in Erbil city are short-term facilities. The higher number of average patient stay was in the (Nanakalee) Hospital (6.8) days, because it is a specialized hospital for blood diseases, followed by (Rzgary) teaching hospital (4.6) days. Increasing of the average patient stay has been recorded for some special hospitals with chronic diseases. These averages are

higher than in other countries, in Jordan its (3.3) days & in Iran its (3.60) days, while it's lower than in Latvia (9. 65) days [26-28]. This study highlighted the valuable uses of GIS in planning and evaluating health services with given constraints in Erbil city by recognizing health facility distribution and comparing them with their catchments areas, revealing immunization coverage, showing inequalities of health manpower distribution among health facilities and mapping of health services in Erbil city. This study recommended the systematic use of GIS in Erbil directorate of health to perform spatial analysis of health facilities distribution in Erbil city and implementing GIS for health services and identifying out of services area as recognizing areas of planning for future investment and differential evolution of health services.

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