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ABSTRACT Geographic information systems (GIS) analysis has not been widely used in underdeveloped countries to ensure that vulnerable populations have accessibility to primary health-care services. This study applied GIS methods to analyse the spatial accessibility to urban primary-care centres of the population in Kermanshah city, Islamic Republic of Iran, by age and sex groups. In a descriptive-analytical study over 3 time periods, network analysis, mean centre and standard distance methods were applied using ArcGIS 9.3. The analysis was based on a standard radius of 750 m distance from health centres, walking speed of 1 m/s and desired access time to health centres of 12.5 mins. The proportion of the population with inadequate geographical access to health centres rose from 47.3% in 1997 to 58.4% in 2012. The mean centre and standard distance mapping showed that the spatial distribution of health centres in Kermanshah needed to be adjusted to changes in population distribution.

Accessibilité spatiale de la population aux centres de santé urbains à Kermanshah (République islamique d'Iran) : analyse des systèmes d'information géographique

RÉSUMÉ L'analyse des systèmes d'information géographique n'a pas été très utilisée dans les pays en développement pour garantir que les populations vulnérables ont accès aux services de soins de santé primaires. La présente étude a appliqué des méthodes des systèmes d'information géographique pour analyser l'accessibilité spatiale aux centres de soins de santé primaires urbains pour la population de la ville de Kermanshah (République islamique d'Iran) par tranche d'âge et par sexe. Dans une étude analytique-descriptive sur trois périodes, une analyse des réseaux et des méthodes de mesure des distances moyenne et standard jusqu'aux centres ont été appliquées à l'aide du logiciel d'information géographique ArcGIS 9.3. L'analyse reposait sur un rayon standard de 750 mètres de distance à partir des centres de soins, à une vitesse de marche d'un mètre par seconde et un temps d'accès souhaité aux centres de soins de santé de 12,5 minutes. La proportion de la population ayant un accès géographique inadéquat aux centres de soins a augmenté, passant de 47,3 % en 1997 à 58,4 % en 2012. La cartographie de la distance moyenne et standard jusqu'aux centres a révélé que la répartition spatiale des centres de soins de santé à Kermanshah devait être ajustée aux changements dans la répartition de la population.

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Introduction

Primary health care is essential for improving and maintaining the health of the population. It has the potential to accelerate achievement of the Millennium Development Goals and fulfil the call for “Health for All” in the Alma-Ata Declaration. Adequate provision of primary health services is one of the essential components of social development (1,2) and the assessment of accessibility to health services provides unambiguous quality-of-life and social welfare indices (3). Understanding the performance of a health system from a geographical perspective is therefore important for improved health planning and evidence-based policy development (4).

One of the major problems confronted by health-care managers, especially in underdeveloped countries, is the uneven distribution of health-care centres in urban regions (5). This imbalanced

geographical distribution can lead to inefficiency in the offered services and inequalities in access to services (6,7), since the necessity to travel long distances to reach health-care services inhibits patients' use of the services and leads to increases in inequalities in health (8–10). Accessibility refers to the relative ease of access to a given location (11). As a general rule, previous studies have identified 2 criteria—availability of services and accessibility to services—as the components of the overall spatial accessibility of people to services (12).

Medical geographers have the ability to assess the spatial distribution and accessibility of health services using geographic information systems (GIS). GIS analysis can be used in a variety of ways to visually display health-service utilization and to take into account the many factors related to location that may limit an individual from acquiring proper health care. Location-allocation models are used to identify how gaps in health services among specific communities can be reduced. Mapping existing health services along with the road networks is used to identify and facilitate patient travel (4). Nowadays, GIS analysis is increasingly applied in health-related fields (13–15) and has turned into a valuable tool to ensure that vulnerable and underprivileged populations have accessibility to hospitals (16–19), palliative care centres (20) and primary health-care services (21–23). Using GIS techniques offers great promise for improving the distribution of health resources, identifying service gaps and allowing policy-makers to better assess potential risk factors and prevent disease especially with regard to at-risk age and sex groups (3).

Political pressures and growing disparities in health services have compelled many health-care administrators to re-evaluate their health-care systems to accommodate population needs (4). In the Islamic Republic of Iran, although some traditional epidemiological studies have been done concerning health management, there have been few studies applying GIS analysis in public health. The study reported here is the first to use GIS methods in a health management context to analyse spatial accessibility of the population to urban primary health-care centres in Kermanshah city by age and sex groups. Kermanshah was targeted for this study due to reports of migration of the residents from the centre of the city to suburban areas, due to informal settlements, inefficient communication networks and damaged infrastructure in the central areas (24).

Methods

Study setting and data sources

Kermanshah province is one of the 31 provinces of the Islamic Republic of Iran and is located in the western half of the country. The city of Kermanshah lies in the eastern half of the province and covers an area of more than 100 00 hectares. The population in 2012 was 851 405, served by 34 health-care centres. The data used in this research were based on the statistic database of the population clusters from Kermanshah for 3 years (1997, 2007 and 2012) which were prepared by the Statistical Centre of Iran in Tehran. The names and addresses of the

health-care centres were provided by the Health Promotion Research Centre in Kermanshah.

Study tools

This was a descriptive-analytical study. The ArcGIS program, version 9.3 was used to map the network of urban streets and health-care centres of the region under study. The topology and the spatial relationships among the routes were created in the environment of ArcCatalog. The ArcGIS Network Analyst extension was used to calculate the mean centre and standard distance of the health-centre network.

Data collection

For the technical calculations of transport, the velocity of a person's movement while walking in normal mode was assumed to be between 0.75 and 1.25 m/s (25). According to the standard accessibility radius of 750 m for health-care centres (26,27) and taking the velocity of a person's movement as 1 m/s, a walking duration of 12 minutes 30 seconds for each individual from their house to the nearest health centre formed the basis of the present research. Using network analysis, borders were created for the areas where services were supplied by the health-care centres in terms of the citizens' accessibility to these areas in a real time and using the actual routes. Then, by using the intersect and symmetric difference tools, the number of people who were deprived of spatial accessibility was calculated by sex (males and females) and age group [0–14 years old (children), 15–64 years old (adults) and > 65 years old (elderly)] (28,29).

To compare the spatial deployment pattern of the health-care services in Kermanshah over the 3 time periods (1997, 2007 and 2012), the mean centre and standard distance were calculated. The mean centre is the mean of the geographical latitude and longitude coordinates of all features in the scope of study. The mean centre is calculated with the following equation (30).

Where Xi and Yi of the coordinates of the areas of (i) and (n) equal the total number of features and areas.

The standard distance (SD) is a method for examining the level of concentration or dispersion of features around the mean centre. The standard distance is calculated with the following equation (30): $SD = \sqrt{(\Sigma Di2/n)}$, where (Di) is the distance between 2 points, the mean centre and n points.

Results

Table 1 shows the total population and the number and percentage of the population with and without accessibility to a health-care centre in the years 1997, 2007 and 2012. The total population of Kermanshah city increased over the study period. In 1997 Kermanshah had a population of 693 157 served by 29 health-care centres, in 2007 the population was 794 863 with 33 health-care centres, and in 2012 the population was 851 405 in 2012 served by 34 health-care centres. Based on a maximum duration of walking for each individual citizen of 12.5 minutes, the results demonstrated that the percentage of the total population with accessibility to a health centre decreased across the 3 time periods and the percentage of the population without such accessibility increased. In 1997 47.3% of the population were deprived of proper accessibility, in 2007 this had risen to 55.7% and in 2012 it was 58.4% (Table 1). The number of people with appropriate spatial accessibility to the health centres also decreased from 365 445 in 1997 to 354 236 in 2012. This decrease in the numbers and proportions of the population with accessibility was seen despite the fact that the number of health-care centres in Kermanshah rose over the same time period, from 29 health-care centres in 1997 to 34 centres in 2012.

Table 2 shows the population without accessibility to a health centre, by sex and age group in 1997, 2007 and 2012. The time-trend analysis by age showed different patterns of accessibility in different age groups. In 1997 38.6% of children (aged 0–14 years old) were deprived of accessibility to a health centre; this reduced to 23.0% in 2007 and again dropped to 20.5% in 2012. In contrast, in the adult age group (15–64 years old) 56.6% were deprived of accessibility in 1997 and this rose to 70.5% in 2007 and reached 74.8% in 2012. In the elderly age group (> 65 years old), 4.8% of the population were deprived of accessibility in 1997 and this increased to 6.5% in 2007 and decreased to 4.8% in 2012.

The location of the health-care centres in Kermanshah and the specific regions that were underserved in the time period of our study are shown in Figure 1 . This shows that during the 3 time periods of the study the health centres were concentrated in the central part of the city but that the expansion of the city outside the border areas meant that the suburban housing estates were beyond the range of walking accessibility to health-care services and thus the residents in border and suburban areas were more deprived in this regard.

The results from the analysis of mean centre and standard distance of the urban health-centre network in Kermanshah demonstrated that the health centres were concentrated in the geographical centre of the city. Compared with 1997–2007 the standard distance in 2012 moved towards the western south side of the city, consistent with the population distribution and the establishment of 2 new health centres in that area during 2007–2012 (Figure 2).

Discussion

In this study the spatial accessibility of the population to primary health-care centres located in Kermanshah and the spatial coverage of the services were examined in a real model based on the maximum span of 12.5 minutes walking. Over the 3 time periods of 1997, 2007 and 2012 the population with accessibility to a health-care centre showed a downward trend. Measures of supply and demand, in the form of areas of coverage and citizens' accessibility respectively, enabled us to better understand the causes of poor performance in the health management systems. In addition, it enabled us to realistically analyse and identify possible obstacles and facilitating factors in citizens' spatial accessibility to primary health-care services. Methods such as these may be useful for improving the policies and planning concerning health care, especially in developing countries such as the Islamic Republic of Iran.

The results of this research indicated that over the 15 years of the study, the percentage of the population of Kermanshah with adequate spatial accessibility to a health-care centre showed a significant downward trend. The percentage with accessibility to a health-care centre was only 52.7% in 1997 and this had decreased to 41.6% by 2012. The decrease in spatial accessibility occurred in spite of an increase in the number of health centres from 29 in 1997 to 34 in 2012. Three points need to be considered to explain this. First, the total population of Kermanshah city increased from 693 000 in 1997 to 851 000 in 2012. Secondly, the spatial distribution of the health centres across the city was not equitable, as according to our analysis of the mean centre and standard distance, health centres were concentrated in the central part of the city; residents of the suburban housing estates therefore did not have adequate accessibility to such facilities. Thirdly, it is likely that displacement and migration of the population residing in the central part of the city to the newly established suburban housing estates was responsible for a reduction in the population residing in areas with the highest number of health centres.

Another interesting point to note in this study was that not only did the percentage of the population with adequate spatial accessibility to health-care centres decline during the time period studied, the number of people with accessibility also decreased, from 365 000 to 354 000. A possible reason for this finding is that there was an over-supply of health centres concentrated in the centre of the city. The city centre of Kermanshah suffers from outdated infrastructure, informal neighbourhoods, inefficient communication networks and lack of proper equipment and facilities (24). There have also been changes in these neighbourhoods from residential to commercial-administrative usage. Kermanshah has therefore seen a reduction in the population concentrated in the city centre as people migrate to other areas. In cities like Kermanshah, where there are ethnic differences among the population in different localities, switching the concentration of services between certain areas can worsen the effects of inequalities. As a result, the human and natural ecological structure of a healthy city can be disrupted and the system of urban health management will still encounter inefficiencies event when adequate funding is allocated for health care.

Comparing the percentage of the age groups deprived of spatial accessibility to the health centres indicated that the proportion of children without accessibility to health centres experienced a downward trend from 38.6% to 20.5%, while the proportion of adults without accessibility to the health centres rose from 56.6% to 74.8% and the proportion of the elderly age group without accessibility to the health centres were at similar levels in 1997 and 2012. This downward trend in the percentage of children deprived of accessibility in relation to the 2 other age groups, could be due to the decreasing rate of population growth in Islamic Republic of Iran over recent years. The spatial organization and the pattern of capital investment in health services should be in such a manner that meets the needs of the population residing in specific localities and takes account of gender and age differences, otherwise there is a risk of ignoring the needs of vulnerable groups among the less-privileged residents.

Our results indicate that the suburban areas had lower potential spatial accessibility to health services than the other parts of the city especially compared with the city centre (Figure 1). This unequal distribution of resources between the centre and outlying areas is similar to Ruishan's study in rural China (18).

Our figures showing only 41.6% of the population having adequate spatial accessibility in 2012 are lower than another study in the Islamic Republic of Iran, in Miandoab city, which found that 67% of the community had access to the national health-care services (31). On the other hand the findings were more consistent with a similar study done in Isfahan, in which only one-third of the community had adequate geographical access to the national health-care centres (32%) (32). In a study in the western province of Rwanda, 3 different travel scenarios utilized by the population to attend the nearest primary health facility were analysed and defined with a maximum travelling time of 60 minutes: scenario 1 (walking), scenario 2 (walking and cycling) and scenario 3 (walking and public transportation). The lowest level of accessibility was observed in scenario 1 (walking), in which the network covered only 26.6% of the population. As in our study, the authors concluded that a majority of the population in the province did not have access to the existing primary health facility network (33).

Social justice in health is a multifactorial issue. Inequity in health is more common in underdeveloped countries than more developed ones. This issue has been demonstrated before by other studies in the Islamic Republic of Iran. Karimi et al.'s comparative research on equity in access to health services in developing countries based on strategies and policies applied showed that inequity was caused by mismanagement of the insurance systems in the Islamic Republic of Iran compared with developed countries (10). Tahari Mehrjardi et al. investigated and ranked the provinces of the Islamic Republic of Iran in terms of access to health sector indicators based on TOPSIS [technique for order preference by similarity] analysis and Shannon indices to determine the degree of development (34). The taxonomy technique in their study showed that 12, 9 and 9 Iranian provinces could be classified as developed,

semi-developed and undeveloped respectively. Kermanshah was classified as a semi-developed province. In a similar study Taghvaei and Shahivandi assessed the level of accessibly and spatial distribution of health-care services in the Islamic Republic of Iran by Granahan's model and cluster analysis (35). Granahan's model is designed to analyse and diagnose development, based on socioeconomic aspects of populations and their locations. They found that 90% of Iranian provinces were deprived in this regard and their ranking of the provinces showed that Kermanshah was one of the more deprived provinces.

Conclusion

The present research shows that a large proportion of the population of Kermanshah lives outside the maximum travel time on foot of 12.5 minutes to a public health-care centre. Over the 15-year time period of the study, the population with spatial accessibility to health centres tended to decrease.

The spatial organization and the pattern of capital investment in health-care centres should be adjusted to meet the needs of the population residing in specific localities. Health-care managers therefore need to revise their policies with the aim of promoting access to health-care services especially in the suburban areas.

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References

1. Bissonnette L, Wilson K, Bell S, Shah TI. Neighbourhoods and potential access to health care: the role of spatial and aspatial factors. Health Place. 2012 Jul;18(4):841–53. PMID:22503565

2. Nikpour B, Asefzadeh S. Healthcare management and planning. Tehran: Tehran University Publications; 1990.

3. Sharifzadegan MH, Mamdoohi AR, Lavi M. A P-median-model-based analysis of spatial inequality in accessibility to public health care intended for urban health development in Isfahan city. Social Welfare Quarterly. 2010 Summer;10(37):265–85 [in Farsi].

4. Musa GJ, Chiang PH, Sylk T, Bavley R, Keating W, Lakew B, Tsou HC, Hoven CW. Use of GIS mapping as a public health tool—from cholera to cancer.Health Serv Insights. 2013 Nov 19;6:111-6. PMID:25114567

5. Yarmohammadian MH, Bahrami S. Need assessment the health organizations. Isfahan: Department of Treatment and Education, Isfahan University Publishing of Medical Sciences; 2005.

6. Nikpour. B. Healthcare in rural Chaharmahal and Bakhtiary. Tehran: Tehran University Publications; 2007.

7. Kottwitz A. Mode of birth and social inequalities in health: the effect of maternal education and access to hospital care on cesarean delivery. Health Place. 2014 May;27:9–21.www.elsevier.com/locate/healthplace PMID:24513591

8. Hiscock R, Pearce J, Blakely T, Witten K. Is neighborhood access to health care provision associated with individual-level utilization and satisfaction? Health Serv Res. 2008 Dec;43(6):2183–200. PMID:18671752

9. Korda RJ, Butler JR, Clements MS, Kunitz SJ. Differential impacts of health care in Australia: trend analysis of socioeconomic inequalities in avoidable mortality. Int J Epidemiol. 2007 Feb;36(1):157–65. PMID:17213209

10. Karimi I, Salarian A, Anbari Z. A comparative study on equity in access to health services in developed countries and designing a model for Iran. Arak Medical University Journal. 2010;12(4):92–104 [in Farsi].

11. Luo W, Wang F. Measures of spatial accessibility to health care in a GIS environment: synthesis and a case study in the Chicago region. Environment and Planning B. Planning and Design. 2003;30:865–84.

12. Delamater PL. Spatial accessibility in suboptimally configured health care systems: a modified two-step floating catchment area (M2SFCA) metric. Health Place. 2013 Nov;24:30–43. PMID:24021921

13. Schempf AH, Kaufman JS, Messer LC, Mendola P. The neighborhood contribution to black-white perinatal disparities: an example from two north Carolina counties, 1999–2001. Am J Epidemiol. 2011 Sep 15;174(6):744–52. PMID:21771918

14. Kazda MJ, Beel ER, Villegas D, Martinez JG, Patel N, Migala W. Methodological complexities and the use of GIS in conducting a community needs assessment of a large U.S. municipality. J Community Health. 2009 Jun;34(3):210–5. PMID:19130191

15. Bazemore A, Diller P, Carrozza M. The impact of a clinic move on vulnerable patients with chronic disease: a Geographic Information Systems (GIS) analysis. J Am Board Fam Med. 2010 Jan-Feb;23(1):128–30. PMID:20051553

16. Graves BA. Access to cardiac interventional services in Alabama and Mississippi: a geographical information system analysis. Perspect Health Inf Manag. 2010;7:1b. PMID:20697472

17. Koutelekos J, Photis YN, Manetos P. Geographic information analysis and health infrastructure. Health Sci J. 2007;1:1–7.

18. Hu R, Dong S, Zhao Y, Hu H, Li Z. Assessing potential spatial accessibility of health services in rural China: a case study of Donghai County. Int J Equity Health. 2013;12:35. PMID:23688278

19. Ebrahimzadeh I, Ahadnezhad M, Ebrahimzadeh Asmin H, Shafiei Y. Spatial organization and planning of health services by the use of GIS: the case of Zanjan city. Human Geography Res Q. 2010;42(73):39–58.

20. Cinnamon J, Schuurman N, Crooks VA. A method to determine spatial access to specialized palliative care services using GIS. BMC Health Serv Res. 2008;8:140. PMID:18590568

21. Dulin MF, Ludden TM, Tapp H, Smith HA, de Hernandez BU, Blackwell J, et al. Geographic Information Systems (GIS) demonstrating primary care needs for a transitioning hispanic community. J Am Board Fam Med. 2010 Jan-Feb;23(1):109–20. PMID:20051550

22. Pollack CE, Gidengil C, Mehrotra A. The growth of retail clinics and the medical home: two trends in concert or in conflict? Health Aff (Millwood). 2010 May;29(5):998–1003. PMID:20439897

23. Tanser F. Methodology for optimising location of new primary health care facilities in rural communities: a case study in KwaZulu-Natal, South Africa. J Epidemiol Community Health. 2006 Oct;60(10):846–50. PMID:16973529

24. Shams M, Masoompour J, Saedi Sh, Shahbazi H. Assessment of earthquake disaster management worn tissues in Kermanshah. Case study: Faizabad neighbourhood. Quarterly Environmental Based Territorial Planning Journal. 2011;4(13):41–66.

25. Ghanbari A, Ghanbari M. Assessing spatial distribution of Tabriz parks by GIS (compared network analysis and buffering). Geography and Environmental Planning. 2013 Summer;24(50):1–3.

26. Sahraeian, Z, Zangiabadi A, Khosravi F. Spatial analysis and site selection of health medical and hospital centres using (GIS) (case study: Jahrom city). Journal of Geographic Space. 2013;1(43): 153-170 [in Farsi].

27. Habibi SM, Masaeli S. [Urban capita, Tehran.] Tehran: Department of National Land and Housing, Ministry of Housing and Urban Development, 2000; 28 [in Farsi].

28. Taghavi N. Introductory demography. Tabriz: Aydin Publications; 2010;9:70 [in Farsi].

29. Mahdavi M. [Foundations of population geography]. Tehran: Payam Noor University; 2010 [in Farsi].

30. Mitchell A. The ESRI guide to GIS analysis. Volume 2. Spatial measurements and statistics. Redlands (CA): Esri Press; 2005.

31. Sarvar R, Mosavi MN, Yazdani R. The analysis of spatial distribution and positioning medical care by multi criterion multi phase decision making model: a case study of city Miandoaab. Quarterly Environmental Based Territorial Planning Journal. 2013;6(22):81–100 .

32. Mamdouhi AR, Lavi M. The development a descriptive model of spatial accessibility to public treatment services hinterland floating two-step method (case study: municipalities of region 10). Research in Human Geography Journal. 2013;44(4) [in Farsi].

33. Huerta Munoz U, Källestål C. Geographical accessibility and spatial coverage modeling of the primary health care network in the Western Province of Rwanda. Int J Health Geogr. 2012 Sep 17;11:40. PMID:22984920

34. Tahari Mehrjardi MH, Babaei Mybodi H, Morovati Sharifabadi A. Investigation and ranking of Iranian provinces in terms of access to health sector indicators. Health Inf Manag. 2012;9(3):369.

35. Taghvaei M, Shahivandi A. Spatial distribution of health services in Iranian cities. Social Welfare Quarterly. 2011;10(39):33–54.

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