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ORIGINAL ARTICLE

Measures of spatial accessibility to health centers: investigating urban and rural disparities in Kermanshah, Iran

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Abstract

Aim Availability of and accessibility to health services are critical factors to maintain the wellbeing of any society. This study aims to investigate the spatial patterns and accessibility levels of urban and rural residents to health centers—i.e., hospitals—in the case of Kermanshah Province located at the western part of Iran.

Subject and methods The study employs a spatial analysis technique as the methodological approach. Datasets were obtained from the latest population statistics—i.e., the 2011 Population and Housing Census—and public and private hospitals in the Kermanshah Province. Access levels to health centers were calculated in a geographical information system environment with network analysis capability.

Results The results revealed that: (a) spatial distribution of health centers in the Kermanshah Province follows a random pattern, (b) health centers are mainly concentrated in the Kermanshah Township, (c) there is a clear inequality in terms of access to health centers in the Kermanshah Province, (d) children, women, and the elderly residing in rural areas are found to be the most vulnerable groups.

Conclusion The bipolar status of the rural population's access to healthcare compared with those residing in the Kermanshah Township clearly underlines an unequal structure of the health system in the Kermanshah Province. There is, hence, a need for effective interventions of policymakers and health managers in the province to eliminate this disparity.

Keywords Accessibility to health centers · Healthcare inequality · Urban and rural disparity · Geographic information systems (GIS) · Kermanshah · Iran

Introduction

Global organizations, including the World Health Organization (WHO), regard the right to healthcare as one of the major objectives of any society. Besides, enjoyment of health is seen as the basis for sustainable development and is one of the main pillars of social justice (Van Lerberghe 2008). Hence, provision of health services should be seen as one of the indispensable components of social development, with clear goals, policies, and programs (Brabyn and Skelly 2002). In this regard, eliminating spatial inequity in access to health services is one of the objectives of health systems. Health policymakers in many countries have strived to improve the health status of their residents and facilitate access to health services—along with increasing the use of health facilities. However, access to healthcare still remains as a challenging issue in many places around the world (Fox 2017; Reshadat et al. 2014).

The literature suggests that healthcare services have significant effects on health outcomes, and poor physical access lowers the use of health services—leading to increased health-related hazards (Reshadat et al. 2015a, b). Studies in the field have shown that demographic characteristics alone do not account for mortality rates, but in many cases they result from different levels of access to health services and facilities (Hare and Barcus 2007). Typically, patients prefer to visit health centers in the vicinity of their place of residence,

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but in some cases, patients require special care and need to visit specialized medical centers (Masoodi and Rahimzadeh 2015). The literature also suggests that access to general health services, such as primary care physicians, nurses, pharmacists, pathologists, and cardiac rehabilitation, at the right time is essential when aiming to optimize the prevention of potentially lethal incidents (World Health Organization 2010). As earlier research found, the lack of access to treatment centers has increased the relative share of out-of-hospital mortalities, especially in younger populations, and 90% of all fatalities associated with acute coronary incidents occur outside hospitals. Research has also revealed that access to healthcare plays a major role in acute cardiac incidents (Dudas et al. 2011).

Distance and time are two decisive factors of access. According to WHO, travel time should be used instead of distance to evaluate the level of geographical access. The existence of big differences in infrastructure and transport availability and quality among the developed and developing countries has created many challenges in terms of comparing distances to healthcare centers (World Health Organization 2001). In this regard, one of the key solutions to strategic planning and policymaking relating to the distribution of health and other facilities is the use of geographic information systems (GIS) (Baum et al. 2010; Teimouri and Yigitcanlar 2018), and advances in GIS have led to the effective analysis of assessing health needs, access to this type of service, its geographical diversity, identification of inequalities among different groups, and planning and provision of support and decision-making towards equal provision of health services (Radcliff et al. 2016). GIS has also enabled researchers to visualize the trends and relationships of health in space and time, with the aim of monitoring the performance of health policymakers in reducing health inequalities (Higgs 2004; Reshadat et al. 2018). Furthermore, analyzing and locating these challenges have led to the effectiveness of executed interventions towards improving access to health centers, especially when the inequalities were encountered in deprived areas (Hewko et al. 2002).

This paper places a region from Iran, namely the Kermanshah Province, under investigation to determine the spatial pattern and access of urban and rural residents to health centers. Kermanshah Province consists of 14 townships, 30 districts, 29 cities, 85 hamlets, and 3163 villages. The results of earlier studies have shown that the distribution of health centers in Kermanshah, which is the capital city, does not fit the needs of its citizens, as there is injustice in terms of access to medical treatment and health centers in the center of the province (Reshadat et al. 2015a, b). In addition, there have been high levels of migration to Kermanshah (Clark and Costello 1973), thereby giving rise to the phenomenon of informal and irregular settlements and the spread of economic, social, and cultural inequalities among the residents of the city (Rostaei et al. 2012). The results of earlier studies confirmed the growing level of disease occurrences (Reshadat et al. 2015a, b; Khademi et al. 2017; Khademi et al. 2016; Reshadat et al. 2016a, b), traffic accidents, and mortality rates (Zangeneh et al. 2018) in the province. This worsening situation has made it necessary to carry out new studies to better address the increasing healthcare access problems in the province. This study aims to investigate the spatial patterns and accessibility levels of urban and rural residents to health centers—i.e., hospitals—in the case of Kermanshah Province located at the western part of Iran.

Methods

In this cross-sectional study, the access of all residents from both urban and rural areas of Kermanshah to medical care in health centers—specifically hospitals—was investigated. In this regard, the latest population statistics of the Population and Housing Census (conducted in 2011) published by the Statistics Center of Iran were obtained. Additionally, datasets related to all public and private hospitals in the Kermanshah Province collected by the Kermanshah University of Medical Sciences were acquired.

As the methodological approach, spatial analysis techniques were adopted. For spatial analysis, modeling in a GIS environment—i.e., Arc/GIS—was undertaken to evaluate actual access levels through network analysis. For this purpose, the base map of the province, including the digital map (urban areas, villages, and roads), was utilized, whereby the network of roads in the province and the medical centers (hospitals) based in the area under study were digitized. Then, the topology and spatial relationships between roads were developed in the environment of the ArcCatalog geo base administration application. Moreover, the boundaries of health centers were established in terms of access of residents to these areas in real-time using network analysis extension of the GIS package. Furthermore, the number of people with and without access to health services was calculated in terms of gender (male and female) and age ranges (children: 0–14 years old, adults: 15–64 years old, the elderly: 65 years old and over) (Reshadat et al. 2015a, b).

Following the suggestions of WHO, travel time was used in the present study to evaluate access to health centers (Bissonnette et al. 2012; World Health Organization 2010; Knowlton et al. 2017). The calculation and measurement of the geographic access to healthcare services are often done through the estimation of travel time using GIS (Higgs 2004). Moreover, estimating travel time to access health services by vehicles has become commonplace in studies. In the present research, as in other studies, travel times of 15, 30, and 60 min by car were considered (Brabyn and Skelly 2002; Masoodi and Rahimzadeh 2015).

To identify the spatial deployment patterns of health centers, the following models were used:

Mean Center: the mean of latitude and longitude coordinates of all features within the scope of the study. Required for following up changes both in the spatial distribution of features and in their comparisons. The mean center is calculated as in Eq. 1 below (Reshadat et al. 2015a, b):

$$\overline{X} = \frac{\sum_{i=1}^{n} xi}{n}, \overline{Y} = \frac{\sum_{i=1}^{n} yi}{n} \tag{1}$$

Where x_i and y_i are the coordinates of feature i, and n is equal to the total number of features.

Standard Distance: a method for examining the level of concentration or dispersion of geographic features around the mean center, calculated as in Eq. 2 below (Reshadat et al. 2015a, b):

$$\sqrt{\frac{\sum_{i=1}^{n}\left(x_i-\overline{X}\right)}{n}+\frac{\sum_{i=1}^{n}\left(y_i-\overline{Y}\right)^2}{n}} \tag{2}$$

Where x_i and y_i are the coordinates of feature i, $\{\overline{X}, \ \overline{Y}\}$ represents the mean center of the features, and n is equal to the total number of features.

Average Nearest Neighbor Index: an indexing approach that measures the average distance of features to the nearest neighbor and used to determine the convergence and divergence of different features. The purpose of this kind of analysis is to determine the type of distribution pattern (clustered, random, or uniform). The nearest neighbor is calculated. In other words, the nearest neighbor index is expressed as the mean of the observed distance divided by the expected distance (calculated through analyzing the quantity of Z). If Z is between 1.96 and − 1.96, there is no significant difference between the observed and random distributions. Otherwise, the distribution will be clustered, random, or uniform (Khademi et al. 2016).

The Average Nearest Neighbor Index is calculated as in Eq. 3 below:

$$ANN = \frac{\overline{D}_0}{D_E} \tag{3}$$

Where $\overline{D}_0$ is the observed mean distance between each feature and its nearest neighbor (see Eq. 4), and $\overline{D}_E$ is the expected mean distance for the features given in a random pattern (see Eq. 5):

$$\overline{D}_0 = \frac{\sum_{i=1}^{n} d_i}{n} \tag{4}$$

$$\overline{D}_E = \frac{0.5}{\sqrt{n/A}} \tag{5}$$

In the above equation, d_i equals the distance between feature i and its nearest neighboring feature, n corresponds to the total number of features, and A is the area of a minimum enclosing rectangle around all features, or its user-specified value.

The average nearest neighbor z-score for the statistic is calculated as in Eqs. 6 and 7 below:

$$Z = \frac{\overline{D}_0 - \overline{D}_E}{SE} \tag{6}$$

$$SE = \frac{0.26136}{\sqrt{n^2/A}} \tag{7}$$

Results

Mean center, standard distance, and standard deviational ellipse of hospital centers

The results of mean center and standard distance models indicated that the mean center of all hospital centers was located in Kermanshah and most of the hospital centers were concentrated in the township. In other words, there was a cumulative distribution of treatment centers within the city. Moreover, the results were indicative of the western–eastern direction of the standard deviational ellipse of hospital centers (Fig. 1).

Nearest neighbor index

The calculated values of the nearest neighbor index and Z-score of the distribution of hospitals in the Kermanshah Province measured 0.911 and − 0.81 respectively. The Z-score was also statistically significant since it was between 1.65 and −1.65. These findings were indicative of the fact that the spatial distribution of hospitals in the Kermanshah Province followed a random pattern, and the formation and construction of hospitals in the province were accidental, and not planned (Fig. 2).

The kernel density estimation test

The results of the Kernel density estimation test also showed that hospital centers were concentrated in the Kermanshah Township (Fig. 3).

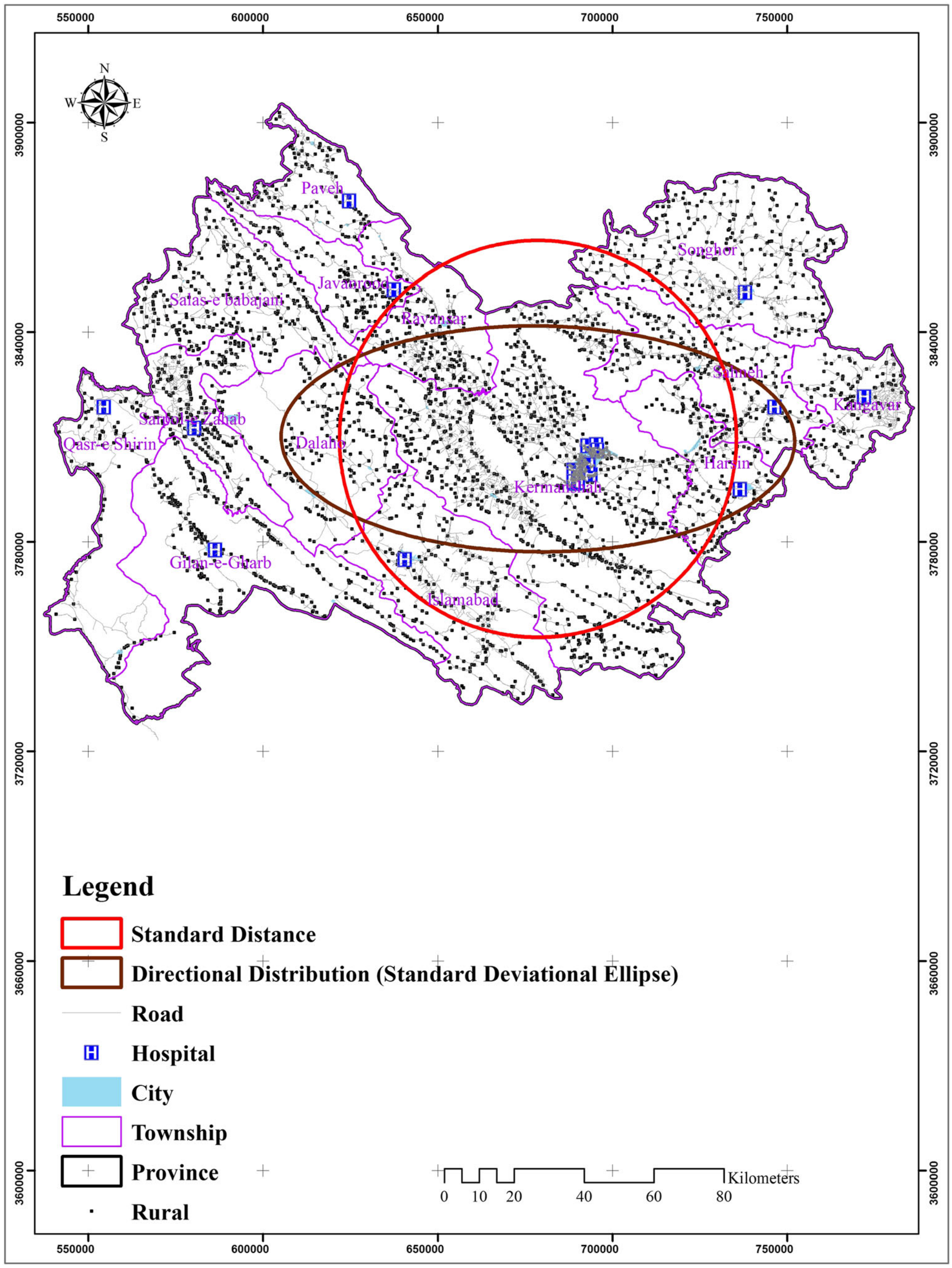

Fig. 1 Mean center, standard distance, and standard deviational ellipse of hospital centers

Assessment of access to health centers through travel time by car

The results showed that, out of the total population of 1,941,715 inhabitants living in urban and rural areas of the Kermanshah Province, 30.71% (596,303 people), 26.34% (511,599 people) and 19.82% (384,787 people) respectively lacked access to health centers within 15, 30, and 60 min of driving. However, in terms of rural inhabitants' access to health centers within 15, 30, and 60 min of driving, 90% (527,967 people), 76.22% (447,161 people) and 56.11% (329,198 people) respectively lacked access (Fig. 4 and Table 1).

In terms of female age groups' access to healthcare centers within 60 min of driving, the results showed that 58.29% of children, 55.65% of adults, and 51.22% of the elderly residing in rural areas lacked access to healthcare centers, as opposed to only 4.45% of children, 3.89% of adults, and 3.15% of the elderly in urban areas. In terms of male age groups' access to healthcare centers within 60 min of driving, the results revealed that 58.60% of children, 56.09% of adults, and 50.36% of the elderly residing in rural areas lacked access to healthcare centers, as opposed to only 4.86% of children, 4.14% of adults, and 3.08% of the elderly in urban areas (Fig. 4 and Table 1).

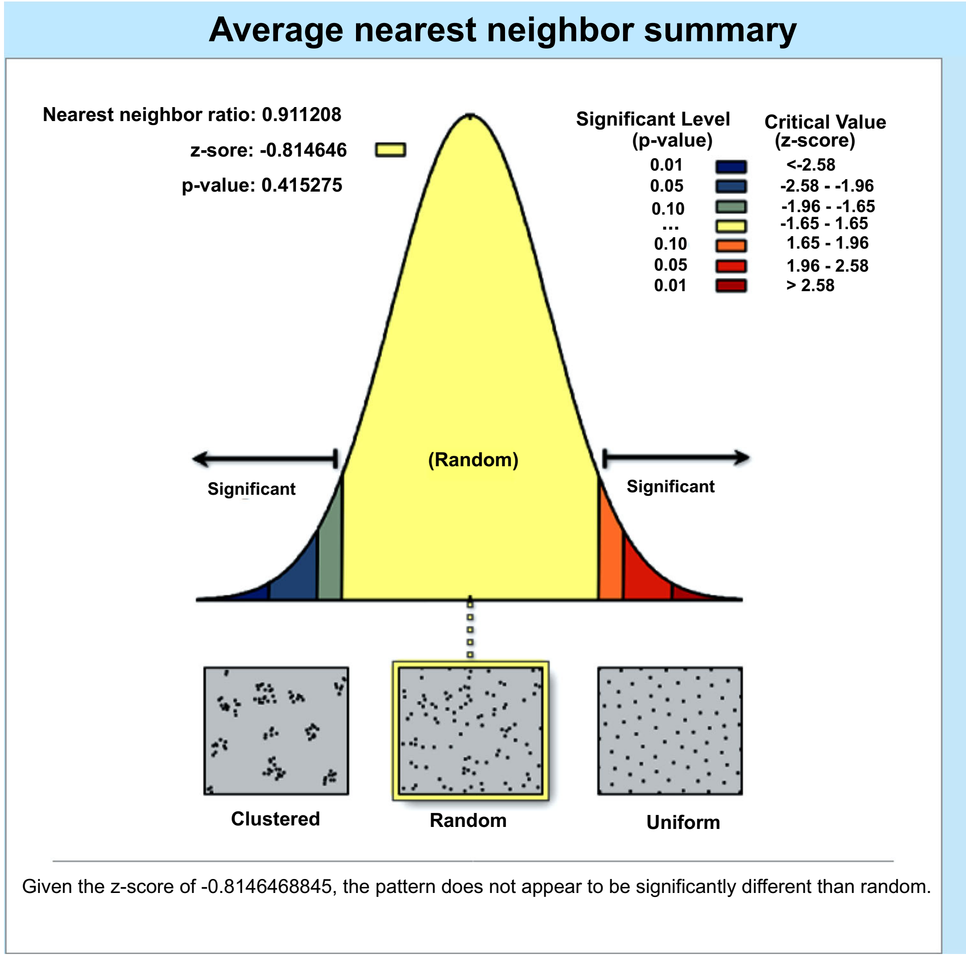

Fig. 2 Distribution of health services in Kermanshah Metropolis using the nearest neighbor model

Discussion

Evaluation of access to health centers in residential areas provides health policymakers with valuable information, thereby enabling them to focus their efforts on addressing health inequalities. This is an issue which has so far been neglected in the Kermanshah Province (Reshadat et al. 2015a, b). Therefore, the study reported in this paper aimed to investigate the spatial patterns and accessibility levels of urban and rural residents to health centers—i.e., hospitals—in the case of Kermanshah Province located at the western part of Iran.

The results demonstrated that the formation and construction of hospitals in the Kermanshah Province followed a random pattern. This finding was another confirmatory factor indicative of the weakness in the management system and policies related to the construction of hospitals in the province based on previous evidence (Reshadat et al. 2016a, b). This is consistent with the results of other studies conducted in Iran, in which the organic growth and lack of planning in the country accounted for the said random pattern (Ebrahim Zadeh et al. 2010). This evidence is indicative of the existence of health inequalities in the province, and confirms the need for a policy shift in this field from the current random pattern to a uniform development, as also found in other similar studies (Reshadat et al. 2016a, b; Ahadnejad et al. 2015).

The present study was also able to demonstrate the concentration of hospital centers in Kermanshah in comparison with other townships in the Kermanshah Province. This finding was consistent with the results of other studies in Iran that confirmed the aggregation of healthcare centers in the township centers (Reshadat et al. 2016a, b; Ahadnejad et al. 2015). The reason for this, as stated in other studies, could be a lack of policies in addressing inequalities in Iran's health system (Reshadat et al. 2015a, b). In this regard, health policymakers should design and implement effective interventions and evaluate them continuously to achieve the goals of providing, maintaining, and improving the health of people from all walks of life (Damari et al. 2011).

This study was able to show that access to health centers in urban areas was higher than that in rural areas, which was consistent with the results of other similar studies (Apparicio et al. 2008). Research suggests that inequality in access to healthcare services affects the health of inhabitants, which leads to a waste of time and imposition of economic costs on families (Casey et al. 2001). According to the results of the previous studies conducted in the Kermanshah Province, there has been a large

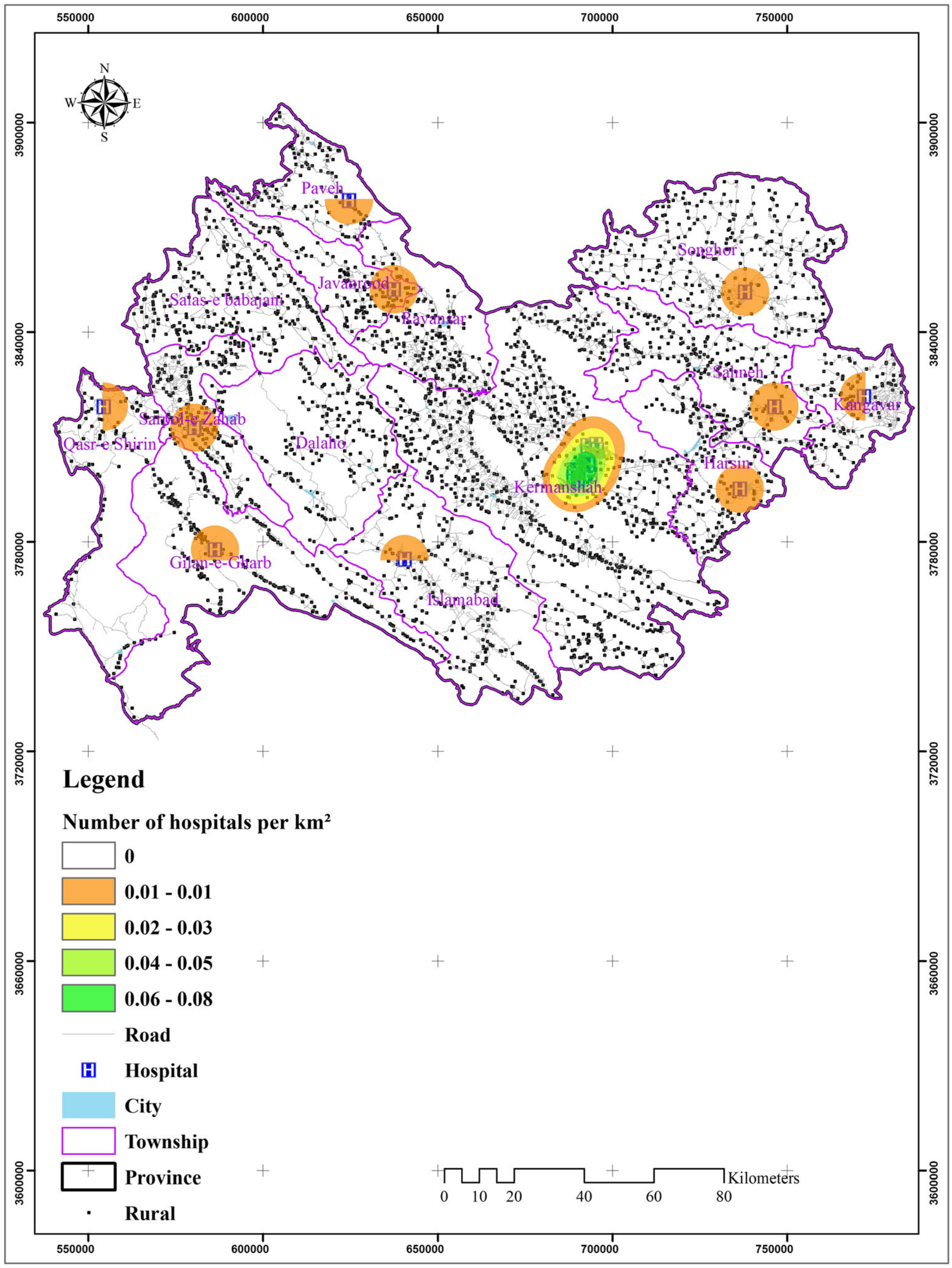

Fig. 3 Mean center, standard distance, and standard deviational ellipse of hospital centers in Kermanshah Province

population migration to the Kermanshah metropolis, which is probably due to inequalities in accessing healthcare in urban and rural areas of the province (Clark and Costello 1973).

Based on the results of the present study, rural children lacked adequate access to treatment centers, which was consistent with the results of other similar studies (Dong et al. 2014). It should be noted that inadequate access of children to healthcare will result in a lack of timely diagnosis and treatment of acute and chronic diseases and injuries, and also inadequate access to preventive care in this age group (Newacheck et al. 2000). In addition, the results of the present study demonstrated that 0–14 year-olds were more deprived of access to health centers than other age groups in the city, thereby making the elimination of this inequality more crucial considering the sensitivity of this age group.

The findings also demonstrated that rural women lacked adequate access to treatment centers, which has also been expressed in other similar studies (Casey et al. 2001). Numerous other studies have confirmed that women's inadequate access to healthcare services leads to the ineffective prevention of diseases, increased congenital mortality, inadequate inoculation of girls, poor treatment of women and girls' anemia, lack of general care provided to women, deficient prenatal and postnatal care (Gulliford et al. 2002), consumption of

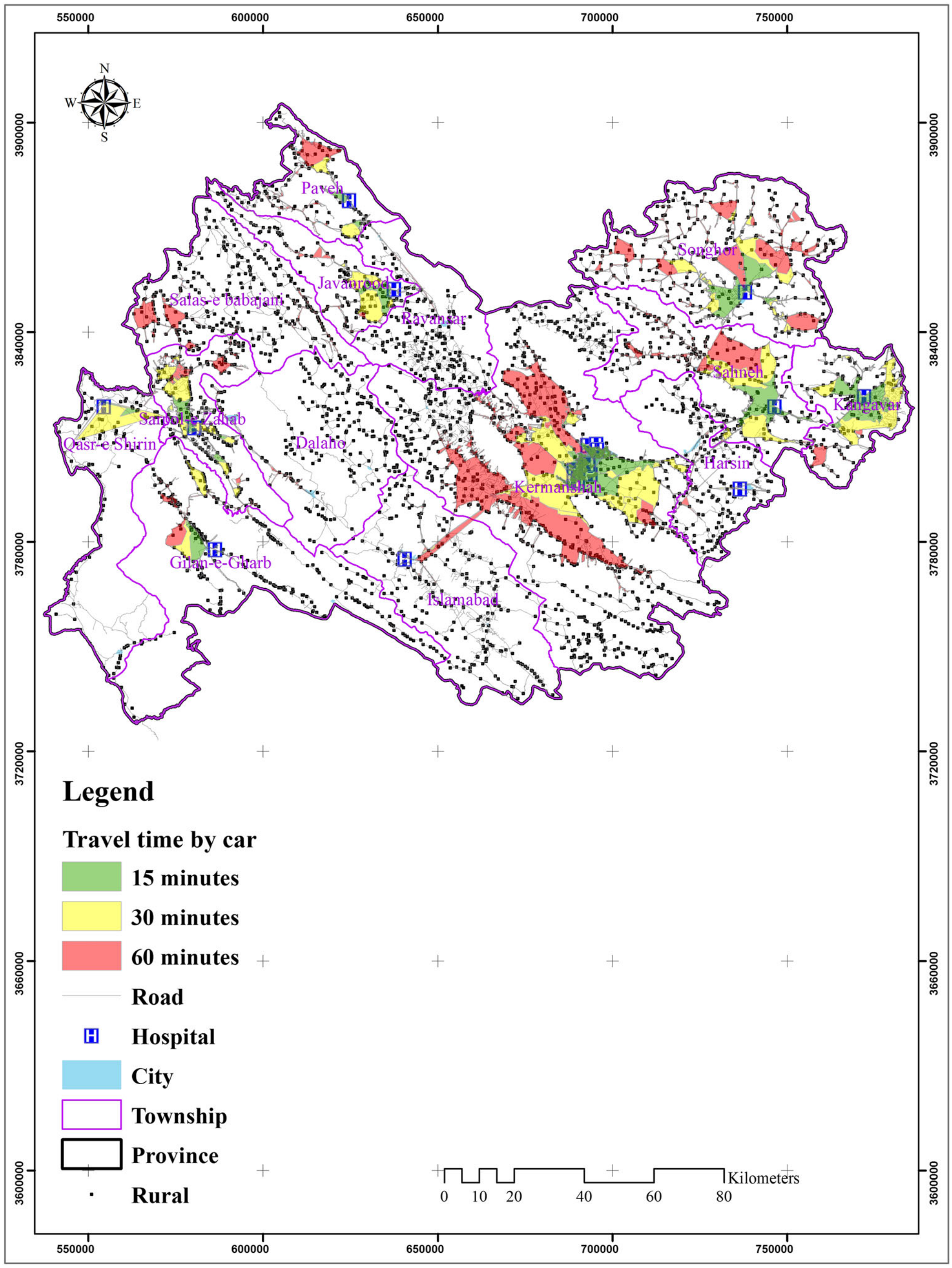

Fig. 4 Network analysis model of travel time by car to nearest hospital in Kermanshah Province

unsafe medication, and insufficient attention to diseases such as breast cancer (Vedadayer et al. 2008).

Furthermore, the results indicated that women's and men's access to health centers was the same at the village level. Similarly, the same situation was observed for women and men at the city level. We were also able to show that the elderly living in rural areas did not have adequate access to health centers, which was in agreement with the results of other studies (Brabyn and Skelly 2002). Furthermore, the factors that make the need for serious interventions more noticeable are the elderly's lack of timely access to health care centers due to aging, changes in the epidemiological pattern of diseases in middle age and the tendency toward chronic diseases, and on the other hand the healthy elderly who are still, however, in need of healthcare support (Eckardt et al. 2017). Accordingly, as the elderly population increases and life expectancy is extended, preventive and therapeutic policies should be aimed at maintaining and improving the health of the elderly population, and life-threatening and protecting factors should be identified in their lives (Hemingway et al. 1997); all of these are issues which have been overlooked in the area under study so far. It should be noted that inequality in access to healthcare in the adult age group was also evident in the present study at village level in comparison with cities.

Table 1 Rural/urban travel time by car to nearest hospital in Kermanshah Province

	Travel time														
	15 min						30 min				60 min				
	Gender	Age groups	In relation to three age groups		In relation to the population in the age group		In relation to three age groups		In relation to the population in the age group		In relation to three age groups		In relation to the population in the age group		
			Access	No access	Access	No access	Access	No access	Access	No access	Access	No access	Access	No access	Total population
Rural	Female	0–14	6797 (23.34)	58,031 (22.56)	10.49	89.51	15,687 (23.04)	49,141 (22.51)	24.20	75.80	27,040 (21.43)	37,788 (23.57)	41.71	58.29	64,828 (22.63)
		15–64	19,928 (68.41)	183,417 (71.29)	9.80	90.20	47,845 (70.28)	155,500 (71.22)	23.53	76.47	90,184 (71.51)	113,161 (70.60)	44.35	55.65	203,345 (70.99)
		= 65	2404 (8.25)	15,837 (6.16)	13.18	86.82	4548 (6.68)	13,693 (6.27)	24.93	75.07	8899 (7.06)	9342 (5.83)	48.78	51.22	18,241 (6.38)
		Total	29,129 (100)	257,285 (100)	10.17	89.83	68,080 (100)	218,334 (100)	23.77	76.23	126,123 (100)	160,291 (100)	44.04	55.96	286,414 (100)
	Male	0–14	7113 (24.09)	61,583 (22.75)	10.35	89.64	16,598 (23.25)	52,098 (22.77)	24.16	75.84	28,438 (21.66)	40,258 (23.83)	41.40	58.60	68,696 (22.88)
		15–64	19,680 (66.66)	190,637 (70.43)	9.36	90.64	49,860 (69.85)	160,457 (70.12)	23.71	76.29	92,341 (70.33)	117,976 (69.85)	43.91	56.09	210,317 (70.06)
		= 65	2732 (9.25)	18,462 (6.82)	12.89	87.11	4922 (6.89)	16,272 (7.11)	23.22	76.78	10,521 (8.01)	10,673 (6.32)	49.64	50.36	21,194 (7.06)
		Total	29,525 (100)	270,682 (100)	9.83	90.17	71,380 (100)	228,827 (100)	23.78	76.22	131,300 (100)	168,907 (100)	43.74	56.26	300,207 (100)
Urban	Female	0–14	138,576 (21.54)	8094 (24.33)	94.48	5.52	139,058 (21.55)	7612 (24.33)	94.81	5.19	140,138 (21.57)	6532 (24.33)	95.55	4.45	146,670 (21.69)
		15–64	468,950 (72.92)	23,723 (71.32)	95.18	4.82	470,364 (72.92)	22,309 (71.32)	95.47	4.53	473,529 (72.91)	19,144 (71.32)	96.11	3.89	492,673 (72.84)
		= 65	35,567 (5.54)	1446 (4.35)	96.09	3.91	35,653 (5.53)	1360 (4.35)	96.33	3.67	35,846 (5.52)	1167 (4.35)	96.85	3.15	37,013 (5.47)
		Total	643,093 (100)	33,263 (100)	95.08	4.92	645,075 (100)	31,281 (100)	95.38	4.62	649,513 (100)	26,843 (100)	96.03	3.97	676,356 (100)
	Male	0–14	140,062 (21.76)	8822 (25.15)	94.08	5.92	140,544 (21.77)	8340 (25.15)	94.40	5.60	141,653 (21.80)	7231 (25.15)	95.14	4.86	148,884 (21.94)
		15–64	464,082 (72.10)	24,709 (70.45)	94.94	5.06	465,432 (72.10)	23,359 (70.44)	95.22	4.78	468,539 (72.08)	20,252 (70.46)	95.86	4.14	488,791 (72.02)
		= 65	39,521 (6.14)	1542 (4.40)	96.25	3.75	39,605 (6.13)	1458 (4.40)	96.45	3.55	39,800 (6.12)	1263 (4.39)	96.92	3.08	41,063 (6.04)
		Total	643,665 (100)	35,073 (100)	94.83	5.17	645,581 (100)	33,157 (100)	95.11	4.89	649,992 (100)	28,746 (100)	95.77	4.23	678,738 (100)

In the previous studies performed in Iran, only a simple buffering method has been used to assess access to hospital centers (Reshadat et al. 2016a, b; Damari et al. 2011). The buffering and functional radius methods can be useful in simple analyses and providing general views (Cromley and McLafferty 2011). However, in the network analysis method (Pitot et al. 2006; Yigitcanlar et al. 2007), which was the basis of our research and used for the first time in Iran, the status of access to health centers was evaluated similarly to other studies in a real model through real journeys (Hare and Barcus 2007; Knowlton et al. 2017). Hence, this could be regarded as one of the strengths of the present study compared to others conducted in Iran. Additionally, the present study is the first in Iran in which access to health centers—i.e., hospitals—is evaluated using travel time in cities and villages and due to its incomparability in terms of the scope of objectives and the population under study. Its successful implementation can be an efficient and appropriate model for conducting studies on access to health centers through travel time for researchers in other developing countries.

Given that the in-depth examination of reasons behind this inequality was not covered in this study, it is recommended that such a detailed investigation should be addressed in further studies. The results of many studies have shown that time is a key factor in the survival of multi-traumatic patients, and the shorter the interval between occurrence of the incident and commencement of surgery, the more significantly the survival rate of the patient increases (Garner et al. 2015). This period is ideally less than 10 min (Oliver et al. 2017). For instance, the proper interval between infarction and the administration of streptokinase is less than 30 min (Writing et al. 2000). Therefore, if the treatment of patients occurs shortly after the onset of symptoms, disease and mortality rates can be significantly reduced (Zerwic et al. 2003).

The results of the study revealed that 76.22% of the population residing in rural areas lacked access to healthcare centers within 30 min. This situation for children and the elderly living in villages was even more acute. According to some studies, the appropriate time for injured children in urban and suburban areas should not exceed 10 and 15 min respectively (Panahi et al. 2007). In the present study, 89.51% and 89.64% of 0–14 year-old girls and boys, respectively, lacked access to healthcare centers within 15 min. Comparing the golden time to revive patients with the access time of rural residents in the Kermanshah Province to emergency services emphasises the significant imbalance and difficulties that rural residents of the Kermanshah Province are faced with.

Needless to say, the study reported in this paper has some limitations. For example, traffic congestion, traffic lights, car parking, and travel time, which were different and influenced by factors such as day and night hours and climate, were not controlled in the present study, nor in other studies (Jenelius and Koutsopoulos 2013). In addition, no distinction was made between populations with and without vehicles. In other words, given that those without vehicles use public transportation, access to health centers may be further reduced (Yang et al. 2006). Some other factors that were not addressed in the present study included the subjects' socio-economic status (e.g., income, education) and its effects on access to health care, waiting times, and the cost of using services. It is worth noting that these limitations have been also mentioned in other similar studies (Ngui and Vanasse 2012).

Conclusion

As stated by Gudes et al. (Gudes et al. 2010), the need to develop sound community-level planning and to overcome the fracturing of knowledge bases provides an incentive for the uptake of new and novel data analysis and presentation approaches. GIS is a sound platform that can address both concerns. This paper, by using various spatial analysis techniques with GIS, provides insights for health managers and policymakers and useful information for planning medical care, which is generally of benefit in decision-making for health policies. The random pattern of constructing hospitals should be changed into uniform patterns in the future. To this end, the aim of the presented model was to display reality in such a way that the conflict between city and villages would be revealed in terms of access to health centers based on our findings, and highlighting inadequate access for children, women, and the elderly to healthcare services, which are especially poor in villages and townships compared to provincial centers.

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Authors contributions SR and AZ developed the idea. AZ, RT and SS designed and analyzed it. SR, AZ, SS, RT and TY interpreted the results and drafted the manuscript. All the authors take responsibility for the integrity of the work as a whole from inception to published article. SR is the guarantor. All the authors read and approved the final manuscript.

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Compliance with ethical standards

This study was approved by the Ethics Committee of Kermanshah University of Medical Sciences with ID 94262. Research involving human participants.

Conflict of interest The authors declare that they have no conflict of interest.

References

Ahadnejad M, Ghaderi H, Hadian M, Haghighatfard P, Darvishi B, Haghighatfard E, Zegordi B, Bordbar A (2015) Location allocation of health care centers using Geographical Information System: region 11 of Tehran. J Fasa Univ Med Sci 4(4):463–474

Apparicio P, Abdelmajid M, Riva M, Shearmur R (2008) Comparing alternative approaches to measuring the geographical accessibility of urban health services: distance types and aggregation-error issues. Int J Health Geogr 7(1):7–21. https://doi.org/10.1186/1476-072X-7-7

Baum S, Kendall E, Muenchberger H, Gudes O, Yigitcanlar T (2010) Geographical information systems: an effective planning and decision-making platform for community health coalitions in Australia. Health Inf Manag 39(3):28–33

Bissonnette L, Wilson K, Bell S, Shah TI (2012) Neighbourhoods and potential access to health care: the role of spatial and aspatial factors. Health Place 18(4):841–853. https://doi.org/10.1016/j.healthplace.2012.03.007

Brabyn L, Skelly C (2002) Modeling population access to New Zealand public hospitals. Int J Health Geogr 1(1):3–14. https://doi.org/10.1186/1476-072X-1-3

Casey MM, Call KT, Klingner JM (2001) Are rural residents less likely to obtain recommended preventive healthcare services? AJPM 21(3):182–188. https://doi.org/10.1016/S0749-3797(01)00349-X

Clark BD, Costello V (1973) The urban system and social patterns in Iranian cities. Trans Inst Br Geogr:99-128

Cromley EK, McLafferty SL (2011) GIS and public health. Guilford Press, New York

Damari BAVM, Monazzam K, Salarianzadeh H (2011) Where and how to make wise policies for health? A qualitative study on the characteristics of health policy system in the Islamic Republic of Iran. Hakim Research Journal 13(4):210–218

Dong X, Liu L, Cao S, Yang H, Song F, Yang C, Gong Y, Wang Y, Yin X, Xu X (2014) Focus on vulnerable populations and promoting equity in health service utilization—an analysis of visitor characteristics and service utilization of the Chinese community health service. BMC Public Health 14(1):503–511. https://doi.org/10.1186/1471-2458-14-503

Dudas K, Lappas G, Stewart S, Rosengren A (2011) Trends in out-of-hospital deaths due to coronary heart disease in Sweden (1991 to 2006). Circulation 123(1):46–52. https://doi.org/10.1161/CIRCULATIONAHA.110.964999

Ebrahimzadeh I, Ahadnezhad M, Ebrahimzadeh Asmin H, Shafiei Y (2010) Spatial organization and planning of health services by the use of GIS; the case of Zanjan City. Human Geography Research Quarterly 73(3):39–58

Eckardt M, Brettschneider C, Bussche H, König HH (2017) Analysis of health care costs in elderly patients with multiple chronic conditions using a finite mixture of generalized linear models. Health Econ 26(5):582–599. https://doi.org/10.1002/hec.3334

Fox DM (2017) Evidence and health policy: using and regulating systematic reviews. AJPH 107(1):88–92. https://doi.org/10.2105/AJPH.2016.303485

Garner AA, Mann KP, Poynter E, Weatherall A, Dashey S, Puntis M, Gebski V (2015) Prehospital response model and time to CT scan in blunt trauma patients; an exploratory analysis of data from the head injury retrieval trial. Scand J Trauma Resusc Emerg Med 23(1):28. https://doi.org/10.1186/s13049-015-0107-1

Gudes O, Kendall E, Yigitcanlar T, Pathak V, Baum S (2010) Rethinking health planning: a framework for organising information to underpin collaborative health planning. Health Inf Manag 39(2):18–29

Gulliford M, Figueroa-Munoz J, Morgan M, Hughes D, Gibson B, Beech R, Hudson M (2002) What does 'access to health care' mean? J Health Serv Res Policy 7(3):186–188

Hare TS, Barcus HR (2007) Geographical accessibility and Kentucky's heart-related hospital services. Appl Geogr 27(3):181–205. https://doi.org/10.1016/j.apgeog.2007.07.004

Hemingway H, Stafford M, Stansfeld S, Shipley M, Marmot M (1997) Is the SF-36 a valid measure of change in population health? Results from the Whitehall II study. BMJ 315(7118):1273–1279. https://doi.org/10.1136/bmj.315.7118.1273

Hewko J, Smoyer-Tomic KE, Hodgson MJ (2002) Measuring neighbourhood spatial accessibility to urban amenities: does aggregation error matter? Environ Plan A 34(7):1185–1206

Higgs G (2004) A literature review of the use of GIS-based measures of access to health care services. Health Serv Outcome Res Methodol 5(2):119–139

Jenelius E, Koutsopoulos HN (2013) Travel time estimation for urban road networks using low frequency probe vehicle data. Transp Res B Methodol 53:64–81. https://doi.org/10.1016/j.trb.2013.03.008

Khademi N, Reshadat S, Zanganeh A, Saeidi S, Ghasemi S, Zakiei A (2016) Identifying HIV distribution pattern based on clustering test using GIS software, Kermanshah, Iran. HIV AIDS Rev 15(4):147–152. https://doi.org/10.1016/j.hivar.2016.11.003

Khademi N, Reshadat S, Zangeneh A, Saeidi S, Ghasemi S, Rajabi-Gilan N, Zakiei A (2017) A comparative study of the spatial distribution of HIV prevalence in the metropolis of Kermanshah, Iran, in 1996−2014 using geographical information systems. HIV Med 18(3):220–224. https://doi.org/10.1111/hiv.12416

Knowlton LM, Banguti P, Chackungal S, Chanthasiri T, Chao TE, Dahn B, Derbew M, Dhar D, Esquivel MM, Evans F (2017) A geospatial evaluation of timely access to surgical care in seven countries. Bull World Health Organ 95(6):437–444. https://doi.org/10.2471/BLT.16.175885

Masoodi M, Rahimzadeh M (2015) Measuring access to urban health services using geographical information system (GIS): a case study of health service management in Bandar Abbas, Iran. Int J Health Policy Manag 4(7):439–445. https://doi.org/10.15171/ijhpm.2015.23

Newacheck PW, McManus M, Fox HB, Hung YY, Halfon N (2000) Access to health care for children with special health care needs. Pediatrics 105(4):760–766

Ngui AN, Vanasse A (2012) Assessing spatial accessibility to mental health facilities in an urban environment. Spat Spatiotemporal Epidemiol 3(3):195–203. https://doi.org/10.1016/j.sste.2011.11.001

Oliver G, Walter D, Redmond A (2017) Are prehospital deaths from trauma and accidental injury preventable? A direct historical comparison to assess what has changed in two decades. Injury 48(5):978–984. https://doi.org/10.1016/j.injury.2017.01.039

Panahi F, Mousavi NS, Azizabadi FM, ASAARI S (2007) Ambulance runs for pediatric trauma in Tehran. Iranian Journal of Surgery 15(1):1–7

Pitot M, Yigitcanlar T, Sipe N, Evans R (2006) Land Use & Public Transport Accessibility Index (LUPTAI) tool: the development and pilot application of LUPTAI for the Gold Coast. In: ATRF06 Forum Papers. Planning and Transport Research Centre, University of Western Australia, Perth

Radcliff E, Delmelle E, Kirby RS, Laditka SB, Correia J, Cassell CH (2016) Factors associated with travel time and distance to access hospital care among infants with spina bifida. Matern Child Health J 20(1):205–217

Reshadat S, Saedi S, Zangeneh A, Amooie MR, Karbasi A (2014) Equity in access to health care using geographic information system: a Kermanshah case study. J Mazandaran Univ Med Sci 24(115):134–140

Reshadat S, Saeidi S, Zangeneh A, Khademi N, Khasi K, Ghasemi SR, Rjabi-Gilan N (2015a) Spatiotemporal distribution of gastrointestinal tract cancer through GIS over 2007-2012 in Kermanshah-Iran. Asian Pac J Cancer Prev 16(17):7737–7742. https://doi.org/10.7314/APJCP.2015.16.17.7737

Reshadat S, Saeidi S, Zangeneh A, Ghasemi SR, Gilan-Rajabi N, Karbasi A, Bavandpoor E (2015b) Spatial accessibility of the population to urban health centres in Kermanshah, Islamic Republic of Iran: a geographic information systems analysis. East Mediterr Health J 21(6):389

Reshadat S, Saeidi S, Sufi E, Rjabi-Gilan N, Ghasemi SR (2016a) Investigating inequalities in access to hospital medical facilities using geographical information system in Kermanshah's metropolitan area. jhosp 15(2):9–22

Reshadat S, Zangeneh A, Saeidi S, Khademi N, Izadi N, Ghasemi SR, Gilan-Rajabi N (2016b) The spatial clustering analysis of hiv and poverty through GIS in the metropolis of Kermanshah, western Iran. Acta Med Mediterr 32(5):1995–1999

Reshadat S, Zangeneh A, Saeidi S, Izadi N, Ghasemi SR, Rajabi-Gilan N (2018) A feasibility study of implementing the policies on increasing birth rate with an emphasis on socio-economic status: a case study of Kermanshah Metropolis, western Iran. Soc Indic Res 2018:1-18. https://doi.org/10.1007/s11205-017-1790-2

Rostaei S, Ahadnejad Reveshty M, Asghari Zamani A, Zangenh A (2012) Assessment of urban poverty spatial distribution in Kermanshah City. Social Welfare 12(45):77–101

Teimouri R, Yigitcanlar T (2018) An approach towards effective ecological planning: quantitative analysis of urban green space characteristics. GJESM 4(2):195–206. https://doi.org/10.22034/gjesm.2018.04.02.007

Van Lerberghe W (2008) The world health report 2008: primary health care: now more than ever. World Health Organization, Geneva

Vedadayer A, Hani Sadaty SM, Ahmadi B (2008) "Women's health" from the perspective of health magazines in Iran. Women's Health 6(2):133–155

World Health Organization (2001) Background paper for the technical consultation on effective coverage of health systems. World Health Organization, Geneva

World Health Organization (2010) Cardiovascular diseases. from http://www.who.int/topics/cardiovascular_diseases/en/. Accessed 10 Aug 2010

Yang DH, Goerge R, Mullner R (2006) Comparing GIS-based methods of measuring spatial accessibility to health services. J Med Syst 30(1):23–32

Yigitcanlar T, Sipe N, Evans R, Pitot M (2007) A GIS-based land use and public transport accessibility indexing model. Australian Planner 44(3):30–37. https://doi.org/10.1080/07293682.2007.9982586

Zalenski RJ, Selker HP, Cannon CP, Farin HM, Gibler WB, Goldberg RJ, Lambrew CT, Ornato JP, Rydman RJ, Steele P (2000) National heart attack alert program position paper: chest pain centers and programs for the evaluation of acute cardiac ischemia. Ann Emerg Med 35(5): 462–471. https://doi.org/10.1067/mem.2000.104027

Zangeneh A, Najafi F, Karimi S, Saeidi S, Izadi N (2018) Spatial-temporal cluster analysis of mortality from road traffic injuries using geographic information systems in west of Iran during 2009–2014. J Forensic Legal Med 55:15–22. https://doi.org/10.1016/j.jflm.2018.02.009

Zerwic JJ, Ryan CJ, DeVon HA, Drell MJ (2003) Treatment seeking for acute myocardial infarction symptoms: differences in delay across sex and race. Nurs Res 52(3):159–167