Original Article

Geographical Information System in Planning the Orthodontist Need: A Pilot Study

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ABSTRACT

Objective: The purpose of this study is to evaluate the geographical distribution of all orthodontic patients who applied to Selcuk University Faculty of Dentistry Department of Orthodontics (SUDO) between 2000 and 2005.

Materials and Method: Data in this study were obtained from computer records of patients who applied to SUDO between 2000 and 2005. Data were integrated into Arcview 3.3 geographical information system (GIS) software. By adding patient address data to the numeric maps of Turkey used in the GIS, spatial queries could be determined and spatial maps showing the geographical distribution of patients applying to SUDO were obtained.

Results: The records of 9191 patients from 48 cities who applied for treatment to SUDO were examined. Distribution of patients' addresses by city was investigated. Accordingly, the highest demand for treatment was from Konya at 66.9% (1000–6147); second, the neighboring cities of Afyon at 0.76%, Karaman at 0.71%, and Aksaray at 0.57% (500–1000); third, Kutahya at 0.36% (250–500); fourth, Nigde at 0.20% (100–250); and fifth, Antalya at 0.09% and Nevsehir at 0.07% (50–100).

Conclusion: The findings show that not only local patients but also a significant number of patients from other cities applied for a treatment to SUDO. Therefore, the situation identified by the GIS method will be a reference point for the officials and authorities who are making plans related to the number of patients seeking orthodontic treatment. (*Turkish J Orthod* 2014;26:177–181)

KEY WORDS: geographical information system, GIS, orthodontist need, population

INTRODUCTION

Parallel with the developing technology of our information era, there has been an increase in applying modern information technology to mapping activities, namely the concept of the geographical information system (GIS), which collects spatial and nonspatial data from location-based observations, then stores, processes, and offers the data to the user, actualizing all of these functions in an integrated way. A number of researchers have done a variety of studies[1–12] using this new method, and GIS has been put into practice in various professional disciplines. In particular, its application in health practices has enabled the production of thematic objective maps depending on local geography.[13] Health-geography applications of GIS offer benefits to the users as it is capable of portraying such information as distribution of health units, personnel management, capacities of units such as hospitals, regional disease analysis, risk analysis, health scanning activities, ambulance services, and geographical distribution of patients.[14] Additionally, GIS is used to determine and map geographical distribution of patients applying for dental treatment.[15]

Waldman *et al*.[16] reviewed the American Dental Association report about distribution of dentists in the United States by region and state in 2006 and compared it with earlier reports. They highlighted the overall increase in the number of orthodontists but found that major differences in ratios of practitioners to children were still found in some geographic areas in the United States. Their study drew attention to the limited numbers of orthodontists in certain locales and states and called for increased efforts to educate

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the public on the need and value of orthodontic services. They also suggested that the orthodontic specialty needs to be aware of the growing diversity in the nation's population and must modify and adjust its effort to attract underserved populations with different familial, cultural, and educational backgrounds and special health care needs.

Martin *et al*.[15] focused on oral health disparities, including those related to orthodontic treatment needs and demands, in the Appalachia region of West Virginia in the United States. Their study showed that parents had a high rate of complete or partial edentulism, an infrequent history of orthodontic treatment, great unmet orthodontic need, and less demand for orthodontic care than was suggested by their clinically determined need.[15] The adolescents studied were similar to national norms with regard to orthodontic treatment history and need but lower with regard to demand. The researchers suggested that culturally sensitive psychoeducational methods to promote recognition of oral health needs may be required among adolescents in Appalachia to change oral health values and prevent oral health problems.[15]

Susi and Mascarenhas[17] conducted a study in the state of Ohio in which the distribution of 6132 dentists according to city was examined in terms of socioeconomic levels by using a GIS program. According to the results, about 70% of dentists worked in 12 high-income cities, 16% worked in 59 low-income cities, and the remaining 14% worked in 17 middle-income cities. The GIS system determined that dentists in Ohio are distributed according to income levels, not population. In the light of this information, state officials should institute regulations to direct dentists to low-income regions.[17] In another application of GIS technology, Bartling and Schleyer,[2] applied various colors and patterns to the specific regions in graphics, pictures, and photographs and managed to save records of patients' dental treatments.

The purpose of this study was to use a GIS to determine the geographical distribution of orthodontic patients from different regions and cities who were seeking treatment at the clinic of Selcuk University, Faculty of Dentistry, Department of Orthodontics (SUDO).

METHODS

Every patient who undergoes orthodontic treatment at SUDO receives the clinic's legal information before the treatment initiation, and all participants were asked to sign an informed consent document. Each subject gave permission for their records to be used and published in medical journals. Approval of the patients and signed informed consents are available in SUDO.

Data in this study were obtained from records of patients who applied to SUDO between 2000 and 2005. In this way, the geographical distribution of all the orthodontic patients who applied to SUDO was proportionally determined.

Data were integrated with the Arcview 3.3 GIS software (ESRI, Redlands, California USA), which is one of the programs of the GIS. By adding patient address data to the numeric maps of Turkey used in the GIS, spatial queries could be determined and spatial maps showing the geographical distribution of patients applying to SUDO were obtained. Study data are available from the corresponding author (E.I.) but permission to access the databases used in this study may only be granted by the head of the department of SUDO.

RESULTS AND DISCUSSION

The records of total 9191 patients from 48 cities who applied for treatment to SUDO were examined. Distribution of patients' addresses by city was determined and percentages of patients are shown in detail in Figure 1. Accordingly, the highest demand for treatment was from Konya at 66.9 (1000–6147); second, the neighbor cities of Afyon at 0.76%, Aksaray at 0.57%, and Karaman at 0.71% (500–1000); third, Kutahya at 0.36% (250–500); fourth, Nigde at 0.20% (100–250); and fifth, Antalya at 0.09% and Nevsehir at 0.07% (50–100). The distribution of findings is shown in Figures 2 and Figure 3.

There are many faculties of dentistry located in different cities of Turkey. In some big cities some faculties of dentistry are obliged to give services to more than one city. These faculties teach students while simultaneously offering health services to patients. In such faculties, patient densities of orthodontic clinics are obviously high. The number of professional orthodontists is very low compared with the national population. According to unofficial records of the Turkish Orthodontic Society, the number of patients per orthodontist is 100,000 in Turkey, a number that is clearly insufficient for the population.

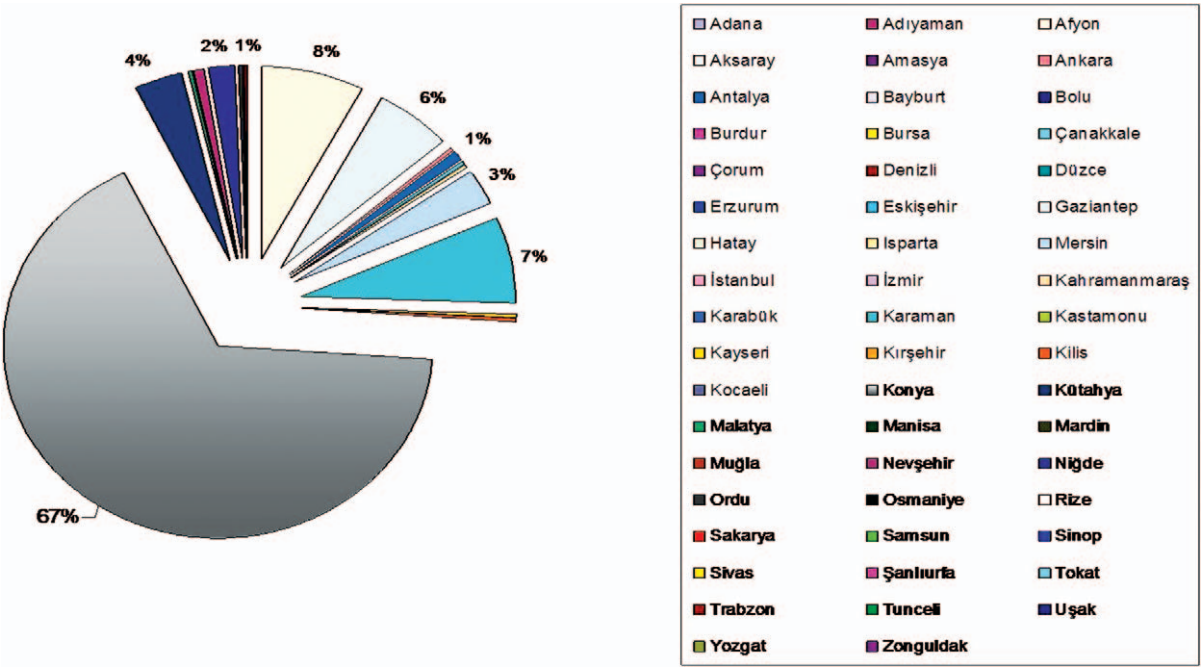


Figure 1. Distribution by city of the orthodontic patients coming to the clinic of Selcuk University, Faculty of Dentistry, Department of Orthodontics.

Up to this time in Turkey, there has been no detailed research about who receives health services from dental faculties, what is the extent, and type of health services received, and which faculty gives services to which geographical regions.

The subject of this study, SUDO, established in 1988 in Konya in Central Anatolia, not only fulfills the orthodontic treatment needs of local people in Konya but at the same time it offers services to neighboring cities outside Konya. Some of the patients from distant cities are students at the university but most of these patients travel a long distance to receive orthodontic treatments in SUDO. However, the fact that these patients travel long distances results in loss of time and money; moreover, these students fall behind in their studies because of missed class time.

To compensate for these problems, it would be beneficial for the government to provide services from freelance orthodontists or establish health institutions offering orthodontic services, thereby increasing the number of orthodontic specialists in the native cities of these patients. Certainly, as a first step, actual orthodontic treatment needs of patients should be evaluated objectively, and only after that should patients should be treated. The patients who will be treated should contribute to the cost of treatment at a ratio according to the significance of



Figure 2. Distribution by city of the orthodontic patients who applied for treatment to Konya Selcuk University, Faculty of Dentistry, Department of Orthodontics.

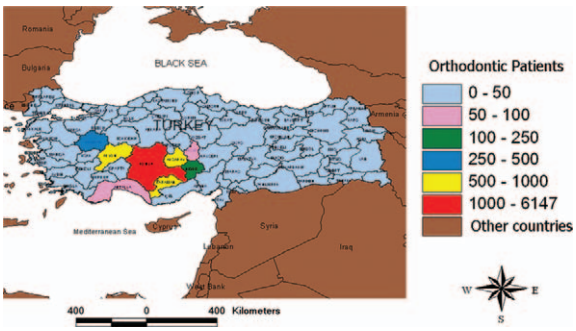


Figure 3. Numeric distribution by city of the orthodontic patients who applied for treatment to Konya Selcuk University, Faculty of Dentistry.

their problems. The government should not pay for orthodontic problems resulting from the neglect of preventive orthodontic treatment since the anomalies occurred during the early stages of life may have more chances to be stopped or restrained and the cost is lower than that of advanced stages of the problems. Thus, it should be an official health policy to encourage the general public to follow preventive treatments. In addition, it becomes even more important to plan these health services in a more scientific way through technologies such as GIS.

GIS is a computer-based program that puts all the data into maps and thus enables better evaluation of the data; it has been used in many scientific studies. The main principle of the GIS is to free the data from scripts and transmit it into figures to enable better understanding. Thanks to this system, many researchers have clarified existing problems and therefore contributed to their solution.[18–21]

Boulos and Phillipps,[4] by applying this program, determined the ratio of dentists per 1000 people in England according to settlement areas and mapped the obtained data by using GIS program and colors of traffic lights. At a single glance, this map allows the user to see the number of dentists for each location.

Similarly, in our study, by forming different maps in different distribution scales, the distribution of patients and distribution by city of orthodontic patients who applied for treatment to SUDO has been visually portrayed. One finding was that the number of patients from the cities of Karaman, Aksaray, and Afyon was too high. Because SUDO could hardly meet the needs of its own city, as patients from other cities also came to Konya, the number of patients waiting for treatment increased day by day and created delays, loss of money, waste of time, and a decrease in treatment quality.

In the literature, very few studies[15,20,22] around the world have discussed the distribution of orthodontists using a GIS program. However, use of the system would help providers in Turkey and other European countries plan orthodontic treatment more effectively once the number of orthodontists in each city and region and patient distribution were determined. The findings would help communities establish new regulations, make investments in line with this need, and make the necessary adjustments in plans to offer orthodontic treatment in their native cities because the number of patients in need could be determined.

This present study provides interesting clues for future research. For example, geographical differences of health status among the townships provide some suitable data for exploring health inequality and differences in health risk factors between urban and rural areas. These findings should stimulate further studies that focus on access to health services and quality of orthodontic care. Factors contributing to this urban versus rural health inequality may include health service accessibility, living conditions, socioeconomic characteristics, affordability, and the quality. Further in-depth studies about these factors will be very useful for understanding the mechanisms of health inequality and will provide solid evidence for policy making.

This study has brought to light that not only local patients but also a significant number of patients from other cities apply for a treatment to SOBU. These distributions can be visually portrayed via a GIS system by using maps in different scales. The present conditions set forth by the GIS method will most assuredly be a reference point for officials and authorities to take steps in making certain plans related to orthodontic care.

CONCLUSIONS

- A GIS can be successfully used to assist in governmental planning for orthodontist distribution and to address other health policies.
- A large amount of patients from outside the city are coming to SUDO for treatment.
- A lack of orthodontists is evident not only in Konya but also in nearby cities.

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