

Clustering the Oral and Dental Health Centers in Turkey with Data Mining Methods according to the Service they Offer

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Abstract

The purpose of this study is to cluster all of the oral and dental health centers that have a wide range of service and rate (119 in 2009, 117 in 2010) in 7 regions of Turkey apart from the dental hospitals under the Ministry of Health according to the services they offer and determine the service groups which affect the clustering. The second aim which the study has focused on is to determine whether the centers in the regions are different from each other in terms of the services they offer. In the clustering analyses, Random Forest and K-Means Clustering were used. Seven regions are statistically different from each other in terms of the surgical tooth extraction, dental fillings, root canal therapy, operation, therapy services and the number of dentists in 2009; and in 2010 in terms of the surgical tooth extraction, root canal therapy, fixed and removable denture and scaling services.

Keywords: Data mining, Cluster analysis, Oral and dental health centers

1. Introduction

Oral disease, such as dental caries, periodontal disease, tooth loss, oral mucosal lesions, oropharyngeal cancers, oral manifestations of HIV/AIDS, necrotizing ulcerative stomatitis (noma), and orodental trauma, is a serious public-health problem. Its impact on individuals and communities in terms of pain and suffering, impairment of function and reduced quality of life, is considerable. Globally, the greatest burden of oral diseases lies on disadvantaged and poor populations. The current pattern of oral disease reflects distinct risk profiles across countries related to living conditions, behavioural and environmental factors, oral health systems and implementation of scheme stop prevent oral disease (Petersen, 2008). The problems related with oral and dental health in Turkey are among the most important public health problems. Diseases related with the mouth, teeth and gums affect 96% of the individuals of the country, and it is the reality that 85% of the individuals are unwholesome respecting the mouth and gum health, and dental diseases are common according to the information obtained from the screening of oral and dental health to the present day (Öner, 2010). The majority of oral and dental health services in Turkey are held by the Oral and Dental Health Centers (ODHCs) of the Ministry of Health (MoH). ODHCs are defined as “independent health institutions in which preventive and curative health services in all branches of dentistry and outpatient or when necessary inpatient examinations, diagnostic and therapy services as well as further evaluation and therapy are also applied, and have a capacity of at least 10 units in which dental treatment and prosthetic centers and dental clinics can be opened” according to the Regulation Amending the Regulation of the Inpatient Treatment of the Business Regulation (Article 3, published in the Official Gazette No. 25806 dated 05.05.2005).

The job description of the ODHCs of the MoH fulfill the dental diagnosis, therapy and prosthetic services and the principles and procedures of the services specified in preventive dentistry. Specified dental services; *Clinical Services*; services of all branches of dentistry are offered in the ODHCs, and these services include the diagnosis, treatment and prosthetic services. *Preventive Oral and Dental Health Services*; include the necessary protective measures to be taken by the mother during pregnancy, and protective measures in order to contribute the prenatal postpartum healthy, functional mouth, teeth and jaw structure including oral hygiene services applied the individuals and orthodontic services and promoting the health of teeth and gums in the process of growth and development (Öner, 2010). ODHCs are among the secondary and tertiary health care institutions according to the amendment of the regulation of Inpatient Treatment Institutions Regulations published in the Official Gazette No. 25806 dated 05.05.2005. And also "Procedures and Principles in the Executions of the Services of ODHCs of the Ministry" regulations related with execution of mentioned institutions have been done by the regulation no. 20555, dated 19.01.2001 (<http://www.dentiss.com/Dental-sektor-agiz-dis-sagligi-merkezlerini-tartisiyory257.html>). However, by the regulations in the recent years, ODHCs are intended to be included within the primary health care services considering the growing importance of oral and dental health, for the purpose of increasing the availability.

The first institution specified on oral and dental health was opened in 1984 under the Health Insurance Institution; and it was transferred to the MoH on 19.02.2005. As of today, there are three dental hospitals, and more than 100 ODHCs (Ministry of Health, ODHC Building Information, access date: 07.07.2010). According to the work of the Turkish Association of Dental Medicine in 2009, 27% of the dentists, in 2010, 30% of the dentists in Turkey work for institutions under the ministry (Dentists Operating Modes, In the institutions, and in the City / Counties in 2009 and in 2010 Distributions Handbooks, 2009-2010, p. 1). The purpose of this study is to cluster all of the oral and dental health centers that have a wide range of service and rate (119 in 2009, 117 in 2010) in 7 regions of Turkey apart from the dental hospitals under the MoH according to the services they offer and determine the service groups which affect the clustering. The second aim which the study has focused on is to determine whether the centers in the regions are different from each other in terms of the services they offer.

2. Material and Methods

The data used in this study is composed of number of services offered and number of staff (dentists, dental technicians, nurses) at the units / department level of the ODHCs of the MoH for 2009 and 2010. None of the samples has been withdrawn from the study and any of the whole universe (all Turkey) was included in the analysis. Main purpose is to determine the difference between decision-makers of the centers and health policy makers of the country. Investments and other expenditures will be determined through this distinction. K-Means clustering method of data mining methods has been preferred. The reason why this method has been preferred is because the cluster centers change iteratively and it is known that the cluster analysis has better results than other methods at the optimal point (MacQueen, 1967). The most important point when using the K-Means method is the right choice of "k" which is the number of clusters. "k" values are given from 2 to 20 for the mentioned module of STATISTICA 7.0 and the algorithm has determined the best number of clusters. The clusters therefore were provided to be statistically different from each other. In the study, Random Forest (Data Mining) was used to determine the optimal number of clusters by using the data of the mentioned centers for 2009 and 2010 and the optimal number of clusters has been determined by the "Expectation Maximization" algorithm. A random forest (RF) is a decision tree ensemble classifier, with each tree grown using some type of randomization. Random forests have a capacity for processing huge amounts of data with high training speeds, based on a Classification and Regression Tree (CART) (Ko et. al., 2013).

For each classification tree, a bootstrap sample is drawn from the original samples. At each non-leaf node of a classification tree, the best split feature is selected from a small random subset of the original features. When the forest receives an input vector, each classification tree casts a unique vote, the final prediction is determined by the majority votes of all the trees in the random forest. Since the bootstrap sample is drawn with replacement, the samples which are not in the bootstrap samples are called out-of-bag (OOB) data (Breiman, 2001). The OOB data can be used to estimate the prediction error of the random forest (Lin, XH et. al., 2011). RF provides a variable importance ranking via the variable predictive importance, which is estimated also using the OOB cases. The importance of variable j is estimated as the average difference between the correct classification rate of OOB cases, and the correct classification rate of OOB cases with the value of the variable of interest replaced with a randomly permuted value over all trees (Carla Chia-Ming Chen et. al., 2011).

K-Means method has been used to ensure putting the similar ODHCs in the same cluster. K-means (MacQueen, 1967) is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to then nearest centroid. When no point is pending, the first step is completed and an early group age is done. At this point we need to re-calculate k new centroids as bary centers of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and then nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more. Finally, this algorithm aims at minimizing an *objective function*, in this case a squared error function. The objective function

$$J = \sum_{j=1}^k \sum_{i=1}^n \|x_i^{(j)} - c_j\|^2$$

where $\|x_i^{(j)} - c_j\|^2$ is a chosen distance measure between a data point $x_i^{(j)}$ and the cluster centre c_j , is an indicator of the distance of the n data points from their respective cluster centres.

3. Results

The first analyzes carried out within the framework of this research is descriptive statistical analysis. The purpose of this descriptive study is to draw a portrait of an organization, individual, group, situation or case properly. Frequency distributions and percentages were used as a measure of spread for descriptive statistics. The second analysis conducted within the research is the descriptive analysis. The purpose of the descriptive analysis is to reveal the hidden relationships between the mentioned centers statistically. These approaches of analysis are the clustering of data mining and the Kruskal-Wallis test. The most important advantage of these advanced level analysis is to be able to assess the huge amount of data. It is difficult to produce data sets from such a large-sized data as in this study under normal circumstances. However, the following conclusions are reached thanks to the approaches used. Especially the clusters obtained as a result of cluster analysis, and the centers of these clusters show that an accurate result was obtained respecting the distinctiveness. Also these cluster distinctions were validated as a result of the statistical comparisons held.

3.1 Descriptive Statistics for All Centers

Number of ODHCs are shown by region in Table 1. The Central Anatolia, the Black Sea Region and the Marmara region are the regions where the most centers take place, according to the table. While there were three regions with more than 20 centers in 2009, and two in 2010, the number of centers are below 20 in other regions. The reason of that is thought to be the levels of development and population.

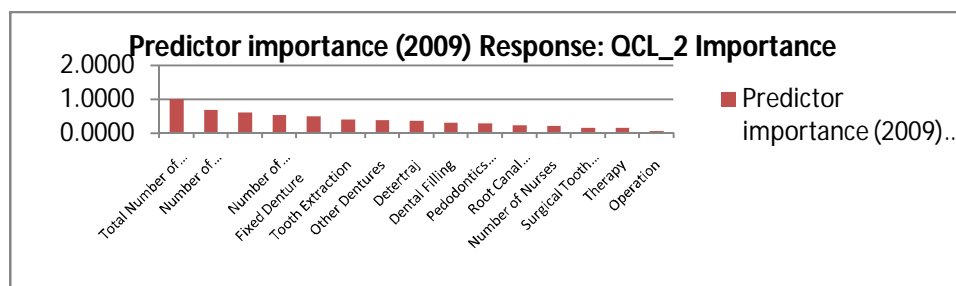
Table 1: Number of ODHCs by Region

REGION		2009 Frequency	2009 Percent	2010 Frequency	2010 Percent
REGION 1	THE MEDITERRANEAN	14	11.76	15	12.82
REGION 2	THE EASTERN ANATOLIA	14	11.76	14	11.97
REGION 3	THE AEGEAN	16	13.45	16	13.68
REGION 4	THE SOUTHEAST ANATOLIA	10	8.40	9	7.69
REGION 5	THE CENTRAL ANATOLIA	22	18.49	23	19.66
REGION 6	THE BLACK SEA	21	17.65	21	17.95
REGION 7	THE MARMARA	22	18.49	19	16.24
TOTAL		119	100.00	117	100.00

3.2 Cluster Analysis

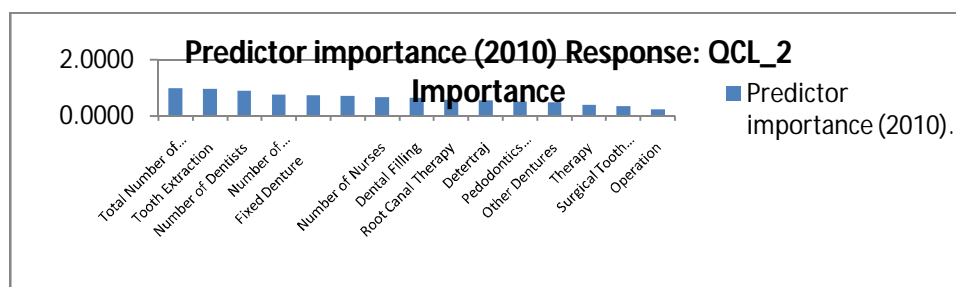
The optimal number of clusters is determined by the method of "Expectation Maximization". When the number of ODHCs and the total number of clustering analysis are compared, 5 centers were excluded from the cluster analysis due to the lack of pediatric dentistry tooth extraction data of these centers for 2010. The optimal number of clusters has been found as 3 in both years. Four centers in the first cluster, 34 centers in the second cluster and 79 centers in the third cluster for 2009 were found. And for 2010, 4 centers in the first cluster, 25 centers in the second cluster and 81 centers in the third cluster were found. Three of the four centers which form the first cluster are same according to the findings. The descriptive statistics of the available data were examined for the possible reasons of four ODHCs being in the first cluster in both two years and also three of them being the same centers, and as a result, the levels of 4 ODHCs mentioned above were more in all the variables. And this is important for the validation of the cluster analysis. Of the data mining methods, "Rondam Forest" has been used in order to determine the factors that affect the above clustering analysis. The number of polyclinics, the number of dentists and removable denture affected the clustering analysis respectively as seen Figure

Figure 1: Variables Affecting the Cluster Analysis of 2009



"Rondam Forest" Method has been used in order to determine the factors that affect the clustering analysis also for 2010. The number of polyclinics, the normal tooth extraction and the number of dentists affected the clustering analysis the most respectively as seen Figure 2. The surgical tooth extraction, dental therapy and operation have been identified as the factors which affect clustering analysis the least for both two years even though the order varies.

Figure 2: Variables Affecting Cluster Analysis of 2010



The Kruskal-Wallis test was used to determine whether the centers in seven geographic regions of Turkey are different from each other in terms of the services they offer and the number of health care personnel. The results for 2009 and 2010 are given in Table 2.

Table 2: Comparison of 2009 and 2010ODHCs Data

Test Statistics ^{a,b}	Year 2009			Year 2010		
	Chi-square	df	Asymp. Sig.	Chi-square	df	Asymp. Sig.
Total Number of Polyclinics	6.567	6	0.363	10.441	6	0.107
Tooth Extraction	4.163	6	0.655	5.593	6	0.470
Surgical Tooth Extraction	22.330	6	0.001	31.852	6	0.001
Dental Filling	13.971	6	0.030	15.041	6	0.070
Root Canal Therapy	20.546	6	0.002	26.066	6	0.001
Fixed Denture	10.768	6	0.096	14.989	6	0.021
Removable Denture (total+parsiyel)	10.304	6	0.112	14.813	6	0.022
Other Dentures	8.760	6	0.188	9.005	6	0.173
Detertraj	12.332	6	0.055	16.201	6	0.013
Operation	24.161	6	0.001	7.835	6	0.250
Pedodontics Tooth Extraction	10.272	6	0.114	8.205	6	0.223
Therapy	14.701	6	0.023	13.499	6	0.066
Number of Dentists	15.083	6	0.020	13.287	6	0.069
Number of Dental Denture Technician	11.005	6	0.088	4.934	6	0.552
Number of Nurses	2.371	6	0.883	4.895	6	0.557

Kruskal Wallis Test, b. Grouping Variable: Region 2

As shown in Table 2, centers in the seven geographical regions are different from each other as of the services they offer and the number of health personnel, in terms of surgical tooth extraction, dental filling, root canal therapy, operation, therapy, and the number of dentists. Pairwise comparisons were made with Dunn's Z test for the different variables. However, no difference was found after the Kruskal-Wallis test as a result of pairwise comparison for dental filling service in 2009 and no difference was observed as a result of pairwise comparison for the service of removable dentures in 2010. The reason for this is that these values are homogeneous for all regions. However, it is statistically different when considering seven regions together. Below are the results of pairwise comparisons according to the regions for the other services.

Table 3: Pairwise Comparison Results for 2009

Pairwise Comparison Results of Surgical tooth extraction for 2009								
	1 R: 78.333	REGION 1 R: 64.786	REGION 2 R: 68.000	REGION 3 R: 55.500	REGION 4 R: 84.300	REGION 5 R: 77.682	REGION 6 R: 38.048	REGION 7 R: 49.905
1		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 1	1.000000		1.000000	1.000000	1.000000	1.000000	0.759975	1.000000
REGION 2	1.000000	1.000000		1.000000	1.000000	1.000000	0.372979	1.000000
REGION 3	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000	1.000000
REGION 4	1.000000	1.000000	1.000000	1.000000		1.000000	0.016760	0.299572
REGION 5	1.000000	1.000000	1.000000	1.000000	1.000000		0.005942	0.264148
REGION 6	1.000000	0.759975	0.372979	1.000000	0.016760	0.005942		1.000000
REGION 7	1.000000	1.000000	1.000000	1.000000	0.299572	0.264148	1.000000	
*Kruskal-Wallis Test : H (7, N=121)= 22.33140, p= .0022								
Pairwise Comparison Results of 2009 Root Canal Therapy								
	1 R: 78.333	REGION 1	REGION 2	REGION 3	REGION 4	REGION 5	REGION 6	REGION 7

		R: 44.071	R: 58.750	R: 36.156	R: 62.100	R: 83.114	R: 65.381	R: 62.167
1		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 1	1.000000		1.000000	1.000000	1.000000	0.031645	1.000000	1.000000
REGION 2	1.000000	1.000000		1.000000	1.000000	1.000000	1.000000	1.000000
REGION 3	1.000000	1.000000	1.000000		1.000000	0.001290	0.337145	0.712097
REGION 4	1.000000	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000
REGION 5	1.000000	0.031645	1.000000	0.001290	1.000000		1.000000	1.000000
REGION 6	1.000000	1.000000	1.000000	0.337145	1.000000	1.000000		1.000000
REGION 7	1.000000	1.000000	1.000000	0.712097	1.000000	1.000000	1.000000	

*Kruskal-Wallis Test: $H(7, N=121) = 21.1857, p = .0035$

Pairwise Comparison Results of 2009 Dental Operations

	1 R: 71.167	REGION 1 R: 43.250	REGION 2 R: 56.607	REGION 3 R: 47.000	REGION 4 R: 50.900	REGION 5 R: 90.591	REGION 6 R: 63.024	REGION 7 R: 56.762
1		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 1	1.000000		1.000000	1.000000	1.000000	0.002206	1.000000	1.000000
REGION 2	1.000000	1.000000		1.000000	1.000000	0.128678	1.000000	1.000000
REGION 3	1.000000	1.000000	1.000000		1.000000	0.004345	1.000000	1.000000
REGION 4	1.000000	1.000000	1.000000	1.000000		0.084150	1.000000	1.000000
REGION 5	1.000000	0.002206	0.128678	0.004345	0.084150		0.279622	0.043948
REGION 6	1.000000	1.000000	1.000000	1.000000	1.000000	0.279622		1.000000
REGION 7	1.000000	1.000000	1.000000	1.000000	1.000000	0.043948	1.000000	

*Kruskal-Wallis Test : $H(7, N=121) = 24.23502, p = .0010$

Pairwise Comparison Results of 2009 Year Dental Therapies

	1 R: 98.000	REGION 1 R: 47.857	REGION 2 R: 50.143	REGION 3 R: 59.031	REGION 4 R: 66.250	REGION 5 R: 82.636	REGION 6 R: 48.619	REGION 7 R: 60.429
1		0.689697	0.895369	1.000000	1.000000	1.000000	0.631210	1.000000
REGION 1	0.689697		1.000000	1.000000	1.000000	0.104343	1.000000	1.000000
REGION 2	0.895369	1.000000		1.000000	1.000000	0.188501	1.000000	1.000000
REGION 3	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000	1.000000
REGION 4	1.000000	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000
REGION 5	1.000000	0.104343	0.188501	1.000000	1.000000		0.041365	1.000000

REGION 6	0.631210	1.000000	1.000000	1.000000	1.000000	0.041365		1.000000
REGION 7	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	
*Kruskal-Wallis Test : H (7, N=121)= 17.91679, p= .0124								
Pairwise Comparison Results of Number of Dentists for 2009								
	1 R: 84.667	REGION 1 R: 58.321	REGION 2 R: 39.214	REGION 3 R: 61.375	REGION 4 R: 59.400	REGION 5 R: 78.477	REGION 6 R: 48.405	REGION 7 R: 68.690
1		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 1	1.000000		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 2	1.000000	1.000000		1.000000	1.000000	0.029653	1.000000	0.416130
REGION 3	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000	1.000000
REGION 4	1.000000	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000
REGION 5	1.000000	1.000000	0.029653	1.000000	1.000000		0.138526	1.000000
REGION 6	1.000000	1.000000	1.000000	1.000000	1.000000	0.138526		1.000000
REGION 7	1.000000	1.000000	0.416130	1.000000	1.000000	1.000000	1.000000	
*Kruskal-Wallis Test : H (7, N=121)= 16.07560, p= .0244								

In Table 3, surgical tooth extraction services provided in the Black Sea Region differ from Southeastern Anatolia ($p = 0.016760$) and the Central Anatolia region ($p = 0.05942$) in the statistical point of view. While the average number of surgical tooth extraction is quite a few in the Black Sea region, the average number of surgical tooth extraction in Southeastern Anatolia and the Central Anatolia regions is quite high. The root canal therapy services offered in Central Anatolia region differ from the Mediterranean ($p = 0.031645$), and Aegean region ($p = 0.001290$). While the average number of root canal therapy is quite a lot in the Central Anatolia Region, this number is quite low in the Mediterranean and Aegean regions. Dental operations presented in the Central Anatolia region ($p = 0.002206$), Mediterranean differ from the Marmara (0.043948) and the Aegean region ($p = 0.004345$). The average number of dental operations in the Central Anatolia Region is quite high compared with those where the number of dental operations differs. Dental therapies offered in the Black Sea Region differ from dental therapies offered in the Central Anatolia region ($p = 0.041365$). While the average number of dental therapies is quite low, this number is quite high in the Central Anatolia region ($p = 0.041365$). The number of dentists providing services in the Central Anatolia differs from the number of dentists providing services in the Eastern Anatolian Region ($p = 0.029653$). While the average number of dentists in the Central Anatolia is high, the average number of dentists in the Eastern Anatolia region is rather less. As seen in Table 4, the surgical tooth extractions offered in the Black Sea region in 2010 statistically differ from the ones offered in the Eastern Anatolia ($p = 0.002616$), Southeastern Anatolia ($p = 0.002158$) and the Central Anatolia region ($p = 0.0011573$). While the average number of surgical tooth extractions is quite a few, the average number of surgical tooth extractions is quite high in the regions where difference was observed. Root canal therapy offered in the Central Anatolia Region statistically differs from the services offered in the Mediterranean Region ($p = 0.018288$) and the Aegean Region (0.001140). The number of root canal therapy offered in the Central Anatolia region is averagely quite high compared with the Mediterranean and Aegean regions. And also root canal therapy services offered in the Aegean region differ from the Southeastern Anatolia Region ($p = 0.019247$). The Aegean Region is the region where the root canal therapy on average emerges the least. Fixed denture services offered in the Marmara Region statistically differ from the Eastern Anatolia Region ($p = 0.039530$) for 2010. The average number of fixed dentures offered in the Marmara Region is quite higher than those in the Eastern Anatolia region.

According to results, the scaling services offered in the Black Sea Region statistically differ from the scaling services offered in the Southeastern Anatolia Region ($p = 0.021576$). While the scaling services, on average, have been offered in the Black Sea region the least, they have been offered the most in the Southeastern Anatolia Region.

Table 4: Pairwise Comparison of Results for 2010

Pairwise Comparison of Surgical Tooth Extraction Results for 2010								
	1 R: 95.750	REGION 1 R: 64.533	REGION 2 R: 79.231	REGION 3 R: 44.438	REGION 4 R: 86.000	REGION 5 R: 73.609	REGION 6 R: 31.667	REGION 7 R: 50.889
1		1.000000	1.000000	0.218225	1.000000	1.000000	0.018513	0.521969
REGION 1	1.000000		1.000000	1.000000	1.000000	1.000000	0.135183	1.000000
REGION 2	1.000000	1.000000		0.193460	1.000000	1.000000	0.002616	0.671765
REGION 3	0.218225	1.000000	0.193460		0.107317	0.262857	1.000000	1.000000
REGION 4	1.000000	1.000000	1.000000	0.107317		1.000000	0.002158	0.354533
REGION 5	1.000000	1.000000	1.000000	0.262857	1.000000		0.001573	1.000000
REGION 6	0.018513	0.135183	0.002616	1.000000	0.002158	0.001573		1.000000
REGION 7	0.521969	1.000000	0.671765	1.000000	0.354533	1.000000	1.000000	
*Kruskal-Wallis Test : H (7, N=121)= 35.96584, p= .0000								
Pairwise Comparison Results of Root Canal Therapy for 2010								
	1 R: 80.250	REGION 1 R: 38.933	REGION 2 R: 61.846	REGION 3 R: 31.875	REGION 4 R: 80.667	REGION 5 R: 77.957	REGION 6 R: 62.143	REGION 7 R: 60.944
1		0.932540	1.000000	0.339439	1.000000	1.000000	1.000000	1.000000
REGION 1	0.932540		1.000000	1.000000	0.115199	0.018288	1.000000	1.000000
REGION 2	1.000000	1.000000		0.559297	1.000000	1.000000	1.000000	1.000000
REGION 3	0.339439	1.000000	0.559297		0.019247	0.001140	0.229347	0.397160
REGION 4	1.000000	0.115199	1.000000	0.019247		1.000000	1.000000	1.000000
REGION 5	1.000000	0.018288	1.000000	0.001140	1.000000		1.000000	1.000000
REGION 6	1.000000	1.000000	1.000000	0.229347	1.000000	1.000000		1.000000
REGION 7	1.000000	1.000000	1.000000	0.397160	1.000000	1.000000	1.000000	
*Kruskal-Wallis Test : H (7, N=121)= 27.20202, p= .0003								
Pairwise Comparison Results of Fixed Denture for 2010								
	1 R: 86.750	REGION 1 R: 64.400	REGION 2 R: 33.808	REGION 3 R: 56.406	REGION 4 R: 69.778	REGION 5 R: 65.957	REGION 6 R: 48.095	REGION 7 R: 73.889
1		1.000000	0.203601	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 1	1.000000		0.539468	1.000000	1.000000	1.000000	1.000000	1.000000

REGION 2	0.203601	0.539468		1.000000	0.453279	0.202589	1.000000	0.039530
REGION 3	1.000000	1.000000	1.000000		1.000000	1.000000	1.000000	1.000000
REGION 4	1.000000	1.000000	0.453279	1.000000		1.000000	1.000000	1.000000
REGION 5	1.000000	1.000000	0.202589	1.000000	1.000000		1.000000	1.000000
REGION 6	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000		0.557778
REGION 7	1.000000	1.000000	0.039530	1.000000	1.000000	1.000000	0.557778	

*Kruskal-Wallis Test : H (7, N=121)= 17.14516, p= .0165

Pairwise Comparison Results of Scaling (Scaling Teeth) for 2010

	1 R: 89.500	REGION 1 R: 58.667	REGION 2 R: 56.154	REGION 3 R: 53.625	REGION 4 R: 86.889	REGION 5 R: 57.870	REGION 6 R: 40.667	REGION 7 R: 74.833
1		1.000000	1.000000	1.000000	1.000000	1.000000	0.264969	1.000000
REGION 1	1.000000		1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
REGION 2	1.000000	1.000000		1.000000	1.000000	1.000000	1.000000	1.000000
REGION 3	1.000000	1.000000	1.000000		0.578308	1.000000	1.000000	1.000000
REGION 4	1.000000	1.000000	1.000000	0.578308		0.906935	0.021576	1.000000
REGION 5	1.000000	1.000000	1.000000	1.000000	0.906935		1.000000	1.000000
REGION 6	0.264969	1.000000	1.000000	1.000000	0.021576	1.000000		0.057284
REGION 7	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	0.057284	

*Kruskal-Wallis Test : H (7, N=121)= 19.13576, p= .0078

4. Discussion and Conclusion

In this study, ODCHs of the MoH in the 7 regions have been clustered and the service groups which affect these services most have been identified. The optimal number of clusters was found as 3 clusters for both two years. Three of the four centers which form the first cluster are similar and the most important services offered for all centers are the total number of polyclinics, the number of dentists and removable dentures respectively for 2009, and the total number of polyclinics, surgical tooth extraction and number of dentists respectively for 2010. The three centers that make up the first cluster for both two years being the same and the services which affect the clustering being the same is an important finding. In our study, it was stated whether the centers in the regions are different from each other in terms of the services they offer. Seven regions are statistically different from each other according to the results obtained in 2009 in terms of surgical tooth extraction, dental filling, root canal therapy, operation, dental therapy services and the number of dentists, and in 2010 surgical tooth extraction, root canal therapy, fixed and removable denture and tooth scaling services. Being in the service group which creates the difference in both two years surgical tooth extraction and root canal therapy services are in the front ranks in terms of numbers in the Central Anatolia and Southeastern Anatolia Regions. While the Southeastern Anatolia Region is the region with the least population and number of ODCHs; it was found remarkable that these two services and scaling services are done at a high rate. The Southeastern Anatolia Region is the region where the development level is the second least one after that of the East Anatolia (Eşiyok and Sekmen, 2012; Kulaksız, 2008). Measuring whether the poor level of development has such an effect on this higher rate of surgical tooth extraction and root canal therapy services can be thought as the subject of a new research.

The Central Anatolia Region appears to be the most traded region in 2009 for all services that make a difference. The Black Sea region is the region where surgical tooth extraction, dental therapy and scaling services are seen the least. The Mediterranean and the Aegean are the regions where the root canal therapy and operations are done the least. From these results it can be said that coastal regions experience less dental health problems. Finding the causes is thought to be the subject of another research. The Marmara region is the most densely populated and developed region. And it is the region where the fixed denture and removable denture services emerged the most. Whether denture services are offered so high is because of the density of the population or other effects such as dental therapy services offered within health tourism has any effects is thought to be revealed.

In Özdemir's study (2011), in which he measured the technical efficiency of 115 ODHCs of the MoH with DEA for 2009, services that create efficient and inefficient statistically significant difference has been identified as dental fillings, root canal therapy and scaling services. In addition Özdemir separated the ODHCs into groups in his study by making an arrangement from the region where the most efficient service is offered to the region where the least effective service is offered. The regions are the Southeastern Anatolia Region, the East Anatolia Region, the Central Anatolia Region, the Mediterranean Region, the Aegean Region and the Black Sea Region respectively. Though the two studies have been done for different purposes, it is seen that the results are similar to each other. It is seen that the geography and the burden of disease are on the top of the factors affecting the development of oral and dental health services in a study held by Quiñonez in Canada (2003). According to Analyses of the National Population Health Survey and the Canadian Community Health Survey, the women who are married, young and middle-aged, living in urban areas and have a higher income level and education, and also have health insurance, receive more oral and dental health services. According to the results of other studies conducted in Canada, people who have public health insurance, especially those with the lowest income level, compared to those with private health insurance, receive more tooth extraction services. People who are educated with higher incomes benefit more from the protective oral and dental health services (Quiñonez, 2009). In the study Eklund held in the USA between 1992-2007, it was stated that the dental fillings and tooth extraction per capita (except for third-molar Extractions) services, endodontic and prosthodontic (dentures) therapies decreased, the use of implants increased over the years (2010). Sets of variables affecting the clusters without classifying the ODHCs according to the regions in Turkey and the sets of variables affecting the clusters by separating the centers according to the regions; the services, which are effective in determining differences between centers in terms of the services they offer, did not result the same. While surgical tooth extraction, dental therapies and the operations affect the clustering least in the analysis without separating into regions, after separating into the regions surgical tooth extraction for both two years, in addition dental therapies and operations for 2009 became the factors affecting the clustering most. It is very important to determine this result. In most developing countries like Turkey, the major challenges are to formulate national policies for oral health, to establish financial resources for primary oral health care and to ensure appropriate health personnel for essential care. It is therefore of utmost importance that oral health systems are based on community orientation and health promotion. Decision-makers in MoH and centers do the related investments by looking at these types of results. Regional differences obtained in the study are important for countries such as Turkey, which has a geographically large area. The analysis held will serve as an example for countries similar to Turkey. This study will have an important role on behalf of promoting the use of data mining clustering analysis in these types of researchs.

5. Limitations

Research has been limited with ODHCs under the MoH on the premise that they are administrated by the same administrative and legislative bases and the presupposition that they are analogous; ODHCs which are not under the MoH could not be included in the study because of the difficulty in obtaining data. In addition, five centers did not have tooth extraction data for pediatric dentistry for 2010, these five centers were excluded from the cluster analysis.

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