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Geographical accessibility of health care network via GIS in Kastamonu

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Abstract: Accessibility is one factor that increases the quality of life in urban areas. Accessibility is an indicator that reflects the ease of reaching an intended point or location. In general, access to healthcare relates to the population in a given area combining the physical distance between home and the location of a healthcare facility. In the study carried out to reach the health service facilities in Kastamonu Central district, the accessible areas of the facilities within walking distance were calculated with the help of GIS at a distance of 300-500 meters with the network analysis technique. With the help of spatial analysis, it aims to determine the current situation and help plans be created to consider the needs of society. In the current situation, the points that can be improved in terms of access to health institutions in the research area have been mentioned, and suggestions have been made.

Keywords: Accessibility, Health, GIS, Network Analysis, Kastamonu

Öz: Kentsel alanlarda yaşam kalitesini artıran unsurlardan biri de erişilebilirliktir. Erişilebilirlik, amaçlanan bir nokta veya bir konuma ulaşabilme kolaylığını yansıtan bir göstergedir. Genel olarak sağlık hizmetlerine erişim, belirlenen kentte yaşayan nüfusun, konut ile bir sağlık tesisinin konumu arasındaki fiziksel mesafeyi birleştirmesiyle ilgilidir. Kastamonu Merkez ilçesinde sağlık hizmet tesislerine ulaşmak için yapılan çalışmada tesislerin yürüme mesafesinde erişilebilir alanları CBS yardımı ile 300- 500 metre mesafede ağ analizi tekniği ile hesaplanmıştır. Ağ analizi uygulanarak tesislerin konumları, geleceğe dönük planlamaların toplumun ihtiyaçlarını gözeten şekilde oluşturulmasına yardımcı olması amaçlanmıştır. Mevcut durumda araştırma sahasında sağlık kuruluşlarına erişim konusunda geliştirilebilir noktalara değinilmiş ve önerilerde bulunulmuştur.

Anahtar Kelimeler: Erişebilirlik, Sağlık, CBS, Ağ Analizi, Kastamonu

1. Introduction

Today, especially in the post-COVID-19 pandemic period, the importance of health care accessibility research has increased. There are many physical factors that affect the accessibility [1]. Easy access opportunities should be provided for transportation, road texture, parking lot and vehicle traffic, especially for pedestrians in urban areas [2-4]. Accessibility to health services [5] is an element that reflects the welfare level of the society and is related to the physical distance between the residence and the place of a health facility where the population living in an area can go when they leave the residential areas [6]. The level of accessibility to health services depends on many factors such as the unique topography of each city [7], its spatial pattern and whether it is planned or not [8, 9]. Therefore, the level of accessibility differs in each city [10].

Although research on access to health services is increasing day by day, a common judgment has not emerged regarding the definition of the concept due to its multidimensional nature [11]. Dimensions such as accessibility of health services in rural areas [12], adequacy of services [13-15] service quality [16-18] is often explored. In addition, physical/geographic accessibility is also a topic of discussion in spatial planning [19-22].

The proliferation of geographic information systems (GIS) and global positioning technologies has reinvigorated studies on the accessibility [23] and use of healthcare facilities [24-26]. In addition, GIS-based analyzes facilitate spatial analysis and reduce the error rate [27].

The research subject is family health centers (FHC) located in Kastamonu and accessibility to these centers. The study aims to determine the areas accessible to family health centers with the Network analysis method applied to the city center. GIS-based network analysis has been applied by considering public/non-public facilities in this context.

2. Material and Method

The case area for the study was chosen as the central district of Kastamonu province (Figure 1). Kastamonu province is located in the Western Black Sea region between 41 degrees 21' north latitude and 33 degrees 46' east longitudes [28]. Its height above sea level is 775m. It has a surface area of 13,108.1 km² [29].

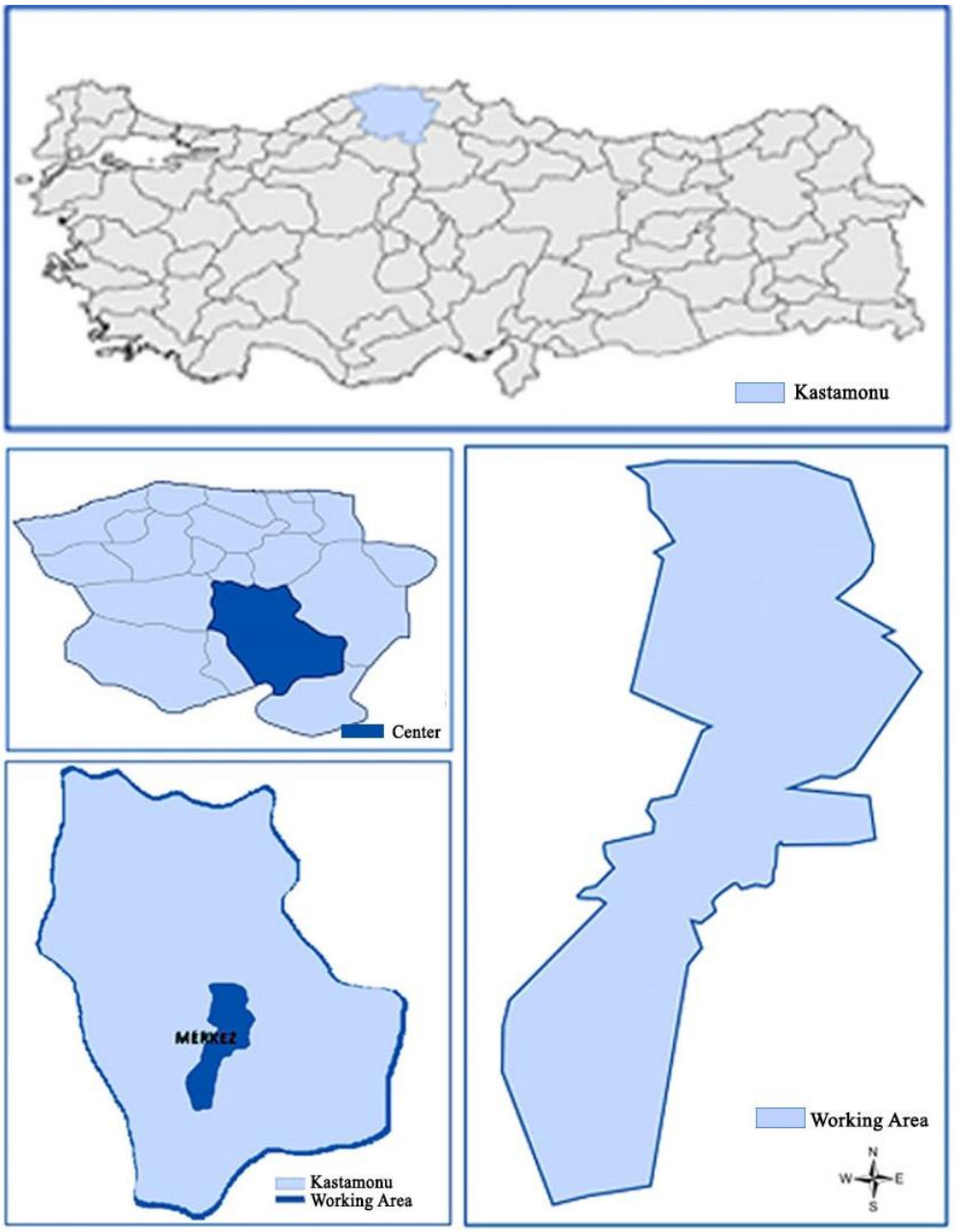

Figure 1. Location of case area

The research consists of four stages. First of all, the locations of FHCs in the city were determined, and neighborhoods with and without facilities were chosen. Then, the possible transportation network to the determined areas was mapped. As in some of the studies on the use of health services, GIS software was used in spatial accessibility analysis studies. Network analysis was performed using GIS software to determine accessible locations.

Digital transportation network to be used in the implementation of the analysis and the evaluation of the analysis result; Data of the locations of Health Service Centers; border and population data of the neighborhoods within the study area; The vector data of the houses in the study area were used. Digital road network data of the study area has been obtained, and corrections have been made. Topology was applied to eliminate errors and deficiencies in the road network data, and the detected errors were corrected. During the analysis, the scanning tolerance of 100 meters to the road was used to prevent the mistakes that may arise from the width of the road. Another data used in the analysis is the location data of Health Service Centers. Addresses and locations obtained from the Provincial Health Directorate were digitized. The buildings within the study area were removed from the municipal zoning plan and converted into point data with the

extension of 'Shp.' with the ArcGIS 10.6 package program. The generated data were collected in a single database. The population data of the research area and the numbers of the population on the basis of neighborhoods were obtained. Spatial accessibility has been taken into account since primary population data on a residential basis cannot be accessed. The data prepared for analysis were subjected to network analysis with the ArcGIS 10.6 package program, taking into account the alternative walking distances specified in the Spatial Plans Building Regulation and determined by the literature review.

3. Result

According to TUIK 2020 data, the population of Kastamonu is 376 377 and the population of the Central district is 151500. 49.83% of the center population is male and 50.17% is female [30]. The health facilities in the central district of Kastamonu, where the study was carried out, constitute the main material of the study. While there are no health facilities in 10 of the 19 neighborhoods in the district, there are health services facility areas in 9 neighborhoods. Neighborhoods with healthcare facilities can be listed as Aktekke, Beyçelebi, Esentepe, Hepkebirler, İnönü, İsmailbey, Kuzeykent, Mehmet Akif, Saraçlar (Figure 2).

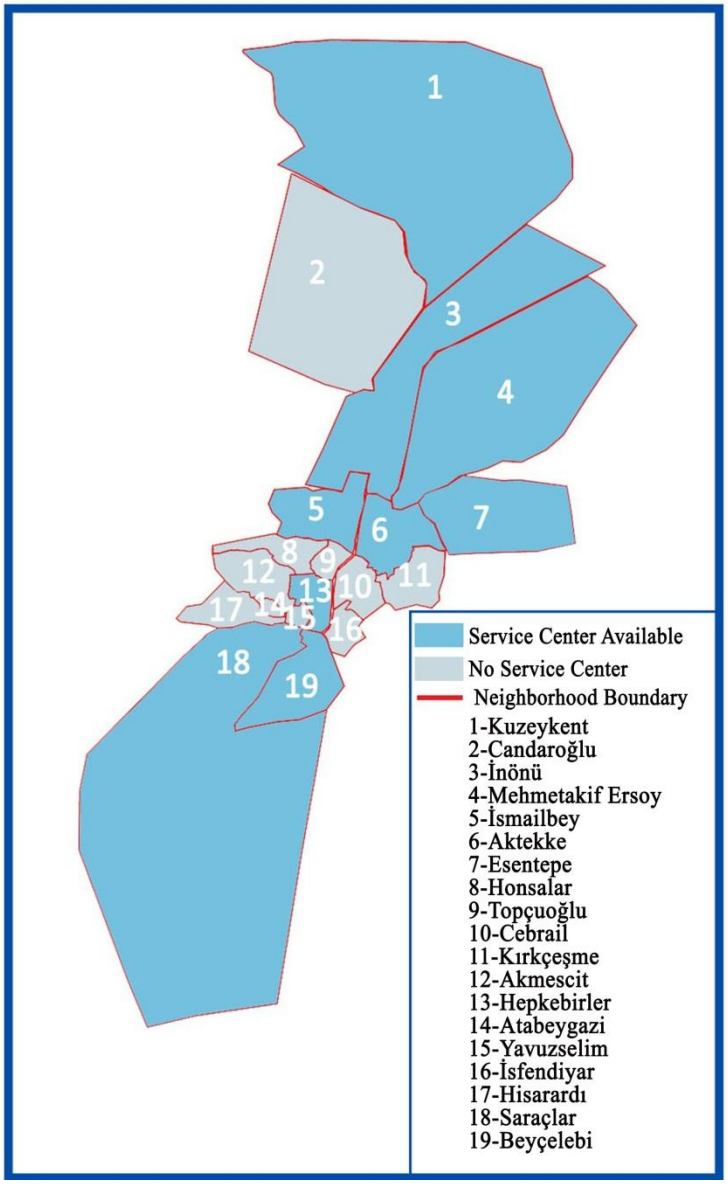

Figure 2. Neighborhoods with health service centers

In the study area, there are 12 health care facility areas, including 1 Training and Research hospital, 1 physical therapy and rehabilitation center, 1 private hospital and 9 family health centers, located at different points of the study area (Figure 3).

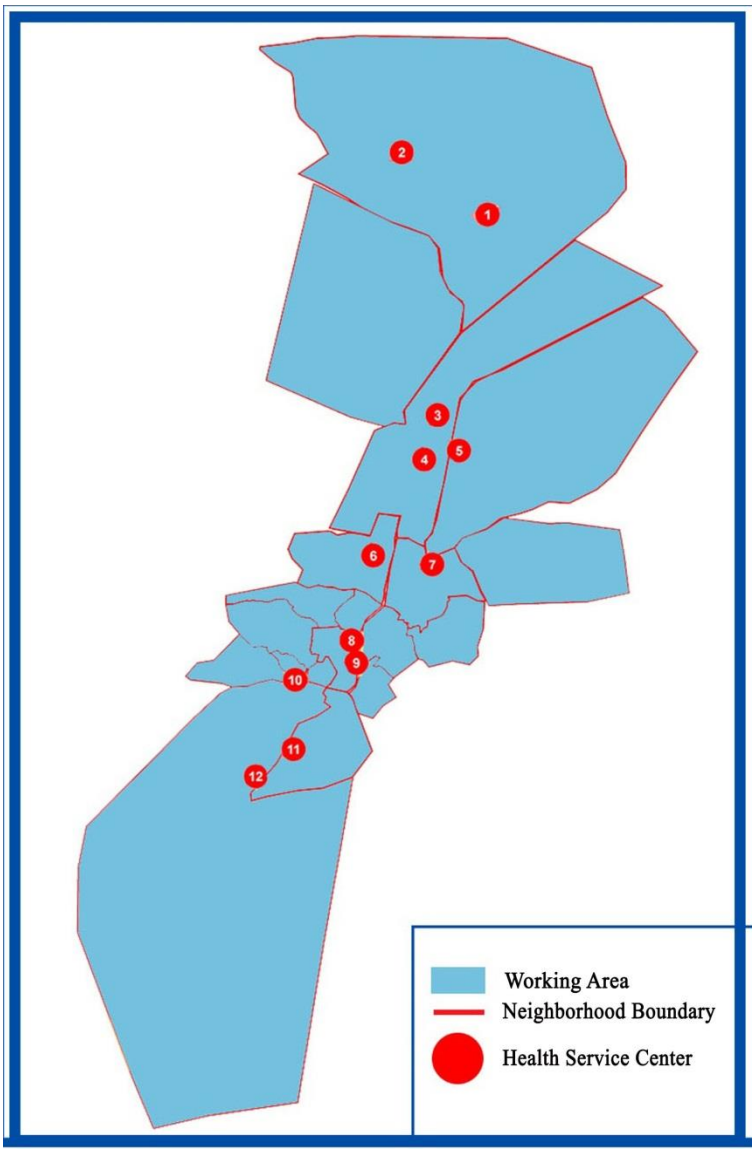

Figure 3. Health service center locations

Access to health services in the city center where the study was conducted is mostly provided by first and second degree roads. It is seen that the first degree roads are concentrated around the Karaçomak Stream, which appears to be continuous throughout the city center and divides the city into two, and the general road network is formed (Figure 4).

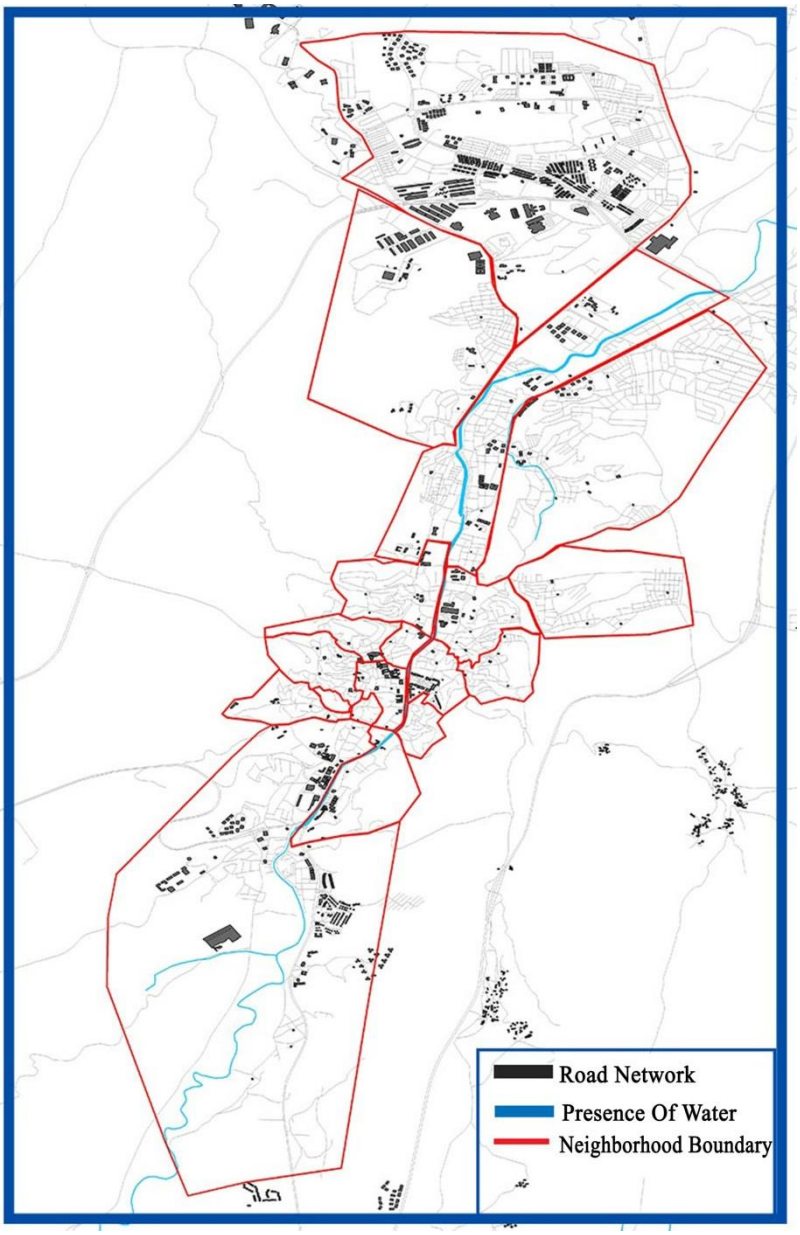

Figure 4. Road network

Network analysis applied, areas accessible to family health centers Spatial Plans. In addition to the 500 meters distance specified in the Building Regulation, an analysis was applied at 300 meters distance. While accessible areas at a distance of 500 meters have a size that can be considered insufficient on the city surface, it can be said that when the accessibility limit is reduced to 300 meters, the area is more private and the population density is higher, while the accessible housing is less in the neighborhoods with lesser population (Figure 5).

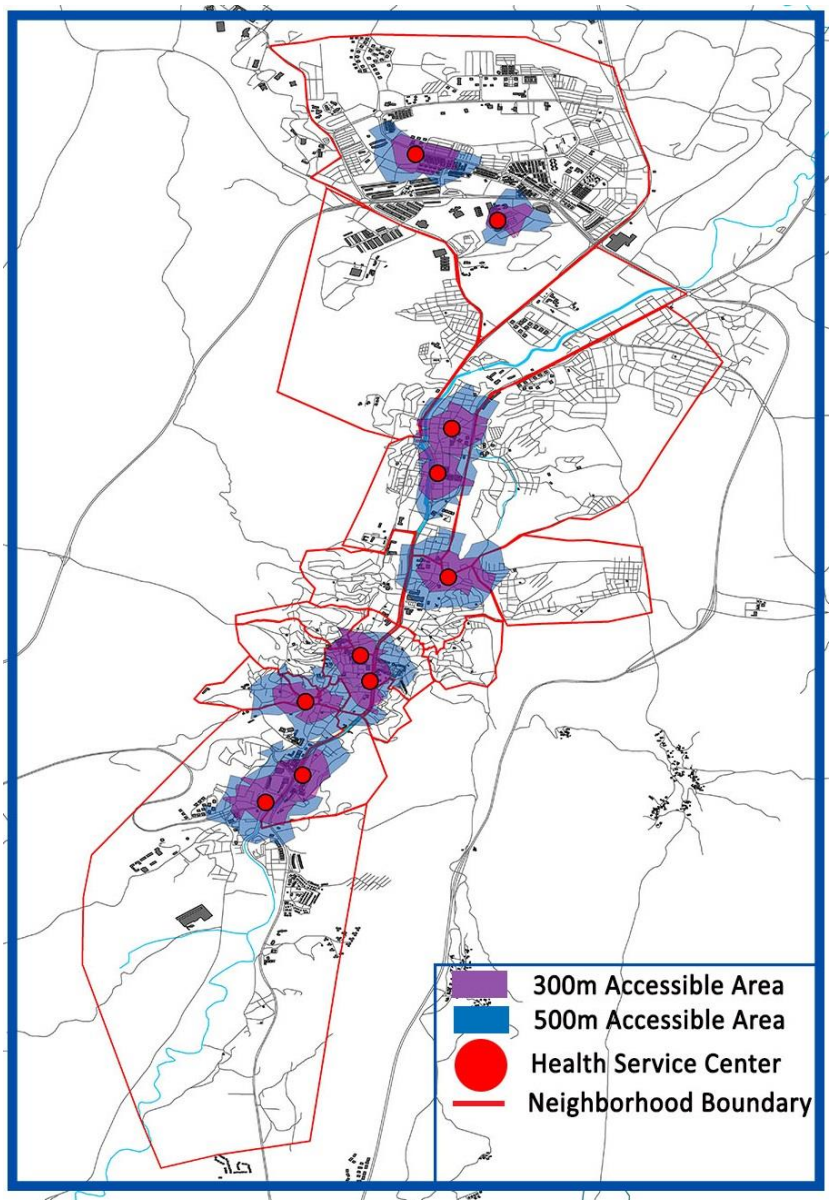

Figure 5. Accessibility to health service centers

Examined on the basis of neighborhoods, it can be said that while the rate of buildings that can be accessed at a distance of 300 meters is zero in Esentepe, İsmailbey, Atabeygazi, Kırkçeşme neighborhoods, it can be said that the access rate is zero only in Kırkçeşme neighborhood when viewed at a 500 meter level. In addition, there is no health service building-service area in Akmescid, Atabeygazi, Candaroğlu, Cebrail, Topçuoğlu, İsfendiyar, Kırkçeşme, Hisarardı, Honsalar, Yavuz Selim neighborhoods. It is Yavuz Selim District with a rate of 37.21, this rate is 97.67 percent at 500 meters, and it has accessibility at a distance that covers almost the entire neighborhood (Table 1).

Table 1. Spatial accessibility status of health service centers

Neighborhood Name	Population	Total Area (m²)	Building			Accessible Rate (%)	
			Total	300m	500m	300m(%)	500m(%)
Aktekke	4505	481000	477	150	250	31.45	51.42
Beyçelebi	2899	685687	188	68	153	36.17	81.38
Esentepe	3528	1231016	540	0	90	0	16.67
Hepkebirler	1842	178000	257	246	257	95.72	100
İnönü	21874	2783000	790	185	319	23.42	40.38
İsmailbey	3687	303000	623	0	23	0	3.69
Kuzeykent	27814	5739000	1710	97	135	5.67	7.89
MehmetAkif	23814	4180000	940	16	45	1.7	4.79
Saraçlar	13618	8487782	1091	192	358	17.6	32.81
Akmescid	1256	383556	405	5	17	1.23	4.2
Atabeygazi	343	46216	156	0	110	0	70.51
Candaroğlu	9230	3112499	577	3	4	0.52	0.69
Cebrail	2304	269436	394	12	126	3.05	31.98
Topçuoğlu	1168	127063	256	47	72	18.36	28.13
İsfendiyar	1328	168016	204	31	104	15.2	50.98
Kırkçeşme	1519	364591	285	0	0	0	0
Hisarardı	890	311615	250	65	104	26	41.6
Honsalar	1297	259484	408	23	23	5.64	5.64
YavuzSelim	536	57559	86	32	84	37.21	97.67
Toplam	151500	29168520	9637	1172	2274	12	23.60

4. Discussion and Conclusion

Today, health services serve two main purposes, raising health standards and increasing knowledge about diseases [31, 32]. The health service centers that are the subject of our study are not separated as primary, secondary or tertiary health services, but are institutions that include private and public services ranging from institutions where users can receive services on follow-up and simple interventions to institutions containing intensive care services.

Hospitals are located very close to the city center in Kastamonu [33]. Network analysis applied to the city center aims to determine accessible areas for family health centers. Analysis was applied to the distance of 500 meters specified in the Spatial Plans Building Regulation. In addition, there is no health service building-service area in Akmescid, Atabeygazi, Candaroğlu, Cebrail, Topçuoğlu, İsfendiyar, Kırkçeşme, Hisarardı, Honsalar, Yavuz Selim neighborhoods. It is Yavuz Selim Mahallesi with a rate of 37.21, this rate is 97.67 percent at 500 meters, and it has enough accessibility

When analyzed at 300 meters, the rate of accessible buildings is seen as zero in Esentepe, İsmailbey, Atabeygazi, Kırkçeşme neighborhoods, and the highest accessibility is Hepkebirler Mahallesi with 95.72. Considering the 500 meter distance analysis, the rate of buildings accessible only in Kırkçeşme neighborhood is seen as zero, the highest accessibility belongs to Hepkebirler neighborhood Yavuz Selim Neighborhood with a rate of 97.67 in it is an important result. In general, neighborhoods with high population density remain within the accessible area. This area, which is 12 percent and 23.60 percent accessible in total, is concentrated in the center of the city and the peripheries of the city, whose population is increasing and growing day by day, are outside the accessible area. Considering these two ratios and the legal distance, it is seen that the number of health service centers is concentrated in the areas where the population is high in the urban spread, and it can be said that the outer periphery of the city remains weaker in terms of accessibility.

According to these results, it has been seen that the absence of a health service area in a neighborhood or work area cannot be said to have no health service access for that area, and when we look at the city as a whole, it is seen that the first or second degree accessibility of that area may be in question. Considering that the health services in the central district of Kastamonu province are concentrated in the center of the city and decrease towards the outer periphery and newly developing neighborhoods, the possible health service centers to be built are the Kuzeykent District, Mehmet Akif District, Saraçlar District Candaroğlu and Kırkçeşme Neighborhoods, which can be considered the outer wall of the city, where development and new construction increase rapidly. It can be said that the positioning is correct.

Competing Interest / Conflict of Interest

The authors declare that they have no competing interests.

Author Contribution

We declare that all Authors equally contribute.

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5. References

[1] Kalay, G., Bogenç, Ç., (2022). An Evaluation of Urban İmage and The Use of Urban Space in Karabük City Center. International Social Mentality and Researcher Thinkers Journal. 8(57): 645-655

[2] Bogenç, Ç., Sabaz, M., (2017). In the Process of Development of the Site Management Plan of the World Heritage Site Safranbolu; Identifying Themes, Goals, and Actions. Journal of Human and Social Sciences Research. 8(3):1526/1544

[3] Ozturk, S., & Isinkaralar, O. (2019). Parking lot problem in Kastamonu city center: A critical evaluation. International Journal of Social Studies, 12(67), 506-511.

[4] Öztürk, S., Isinkaralar, Ö., & Yilmaz, D. (2019). Cittaslow Movement and Social Awareness: The Case of Gerze (Sinop). Academic Studies On Social and Education Sciences.

[5] Dönmez, Y. (2017). The Attitudes of University Students towards Today's World Affairs, Journal of History Culture and Art Research, 6(6) pp. 303-312 [ESCI]

[6] Rød, J. K., Eide, A. H., Halvorsen, T., & Munthali, A. (2021). Using Prospective Methods to Identify Fieldwork Locations Favourable to Understanding Divergences in Health Care Accessibility. ISPRS International Journal of Geo-Information, 10(8), 506.

[7] Dönmez, Y., Salhi, Z. (2021). Urban Identity and Environmental Perception in Annaba, Algeria, Journal of Engineering and Sciences, 7(2) pp. 83-99

[8] Bogenç, Ç., Bekci, B., (2020). Landscape Values and Tourism Interaction of Artvin Borcka District. Safran Journal of Culture and Tourism Studies. 3(2):171-181

[9] Öztürk, S., İsmail, T. S. Y., & Işınkaralar, Ö. (2020). Landscape Design Suggestions for Benli Sultan Complex in the Focus of Faith Tourism. Turkish Journal of Tourism Research, 4(1), 349-360.

[10] Wei, C., Fu, M., Wang, L., Yang, H., Tang, F., & Xiong, Y. (2022). The Research Development of Hedonic Price Model-Based Real Estate Appraisal in the Era of Big Data. Land, 11(3), 334.

[11] Russell, J. Deborah; Humphreys, S. John, Ward Bernadette, Marita Chisholm, Penny Buykx, Matthew McGrail and John Wakerman (2013). Helping PolicyMakers Address Rural Health Access Problems, The Australian Journal of Rural Health, Vol.21, p.61-71.

[12] Arcury, T. A., Gesler, W. M., Preisser, J. S., Sherman, J., Spencer, J., & Perin, J. (2005). The effects of geography and spatial behavior on health care utilization among the residents of a rural region. Health services research, 40(1), 135-156.

[13] Genovesi, F. F., Canario, M. A. D. S. S., Godoy, C. B. D., Maciel, S. M., Cardelli, A. A. M., & Ferrari, R. A. P. (2020). Maternal and child health care: adequacy index in public health services. Revista Brasileira de Enfermagem, 73.

[14] Nnebue, C. C., Ebenebe, U. E., Adogu, P. O., Adinma, E. D., Ifeadike, C. O., & Nwabueze, A. S. (2014). Adequacy of resources for provision of maternal health services at the primary health care level in Nnewi, Nigeria. Nigerian medical journal: journal of the Nigeria Medical Association, 55(3), 235.

[15] Roberge, P., Normand-Lauzière, F., Raymond, I., Luc, M., Tanguay-Bernard, M. M., Duhoux, A., ... & Fournier, L. (2015). Generalized anxiety disorder in primary care: mental health services use and treatment adequacy. BMC family practice, 16(1), 1-11.

[16] Arntsen, B., Torjesen, D. O., & Karlsen, T. I. (2021). Asymmetry in inter-municipal cooperation in health services–How does it affect service quality and autonomy? Social Science & Medicine, 273, 113744.

[17] Dagger, T. S., Sweeney, J. C., & Johnson, L. W. (2007). A hierarchical model of health service quality: scale development and investigation of an integrated model. Journal of service research, 10(2), 123-142.

[18] Tefera, B. B., Kibret, M. A., Molla, Y. B., Kassie, G., Hailemichael, A., Abate, T., ... & Saad, A. (2021). The interaction of healthcare service quality and community-based health insurance in Ethiopia. PloS one, 16(8), e0256132.

[19] Hierink, F., Okiro, E. A., Flahault, A., & Ray, N. (2021). The winding road to health: A systematic scoping review on the effect of geographical accessibility to health care on infectious diseases in low-and middle-income countries. Plos one, 16(1), e0244921.

[20] Ouma, P., Macharia, P. M., Okiro, E., & Alegana, V. (2021). Methods of measuring spatial accessibility to health care in Uganda. In Practicing Health Geography (pp. 77-90). Springer, Cham.

[21] McCarthy, S., Moore, D., Smedley, W. A., Crowley, B. M., Stephens, S. W., Griffin, R. L., & Jansen, J. O. (2021). Impact of rural hospital closures on healthcare access. Journal of Surgical Research, 258, 170-178.

[22] Pollack, C. C., Onega, T., Emond, J. A., Vosoughi, S., O'Malley, A. J., McClure, A. C., ... & Gilbert-Diamond, D. (2022). A national evaluation of geographic accessibility and provider availability of obesity medicine diplomates in the United States between 2011 and 2019. International Journal of Obesity, 1-7.

[23] Gökyer, E., Öztürk, M., Dönmez, Y., Çabuk, S. (2015). Evaluation of Ecotourism Activities Using Geographic Information Systems in Mountain Areas of Bartin City, Faculty of Fine Arts and Design, Art and Design Magazine, 5(12) pp. 25-35

[24] Ahmed, S., Adams, A. M., Islam, R., Hasan, S. M., & Panciera, R. (2019). Impact of traffic variability on geographic accessibility to 24/7 emergency healthcare for the urban poor: A GIS study in Dhaka, Bangladesh. PloS one, 14(9), e0222488.

[25] Martin, B. S., & Paul, J. (2022). Evaluating the Performance of GIS Methodologies for Quantifying Spatial Accessibility to Healthcare in Multi-Island Micro States (MIMS). Health Policy and Planning.

[26] Teimouri, M. S., Forghani, A., & Baghban, S. (2022). A Geospatial Analysis Approach for Mapping and Ranking of Tourist Corridors in Mashhad Metropolis Iran. World Journal of Geomatics and Geosciences, 2(1), 1-23.

[27] Carver, S. (2019). Developing Web-based GIS/MCE: Improving access to data and spatial decision support tools. In Spatial multicriteria decision making and analysis (pp. 49-76). Routledge.

[28] Cetin, M. (2015). Determining the bioclimatic comfort in Kastamonu City. Environmental monitoring and assessment, 187(10), 1-10.

[29] Akkemik, Ü., Dağdeviren, N., & Aras, A. (2005). A preliminary reconstruction (AD 1635–2000) of spring precipitation using oak tree rings in the western Black Sea region of Turkey. International Journal of Biometeorology, 49(5), 297-302.

[30] Turkstat (2020) https://ty.tuik.gov.tr, 2020.

[31] İlgün, G., & Şahin, B. (2016). Examining the views of family medicine professionals about family medicine practice. Hacettepe Journal of Health Administration, 19(2).

[32] Öztürk, S., Işinkaralar, Ö., Yilmaz, D., Şimşek, M., Almansouri, H. M. S., & Elahsadi, A. H. M. (2021). A research on the effect of Covid-19 on consumer habits: Turkey-Libya comparison. Journal of Eastern Geography, 26(46), 97-108.

[33] Sevik, H., Isinkaralar, K., & Isinkaralar, O. (2018). Indoor air quality in hospitals: the case of Kastamonu Turkey. J Chem Biol Phys Sci Sect D, 9(1), 67-73.