



Analysis of Accessibility of Primary Schools in Niğde Using GIS[#]

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ABSTRACT

In this study, it is planned to make a spatial analysis of the accessibility function of a city using GIS. The main purpose of this study is to reveal the spatial accessibility of primary schools, which are among the educational institutions in the Merkez district of Niğde province. The Spatial Plans Building Regulation was used as a criterion for accessibility. The current number of students and teachers in the schools and the number of classrooms were obtained from the Niğde Provincial Directorate of National Education, and the obtained data were analyzed by transferring them to ArcGIS software. In the study, the Zoning Plan from the Niğde Municipality, the road and housing data obtained from OpenStreetMap, the location information of the schools and the number of students obtained from the Niğde Provincial Directorate of National Education, and the population data obtained from TÜİK were used. According to the results of the study, there are problems in accessibility the primary schools in some neighborhoods in the Merkez district, and this problem is increasing especially in rural areas. It should not be forgotten that accessibility is important for everyone, school and settlement plans should be made with reference to the values specified in the spatial plans regulation.

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Introduction

Accessibility; it is defined as an indicator that reflects the ease of reaching an intended point or a location when viewed by the user, and on the other hand, when viewed from the perspective of a product, device, service or environment, it is defined as a degree that indicates the amount of users who can use the phenomenon of interest. Failure to consider accessibility in the spatial planning and decision processes of the city may result in a total barrier to accessing the relevant service for all disabled and non-disabled individuals, and a disability for users. In this sense, accessibility is in the selection of a new urban equipment (education, health, fire brigade, etc.) for decision makers; It is also used to direct the planning by determining the capacity and service area of the relevant equipment (Güray and Kemeç, 2016).

One of the criteria that determines the quality of urban life is education. There are sub-criteria that determine the good level of educational activities such as physical (building) adequacy, level of teacher status, the

environment being suitable for education, socio-cultural level, number of schools and accessibility of these schools. Although there are not many studies in the relevant literature, there are examples for determining the places of new schools to be opened. Uslu et al. (2017) in their study to determine the appropriate school location for the Ankara province, they applied the analyzes using the criteria of accessibility, potential growth, population, safety, environmental pollution and the number of existing schools (Deniz et al., 2019; Duman and İrcan, 2020; Pizzol et al., 2021; Idris et al., 2022). In another study, Başeğmez (2019) took the flood area, tension lines, slope, noise, infrastructure, geology, population and distances to certain areas of the city as criteria (Başeğmez and Taşdemir, 2019). While carrying out these studies, the software and hardware that have developed in recent years, Geographic Information Systems (GIS) and spatial analysis, and multi-criteria decision making methods have been used, and suitable areas have been determined.

The widespread use of GIS, especially in spatial analysis, facilitated the collection, updating, analysis and synthesis of spatial data, as well as producing up-to-date and highly accurate data (Meydan and Öner, 2014). Geographical Information Systems includes three concepts in its structure. These are: geography, data and system. Geography deals with all processes occurring on earth and the characteristics of these processes. Information or data is at the heart of the geographic information system and largely involves the storage and analysis of data. The system, on the other hand, is the structure that explains the network of relations between computer, data and human by asking questions and producing new answers (Ludwig and Audet, 2000). Geographical Information Systems have applications and benefits in many areas of life such as security, education and health, transportation and economy (Koçak, 2009).

This situation necessitates the use of GIS for convenience, especially in areas where human life is intense, such as cities, with the rapid development of technology and industrialization. In geography, some criteria are used to determine whether a settlement is a city or not. At the beginning of these are the amount, density, functions, physiognomy and unique lifestyle of the population (Doğanay, 1995; Elmacı and Bekdemir, 2008).

The economic activities used as criteria in the distinction between urban and rural settlements and the sectoral distribution of the population with economic activities in this context come to the fore (Doğanay, 1995; Yücel, 1961; Darkot, 1967; Elmacı and Bekdemir, 2008). However, the most important criterion used in this distinction is the amount of population. In this regard, Özgür (1996) and Özçağlar (1997) accept the population of 20,000 as criteria, while Darkot (1967), Selen (1945), Tümertekin (1965), Emiroğlu (1975), Sergün (1974-1977); Many researchers such as Karabulut (1981), Gözenç and Günal (1987), Avcı (1993) and Doğanay (1995) accept the threshold population in urbanization as 10,000 (Duman and İrcan, 2020). In Turkey, there are non-compulsory kindergartens and kindergartens, together with 12 years of compulsory education at primary, secondary and high school levels under the Ministry of National Education. The appropriate accessible distances of the schools at this level are determined by the regulations. Spatial Plans are determined in the Building Regulations. According to the second paragraph of article 12 of the fourth part of the relevant regulation, the appropriate walking distance for kindergarten, kindergarten and primary schools is determined as maximum 500 meters, maximum 1000 meters for secondary schools, and maximum 2500 meters for high schools. The remaining areas are suitable for accessibility. (Official Gazette, 14.06.2014, No: 29030). The high accessibility rate at the distances specified within the distances specified in the regulation increases the Quality of Urban Life for the education criterion (Deniz et al., 2019). In this study, it is planned to make a spatial analysis of the accessibility function of a city using GIS.

The main purpose of this study is to reveal the spatial accessibility of primary schools, which are among the educational institutions in the Merkez district of Niğde province. The Spatial Plans Building Regulation was used as a criterion for accessibility. The current number of students and teachers in the schools were obtained from the

Niğde Provincial Directorate of National Education, and the obtained data were analyzed by transferring them to ArcGIS software. In the study, the Zoning Plan from the Niğde Municipality, the road and housing data obtained from OpenStreetMap, the location information of the schools and the number of students obtained from the Niğde Provincial Directorate of National Education, and the population data obtained from TÜİK were used.

Materials and Method

In the study, primary schools in the Merkez district of Niğde were examined. Niğde is surrounded by Mersin in the south, Kona in the west, Nevşehir in the north, Aksaray in the northeast and Kayseri in the east (Figure 1). Merkez district located between 34°40'59.99" east longitude and 37°57'59.99" north latitude. The Merkez district is the largest district of Niğde and has the highest number of educational institutions. The area of the district is approximately 2,170 km² and its average elevation is approximately 1,229 m. The general climate characteristics of Niğde; summers are hot and dry, winters are cold and snowy. Precipitation occurs in the form of snow in the winter, and in the form of rain in the spring. Niğde located in the middle zone of the northern hemisphere, the average of the hottest month is July and the average of the coldest month is January. Vegetation: provincial lands generally have steppe appearance. Forests are very scarce. It constitutes 1.7% of the province's lands, and increases to 3% with heaths. 50% of the province's lands are cultivated areas, from wheat fields, apple orchards and vineyards; 37% consists of meadows and pastures. In this research, it was planned to reveal the spatial access of the population in the Merkez district to primary schools on foot.



Figure 1. Location of the study area

In the 1927 census, the first census of the Republic, the total population of Niğde was 166,576 and 59,286 people lived in the Merkez district. By 2021, the total population of the district is 363,725 and 234,118 of this population live in the Merkez district (Table 1). While the Merkez neighborhood with the largest population is Aşağı Kayabaşı with 36,671 people, Selçuk neighborhood is the 2nd with 21,837 people, and İlhanlı neighborhood is the 3rd largest neighborhood with 21,675 people.

Table 1. Distribution of Population by Years in the Merkez district (TUIK, 2022)

Year	Merkez Population	Male Population	Female Population
2021	234,118	117,001	117,117
2020	230,776	115,785	114,991
2019	229,121	114,661	114,46
2018	224,289	112,384	111,905
2017	220,277	109,977	110,300
2016	216,695	108,312	108,383
2015	211,092	105,363	105,729
2014	205,753	103,056	102,697
2013	201,597	100,876	100,721
2012	200,044	100,277	99,767
2011	198,088	98,992	99,096
2010	196,087	97,502	98,585
2009	195,407	98,014	97,393
2008	193,373	97,288	96,085
2007	188,999	94,131	94,868

It is aimed to provide the data to be used in the study first. Within the scope of the study, 4 basic data sets were tried to be obtained. In this context, firstly, the locations of primary schools in Niğde province Merkez district were tried to be determined. In order to determine the locations of the primary schools in the Merkez district, the Provincial Directorate of National Education was contacted and data on the locations of the primary schools were obtained. Secondly, the zoning plan for the Merkez district was obtained from the Niğde Municipality. The reason for this is that the data received from the Provincial Directorate of National Education is in the form of raw data and these data are made available for processing. The third data set used within the scope of the study is to provide the road data of the study area. The road data, which is the most important part of the analysis, was created using OpenStreetMap open data. Neighborhood and age-based population required for the interpretation of the analysis in the obtained digital maps were obtained from TUIK. While applying the accessibility analysis, the locations of the houses scattered in the neighborhoods and the number of buildings in each neighborhood were taken into account. Since the number of individuals residing in the residences in the city cannot be obtained from TUIK, Provincial Population Directorate or District Population Directorate, the population living in a neighborhood is divided by the number of buildings in that neighborhood and it is assumed that the population is equally distributed in each building. It has been observed that this approach has been used by different researchers in the past (Güray and Kemeç, 2016; Deniz, 2018; Deniz et al., 2018; Yasak, 2020; Duman and İrcan, 2020). The research is based on mapping the

available statistical data, transforming them into digital vector data and analyzing them with the help of geographic information systems (GIS). Arc-Map 10.8 software was used in all stages of the study. In this way, the research is a descriptive research. Network analysis examines the relationships of entities connected to each other through flows. When the network analysis is examined in spatial dimension, the size of the distance between the objects is revealed. It is seen that analyzes of various education and health institutions in Turkey are made using this method (Güray and Kemeç, 2016; Sezer et al., 2018; Deniz, 2018; Deniz et al., 2018; Deniz et al., 2019; Yasak, 2019). It is seen that analysis is applied based on the distances determined for public institutions in the Spatial Plans Building Regulation. According to this regulation, it is stated in the zoning plans that a distance of approximately 500 m should be taken into account for primary schools (Official Gazette, 14.06.2014, No: 29030). Network analysis was applied to the schools, taking into account the distances specified in the study.

In order to strengthen the results of the study and to determine the source of the problems, the analysis was applied by doubling the distances and the results were tried to be revealed. In this context, analysis was applied at 500 and 1000 meters distances in primary schools. Another point to be considered while applying the analysis is the tolerance value of 100 meters given to eliminate the deviations on the road. In order to interpret the values determined as a result of the analysis, existing residences and population data obtained from TUIK were used. Since the distribution of the population to the residences was not reached during the interpretation, it was assumed that the population in the neighborhoods was equally distributed among the residences. Since the distribution of the population according to the school ages by neighborhoods is given in the findings tables, it has not been tabulated separately. After the analyzes were made, accessibility analyzes were made for the groups aged 0-9 and over the age of 65. Finally, the accessibility of the Merkez district of Niğde to primary schools was analyzed.

Results and Discussion

While there are 69 Merkez neighborhoods in the Merkez district of Niğde (Table 2), there are 34 Merkez villages (Table 2). Within the scope of the study, the Merkez villages were excluded from the evaluation. The reason for this is that there is bussed education in Niğde province and the number of primary schools in the Merkez villages is low. After determining the population of the neighborhoods, the digital transportation network (highway) of the city was provided after the vector point data were processed on the map (Figure 2).

When primary schools are examined, it is seen that the accessibility problem is present at very high rates. Only 26.40% of the existing residences remain within the distance in the regulation in terms of access to primary school level schools. When the accessibility distance is increased to an alternative distance, this rate decreases to 16.43%. This shows that the problem of accessibility, which continues at a distance of 500 meters, increases even more at 1000 meters.

Table 2. Properties of the Merkez neighborhoods (TUİK, 2022)

No	Neighborhood	Population	No	Neighborhood	Population	No	Neighborhood	Population
1	AHİPAŞA	255	36	¹ HÜRRİYET	3,424	71	*AŞLAMA	784
2	ALAADDİN	51	37	¹ HÜRRİYET	1,383	72	*BALLI	77
3	¹ AŞAĞI	842	38	¹ HÜRRİYET	1,419	73	*ÇARIKLI	658
4	¹ AŞAĞI	1575	39	HÜYÜK	352	74	*ÇAVDARLI	1,063
5	¹ AŞAĞI	908	40	İLHANLI	21,675	75	*ÇAYIRLI	1,199
6	A. KAYABAŞI	36,761	41	İNÖNÜ	6,863	76	*DİKİLİTAŞ	740
7	BAHÇELİEVLER	1,060	42	KALE	142	77	*ELMALI	797
8	BALHASAN	237	43	KUMLUCA	1,778	78	*FESLEĞEN	458
9	BOĞAZIÇI	230	44	MİLLİYET	942	79	*GÖSTERLİ	976
10	BURHAN	1,487	45	NAR	3,167	80	*GÜLLÜCE	609
11	¹ CUMHURİYET	681	46	ORTA	336	81	*HACİBEYLİ	719
12	¹ CUMHURİYET	1,036	47	SARUHAN	920	82	*HANÇERLİ	238
13	¹ CUMHURİYET	1,243	48	SELÇUK	21,837	83	*HASAKÖY	878
14	¹ CUMHURİYET	343	49	SIRALI	736	84	*HİMMETLİ	636
15	¹ CUMHURİYET	1,431	50	SONGUR	420	85	*İÇMELİ	685
16	¹ CUMHURİYET	2,010	51	ŞAHİNALI	7,456	86	*KAYIRLI	1,035
17	¹ CUMHURİYET	1,270	52	ŞAHSÜLEYMAN	4,090	87	*KIRKPINAR	478
18	¹ CUMHURİYET	1,073	53	ŞEHİTLER	3,284	88	*KIZILÖREN	284
19	ÇAYIR	1,313	54	YAVUZ	1,136	89	*KOYUNLU	679
20	DERE	6,818	55	¹ YENİ	726	90	*KÖMÜRCÜ	2,178
21	DEVLET	689	56	¹ YENİ	1,827	91	*KÜÇÜKKÖY	30
22	DUMLUPINAR	833	57	¹ YENİ	1,610	92	*NARKÖY	165
23	EFENDİBEY	23,989	58	¹ YENİ	1,273	93	*OVACIK	834
24	ESENBEY	930	59	¹ YENİ	1,084	94	*ÖZYURT	93
25	ESKİ GÜMÜŞ	1,036	60	¹ YENİ	938	95	*PINARCIK	682
26	ESKİSARAY	2,515	61	YENİ GÜMÜŞ	1,486	96	*TAŞLICA	136
27	¹ FATİH	253	62	¹ YENİCE	5,680	97	*TEPEKÖY	314
28	¹ FATİH	867	63	¹ YENİCE	633	98	*TIRHAN	291
29	¹ FATİH	1,373	64	¹ YUKARI	502	99	*ULUAĞAÇ	324
30	FERTEK	8,871	65	¹ YUKARI	850	100	*YARHİSAR	194
31	FEVZİPAŞA	760	66	¹ YUKARI	928	101	*YAYLAYOLU	214
32	HAMAMLI	191	67	Y. KAYABAŞI	5,045	102	*YEŞİLBURÇ	475
33	¹ HÜRRİYET	1,133	68	¹ ZAFER	1,141	103	*YEŞİLOVA	208
34	¹ HÜRRİYET	912	69	¹ ZAFER	1,476			
35	¹ HÜRRİYET	744	70	*AĞÇAŞAR	2,478			

*Village; ¹They have the same name but belong to different towns. In the study, only those affiliated to the center were examined; All of the buildings in Bahçelievler, Devlet and FerteK Neighborhoods are outside the accessible area. Access to primary schools outside of Yenice, Şahsüleyman, Selçuk, Saruhan, İnönü, Eskişehir and Dere districts is below 50%.

Aşağı, Aşağı Kayabaşı, Bahçelievler, Boğaziçi, Cumhuriyet, Aktaş, Karaatlı, Efendibey, Gümüşler, FerteK, Edikli, Hamamlı, Hürriyet, Konaklı, İlhanlı, Kumluca, Nar, Selçuk, Şahinalı, Yeni, Yukarı and Yukarı Kayabaşı neighborhoods are one of the neighborhoods with accessibility problems.

The access rate of these 22 neighborhoods is below 50%. While the rate of transportation to schools is 51.71% at 500 meters distance, this rate is 18.43% at 1000 meters distance. The access rate of the buildings in 6 neighborhoods and the population living in these buildings within 1000 m of the schools is over 50%.

These rates show that the problematic structure seen at a distance of 500 meters in terms of accessibility continues at 1000 meters. At this level, only 6,773.61 of the 19,724 students in the district, and 5,403.02 at the alternative distance, can reach primary schools at an appropriate distance. The fact that primary schools are generally concentrated in the center of the city also reduces the rate

of accessibility to schools in outlying neighborhoods. The districts where primary school children are most concentrated are A. Kayabaşı(53,499), Efendibey (2,245), Selçuk (2,044) and İlhanlı (2,029) neighborhoods (Table 3, Figure 3-4). Among these neighborhoods, Selçuk neighborhood is partially in good condition in terms of regulations, while accessibility in other neighborhoods is quite insufficient. The access problem of these students continues to increase in terms of alternative distances.

The total population of the population aged 5-9 years and over 65, who may have problems in walking to schools in the research area, is 67,285 (Figure 5). However, considering that the distance determined for the school-going distances of primary school children is 500 meters in the regulation, it comes to mind that the same distance can be used for the elderly as well. In such a case, in the city where 53,394 people aged 0-9 and 38,681 people over 65 live, 92,075 people are expected to be evaluated within 500 meters of walking distance to access schools.

Table 3. Accessibility of Primary Schools in Merkez district

Neighbourhood	Primary School Age Population	Accessible Rate		Accessible Buildings		Accessible Population	
		500 m. (%)	1000 m. (%)	500 m. (%)	1000 m. (%)	500	1000
Ahipaşa	24	100.00	0.00	9	0	24	0
Alaaddin	5	100.00	0.00	29	0	5	0
Aşağı	311	28.47	44.44	25	32	89	138
Aşağı Kayabaşı	3449	26.01	20.50	33	30	897	707
Bahçelievler	99	0.07	16.60	0	13	0	16
Balhasan	22	100.00	0.00	27	0	22	0
Boğaziçi (Hacıabdullah)	22	26.42	36.63	17	24	6	8
Burhan	139	100.00	0.00	38	0	139	0
Cumhuriyet	850	1.06	3.23	3	9	9	27
Çayır	123	100.00	0.00	26	0	123	0
Dere	638	80.22	19.78	56	14	512	126
Devlet (Aktaş)	64	0.00	0.00	0	0	0	0
Dumlupınar (Karaatlı)	323	3.73	77.26	18	43	12	249
Efendibey	2245	9.76	12.23	14	22	219	275
Esenbey	87	100.00	0.00	20	0	87	0
Gümüşler	258	15.82	25.66	18	24	41	66
Eskisaray	235	100.00	0.00	52	0	235	0
Fatih (Orhanlı)	340	55.98	43.50	30	23	190	148
Fertek	830	0.00	1.89	0	12	0	16
Fevzipaşa (Edikli)	71	32.23	39.61	12	16	23	28
Hamamlı	18	1.66	24.73	4	48	0	4
Hürriyet	844	3.23	5.04	12	18	27	43
Hüyük (Konaklı)	33	33.16	66.84	13	26	11	22
İlhanlı	2029	8.44	15.64	26	45	171	317
İnönü	642	85.70	14.30	64	12	550	92
Kale	13	100.00	0.00	27	0	13	0
Kumluca	166	31.44	10.20	9	3	52	17
Nar	296	17.39	67.45	24	84	52	200
Orta (Değirmenli)	31	71.29	9.89	21	3	22	3
Saruhan	86	100.00	0.00	52	0	86	0
Selçuk	2044	30.10	56.47	60	97	615	1154
Sıralı	69	100.00	0.00	30	0	69	0
Songur	39	100.00	0.00	26	0	39	0
Şahinalı	698	43.18	56.18	16	20	301	392
Şahsüleyman	383	100.00	0.00	72	0	383	0
Şehitler	307	100.00	0.00	34	0	307	0
Yeni	698	25.20	15.78	16	9	176	110
Yenice	591	100.00	0.00	84	0	591	0
Yukarı	129	1.42	2.61	21	0	2	3
Yukarı Kayabaşı	472	36.45	50.91	18	30	172	240
Total - Rate	19,724	51.71	18.43	26.40	16.43	6,773.61	5,403.02

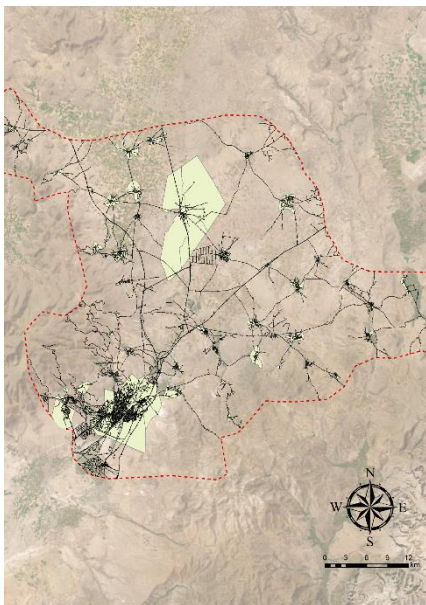


Figure 2. Road Network in Merkez district

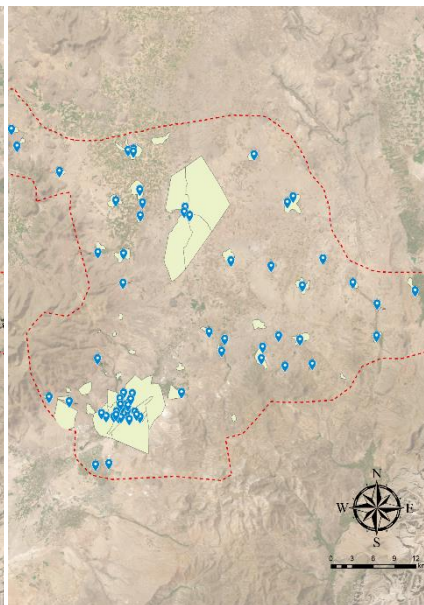


Figure 3. Distribution of Primary Schools in Merkez district

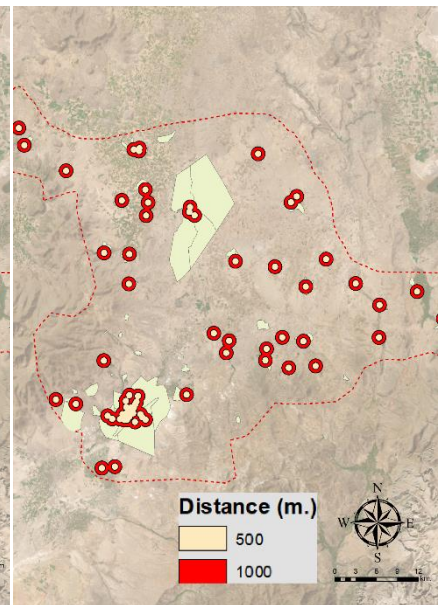


Figure 4. Accessibility to Primary Schools in Merkez district

Population distribution by age

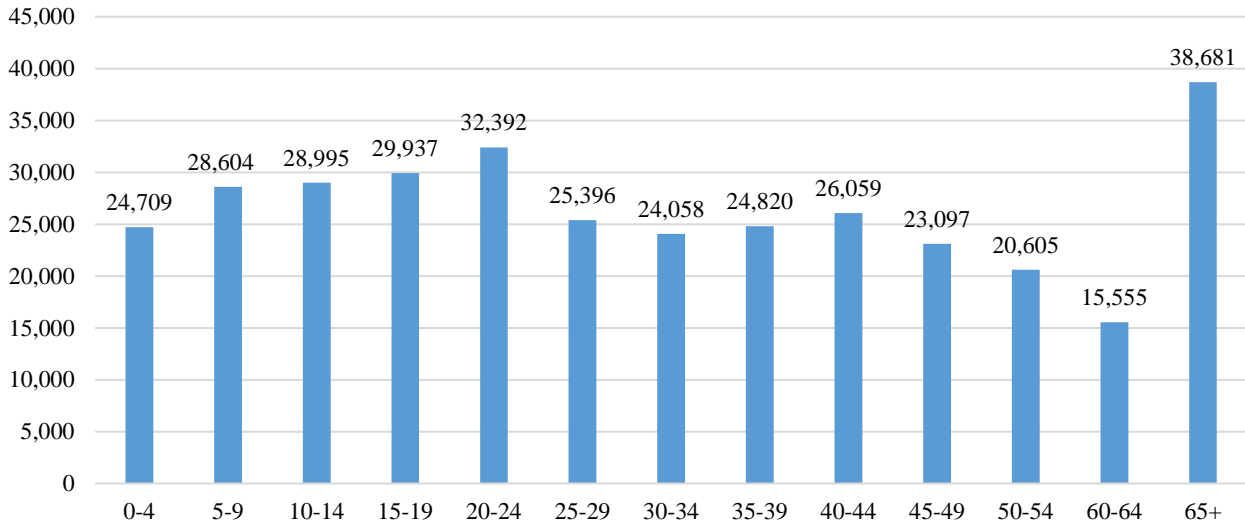


Figure 5. Population distribution by age (TUİK, 2022)

However, considering that approximately 75% of the population is likely to encounter access problems in the analysis based on 500 meters, it is seen that there is a significant problem. The fact that the schools are outside the walking distance creates a problem for the younger ones and the population who have to go to school with their family members.

Conclusion

One of the most important features of a quality education is the accessibility of the places where the education will be given. The accessibility of the schools that students have to go to for education is one of the most important factors that positively affect the quality of education. The settlements of the cities, whose population is increasing day by day, spread over wider areas. It is important where the school units that will meet the educational needs in the expanding urban areas will be built or where they should be built according to the spreading area of the city. It is of great importance that the education spaces in the urban settlement are correctly positioned according to the characteristics of the population living there. If the correct positioning is not made, there are serious problems in meeting the needs, especially the principle of equality in education and transportation.

For example, if the schools are farther from the area where the students of education age live, it may cause serious energy loss or high costs in meeting the education needs, while the fact that more places are made than the population in need means wasting resources (Sezer et al., 2019; Güngör et al., 2020). In the study area, it is seen that primary schools are generally concentrated in the center and west of the city. Within the framework of the regulation, more than half of the 19,724 primary school students in the city cannot reach their schools. Due to their young age, children who cannot walk long distances at this level need a vehicle to reach their school. It can be stated that the accessibility of primary schools is affected not only

by the inadequacy of the number of schools, but also by the irregular spatial planning. Situations where spatial distance is not suitable for pre-school and primary school students are quite risky for students of this age. This situation reveals the fact that children get tired while commuting to school, as well as safety problems such as accidents and injuries during transportation. This situation negatively affects the success in school and the desire to go to school.

Situations where the accessible distance is not suitable bring many problems with it. In cases where the distance is far, the walking of the students will cause fatigue and affect the course performance. Especially at primary school level, walking with school bags to schools outside the distance specified in the regulation may also negatively affect their physical development. On the other hand, students who prefer shuttle and public transportation instead of walking face other problems. In these matters, as stated in previous studies, problems such as gaps in service criteria, traffic accidents, being forgotten in the service, accidents in the service, and increase in $CaCO_2$ ratio arise. Lack of education of service personnel and rent fights have an important role in our children's encounter with these problems (Sezer et al., 2018; Sezer et al., 2019; Deniz et al., 2019). It is important to consider problematic areas in future planning and schools to be built, as well as to consider locations and primarily for which education level a school should be built.

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