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Epidemiological Characteristic and Spatial Analysis of the Admission Rate of Hypertension in Zanjan Province, Iran

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ABSTRACT

Background & Objective: hypertension is one of the most common global health problems and the leading cause of premature mortality worldwide. This study aims to investigate the epidemiological characteristic and the spatial-temporal variations of the admission rate of hypertension in Zanjan province, Iran, during 2014-2019.

Materials & Methods: Data were obtained from nine health information system (HIS) databases. Univariate chi-square and T-test methods were used to test the hypothesis, and binary logistic regression was used to model the probability of admission due to hypertension.

Results: Sixty-eight thousand eight hundred forty-three patients have been hospitalized due to cardiovascular diseases in Zanjan province, Iran, and 5931 cases had hypertension. The admission rate of hypertension was 555 cases per 100,000 which were higher in women than in males (755 cases vs. 357) (P<0.001). The highest admission rate of hypertension was detected in the age group over 80 and in Khoramdareh county, Zanjan province, Iran (P<0.001). The probability of admission due to hypertension was increased by aging in all regions, which was higher among women and in the Southeast study area.

Conclusion: This study shows the high admission rate of hypertension in Zanjan province, Iran, from 2014-2019. It is a warning to policymakers and local health authorities to increase their efforts to reduce the incidence of hypertension by identifying the principal main risk factors and applying periodic screening programs in high-risk, high areas.

Keywords: Hypertension, Cardiovascular Diseases, Spatial Analysis, Geographic Information Systems

Introduction

High blood pressure or hypertension is one joint global health problem, a risk factor, and the leading main cause of premature deaths due to cardiovascular diseases worldwide (1). In 2017, over ten multiple worldwide and 97,000 people in Iran lost their lives due to hypertension-related illnesses and conditions (2). According to the world health organization (WHO) report, the incidence rate of hypertension (IRH) was significantly higher in Eastern Mediterranean countries, ranging from 14.7% to 26.4% (3). IRH was 42.5% in Latin America (4), 20-33% in Africa (5), 18–22% in the United States, and 25–30% in the Far East (6). The lowest IRH was identified in some rural areas in India (4-8%), while Poland had the highest IRH with 72.5% in women and 68.9% in men (7). The national survey in Iran showed that IRH was higher among people over 55 (49.5%), which tripled in the last 25 years. (8).

Iran is a large country with an 80 million population of different ethnicities, cultures, lifestyles, and socioeconomic statuses. All of these factors play an essential role in the development of hypertension in Iran. The latest population census report in 2016 shows that 75% of people lived in urban areas in Iran, while only 25% of them resident in rural areas. Urbanization and a sedentary lifestyle can expose people to cardiovascular disease (CVD) risk factors, such as hypertension (2, 9). The high IRH imposes considerable economic and social costs on society. The most critical adjustable factors that can modulate hypertension are high blood sugar, obesity, high cholesterol, sedentary lifestyle, alcohol consumption, smoking, stress, and long-term use of oral

contraceptive pills. The non-adjustable factors of hypertension are age, sex, race, and genetic factors (2). However, hypertension can be prevented by following simple health instruments and changing lifestyles (9-12).

The incidence rate of hypertension can be varied in different geographical areas according to risk factors, environment, age, sex, lifestyle, and race (13). Sex and age-specific screening programs and identifying the high-risk groups and regions are well known as common prevention strategies in the literature (14-17). These strategies can help health authorities and policymakers recognize the high-risk areas and groups to apply for prevention programs and appropriately allocate health resources (18-20).

The first step in identifying the high-risk areas of hypertension is drawing the geographical pattern of the incidence rate of hypertension on maps. Geographical Information System (GIS) is a valuable tool that can help map disease distribution across different areas (21). Although some studies showed a higher incidence of hypertension in Iran, there is a limited study about the incidence rate of hypertension in more OK geographical regions such as counties scales which is a significant gap in the literature. The current study aimed to fill this critical gap by exploring the epidemiological characteristic and the spatial-temporal analysis of the admission rate of hypertension (ARH) at district levels in Zanjan province, Iran county areas. This study also predicted the probability of admission due to hypertension based on the age group by county and gender.

Materials and Methods

Study area

Zanjan province is located northwest of Iran with eight counties and 48 rural district regions. The population of Zanjan province was 1,057,461 people in 2016. Zanjan is between 36.6830° north and 48.5087° east covering an area of 291.27 square kilometers.

Study design and data collection

This descriptive and geo-spatial analysis study was conducted in Zanjan province, Iran, in 2021. Data were obtained from nine HIS databases. Data included age, sex, date of admission, date of discharge, discharge diagnosis code, and residential address of patients who were admitted to hospitals due to hypertension during 2014-2019. Patients with hypertension were defined using the International Classification of Diseases 10th revision (ICD-10) discharge diagnosis codes (I10). The discharging diagnosis is determined as the final diagnosis is given to a patient before release from the hospital after all tests, surgery, and therapeutic interventions have been considered and completed. The coding experts provide a specific code for each diagnosis based on the ICD-10 and register it in the hospital information system. Patients whose residential address was not in Zanjan province, Iran, or their admission date was not between March 21, 2014, and March 21, 2019, were excluded from this study. The national population census in 2016 was used to calculate the ARH per 100,000 in the study area because the federal population census was conducted every five years in Iran. The 2016 national population census report was the last available report.

Statistical and spatial analysis

One-sample Kolmogorov-Smirnov test was used for testing the normality of data distribution. Continuous variables were reported as mean and standard deviation (SD) because the data followed a normal distribution and were compared by the T-test method among men and women. Categorical variables were reported as numbers and percentages and compared by univariate Chi-Square test between counties, hospitals, age groups, and years. The binary logistic regression method was used to model and predict the probabilities of admission due to hypertension. ARH was calculated at the province level and for each county, age group, and year per 100,000 by dividing the total number of cases by its population and multiplying 100,000 at a 95% confidence interval (CI).

All analyses were performed for men, women, and counties separately. Statistically, significant tests were at the level of α=0.05. All statistical analyses were performed using R software, version 4.0.5 (R Foundation for Statistical Computing). All spatial analyses were performed using ArcGIS v10.7 (ESRI Inc., Redlands, CA, USA). The ethics committee approved the study of Zanjan University of Medical Sciences, Zanjan, Iran, code: IR.SSU.MEDICINE.REC.1396.311.

Results

Sixty-eight thousand eight hundred forty-three patients were admitted to hospitals due to cardiovascular diseases in Zanjan province, Iran, from 2014-2019. 5931 (9.32%) cases had hypertension after excluding 5238 points due to duplicated or incomplete data. The admission rate of hypertension was 555 cases per 100,000, which was higher in women (755 cases per 100,000) compared to men (357 cases per 100,000) (P<0.001). (Table 1) There was a significant difference between the mean age (65.4 years vs. 65.1 years, $p < 0.001$) and the mean length of stay (LOS) (69.8 hours in men vs. 61.2 hours in women, $p = 0.04$) among men and women which were higher in men. The highest ARH was observed in the age group over 80, with 5672 cases per 100,000. At the same time, it was relatively uncommon among younger people, and only 109 people had experienced hypertension before the age of 30 years (Table 1).

Table 1 and Fig 1B reveal the age distribution of the ARH at county levels in Zanjan province, Iran, from 2014-2019. Most patients were in the age group of 60-69 (27%), and ARH increased significantly with aging. The highest ARH was detected in the age group over 80 with 5672 cases per 100,000, while the lowest was identified in the age group of 05-14 with only 3 cases per 100,000.

Table 1. Admission rate of hypertension by sex, county and Age groups in Zanjan province, Iran from 2014-2019

Characteristic		Population N (%)	Total N (%)	Women N (%)	Men N (%)	Admission rate Per 100,000 (95% CI)	AGE Mean ±SD	LOS Mean ±SD	P-Value
Total		1069533	5931 (100)	4012 (67.6)	1919 (32.4)	555 (541,569)	65.25±14.5	65.5±141.7	-
Sex	**Women**	531557 (49.7)	4012 (68)	-	-	755 (732,778)	65.1±13.4	61.2±103	<0.001
	Men	537976 (50.3)	1919 (32)	-	-	357 (341,373)	65.4±15.7	69.8±180.5	
County (Location)	**Abhar (South-East)**	150431 (14.1)	947 (16)	658 (69.5)	289 (30.5)	630 (590,671)	66.1±13.8	53.4±54.8	<0.001
	Ijrood (West)	38142 (3.6)	211 (3.6)	141 (66.8)	70 (33.2)	553 (481,633)	64.1±15.7	77.8±161.1	
	Khodabandeh (South)	171319 (16)	235 (4)	139 (59.1)	96 (40.9)	137 (120,156)	59.9±18.4	79.6±109	
	Khoramdareh (South-East)	68699 (6.4)	796 (13.4)	568 (71.4)	228 (28.6)	1159 (1080,1242)	65.8±12.9	59.4±115	
	Mahneshan (West)	40722 (3.8)	247 (4.2)	170 (68.8)	77 (31.2)	607 (533,687)	61.9±16.2	95.2±239.2	
	Soltanieh (East)	30631 (2.9)	131 (2.2)	93 (71)	38 (29)	428 (358,507)	68.2±14.8	105.1±406.3	
	Tarom (North-East)	47983 (4.5)	203 (3.4)	128 (63.1)	75 (36.9)	423 (367,485)	64.3±16.2	62.2±76.6	
	Zanjan (North)	521606 (48.8)	3161 (53.3)	2115 (66.9)	1046 (33.1)	606 (585,628)	65.5±13.7	62.2±120.8	
Age groups (Year)	**0-4**	97161 (9.1)	11 (0.185)	6 (54.54)	5 (45.45)	11 (6,20)	1.4+1.4	48.2+76.4	<0.001
	05-14	159227 (14.9)	3 (0.051)	2 (66.66)	1 (33.33)	2 (0,6)	8.7+1.5	41.1+47.3	
	15-29	277901 (26)	95 (1.602)	40 (42.10)	55 (57.89)	34 (28,42)	23.1+3.6	65.3+139.3	
	30-44	280964 (26.3)	327 (5.513)	204 (62.38)	123 (37.6)	116 (104,130)	39+4.2	57.7+134.5	
	45-59	152545 (14.3)	1432 (24.14)	1007 (70.32)	425 (29.6)	939 (891,989)	53.3+4.2	58.4+95.7	
	60-69	53626 (5)	1602 (27.01)	1156 (72.16)	446 (27.8)	2987 (2843,313)	64.5+2.9	63.9+132.8	
	70-79	31797 (3)	1536 (25.898)	1058 (68.88)	478 (31.12)	4831 (4592,5078)	74.3+2.8	65.2+142.3	
	80+	16309 (1.5)	925 (15.59)	539 (58.27)	386 (41.7)	5672 (5312,604)	84.5+4.1	73.3+163.8	

N-Number; LOS – length of stay; SD – standard deviation

The admission frequency and the mean LOS of patients differed among hospitals (p<0.001). Most patients were hospitalized at Valiasr hospital in Zanjan County, Iran, with 840 cases (33.2%). Emdadi hospital, located in Abhar County, had the lowest mean LOS (3.5 hours), while it was 87.7 hours at Mousavi hospital, situated in Zanjan County. The highest mean age was in Soltanieh County (the East) with 68.2 years, while the lowest mean age was in Khodabandeh County with 59.9 years. Soltanieh County had the highest mean LOS with 105.1 hours, while the lowest mean LOS was observed in Abhar County (53.4 hours).

The Chi-Square test results showed that the ARH was not homogeneous during 2014-2019 and was more frequent in 2019 (p<0.001). The highest ARH was detected in 2019 with 157 cases per 100,000, while the lowest was identified in 2014 with 85 cases per 100,000. (Table 2) In recent years, an ascending trend of ARH was detected in Zanjan province, Iran (Fig1-A). It increased significantly from 85 points in 2014 to 157 cases in 2019 per 100,000, a 72% increase. At the same time, the population size increased only 2% (from 1059884 to 1086497 people). (Table 2) The mean age of patients increased from 65 years in 2014 to 65.5 years in 2019, while the mean of LOS decreased from 89.2 hours to 49.3 hours in recent years. (Fig 1-B, 1-C)

ARH was significantly different across counties of Zanjan province, Iran (p<0.001). The highest ARH belonged to Khoramdareh county (the South-East) with 1159 cases per 100,000, while the lowest was detected

in Khodabandeh county (the South) with 137 cases per 100,000. (Fig 2) Zanjan County (the North), the province's capital, was ranked as the fourth high-risk area with 606 cases per 100,000. The highest increase of ARH was identified in Abhar (from 20 points in 2014 to 558 topics in 2019, a 2900% increase) and Khoramdareh counties (from 52 cases in 2014 to 232 cases in 2019, a 440% increase) during 2014-2019. (Fig 2)

Fig 3 shows the probability of admission due to hypertension among genders and counties in Zanjan province, Iran. The likelihood of access due to hypertension was increased in both genders by aging, but it was higher in women. Women aged 70-79 were a high-risk group for the hospitalized due to hypertension. The probability of admission due to hypertension was increased in all regions by aging, and the highest chance was detected in the Southeast of the study area. (Fig 3)

Table 2. Admission rate of hypertension by year in Zanjan province, Iran from 2014-2019

Characteristic		Population N (%)	Total N (%)	Women N (%)	Men N (%)	Admission rate Per 100,000 (95% CI)	AGE Mean±SD	LOS Mean±SD	P-Value
Years	**2014-2015**	1059884	896 (15.1)	585 (65.3)	311 (34.7)	85 (79,90)	65±14.7	89.2±208.7	< 0.001
	2015-2016	1070886	981 (16.5)	678 (69.1)	303 (30.9)	92 (86,98)	65.1±13.5	73.1±139.3	
	2016-2017	1057461	1041 (17.6)	711 (68.3)	330 (31.7)	98 (93,105)	64.7±13.9	60.3±106	
	2017-2018	1072939	1304 (22)	878 (67.3)	426 (32.7)	122 (115,128)	65.5±14.1	62.1±143.6	
	2018-2019	1086497	1709 (28.8)	1160 (67.9)	549 (32.1)	157 (150,165)	65.5±14.6	49.3±66.4	

N-Number; LOS – length of stay; SD – standard deviation;

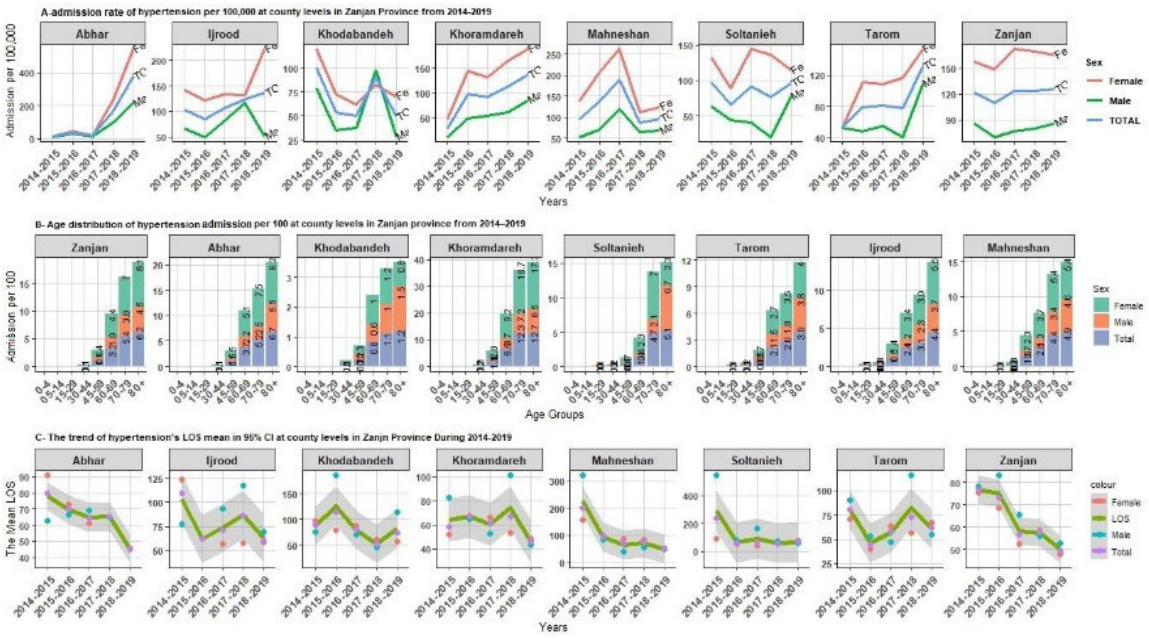

Figure 1. Admission rate, age distribution and mean LOS of hypertension at county levels in Zanjan province, Iran

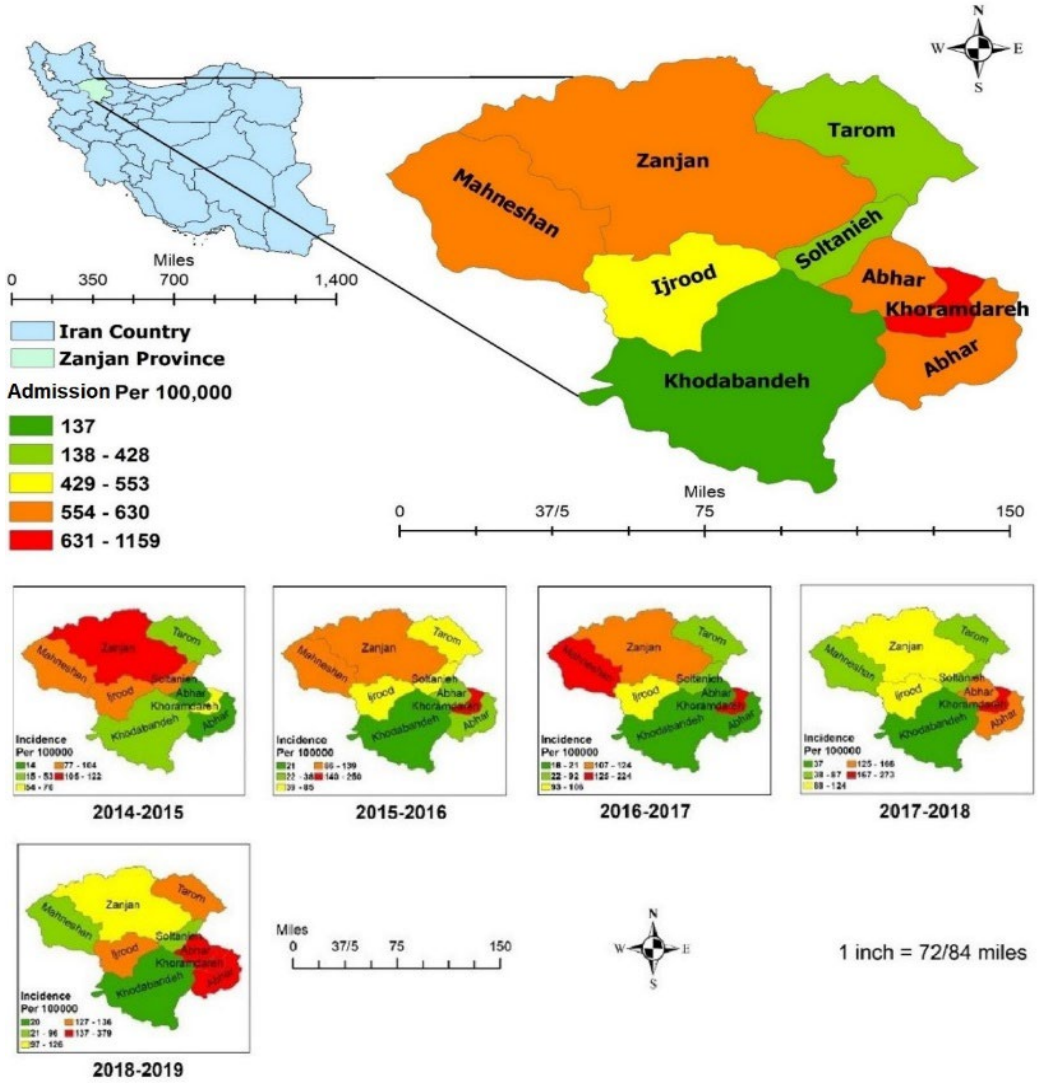

Figure 2. Geographic information system of hypertension admission per 100,000 at county levels in Zanjan province, Iran from 2014-2019

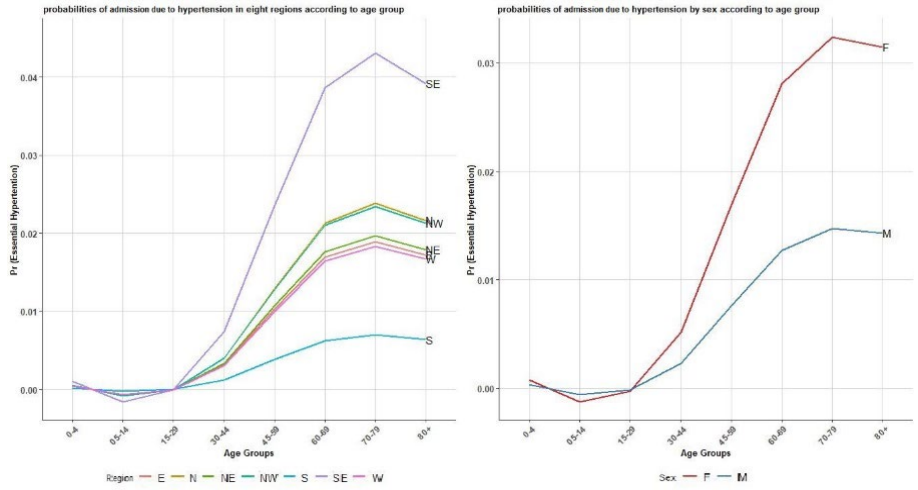

Figure 3.Probabilities of admission due to hypertension in different age groups by sex and regions in Zanjan province, Iran

Discussion

Hypertension is one of the most common preventable causes of death and a significant public health concern worldwide. To the authors' best knowledge, there was no adequate information regarding the incidence of hypertension in more OK geographical areas, a considerable gap in the literature. The authors' primary focus in the present study was to explore the ARH among genders and different age groups and identify the potential high-risk areas of hypertension in Zanjan province over five years. The result of this study can help health authorities and policymakers in planning prevention activities to reduce the incidence of hypertension in high-risk areas and groups.

The results of this study show that the overall ARH was 555 cases per 100,000, with the highest frequency among women (68%) in Zanjan province, Iran. Most patients were in Khoramdareh County, and the ARH was increased by aging. Different factors contribute to the incidence of hypertension. Hypertension originates from genetic, geographical factors, nutritional status, lifestyle, and socioeconomic determinants. The influence of age, overweight, alcohol consumption, and smoking on hypertension had been proven in previous studies **(1, 2, 8, 10, 13, 20)**. We could not find any study about the assessment of risk factors for the incidence of hypertension in Zanjan province, Iran, to describe the leading causes of hypertension in the study area. We recommended that future studies explore the main risk factors contributing to the incidence of hypertension in high-risk regions of Zanjan province, Iran, using the present study's results. Targeted or population-based strategies can help to prevent and reduce the incidence of hypertension. Increasing awareness, early treatment, and control interventions in individuals are the targeted strategy to control hypertension. Weight loss, a healthy diet, low dietary sodium and adequate potassium intake, sufficient physical activity, and avoidance of alcohol consumption were introduced in the literature as the main approaches to preventing hypertension **(2, 9, 10)**.

This study showed that the ARH varied among different age groups and regions. According to the previous studies, the incidence of hypertension differed from 15.7% to 41.8% in Iran. It was 37.3% in Yazd **(1)**, 26.2% in Tehran **(22)**, 22.6% in Tabriz **(2)**, 15.7% in Kurdistan **(23)**, 38.2% in Shahrood **(24)**, 41.8% in Golestan **(9)**, and 22% in Mashhad **(10)**. Contrary to the incidence of hypertension in Iran, the global prevalence of hypertension was 31.2% in adults **(20)**. In general, it can be said that the incidence of high blood pressure in Zanjan province, Iran, compared to America, Brazil, India, and individual studies in India, China, and Korea, is equal to [(30-35%), (32-36%), (29.8%), (19.7-30.8%), (40.8%), (32.3%), and (31.6%)], that it was less. **(5, 20-29)**. Comparing the results of this study with other studies showed that the social-economic and cultural differences, lifestyles, age group span, and methodology used in various studies can lead to different results. Therefore, these results cannot be compared directly because of varying age ranges and methods.

Hypertension was prevalent among adults (aged 45 and older) in all counties of Zanjan province, Iran, which indicates the central role of aging in the incidence of hypertension, consistent with other studies **(5, 8, 9)**. The incidence of hypertension was common among adults (22.1%) and the people in the age group over 55 years (49.5%) in Iran, which was consistent **(20, 30)**. The results of a global survey showed that 37.2%, 46.6%, and 51.7% of adults in the age groups of 50-59, 60-69, and over 70 years had hypertension in the Middle East, and 44.8%, 60.3% and 7.2% of people at these age groups in developed countries had hypertension. **(31)**. Because of the different age group spans and the methodology of the previous and present studies, these results cannot be compared directly. However, the age-specific ARH showed that most patients were in the 60-69-year age group (27.0%), while the highest ARH was observed in the age group above 80, with 5672 cases per 100,000. Future studies should identify the main risk factors related to age and examine their influence on hypertension to be aware and help health authorities to reduce the incidence of hypertension in high-risk age groups.

The national health h and nutrition examination survey in the US and s of some studies in Iran showed no significant relationship between genders and hypertension **(10, 11, 32, 33)**. At the same time, a high prevalence of hypertension was reported in women in Iran, which was consistent with the results of this study **(2, 23, 24)**. A higher body mass index (BMI) and lack of physical activity can be considered the leading cause of these differences **(9)**.

Some conflicting reports about the influence of residential area factors or geographical areas on the incidence of hypertension. While different studies reported no differences between the incidence of hypertension in rural and urban areas, **(8, 34)**, a national survey in Iran reported a higher prevalence of hypertension among the people who lived in urban areas **(35)**. The study conducted in Golestan province, Iran, showed that hypertension is more prevalent among people who live in rural areas **(9)**. According to a study in India, the prevalence of hypertension is significantly higher in the urban population than in the rural population, which may be due to differences in the level of awareness of hypertension, access to health services, and socioeconomic characteristics **(26)**. Studies in Uganda **(5)** and China **(15)** also showed that the prevalence of hypertension was different across various regions, which was consistent. There seems to be a direct and substantial relationship between the incidence of hypertension and the economic and social characteristics. As a previous study in Iran showed, the prevalence of hypertension is much lower in areas with favorable socioeconomic status than in areas where

socioeconomic status is worse (9). The present study showed that the admission of hypertension was higher in some counties of Zanjan province, Iran. This may be due to socioeconomic diversity or different lifestyles across these areas and need further studies to determine the main reasons for these differences.

The results of the present study provide new knowledge that can be used to manage, control, and offer essential diagnostic and remedial services to patients living in high-risk areas of hypertension. In addition, identifying the high-risk areas of hypertension can help organize and allocate professional teams and care facilities' resources effectively.

Conclusion

In conclusion, this study shows a high ARH in Zanjan province, Iran, during 2014-2019, which was more prevalent in women and at above 45 years of age groups. The high prevalence of hypertension in Khoramdareh County is a warning to local policymakers to consider the significant risk factors and apply prevention programs to reduce the incidence of hypertension in this area. This study showed that hypertension is a significant public health concern in Zanjan, Iran. The probability of admission due to hypertension in women and the South-East of Zanjan is very high. It is essential to implement periodic hypertension screening programs, especially among the elderly and women, and also increase the awareness of people about hypertension, the importance of lifestyle changes, good nutrition, and physical activity among people who live in high-risk areas to reduce the incidence of hypertension in Zanjan province, Iran.

Limitation

This study has some limitations. First, data included only the patients hospitalized due to hypertension at Zanjan University Medical Sciences hospitals، from 2014-2019 in Iran. So, it may not represent all hypertension patients in Zanjan province, Iran. In addition, Data from two Social Security organizations (Taemin Ejtemaee) hospitals did not include in this study. The second limitation was using census population data as the dominant method for calculating ARH. The population census is conducted every five years in Iran, so in the absence of an annual population census, we used the 2016 census data.

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Ethical Approval and Consent to Participate

This study approved by the Ethics Committee of ZUMS. (Code IR.ZUMS.REC.1398.056)

Availability of Data and Material

The datasets generated and/or analyzed during the current study are not publicly available due to use of these data for other research studies not yet published.

Funding

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Conflict of Interest

The authors declare that they have no conflict of interests.

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