Magnetic Resonance Imaging Utilization in Iran

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Research

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Abstract

Background: The increased use of diagnostic and therapeutic equipment and services increases the costs of the health system and insurance organizations. Evaluating the status of utilizing these services can provide a clear picture of the demand rate, responding process and methods of providing the relevant services. This study aimed to examine the status of using magnetic resonance imaging (MRI) services among the insured people by one of the insurance companies.

Methods: This research was a descriptive and cross-sectional study. The studied statistical population included all insured persons covered by a private insurance company that had used the MRI services provided in hospitals and other diagnostic and treatment centers in 2018-2019. The data were analyzed using STATA and GIS statistical software.

Results: In one contractual year, 22,738,215 medical expenses records have been filed in the entire country, out of which, 119,761 records (0.5% of all cases) were related to MRI services. The shares of the basic (main) insurer and supplemental insurance related to this service of the total MRI costs were estimated as 52,946,159,376 Rials (1,259,860.6077 USD) and 231,303,021,838 Rials (5,503,884.87252 USD), respectively. In the study, 102,024 people have used MRI at least once a year. The average cost of using MRI services at each time in the country was 2,373,470 Rials (56.47702 USD). The average number of referrals in the whole country was 0.07 times. The highest frequency of referrals was in Lorestan and Qom provinces, while Kerman and Sistan and Baluchestan provinces had the lowest frequency of referrals. The overall rate of utilization of MRI services in the country was estimated to be 6%.

Conclusion: In general, the study results suggested a high rate of using MRI services in Iran, which can be due to the 100% coverage of costs by insurance companies and the increased access to health diagnostic and treatment services in the country.

Background

The increasing growth of the health system costs has turned into one of the major concerns of policymakers and health system managers. The most important reasons causing such a growth in the costs include the rising public expectations and increased demand for healthcare services, aging, increasing chronic diseases among the people, and the healthcare and therapeutic professionals' mistakes (1). Besides these factors, the population size and its demographic characteristics, the rate of using services, and utilizing advanced diagnostic and treatment equipment have dramatically influenced the health care costs (2, 3).

The use of medical technologies in the diagnosis and treatment of diseases has also expanded significantly in recent decades (4). Magnetic Resonance Imaging (MRI) is recognized as a non-invasive medical procedure, which facilitates the diagnosis of a wide scope of diseases. Unlike other imaging devices such as X-rays and computed tomography (CT scans), MRI does not use ionizing radiation. Rather, accurate images of soft tissues and almost other internal structures of the body are generated in this

method using a strong static magnetic field, radiofrequency pulses, and computer processing (5). Medical imaging services, especially MRI, fall into the highly expensive services of the health system, which need significant financial, capital, and manpower resources. As a result, low-income or middle-income countries will face many limitations in providing such resources (6). These diagnostic services can lead to serious concerns regarding the optimal use of resources, especially if they are overused or if there is no certain indication for using them (6, 7).

Health care providers extensively employ diagnostic methods generally aimed at reducing the risk of medical errors, and thus, the development of induced demand by them has considerably increased the use of MRI services (8). Factors effective in increasing the use of these services can be mentioned as the increased number of doctors and radiologists, easy access to diagnostic and treatment services, increase household income, the patients' expectation for ordering such services, professional uncertainty, and payment systems encouraging doctors to prescribe and order such tests (2, 9–14). The private system, which constitutes a major part of the health system of countries that allows patients to receive medical care simultaneously from several providers in addition to the ability to freely choose the health care providers, may also provide MRI services without any limitations (2). The rate of utilizing MRI services also enhances with the increased number of MRI devices and scanners and the establishment of new imaging centers (15).

The number of MRI machines per million inhabitants of Iran has increased twenty times from 1992 to 2002,67% of which had been employed in private medical centers (16). At the beginning of 2016, 3.5 MRI units per one million populations have been functioning in Iran (17). A high percentage of the costs of these para-clinical services is paid directly from the patients' pockets given that the number of centers and MRI devices in Iran has increased in recent years. Although basic insurances cover part of the costs of these services, different financial pressures are imposed on people due to the non-participation of supplemental insurances, and consequently, a large portion of the household income will be spent on health-related expenses (18).

The purchase and use of diagnostic and treatment technologies have caused tremendous problems, including excessive increases in health care costs due to limited resources and high prices of such technologies (19). Moreover, the unnecessary use of medical imaging services may not improve the patients' health status since some studies have demonstrated the unnecessary utilization of about half of the medical imaging techniques based on advanced technology (20, 21). On the other hand, despite available MRI centers, over-prescribing MRI tests by doctors can cause the patients and their families to suffer a lot of difficulties in the process of appointment scheduling by referring to medical imaging centers besides the pain and suffering of the disease. Also, a large amount of health insurance resources is spent to cover the costs of medical imaging of the insured.

Considering the aforementioned, evaluating the utilization status can provide us with a clear picture of the demand rate for diagnostic services, the process of responding to these demands, and the methods of providing the relevant services. Besides, many savings can be made in the financial resources of insurance organizations by reducing the per capita burden of the insured visits to healthcare centers. Using these

savings, new service-providing systems can be designed and developed for the insured of the organizations to provide them with new services with higher quality. This study was performed to examine the status of using magnetic resonance imaging (MRI) services among the insured people covered by a supplemental insurance company.

Methods

This research was a descriptive-analytical and cross-sectional study that was conducted using the data of a contractual year (2018.10.23–2019.11.21) of a private insurance company. The statistical population studied in this research included all insured persons covered by the company in 31 provinces of Iran who had used the MRI services provided in hospitals and other diagnostic and treatment centers. No sampling was done in this study due to considering the data of the whole population of the insured and users of diagnostic services. A data extraction form was used as the research tool, which included the following variables: The total number of the insurance company records, the total number of MRI records, the total number of insured persons of the company, the shares of the basic insurer and the supplemental insurance of the MRI service, the number of people using the services, and the information related to the age and gender of the people using the services. To calculate the loss severity, the ratio of the total share of supplementary and basic insurance to the number of users and in calculating the frequency referrals to receive MRI service, the ratio of the total number of MRI records to the total number of insured persons was used. Also, the average cost of each record was considered as the ratio of the total share of MRI supplementary insurance and the share of the basic insurer to the total number of MRI records. In calculating the ratio of MRI utilization, the ratio of the number of people using MRI to the total number of insured people was used, too.

All the data required for this research was collected from the Business Intelligence (BI) system of the insurance company. The STATA statistical software and Geographic Information System (GIS) were used to describe and analyze the obtained data. Ethical considerations such as the confidentiality of the insured's personal information and obtaining any permissions to collecting data were fully observed as well.

Results

In a contractual year (2018.10.23–2019.11.21) of the insurance company, 22,738,215 medical expenses records have been filed in the whole country, of which, 119,761 records (0.5% of all cases) were related to MRI services. The MRI services have been used at least once by 102,024 people. The basic insurer's share of total MRI costs accounted for 52,946,159,376 Rials (1,259,860.6077 USD), while the share of the supplemental insurance related to this service was estimated as 231,303,021,838 Rials (5,503,884.87252 USD). The average cost using MRI services in the country at each time has been equal to 2,373,470 Rials (56.47702 USD) (Table 1).

Table 1
The information on the supplemental insurance and the insured covered separated by province

Province	Total number of records	Total number of MRI records	The share of basic insurance (USD)	The share of supplemental insurance (USD)	Number of users	Average cost per case (USD)
Alborz	264,647	2,453	35,480.18205	120,366.1474	2,085	63.53294
Kohgiluyeh & Boyer-Ahmad	660,371	2,294	22,492.6679	73,950.56837	2,005	42.04152
East Azerbaijan	826,040	4,107	46,250.19660	183,480.7499	3,562	55.93644
West Azerbaijan	590,486	2,749	6,345.69278	116,648.3538	2,399	44.74138
Ardabil	487,683	1,747	8,265.81729	75,976.82849	1,545	48.22133
Isfahan	2,348,728	10,718	143,368.3757	426,962.53270	9,223	53.21245
Ilam	637,047	2,304	5,895.78139	105,840.4440	2,021	48.49663
Bushehr	254,069	1,114	16,235.5062	37,369.20731	942	48.11913
Tehran	2,278,500	21,353	149,714.7585	1,369,036.4236	17,557	71.12590
South Khorasan	154,326	479	1,205.8842	11,329.9415	444	26.17083
Khorasan Razavi	2,346,132	6,116	34,197.47942	198,145.6295	5,490	37.98940
North Khorasan	391,989	1,058	1,837.3152	36,584.39070	939	36.31541
Khuzestan	1,013,673	5,432	53,052.04407	352,338.61655	4,563	74.63009
Zanjan	315,979	1,436	18,551.1353	58,573.21380	1,256	53.70777
Semnan	290,488	1,514	16,150.7188	49,520.00096	1,338	43.37564
Sistan & Baluchestan	88,058	463	5,203.61345	19,157.1210	410	52.61498
Fars	1,188,246	6,931	83,510.96554	261,437.97576	5,597	49.76901
Qazvin	304,326	1,124	5,510.34033	52,651.81624	974	51.74569
Qom	766,394	4,407	82,867.30948	195,942.4899	3,674	63.26522
Lorestan	787,899	5,547	64,758.08479	245,157.28185	4,698	55.87082
Mazandaran	930,698	7,930	122,163.5616	354,354.65858	6,759	60.09057
Markazi	745,265	4,537	49,738.80925	189,261.9970	3,797	52.67815

Province	Total number of records	Total number of MRI records	The share of basic insurance (USD)	The share of supplemental insurance (USD)	Number of users	Average cost per case (USD)
Hormozgan	87,828	291	1,091.3053	10,175.7401	254	38.71836
Hamedan	854,679	4,430	49,308.39723	180,199.6698	3,834	51.80768
Chaharmahal & Bakhtiari	477,948	1,961	26,413.52309	82,825.25428	1,670	55.70565
Kurdistan	302,623	2,475	29,511.29387	99,931.57339	2,128	52.30014
Kermanshah	757,682	3,571	16,820.5870	157,260.3761	3,126	48.74853
Kerman	620,332	1,792	5,196.20674	53,820.42160	1,577	32.93338
Golestan	589,318	3,186	57,474.79886	149,552.7563	2,710	64.98040
Gilan	896,216	4,703	94,085.36196	204,296.2796	4,117	63.44495
Yazd	480,545	1,539	7,162.89377	31,736.41254	1,330	25.27571
Iran	22,738,215	119,761	1,259,860.6077	5,503,884.87252	102,024	56.47702

About 65.4% of the people using MRI services in the country were women and more than half of the users were aged between 40 and 60 years old (Fig. 1).

The average loss per person using MRI services (average loss severity) in the whole country was obtained as 2,786,101 Rials (66.29563 USD). The highest loss severity rate was related to the provinces of Khuzestan (3,733,664 Rials-88.84301 USD) and Tehran (3,635,367 Rials-86.50402 USD), while the lowest loss severity rate was found in the provinces of South Khorasan (1,186,539 Rials-28.23355) and Yazd (1,229,142 Rials-29.24759) (Fig. 2).

The review of the referral frequency of the insured covered by the insurance company to hospitals and other diagnostic and treatment centers in the provinces of Iran to receive MRI services indicated that Lorestan and Qom provinces have had the highest rates of referral, while Kerman and Sistan and Baluchestan provinces have had the lowest rates of referral. The average number of referrals in the whole country (Iran) was 0.07 times (Fig. 3).

Finally, the rate of utilizing MRI service in the whole country (Iran) was equal to 6%. The highest rate of utilization was in Lorestan and Qom provinces, while Kerman and Hormozgan provinces had the lowest rate of utilization (Fig. 4).

Discussion

This study was performed to determine the rate of utilizing MRI services in people covered by supplemental insurance in Iran. According to the results, in total, the average number of referrals of the insured covered by insurance to receive diagnostic and therapeutic MRI services in the whole country was equal to 0.07. The rate of utilizing MRI services in the whole country was obtained as 6%.

The use of medical imaging services is growing in countries around the world despite its high costs. The average referral frequency of each person to receive diagnostic and therapeutic services depends on multiple factors such as the increased rate of patients' demand, the increased number of MRI units, increasing advances in diagnostic technologies, the increased number of radiologists and other health care providers, access to MRI services, and the physicians' behavior in creating induced demand (9, 12, 22, 23). As demonstrated by the results of a study conducted in one of the cities of Isfahan province, the most requested diagnostic services have included laboratory and radiology and the average frequency of referrals to medical diagnostic centers per person has been 1.32 per year. The mean referral for diagnostic services was obtained as 0.7 and 1.22 in other studies. The results of these studies indicate that each person uses diagnostic and treatment services almost once a year. The findings also suggest that the demand for diagnostic services increases with the increased age of parents, increased number of children, employed parents working in government offices and living in different geographical areas, the increased income of the whole household, higher education levels of parents, and the use of insurance coverage, especially in the case of full coverage of costs (21, 24, 25).

The average per capita MRI unit index in the OECD countries has been equal to 15.9 units per million populations in 2017. The per capita MRI frequency has been at the highest level in Germany, the United States, Japan, and France (more than 100 MRI tests per 1000 population). The number of MRI uses in 2017 has doubled in most of these countries compared to the previous decade. The highest and lowest number of MRI units per million populations has been reported in Japan (46.9) and Mexico (2.1) in 2015, respectively. On average, 13.3 MRI units per million populations have been available in these countries. This ratio has been reported to be 11.6 units for Germany and 6.1 units for the United Kingdom. The utilization of these services has increased in countries with an increased number of diagnostic and therapeutic devices (26–28).

With the introduction of new diagnostic and treatment technologies during the past years, the import of these devices into Iran has dramatically grown (29). The total number of MRI units in Iran's hospitals has been equal to 181 devices in 2017 based on statistical reports obtained from the hospital statistics and information system of the Ministry of Health. Also, 2036408 people have been referred to hospitals to receive the relevant services. The number of clients per 1000 population has been reported to be 25.19. Moreover, the MRI index per population (per million population) in the hospitals of all organizations and hospitals of the Ministry of Health has been 3.85 and 1.19, respectively. In 2016, MRI units had the highest frequency among imaging devices in Iran after CT scans (17, 30). In general, there are no general guidelines or international criteria for the ideal number of MRI units per million people. However, a very low number of these devices may lead to reduced access, especially geographically. An excessive increase in

the number of devices can also lead to the overuse of costly diagnostic methods while using these methods has no benefit for the patients (28).

According to the results of a study performed in 46 universities of medical sciences of Iran in 2016, most of the diagnostic capital equipment and devices are concentrated in the northern and central regions of the country, especially in Tehran, while the eastern and southern regions of Iran have much lower access to such equipment. The results of this national study suggested that there is a fairer distribution of the MRI devices than other devices and the dispersion index of this device in Iran is lower than other imaging devices (17). It should be borne in mind that improper distribution of health system resources is known as one of the contexts of developing inequality in the health status of society (31) and equitable access of communities to healthcare services will lead to the improvement of the health level and the growth atmosphere in the country. Besides, the level of access to health care providers is also considered as one of the most important factors in benefiting from health services (32). The results of Pourreza study focused on evaluating justice in providing, allocating, and distributing resources in Iran's health system suggested differences in the allocation of resources geographically and economically, which have led to limited access in the deprived and low-income areas of the country (33). Sepehrdoost has also found a deep inter-provincial gap in the country in the ranking of the provinces of Iran based on benefiting from healthcare facilities and equipment (34). Due to numerous gaps in the utilization of health indicators both between countries and between different regions of a country, and even within the provinces (35), the balanced development of health care facilities in different geographical locations seems to be necessary.

The introduction of diagnostic and therapeutic technologies may lead to the development of induced demand by service providers and inappropriate and wasteful consumption of these services. Research by Ivan K et al. has demonstrated that the radiologist's advice is associated with the repetition of imaging exams and this rate has been reported to be much higher in outpatients (36). About 20 to 50% of imaging techniques that use advanced and up-to-date technologies are unnecessary according to available studies (37, 38). The provision of unnecessary services such as MRIs, CT scans, etc. can be associated with side effects for patients besides imposing additional costs on the health system. On the other hand, imposing costs on insurance companies will ultimately lead to the patients' dissatisfaction due to the lack of resources. In their study, Jones et al. showed that performing routine screenings such as physical examinations, and radiography to diagnose malignancies only accounts for 0.1 of the cost compared to MRIs, while the cost of finding one more malignancy with performing an MRI exam accounts for $ 625,000 (39). Therefore, we have to pay attention to the culture of optimal use of diagnostic and treatment services and the expansion of overseeing service providers both in the public and private sectors. In general, one can suggest that evaluating the referral times of people to receive diagnostic and therapeutic services associated with identifying predisposing factors and determining socio-economic factors affecting the availability and receiving of such services are important in order to provide optimal health services, allocating resources, and facilitating the access and utilization, and ultimately increasing the people's satisfaction.

Conclusion

In general, the results of this study indicated a high rate of utilizing MRI services by the examined community, which may be due to 100% coverage of costs by insurance companies and the increased access to these services in diagnostic and treatment centers in Iran. Accordingly, policymakers and managers of health insurance organizations should make the necessary planning and take the required measure to respond appropriately to the community covered and provide proper services by considering the referral frequency of the insured.

Abbreviations

MRI: Magnetic Resonance Imaging, CT: Computed Tomography, BI: Business Intelligence, GIS: Geographic Information System, OECD: Organization for Economic Co-operation and Development

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the first author on reasonable request.

Competing interests

The first author is the head of technical assistance of personal insurance in a private insurance company

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Authors' contributions

All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript. A.M. provided general supervision on all the stages and commented on the paper draft.

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Figures

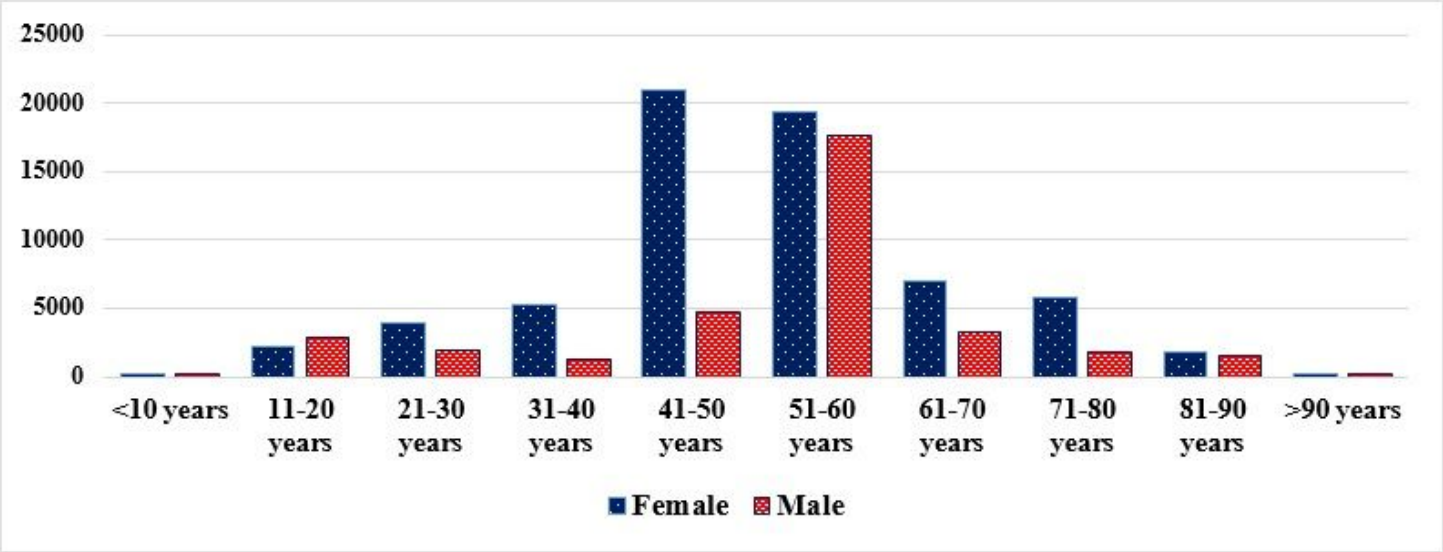

Figure 1

The information related to the demographic factors of people using MRI services in Iran

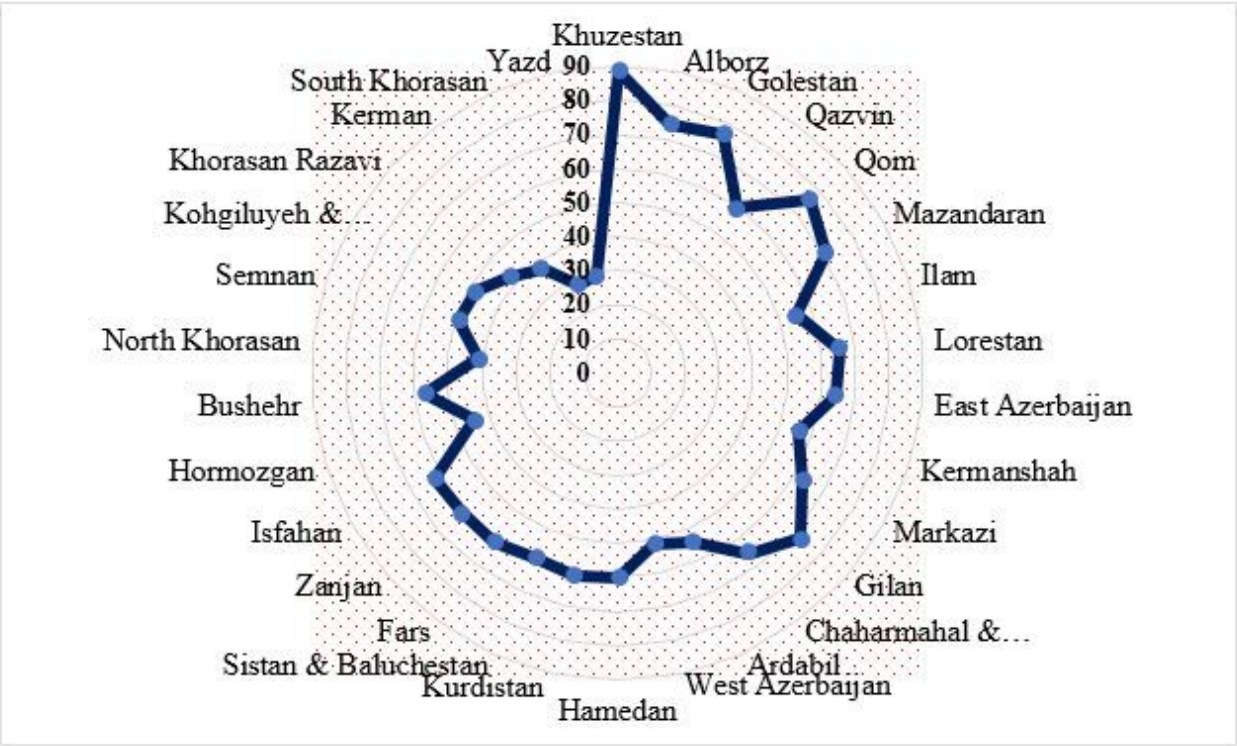

Figure 2

The per capita cost of each person using MRI service (loss severity) by province

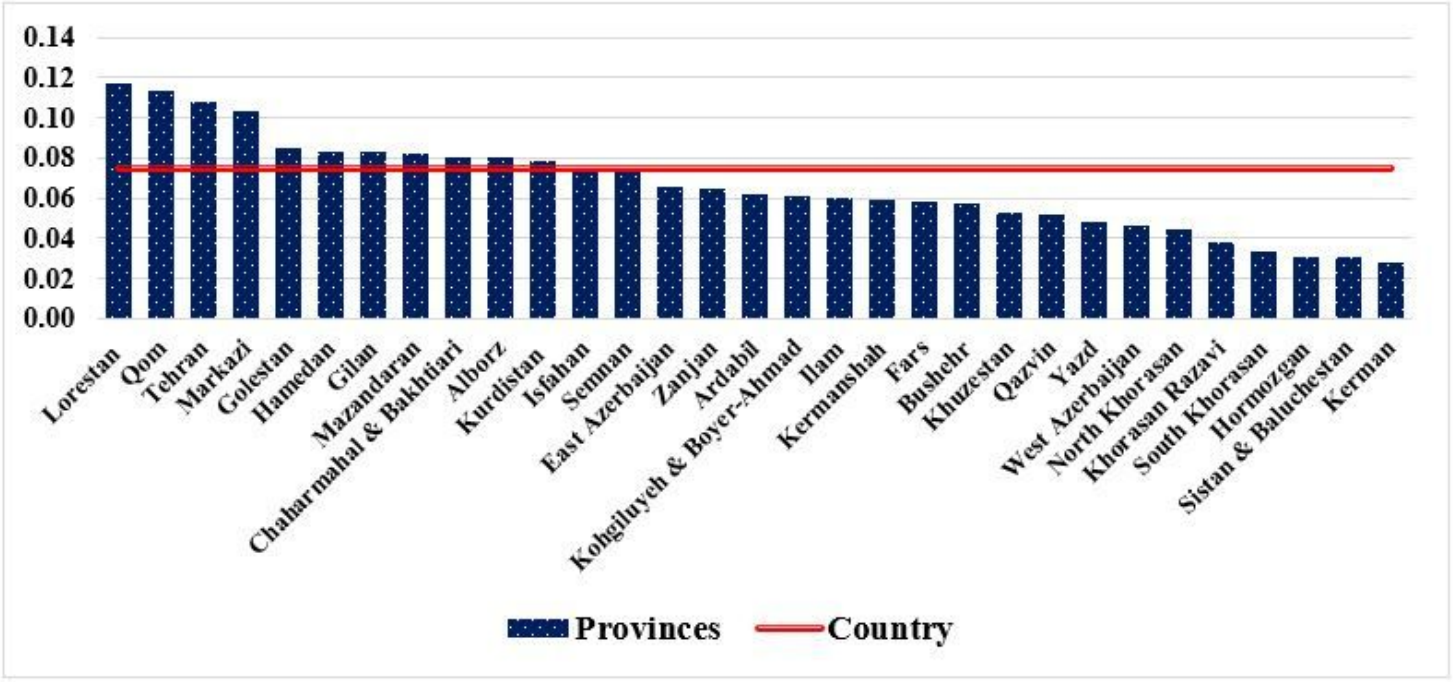

Figure 3

The referrals of the insured persons to receive MRI diagnostic and treatment services in Iran

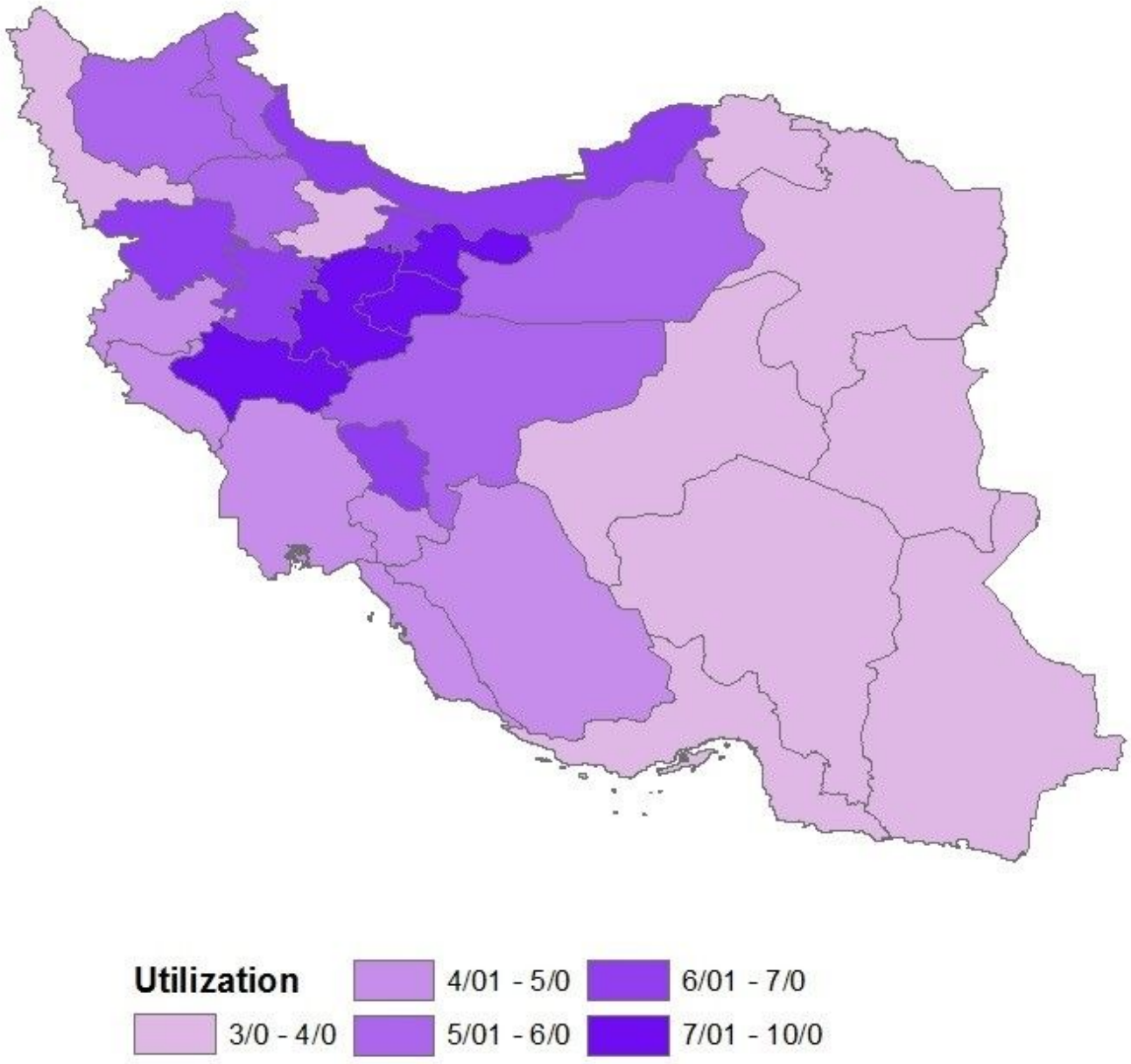

Figure 4

The rate of utilizing MRI diagnostic and treatment services in Iran's provinces (Percentage). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.