Iran J Public Health, Vol. 53, No.1, Jan 2024, pp.228-237

Original Article

Physician Induced Demand: The Empirical Evidence of Angiography for Suspected Coronary Artery Disease

Marita Mohammadshahi [1], *Sara Emamgholipour [2], Alireza Olyaeemanesh [1], Minoo Alipouri Sakha [3], Ali Akbari Sari [2], Shahrooz Yazdani [4]

1. *Department of Health Economics, National Institute of Health Research, Tehran University of Medical Sciences, Tehran, Iran*
2. *Department of Health Management, Policy and Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran*
3. *Department of Health Education and Promotion, Deputy of Health, Iran University of Medical Sciences, Tehran, Iran*
4. *Department of Cardiology, School of Medicine, Alborz University of Medical Sciences, Karaj, Iran*

***Corresponding Author:** Email: s-emamgholipour@tums.ac.ir

(Received 15 Aug 2022; accepted 12 Nov 2022)

Abstract

Background: We aimed to investigate the existence of unnecessary demand for angiography and the factors affecting it to provide evidence for decision makers.

Methods: This longitudinal panel study was conducted in public hospitals in Tehran, Iran by using 2458 patients' records that were undergoing angiography for suspected coronary artery disease 2013-2015. To modeling the physicians' behavior based on physician-induced demand (PID), the patients were classified as appropriate, uncertain, and inappropriate and then Hierarchical Linear Modeling (HLM) model besides the physician ethic index was developed and finally the existence of PID showed based on three scenarios.

Results: Angiographies were performed inappropriately in 23.8% of 2458 patients as well 46.7% were uncertain, and 29.5% were appropriate. According to the HLM model, the physician-to-population ratio ($\delta 0$= -0.161) and the interaction variable coefficient are higher than zero and significant ($\delta 1$ = 253). The results of the physician ethic index showed that most physicians were at a moderate rate, meaning that their utility was a combination of both pecuniary and non-pecuniary profits ($0 < |\varepsilon_{p\delta}| < 1$). Considering the HLM model and the medical ethics index together has almost shown the condition of PID (the necessary condition $\delta 1 > 0$ and the sufficient condition ($1 \leq |\varepsilon_{p\delta}|$)) existed for about 26% of all studied physicians who had pure profit maximizer.

Conclusion: To reduce induced demand and improve medical ethics adherence in cardiologist, policy makers should develop native guidelines, rules, and instructions besides policies related to education, and increasing patients' awareness.

Keywords: Supplier induced demand; Physician ethic index; Angiography; Coronary artery disease; Risk score; Insurance; Econometric model

Introduction

Increasing in total health expenditures has many factors such as income levels, technological progress, and population aging. Economists and policymakers emphasize the inefficiency of demand

Copyright © 2024 Mohammadshahi et al. Published by Tehran University of Medical Sciences.
This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license.
(https://creativecommons.org/licenses/by-nc/4.0/). Non-commercial uses of the work are permitted, provided the original work is properly cited

side and supply side of the health market (1). This study emphasis on the supply side inefficiency as supplier induced demand (SID).

In health care setting, SID refers to the notion that a physician uses his or her informational power to create induced demand to increase the utilization of health care, which are unnecessary from the point of view of an informed patient (2, 3). The physicians who act as the agent for a patient can directly control the use of inputs in health care sector, so their decisions will influence the quantity, quality, and cost of the health care system (4). Provision of unnecessary services puts a significant financial burden on patients and the health system and can drive vulnerable people, especially the poor in poverty. On the other hand, due to unnecessary services, the patient's health may deteriorate (4, 5).

Physician-induced demand can occur in all types of health care services; one of them can be cardiovascular disease (CVD). As "CVD was the first leading cause of mortality and a million disability adjusted life years(DALYs) led to 46% of all deaths and 20%-23% of the burden of disease in Iran" (6); early diagnosis and treatment of patients can be so important to prevent of deaths and disabilities. Since the coronary angiography is the most accurate method to show the severity of disease and considered as the gold standard to examine the degree of lumen obstruction (7), it was used in almost all cases although a considerable number of them may be inappropriate (8).

Coronary angiography is an invasive test and imposes a high cost on the health system, it should be done on appropriate patients who may have a high likelihood of significant coronary artery disease (CAD) in clinical findings and non-invasive tests like stress tests and echo. Physicians are more likely to refer patients to angiography based on financial incentives; as the payment system to physicians in Iran is based on salary and per case and almost 95% of the population are insured (9), the motivation for inducing demand can be increased.

Therefore, we aimed to investigate the probability of existence and the factors affecting the high rate of unnecessary induced demand for angiography.

Materials and Methods

This longitudinal panel study was conducted in public hospitals in Tehran, Iran by using 2458 patients' records that were undergoing angiography for suspected coronary artery disease 2013-2015. At first step a checklist according to the cardiologists comments (whom were not the same cardiologists participating in the study) was developed to collect data of patients undergoing coronary artery catheterization and their physician and then the data for 2458 patients were extracted and classified the patients by using appropriate use criteria, that it's results were published in our previous article (10). It showed that approximately 99% of patients in the inappropriate division had never undergone prior stress testing either without symptoms with a low/moderate risk score or low likelihood of CAD in clinical assessment. Overall, angiographies were performed inappropriately in 23.8% of 2458 patients as well 46.7% were uncertain and 29.5% were appropriate (10).

Econometric model of SID

After classifying the patients, we modeled physicians' behavior. Necessary but not sufficient condition to prove the existence of induced demand is established through the positive correlation between per capita utilization of health services and the number of physicians, payment method, or patient insurance coverage. We needed to show the increased supplier-demand that made more profit for their as a sufficient condition. An improved model of the Greaten and Sorensen by employing the Hierarchical Linear Model (HLM) was used as the necessary condition (11). The Jagher and Jaggers Physician's Ethics Index (2000) was used to meet the sufficient condition (12, 13).

For running HLM, according to Label, we considered inappropriate and uncertain cases as un-

necessary items in a group and defined appropriate ones in the necessary group (14).

First level (patients)

$Appropriateness_{ij} = \beta_{0j} + \beta_1 sex_{ij} + \beta_2 age_{ij} + \beta_3 education_{ij} + \beta_4 address_{ij} + \beta_5 risk\ score_{ij} + \beta_6 insurance_{ij} + \beta_{7j} density_j + \varepsilon_{ij}$ (1)

Here, appropriateness is the classification of angiography (appropriate, uncertain, and inappropriate) of patient i and physician j. The risk score is a global risk of a patient (computed using age, sex, cholesterol, blood pressure, and smoking status). The density is the virtual variable of the number of patients per doctor (one doctor per 200 patients per year) in each hospital.

Subtitles i and j are also defined as follows:

i = 1, …, n_j) n_j Number of patients of physician j

j = 1, …, m) Number of reviewed physicians

Second level(physicians):

$\beta_{0j} = r_0 + r_1 hospital_j + r_2 age_j + r_3 sex_j + r_4 education_j + r_5 expriance_j$ (2)

$\beta_{7j} = \delta_0 + \delta_1 contract_j$ (3)

Therefore, the reduced form equation is as follows:

$appropriateness_{ij} = r_0 + \beta_1 sex_{ij} + \beta_2 age_{ij} + \beta_3 education_{ij} + \beta_4 address_{ij} + \beta_5 risk\ score_{ij} + \beta_6 insurance_{ij} + r_1 hospital_j + r_2 age_j + r_3 sex_j + r_4 education_j + r_5 expriance_j + \delta_0 density_{ij} + \delta_1 (contract_j * density_{ij}) + \varepsilon_{ij}$ (4)

The effect of physician density consists of two dimensions. One is the effect of increasing access to a physician, and the other is the pressure of physicians to raise patients' demand, which stems from an increase in their competitive pressure (induced demand effect).

If $\beta_6 > 0$, the physician provides more services for patients with health insurance coverage;

If $\delta_0 < 0$, there is an access effect for consumers in areas with higher densities;

If $\delta_0 \geq 0$, the access effect for consumers in higher-density areas does not exist.

Statistically significant δ_1 coefficient means that non-salaried physicians provide more additional services for their patients than salaried physician (salaried by Ministry of Health and Medical Education) in denser areas (more competitors). A zero value of δ_1 indicates that salaried physicians do not change the number of services. If $\delta_1 < 0$, non-salaried physicians provide fewer services to their patients in areas with a high density of physicians. Jagher and Jaggers created an Index for Ethics in medicine using first-order conditions and the implicit function theory as follows:

$$\left|\varepsilon_{p\delta}\right| = \frac{Ø - c_Q}{Ø - c_Q + \gamma}$$

Where $\gamma = W_U + W_P P_U / W_Y P_U$ is the shadow benefit as the altruistic marginal benefit of treatment of the last patient, Ø is the price of each unit of service set by the doctor and the function of the physician's cost per service.

If $\left|\varepsilon_{p\delta}\right| \geq 1$, physician is a pure profit maximizer and is looking for a pecuniary benefit;

If $0 < \left|\varepsilon_{p\delta}\right| < 1$, physician's utility is a combination of the utility of both pecuniary and non-pecuniary profits;

If $\left|\varepsilon_{p\delta}\right| = 0$, the physician is purely altruistic and prefers the utility of patients to his or her utility.

The most important part of this study is the combination of physician ethics index coefficient, β_6, patient insurance coverage coefficient, and δ_1 coefficient of interaction term of physicians' density and physicians' contract, which is as follows:

The effect of physician induced demand

If $\left|\varepsilon_{p\delta}\right| \geq 1$ and $\delta_1 > 0$ or $\beta_6 > 0$, physicians act like for-profit firms and seek to maximize their pecuniary profits, and salaried physicians provide additional services in areas with higher densities, or patient insurance coverage has increased the use of services. Establishing these conditions means that there is a possibility of induced demand by physicians.

Practice style difference

If $0 = \left|\varepsilon_{p\delta}\right|$ and $\delta_1 > 0$ or $\beta_6 > 0$, non-salaried physicians provide more services to their patients, or patient insurance coverage increases the use of services. It is not due to the effect of induced demand, but that is because of a difference in the practice style of non-salaried physicians, meaning that physicians, in this case, are not seeking higher incomes.

Results

As we can see Fig. 1 shows the frequency distribution of patients with suspected coronary artery disease that undergone coronary angiography based on three categories: appropriate, uncertain, or inappropriate in hospitals. Hospital "C" had the highest frequency of inappropriate rate according to the number of patients, and hospital "A" had the lowest rate. According to the guidelines recommendations, hospital B (a Cardiology & Heart Surgery center) had the highest appropriate CAD.

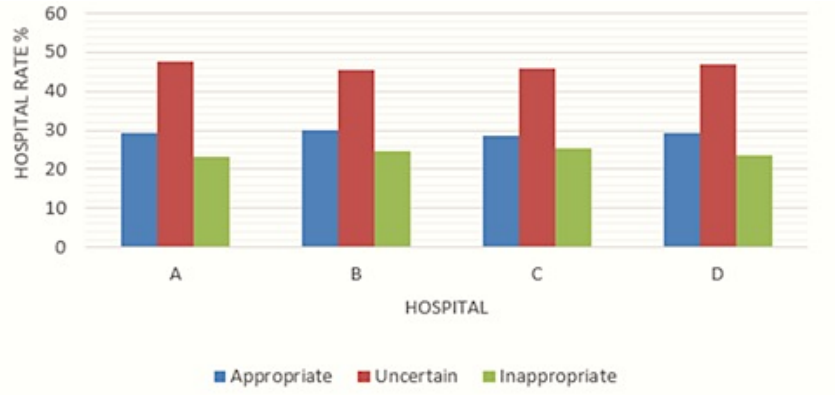

Fig. 1: Interhospital variation in diagnostic catheterization rates for patients with suspected coronary artery disease

Table 1 shows the estimates of supply and demand-side determinants using the Hierarchical linear modeling (HLM) approach. Age and global risk score variables were the most crucial variables that significantly affect the demand side. The condition that affected the proportion of inappropriate angiographies at the patient level was younger patient age, meaning that the younger the patients, the less likely they were to have inappropriate angiography. The negative age-related coefficient (-0.039, -0.084) shows the inverse correlation between age and angiographic appropriateness variable. Another component was the patient's global risk score (0.126). Regarding the factors related to the supply-side, the most important factors influencing unnecessary angiographies were the physician's age with positive effect (0.070), the physician type of employment with negative effect (-0.112), and the physician-to-population ratio (-0.161). Considering the significance of the coefficients, the younger the physicians, the greater the likelihood of performing inappropriate angiographies. Salaried physicians have carried out less inappropriately angiographies than non-salaried ones.

On the other hand, by increasing the patient-to-physician ratio, the likelihood of inappropriate angiographies decreases. Other variables such as medical history, physician gender, and education had not significantly affected the dependent variable.

Three key coefficients are patient's health insurance, patient to physician ratio, and patient-to-physician ratio multiplied by the type of physician employment. Since the patient's health insurance coefficient is not significant.

The patient to physician ratio indicates the responses of patients and physicians to the increased access. The interaction coefficient of the patient-to-physician ratio multiplied by the type of physician employment determines the response of non-salaried physicians to the increased density (increased competition). The significant negative physician to population ratio (δ_0= -0.161) means that as the density increases, the number of inappropriate angiography cases decreases. Because the density of physicians has increased, there has been an increase in easy access for patients.

Table 1: Estimation of the physician (supplier) induced demand model in the HLM approach

Variable		*Parameter*	*Standard Error*	*CI*	*t*	*P-Value*
Intercept		0.054	0.462	(-0.852, 0.960)	0.118	0.001 *
Age(yr)	<55	-0.039	0.034	(-0.108, -0.028)	-1.140	0.054 *
	55-64	-0.084	0.033	(-0.149, -0.019)	-2.537	0.011 *
	65-74	-0.026	0.035	(-0.095, 0.042)	-0.761	0.447
	>75	a_0	-	-	-	
Sex	Female	0.647	0.452	(-0.239, 1.534)	1.432	0.152
	Male	-				
Education	<11 yr	-0.005	0.023	(-0.051, 0.041)	-0.212	0.832
	11 yr	-0.003	0.103	(-0.087,0.123)	0.186	0.724
	>11 yr	a_0	-	-	-	-
Area of residence	developed	-0.040	0.034	(-0.107, 0.026)	-1.181	0.238
	Relatively developed	0.000	0.043	(-0.086,0.085)	-0.018	0.986
	developing	-0.014	0.029	(-0.073,0.043)	-0.494	0.622
	undeveloped	-0.020	0.029	(-0.078,0.037)	-0.703	0.489
	others	a_0	-	-	-	-
Total risk score	high	0.126	0.030	(0.066, 0.187)	4.115	0.000 *
	medium	0.036	0.029	(-0.021,0.095)	1.234	0.217
	low	a_0	-	-	-	-
Insurance coverage	Yes	-0.049	0.041	(-0.130, 0.030)	-1.209	0.227
	No	a_0	-	-	-	-
Type of hospital	specialized	0.059	0.035	(-0.009, 0.128)	1.690	0.091
	general	a_0	-	-	-	-
Age of physician	≤40	0.039	0.073	(-0.104, 0.182)	0.786	0.375
	41-50	0.070	0.059	(-0.054,0.186)	6.086	0.014*
	51-60	0.029	0.040	(-0.050,0.110)	0.730	0.466
	≥61	a_0	-	-	-	-
Sex of physician	male	-0.042	0.040	(-0.121, 0.036)	-1.047	0.295
	female	a_0	-	-	-	-
Education of physician	specialty	-0.033	0.031	(-0.095, 0.028)	-1.054	0.292
	subspecialty	a_0	-	-	-	-
Experience	10 yr ≥	0.008	0.052	(-0.095, 0.111)	0.152	0.879
	10 yr ≤	a_0	-	-	-	-
Contract	employed	-0.112	0.162	(-0.136, 0.135)	-1.996	0.055 **
	unemployed	a_0	-	-	-	-
Density		-0.161	0.138	(-0.174, 0.087)	-1.967	0.054 *
Density×Contract		0.253	0.134	(0.073, 0.361)	0.550	0.042**
Goodness-of-fit			Akaike Information Criteria : 692.029			0.000
			Schwarz's Bayesian Criteria: 604.320			0.000

a_0 means that lowest group is considered as base.
***** 0.05 is considered significant
** 0.10 is considered significant

The value of the interaction variable coefficient is greater than zero and significant (δ_1 = 253), so non-salaried physicians compared to salaried ones have done angiographies that are more inappropriate. The goodness of fit of this estimate indicates a proper specification of the model.

The average response rate for each physician, which determines the probability of performing inappropriate angiographies for each physician, is

shown in Table 2. More than 30% of the angiographies were carried out as inappropriate for most physicians. In general, nearly 40% of all angiographies were reported as inappropriate.

Table 2: Probability of inappropriate CAD for each physician

Physician code	*Probability of inappropriate CAD (%)*	*Standard deviation*	*Physician code*	*Probability of inappropriate CAD (%)*	*Standard deviation*
1	27.5	0.07	15	28.7	0.06
2	26.8	0.06	16	27.3	0.05
3	33.8	0.06	17	33.1	0.07
4	29.1	0.06	18	33.7	0.05
5	33	0.06	19	32.3	0.07
6	27.2	0.06	20	33.3	0.06
7	29.1	0.04	21	37.3	0.04
8	30	0.06	22	31.8	0.06
9	30	0.05	23	33.5	0.05
10	35.2	0.06	24	26.4	0.05
11	28.6	0.05	25	35.4	0.05
12	27.5	0.06	26	28.7	0.06
13	33.9	0.08	27	30.3	0.05
14	30.2	0.12	Total	39.3	0.25

The physician ethics index varied among different physicians in proportion to the number of their patients. According to the classification, most physicians were at a moderate rate, meaning that their utility was a combination of both pecuniary and non-pecuniary profits (Table 3).

Table 3: Physicians Ethics Index for Cardiologists

Physician code	*Physician ethic index*	*Appropriateness of Angiography*			*Physician code*	*Physician ethic index*	*Appropriateness of Angiography*		
		Appropriate	Uncertain	Inappropriate			Appropriate	Uncertain	Inappropriate
1	0	54	97	42	15	-0.04	27	39	16
2	0	103	190	93	16	-0.01	27	36	27
3	-0.01	22	30	17	17	-0.01	18	13	14
4	0	35	65	29	18	1.66	13	23	9
5	-0.02	22	36	20	19	3.55	21	40	10
6	-0.02	8	13	11	20	-0.03	14	23	13
7	-0.05	17	42	15	21	1.06	23	44	8
8	-0.06	15	39	23	22	-1.01	26	48	25
9	-0.03	11	4	4	23	-1.01	42	57	37
10	-0.04	15	21	11	24	0	23	35	14
11	0	47	91	39	25	3.14	16	19	16
12	0	27	41	26	26	0.29	4	6	1
13	-0.06	36	55	14	27	1.07	25	38	17
14	0	30	38	34					

As the condition for the probability of existence physician induced demand which mentioned in methodology (the necessary condition $\delta_1 > 0$ and the sufficient condition ($1 \leq |\varepsilon_{p\delta}|$), the results showed that physicians who had codes 18, 19, 21, 22, 23, 25, and 27 are the profit inclination physicians (about 26% of all studied physicians).

On the other hand, if $= |\varepsilon_{p\delta}| = 0$ and $\beta_6 > 0$ or $\delta_1 > 0$, non-salaried physicians provide more services to their patients, due to the differences in practice style. This was true for 22.3% of physicians (codes 1, 2, 4, 11, 12, 14 and 24) (Table 4).

Table 4: Classification of physicians based on physician ethics index

Physician Ethic Index	*Physician code*	*Percentage*
Profit maximizing physician($\lvert\varepsilon_{p\delta}\rvert \geq 1$)	18, 19, 21, 22, 23, 25, 27	25.9
Moderate physician($0 < \lvert\varepsilon_{p\delta}\rvert < 1$)	3, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, 20, 22, 26	51.8
Altruistic physician($\lvert\varepsilon_{p\delta}\rvert = 0$)	1, 2, 4, 11, 12, 14, 24	22.3

Discussion

According to the model, the most crucial demand-side variables were patients' age and total risk score. That is, the younger the patients, the less likely they were to have inappropriate angiography. The finding could be explained in two ways: the first explanation is that younger people have more medical information than elderly individuals do, so physicians are less likely to encourage them to undergo such invasive operations. The second explanation is that because the risk of heart disease is lower in young people, inappropriate use of coronary angiography is relatively low.

Numerous studies on physician-induced demand have examined the patient's age factor and have empirically demonstrated a positive relationship between aging and provision of unnecessary services. By increasing the age of patients, physicians increased the number of home visit and 20 min or more counseling services (15, 16). As women get older, the rate of unnecessary cesarean section has grown (17, 18).

The coefficient of total risk score showed that patients with high scores were more likely to undergo inappropriate angiography. This factor could have led to the request for angiography, which could have been inappropriate and only for-profit inclination or as a matter of necessity. Increase in cesarean delivery rate was attributable to non-clinical factors, and women's health status has played a small role (19).

The most important supplier side variables were age, type of physician's recruitment, and patient to physician ratio. The younger the physicians', the more likely they were to have inappropriate angiographies. Since young physicians have just entered the market, they are more likely to respond to monetary incentives by performing more angiography procedures; it may also be due to their low experience. The results of other studies about physicians' age were different; the older the physicians, the income had less impact (20). However, for primary care physicians, more visits were significantly associated with an increase in physician age (21). The lowest share of the unnecessary requests for MRI was related to physicians with over 20 years of experiences (22).

Regarding the type of physicians' employment, salaried physicians have performed less inappropriate angiographies than non-salaried ones. These physicians may be reluctant to perform inappropriate procedures due to feeling more confident at a position and fixed salary. The ratio of salaried physicians in the hospital had a significantly positive effect on induced demand (23).

On the other hand, by increasing the physician-to-patient ratio in each hospital, the probability of inappropriate tests decreased. In this case, an increase in the number of physicians has led to better access to patients. The role of physician density in different specialties was examined and

found that obstetricians and psychiatrists had increased the number of their services in response to the increase in density (24).

Based on the mentioned scenarios, beside the 23.8%, which considered as an inappropriate, percentage of uncertain angiographies could also be categorized as inappropriate. Overall, about 40% of angiographies were inappropriate, and according to the sufficient condition based on the physician ethics index, most of the physicians behaved moderately, their utility depends on altruistic and pecuniary profits, while others were *profit* maximizers. By combining the results of the physician ethics index and estimation of the induced demand model, we interpreted the physicians' behavior based on two different groups.

A group of physicians who were altruistic according to the medical ethics index was excluded. Of the 27 physicians included in the study, 7 acted like for-profit enterprises and sought to maximize their pecuniary profits ($1- \leq |\varepsilon_{p\delta}|$ and $\delta_1 > 0$). Non-salaried physicians in areas with a higher density also provided additional services, which could show the existence of physician-induced demand.

Although the combination of the ethics index and induced demand model was used in limited studies (24, 25), this method consider necessary and sufficient conditions in formulation, so it has enough strength to calculating physicians induced demand which can be used in different clinical fields.

Conclusion

To reduce unnecessary angiographies, using non-invasive tests before surgery, developing native guidelines, rules, and instructions that oblige physicians to observe the principles set out in the guidelines seems necessary. On the other hand, the policy-makers should pay more attention to increased monitoring of performance and setting revenue caps. To improve the adherence of physicians to medical ethics, more training is required to make a convincing commitment to the medical education system. Besides, policies related to education and increasing patients' awareness can play an efficient role in reducing induced demand.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

The authors acknowledge Clinical Research Development Unit of Shahid Rajaei Hospital, Alborz University of Medical Sciences (ABZUMS) that helped by providing useful comments to finalize the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Pawson R J, Greenhalgh, Brennan C (2016). *Demand management for planned care: a realist synthesis*. Health Services and Delivery Research, europepmc, Southampton (UK), No. 4.2.
2. Peacock SJ, Richardson JR (2007). Supplier-induced demand: re-examining identification and misspecification in cross-sectional analysis. *Eur J Health Econ*, 8(3): 267-277.
3. Richardson JR, Peacock SJ (2006). Supplier-induced demand. *Appl Health Econ Health Policy*, 5(2): 87-98.
4. Folland S, Goodman AC, Stano M (2017). *The Economics of Health and Health Care*. 8th ed. Routledge Taylor & Francis Group, London & New york, pp: 137- 89.
5. Mohammadshahi M, Yazdani S, Olyaeemanesh A, Sari AA, Yaseri M, Emamgholipour Sefiddashti S (2019). A scoping review of components of physician-induced demand

for designing a conceptual framework. *J Prev Med Public Health*, 52(2):72-81.
6. Sarrafzadegan N, Mohammmadifard N (2019). Cardiovascular disease in Iran in the last 40 years: prevalence, mortality, morbidity, challenges and strategies for cardiovascular prevention. *Arch Iran Med*, 22(4): 204-210.
7. Patel MR, Bailey SR, Bonow RO, et al (2012). ACCF/SCAI/AATS/AHA/ASE/ASNC/HFSA/HRS/SCCM/SCCT/SCMR/STS 2012 Appropriate Use Criteria for Diagnostic Catheterization: A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, American Association for Thoracic Surgery, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. *J Am Coll Cardiol*, 59(22):1995-2027.
8. Warnes CA, Williams RG, Bashore TM, et al (2008). ACC/AHA 2008 guidelines for the management of adults with congenital heart disease : a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Develop Guidelines on the Management of Adults With Congenital Heart Disease). Developed in collaboration with the American Society of Echocardiography, Heart Rhythm Society, International Society for Adult Congenital Heart Disease, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. *J Am Coll Cardiol*, ;52(23):e143-e263.
9. Sajadi HS, Ehsani-Chimeh E and Majdzadeh R (2019). Universal health coverage in Iran: where we stand and how we can move forward. *Med J Islam Repub Iran*, 33: 9.
10. Mohammadshahi M, Emamgholipour S, Sakha MA, Olyaeemanesh A, Yazdani S (2021). Appropriateness of angiography for suspected coronary artery disease. *Indian Heart J*, 1;73(3): 376-8.
11. Grytten J and Sørensen R (2001). Type of contract and supplier-induced demand for primary physicians in Norway. *J Health Econ*, 20(3): 379-393.
12. Stano M (1987). A clarification of theories and evidence on supplier-induced demand for physicians' services. *J Hum Resour*, 22(4): 611-620.
13. De Jaegher K and Jegers M (2000). A model of physician behaviour with demand inducement. *J Health Econ*, 19(2): 231-258.
14. Labelle R, Stoddart G, Rice T (1994). A re-examination of the meaning and importance of supplier-induced demand. *J Health Econ*, 13(3): 347-368.
15. Van Dijk CE, Verheij RA, Te Brake H, Spreeuwenberg P, Groenewegen PP, De Bakker DH (2014). Changes in the remuneration system for general practitioners: effects on contact type and consultation length. *Eur J Health Econ*, 15: 83-91.
16. Amporfu E (2011). Private hospital accreditation and inducement of care under the ghanaian national insurance scheme. *Health Econ Rev*, 1(1): 13.
17. Kim B (2010). Do doctors induce demand? *Pac Econ Rev*, 15(4): 554-575.
18. Triunfo P and Rossi M (2009). The effect of physicians' remuneration system on the Caesarean section rate: the Uruguayan case. *Int J Health Care Finance Econ*, 9(4): 333-45.
19. Arrieta A (2015). Over-utilization of cesarean sections and misclassification error. *Health Serv Outcomes Res Methodol*, 15(1): 54-67.
20. Munkerud SF (2012). Decision-making in general practice: the effect of financial incentives on the use of laboratory analyses. *Eur J Health Econ*, 13(2): 169-180.
21. Busato A, Matter P and Künzi B (2009). Factors related to treatment intensity in Swiss primary care. *BMC Health Serv Res*, 9:49.
22. Akhavan S, Emamgholipour S, AliKhassi A, Habibi Z, Ahmadi B (2023). A survey on the amount of unnecessary brain and spine magnetic resonance imaging and reasons to affect it in Tehran, Iran. *Int J Finance Econ*, 28(1): 996-1005.
23. Yuda M (2013). Medical fee reforms, changes in medical supply densities, and supplier-induced demand: Empirical evidence from Japan. *Hitotsubashi J Econ*, 54(1): 79-93.

24. Liao CC. Evidence of physician(supplier) induced demand and physician altruism. [PhD thesis], Wayne State University; 2009.
25. Nasibparast S, Panahi H, Imani A (2018). Determinants of Patient Visit Time With Obstetricians in East Azarbayjan Emphasizing on Physician Induced Demand: Approach of Hierarchical Linear Modeling. *QJ Appl Theo Econ*, 5(2): 127-148.