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Effect of Information and Communication Technology Deployment on Health Expenditures of Iranian Households: A Provincial Approach

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Abstract:
Information and communication technology (ICT) has been rapidly developed in the last two decades and has directly or indirectly affected most areas of human life, including health, which is also referred to as e-health. On the other hand, in the past three decades, most countries in the world have experienced rapid growth in health expenditures, as health expenditures have become one of the most important items of household expenditure. Besides, in developing countries, including Iran, the main financial burden of using health goods and services is borne by households. Reducing the financial burden of health services on households has been one of the long-standing goals of policymakers. It seems that using the ICT capabilities in the form of e-health can be one of the effective solutions in this regard. The present study seeks to investigate this issue. For model estimation, the panel data method and the GLS model in the form of provincial data were applied. The results imply that besides other factors affecting the household health expenditures (such as income, education level, insurance coverage level, etc.), the development of ICT managed to have a significant effect on reducing the health expenditures. It seems developing ICT infrastructure, expanding its penetration rate and developing its applications in the form of e-health can be considered as a proper strategy in the field of health care.

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Introduction

Today, information and communication technology (ICT) has influenced all aspects of human life, from individual relationships to macro areas and social relationships between individuals with varying intensity. Information and communication technology refers to the technology used to collect, transmit, store, retrieve, process, publish and display information [1]. The introduction of this technology into various fields of human life has led to the emergence of sub-categories including e-commerce, e-learning, e-banking, e-government, e-health, etc. In each of these sub-categories, technology emerges as an enabler and increases the productivity, efficiency and effectiveness of policies and activities.

In this context, e-health can be defined as the interface of information and communication technology, public health and medical knowledge as the cost-effective and safe use of information and communication technologies in support of health, including healthcare, regulatory and educational services, knowledge and related research, etc. In line with the above definition, the basic applications of information and communication technology in the field of health care can be mentioned as follows.

1. Health Knowledge Management
2. Electronic Health Records
3. Electronic Personal Health Records
4. E-booking [2-4].
5. Wearable Biosensor
6. Smart E-Home
7. Telemedicine [5,6].
8. Informatics Health Consumer
9. Virtual Mobile Health
10. Healthcare teams [1,7].
11. Healthcare Information Systems
12. …

The review of empirical studies and performance reports suggests [8]. that the use of e-health and internet information instances to access health services by eliminating the intermediaries, administrative costs, long and redundant processes, and medical errors which increase the demand for care, leads to the savings in the healthcare costs. Also, the designed systems make people connect with health care providers faster and with higher quality [2,,9,10,11]. This makes it possible to use e-health capabilities for making the public notification and providing counseling services, semi-specialized and general training and health information sharing, and also the electronic monitoring of policies, prescriptions and practices in the field of health care [10,12,13].

Achieving the e-health benefits requires the proper functioning of (at least) three effective areas in this regard, namely "ICT", "health care" and "health

service providers and clients" as the major components of e-health. In other words, if the above areas have good conditions in a country and serve a proper function, it can be expected that e-health in the community has an acceptable penetration rate. The study of each of the above cases requires independent and separate studies. The present study is intended to investigate the impact of the first component in this field, namely ICT, on the public health components. For this purpose, using the theoretical and empirical economic principles, the effect of ICT development on the expenditures of Iranian households is investigated in the field of health (as one of the most important policy-making variables in the field of health economics). The present study consists of five sections. After the present introduction, the second section reviews the theoretical and empirical foundations of the issue. The third and fourth sections are devoted to the materials and methods and model estimation and findings analysis. The final section will be the discussion and conclusion.

Methods

Theoretical and Empirical Foundations

Today, the health sector is one of the most important economic sub-sectors and, at the same time, has a significant share in household expenditures. In this regard, increasing productivity and efficiency in the turnover of this sector can be very important. It is expected that by further utilizing the ICT, the health services will be faster and of better quality, and as a result, the household health expenditures will be reduced. This issue is the focus of attention in the present study. In this regard, the question to be answered is whether the development of information and communication technology could reduce household health expenditures? In other words, has ICT been able to play a role as one of the factors affecting household expenditures in the field of health? A review of the literature suggests that the main factors affecting household health expenditures can be classified as follows:

A) Income: In most empirical studies, a direct relationship has been observed between income in various forms (current or permanent, a householder or per capita income, etc.) and household health expenditures [14-21].[1]

B) Education level: The theoretical and empirical foundations in the field of health economics indicate that there is expected to be a positive relationship between education and health expenditures, which include the treatment costs and contingency and preventing measures. However, it is not possible to firmly state the type of this relationship[14,15,19,21,25].

[1] . It should be noted that investing in health can also lead to economic growth [22,23].It implies that there is a bilateral causality between health quality and economic growth.

C) Gender: The studies indicate that due to the physical differences between men and women, the gender differences in household members can lead to the differences in the amount they spend for the health expenditure [14,15,26].
D) Age Structure: Age structure has been proposed as one of the factors affecting the pattern of health expenditures. In this regard, in various studies, age has been measured in various ways, including the proximity to death, presence or absence of the elderly and children, age of the individual or householder, the average age of family members, etc[14,15,21,26,27,28].
E) Wealth: The demand for goods and services, according to Friedman's theory, is a function of permanent income instead of current income. Part of the permanent income comes from the wealth of individuals. Also, households may provide part of the cost required for health care through the sale of their assets [14,26,29].
F) Insurance Coverage: As discussed in the basics of microeconomics, one of the main factors for the demand for all goods and services is the price or the associated consumption cost. Therefore, the insurance status of the household or householder as one of the main factors in the cost of goods and services in the field of health can affect the amount of health [14,15,19,28].
G) Household Dimension: The number of family members or household dimension affects household health expenditures in different ways. The first effect is the increase in health expenditures due to the need for more health goods and services in larger families. The second effect occurs in the conditions where in the event of limited financial resources, instead of investing in the health of members to benefit from the optimal state of physical and mental health, families (necessarily) allocate the available resources to more essential needs such as food, clothing and housing. Therefore, the family dimension is one of the effective factors that can play a dual role[14,15,30].
H) Spatial (Geographical) Pattern of habitation: Most countries in different geographical areas have significant differences with each other depending on the development level, especially in terms of access to appropriate health facilities. These differences can lead to changes in the need for treatment or the cost of accessing the goods and services [14,15,19,25].
In summary, it can be stated that the main factors affecting the household health expenditures can be classified into four categories, namely economic (income, insurance and wealth), social (education, geographical location), demographic factors (household dimension, gender and age structure) and other influencing factors such as ICT deployment (in the context of e-health) as discussed previously. The results are shown in the following conceptual models (Figure 1), which is an adaptation of the studies conducted by [14,24,28]…. .

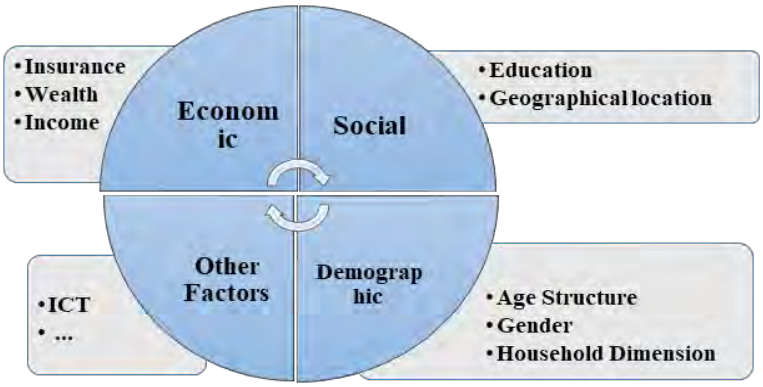

Figure 1: Affecting Factors of Health Expenditures
Source: Research finding

Material & Models

The empirical model is based on the quantitative estimates using the studies in [1,14,24]. to investigate the impact of ICT development on health expenditures can be presented with some adjustments as follows.

$\text{Ln He1}_{it} = B_0 + B_1 \text{Ln IDI}_{it} + B_2 \text{Ln Y}_{it} + B_3 \text{Ln Ins}_{it} + B_4 \text{LnEd}_{it} + U_{it}$

$\text{Ln He2}_{it} = B_0 + B_1 \text{Ln IDI}_{it} + B_2 \text{Ln Y}_{it} + B_3 \text{Ln Ins}_{it} + B_4 \text{LnEd}_{it} + U_{it}$

In these equations the variables are as follows:

$He1_{it}$: Per capita real health expenditure of urban households in the province i at the time t (including expenditure on laboratory services, painkillers, radiology, sonography, radiotherapy, scanning, echo and general physician visit).

$He2_{it}$: Per capita real health expenditure of urban households in the province i at the time t (including expenditure on general physician visit as a proxy for all health expenditure[1]).

IDI_{it}: ICT Development Index in the province i at the time t.

Y_{it} : Per capita real income in the province i at the time t.

Ins_{it} : Provinces' share of total purchased insurance in the province i at the time t.

Ed_{it}: Ratio of educated people to the population in the province i at the time t (including Diploma and higher education).

Ln; stands for Logarithm value of variables.

1 . We opted variable and considered it in our estimation in the favor of robustness of results.

Data Collection Method: In all models, the variables are adjusted for price and population fluctuations, meaning that all variables, as the case may be, are considered as per capita or real values. For the information and communication technology (ICT) index, the data related to the ICT development index (IDI)[1] adapted from the portal of information society monitoring of the Islamic Republic of Iran were used. Other data were collected from the sources of the Statistics Center of Iran. Besides, pending on availability of data, all the data are collected on a provincial basis for the period of 2008-2015 and provide the basis for the estimates.

Model Estimation: In the present study, the panel data method is used to estimate the model. The models are estimated using the fixed effect and Generalized Least square (GLS) technique. Before making the estimates, it is inevitable to perform the following diagnostic tests.

F-test (equality of intercepts): The F-test was performed to check for the presence or absence of a separate intercept for each of the sections. After ensuring that the variables are stationary, in the next step, the type of pool or panel data in the estimation is determined using the Chow test. The results of this test (table1) indicate that the null hypothesis, namely pool data, is rejected and the panel data is confirmed.

Hausman test: The results of the Hausman test (table2) show that the fixed effects should be applied in the model.

Variance heterogeneity test: The significance of the test statistic in Table 2 shows that the variance of the error terms is not homogeneous and there is the heterogeneity of variance.

Error term autocorrelation test: The significance of the test statistic in table 1 for models 1 and 2 shows that the error terms are auto-correlated.

Table1: F- test & Error Term Autocorrelation Test Results

Models	Dependent variable	Independent variables	F-test	Prob
		F- test:		
1	LHE1	LY, LIDI, LED, LINS	11.08	0.000
2	LHE2	LY, LIDI, LED, LINS	9.98	0.000
		Error Term Autocorrelation Test:		
1	LHE1	LY, LIDI, LED, LINS	10.620	0.003
2	LHE2	LY, LIDI, LED, LINS	22.678	0.000

1 . IDI is an index designed and published by the International Telecommunication Union (ITU) and is calculated from a combination of 11 sub-indices in the three areas of access, consumption and skills.

Table 2: Hausmann Test & Variance Heterogeneity Test Results

Models	Dependent variable	Independent variables	X^2-test	Prob
		Hausmann Test:		
1	LHE1	LY, LIDI, LED, LINS	13.46	0.0092
2	LHE2	LY, LIDI, LED, LINS	38.47	0.000
		Variance Heterogeneity Test:		
1	LHE1	LY, LIDI, LED, LINS	2362.46	0.000
2	LHE2	LY, LIDI, LED, LINS	2799.45	0.000

Results

Since the models have heterogeneity of variance and autocorrelation, the GLS method was used to solve these two problems and accurately estimate the model. The results of estimating the model by the GLS method is reported in table 3 and 4. [1]

Table 3: Results of Model 1

Variable	Coefficients	Prob
LY	0.204	0.000
LIDI	-0.289	0.004
LED	-0.077	0.016
LINS	-0.599	0.000
C	-2.632	0.000

Table 4: Results of Model 2

Variable	Coefficients	Prob
LY	0.254	0.000
LIDI	-0.538	0.000
LED	-0.524	0.012
LINS	-0.563	0.000
C	-5.498	0.000

In the first and second models, according to the estimation results, the health expenditures have a positive and significant income elasticity and its coefficients are equal to 0.2 and 0.25. This means that with a 1% increase in the per capita real income, the per capita health expenditures increase by less than 1% (0.20-0.25%). The positive value of this coefficient indicates that with economic

[1] . Among different combinations of variables in our estimations, model 1 & 2 implied best fitness and other variable such as age Structure, geographical habitation pattern, etc. had not meaningful estimated coefficient.

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growth and improved living standards, people tend to pay more attention to their health status to achieve higher quality and more comfortable life because income is one of the most important factors affecting household health expenditures. Income provides people with the ability to supply health goods and services. This finding has also been confirmed in practical studies such as[19,20,31,32].

The coefficient of the ICT development index (IDI) is negative and significant. The negative value of this variable indicates that the increase in this amount, or in other words, the development of information and communication technology leads to a decrease in the per capita health expenditures of urban households at the provincial level. This finding implies that information and communication technology development can lead to wider communication, faster detection of diseases, timely treatment and prevention of diseases, increased communication between physicians and patients, establishing rational communication between experts and citizens without time and space restrictions, and fairer access. For these reasons, it can be stated that the development of information and communication technology will reduce household health expenditures. As a result, the main hypothesis of the research is confirmed (based on the significant effect of ICT development on the reduced household expenditures). The coefficient of this variable shows the per capita elasticity of health expenditures relative to the ICT development index and indicates that for the 1% increase in the ICT development index, the per capita health expenditures decrease by less than 1%. This is because health is an essential and normal service. This finding has also been confirmed in practical studies [8,11,].

The coefficient of the education share variable is negative and significant. The negative value indicates that the increase in the ratio of the number of educated people to the population (diploma, associate and bachelor) decreases the per capita health expenditures of urban households at the provincial level. As mentioned earlier, education has a positive or negative effect on household health expenditures. As education levels increase, people become more aware of their health needs and use preventive healthcare services when needed so that they have less need for healthcare services in the future. According to this approach, the higher the education level, the higher the preventive health expenditures in the short run, and the lower the healthcare costs in the long run. However, increasing the education level by increasing public awareness and disease prevention in the short term can also have a reducing effect on health expenditures, which is also observed in the present study and has also been confirmed in some practical studies [14,32,33].

The coefficient of the variable related to the insurance coverage level became negative and significant. The negative value of this variable indicates that the increase in the share of insurance expenditures leads to a decrease in the health

expenditures of urban households. This means that if households are covered by insurance, their per capita health expenditures will be significantly reduced. This finding has also been confirmed by practical studies[15,28,34].

Discussin

One of the effective approaches in reducing and managing household health expenditures is to use the capabilities of information and communication technology. This issue was studied in the present study. According to the existing theoretical and empirical foundations and the estimates made during the present study (tables 3 and 4), it was observed that there is a negative and significant relationship between the development of information and communication technology in Iranian provinces and the per capita health expenditures of urban households. These results confirm that the utilization of ICT capabilities in the context of E-health (by establishing extensive communication between physician and patient, wider geographical coverage, faster detection and prevention of diseases and their timely treatment, creating a healthy competitive environment among health professionals and those involved in the healthcare, improving the quality of services and establishing a rational connection between experts and citizens without time and space constraints, etc.) leads to the savings in the health expenditures for households. This result implies that investing in E-health readiness can be a proper strategy in Iran [35].

In general, it can be concluded that the development of ICT has had a significant effect on reducing the health expenditures of Iranian households (e.g., reducing the physician visit cost). It seems that one implication of the present study can be seen in the current pandemic conditions of Covid-19. Undoubtedly, the use of Iran and the world health system of ICT capabilities as an enabler in the instances such as disease monitoring, counseling, notification, and online training, etc., has been very effective in dealing with and managing this disease. Besides, other instances of this technology such as e-learning, e-commerce, e-government, etc. have also been effective in the achievements of this field.

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper

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تأثیر استقرار فناوری اطلاعات و ارتباطات بر هزینه های سلامت خانوارهای ایرانی: رویکرد استانی

چکیده:
فناوری اطلاعات و ارتباطات (ICT) در دو دهه اخیر به سرعت توسعه یافته است و به طور مستقیم یا غیرمستقیم بیشتر حوزه های زندگی انسان از جمله سلامت را تحت تاثیر قرار داده است که از آن به عنوان سلامت الکترونیک نیز یاد می‌شود. از سوی دیگر، در سه دهه گذشته، اکثر کشورهای جهان رشد سریعی در هزینه‌های سلامت داشته‌اند، زیرا هزینه‌های سلامت به یکی از مهم‌ترین اقلام هزینه‌های خانوار تبدیل شده است. همچنین در کشورهای در حال توسعه از جمله ایران، عمده بار مالی استفاده از کالاها و خدمات بهداشتی بر دوش خانوارها است. کاهش بار مالی خدمات سلامت بر خانوارها یکی از اهداف دیرینه سیاستگذاران بوده است. به نظر می‌رسد استفاده از قابلیت‌های ICT در قالب سلامت الکترونیک می تواند یکی از راهکارهای موثر در این زمینه باشد. پژوهش حاضر به دنبال بررسی این موضوع است. برای برآورد مدل از روش داده های تابلویی و مدل GLS در قالب داده‌های استانی استفاده شد. نتایج حاکی از آن است که علاوه بر سایر عوامل مؤثر بر مخارج سلامت خانوار (مانند درآمد، سطح تحصیلات، سطح پوشش بیمه‌ای و غیره)، توسعه فناوری اطلاعات و ارتباطات توانسته تأثیر بسزایی در کاهش هزینه‌های سلامت داشته باشد. به نظر می‌رسد توسعه زیرساخت ICT، گسترش ضریب نفوذ آن و توسعه کاربردهای آن در قالب سلامت الکترونیک می‌تواند به عنوان یک استراتژی مناسب در حوزه مراقبت های بهداشتی تلقی شود.

واژه های کلیدی: فناوری اطلاعات و ارتباطات، ایران، هزینه های بهداشتی، خانواده، استان.