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RESEARCH ARTICLE

THE EFFECT OF SPORTS PARTICIPATION, ECONOMIC FACTORS, AND MEDICAL CAPACITY ON HEALTHCARE COSTS IN IRAN

Saeed Khanmoradi[1], *Farimah Rahimi*[2], *Reza Rezayatmand*[2*]

1. Department of Physical Education, Farhangian University, Tehran, Iran
2. Health Management and Economics Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

*Correspondence: reza.rezayatmand@gmail.com

ABSTRACT

BACKGROUND:

Rising household healthcare expenditures have become a critical global concern, compelling health policymakers to identify effective strategies for cost management. Iran, grappling with significant economic and healthcare challenges, faces increasing financial burdens on households within its healthcare system. This study aims to investigate the relationship between sports participation, economic factors, medical capacity, and healthcare costs in Iran, drawing upon the theoretical framework of the Grossman Health Production Function.

METHODS:

This study utilizes panel data covering all Iranian provinces over a 15-year period (2008–2022), resulting in 420 observations. The Panel Estimated Generalized Least Squares (EGLS) approach is employed to estimate the long-run associations between the identified health-producing inputs and healthcare expenditures.

RESULTS:

The findings reveal that higher levels of sports participation are significantly associated with reduced healthcare costs. Economic growth, proxied by Gross Domestic Product (GDP), shows a negative association with healthcare spending. Conversely, an increase in the inactive population and physician manpower is linked to higher healthcare costs, while a higher density of authorized hospital beds is associated with a reduction in household healthcare expenditures, potentially reflecting enhanced service efficiency.

CONCLUSION:

The results suggest that integrating sports-based preventive programs with strategic management of medical capacity and economic planning could serve as a viable strategy for healthcare cost containment in Iran. Policymakers are encouraged to consider these multidimensional factors to mitigate the financial burden of healthcare on households and foster a more sustainable healthcare financing environment.

KEYWORDS

sports participation, health care, gdp, physician manpower, hospital beds, population.

INTRODUCTION

Household healthcare costs represent a substantial financial burden, particularly in developing and low-income countries, where high out-of-pocket expenditures can have severe economic consequences. These costs encompass all direct payments made by families for medical care, including doctor fees, hospitalization, and medications, often constituting a significant portion of household income [1]. The heavy financial burden can prevent lower-income families from accessing essential treatments [2]. Evidence indicates that healthcare costs for households can be enormous. For instance, Bangladeshi households spend up to 35% of their income on healthcare [1]. In developing countries, where individuals cover more than 75% of healthcare costs themselves, this issue can push them into severe poverty [3]. India has also experienced an increase in healthcare costs in the private sector, reaching 5,019 rupees, which is significantly higher compared to the 1,307 rupees in the public sector [4]. Rising healthcare costs are increasingly recognized as a major global concern, driven in part by the prevalence of chronic diseases such as chronic kidney disease, prostate cancer, and liver diseases [5]. Global healthcare costs reached $8.3 trillion in 2018, equivalent to 10% of global GDP. It is projected that this figure will rise to approximately $18.3 trillion, or 10.2% of global GDP, by 2040 [6].

Iran's healthcare financing system, though not fully dependent on out-of-pocket payments, faces major challenges, including heavy reliance on such payments and persistent inequalities in access [7]. Despite reforms such as the Health Transformation Plan (HTP), the system remains fragmented and inefficient, negatively impacting overall health outcomes, leading to increased household healthcare costs [2]. Healthcare expenditures have surged from $7 billion to $34 billion, while insurance coverage remains limited due to regressive financing and administrative gaps [8]. Understanding these factors is critical for policymakers to design effective, equitable health financing reforms [1]. enabling health managers to mitigate the growing financial burden.

It is believed that regular physical activity and exercise can offer long-term health benefits and are associated with a reduction in healthcare-related costs [9]. In fact, sports participation significantly reduces healthcare expenses due to health benefits. During childhood and adolescence, sports participation declines in adulthood, especially among older adults. Studies show positive impacts on cardiovascular and metabolic outcomes, mental health, and cost savings across different demographics [10, 11].

Effective management of healthcare costs through sports participation requires strategies tailored to a country's economic context [12]. Economic income can either increase or reduce healthcare costs, with rising incomes causing higher usage and costs, and economic development providing resources for public health programs and technological advancements [13]. Healthcare costs also vary across demographic groups; for instance, children typically incur lower expenses than adults or the elderly [14]. Homemakers may experience different health outcomes compared to employed women [15]. Prior studies have used GDP to assess the impact of economic factors on healthcare costs [16, 17]. and research highlights the role of population size and demographic trends in shaping healthcare expenditures [18, 19].

Medical capacity should undoubtedly be considered in healthcare cost policymaking. Healthcare infrastructure, including hospitals, clinics, and the number of physicians, significantly impacts costs [20]. A study on emergency departments (EDs) in Montreal revealed that variations in physicians' practice styles could lead to substantial differences in healthcare costs [21]. Additionally, a study focused on Medicare stakeholders identified regional characteristics, including the number of specialists available, as key determinants of healthcare costs at the end of life [9]. In situations where there is a shortage of beds, patients may be discharged quickly, potentially leading to readmissions and increased costs. Conversely, if beds are readily available, patients may stay longer than necessary, increasing costs [22].

Iran's healthcare system faces challenges that raise out-of-pocket costs. Although sports participation and effective management of healthcare capacity and economic factors can reduce expenses, their combined impact remains largely unexplored. This study examines these factors' influence on healthcare costs, providing actionable insights for policymakers and health managers.

METHOD

DATA AND VARIABLE

The theoretical foundation of this study is based on the Grossman Health Production Function (1972), which posits that individuals produce their own health through the investment of inputs such as time, lifestyle choices, and medical services. Within this framework, health is conceptualized as a durable capital stock that depreciates overtime, and investments in preventive measures are essential to maintain or enhance this stock. In the context of this study, sports participation is treated as a critical preventive investment that contributes to the 'health stock' of the provincial population. Consequently, the panel data model employed here seeks to estimate how variations in health-producing inputs—namely sports participation, economic growth (GDP), demographic factors (inactive population), and healthcare infrastructure (physician manpower and hospital beds)—relate to provincial healthcare expenditures. By adopting this theoretical lens, we frame healthcare costs not as independent outcomes, but as the result of cumulative investments and demographic shifts within the provincial health production process. Following this conceptual approach, the empirical model is specified as follows. Panel data will be used in this research. Therefore, data from all provinces of Iran were collected from the Statistical Center of Iran from 2008 to 2022. Observations were gathered for 15 years across 28 provinces of Iran (420 Observation).

Sports participation (SP) was measured as the number of registered athletes in official sports clubs who hold a valid membership and regularly attend sports venues. This indicator provides a consistent, government-verified measure of organized sports activity across province. The healthcare costs variable represents households' average annual healthcare expenditures, encompassing healthcare and insurance costs. The economic factors include the variables of Gross Domestic Product (GDP), the active population, and the inactive population. GDP which shows the total value of goods and services produced within Iran annually Also, GDP was measured in constant prices to remove the effect of inflation. The active population was calculated by determining the percentage of individuals from the population who are of working age (typically 15 to 64 years old) and are either employed or actively seeking employment (unemployed but looking for work). The inactive population was calculated as the percentage of individuals from the population who are of working age (typically 15 to 64 years old) but do not participate in economic activities, such as students, homemakers, and those with income but without employment. The medical capacity factors include physician manpower (the number of medical doctors) and hospital beds. These beds refer to those for which a hospital has obtained official government permission and the latest license, allowing them to be used and maintained. All monetary variables, specifically Healthcare Costs (HC) and Gross Domestic Product (GDP), were converted into constant prices (real terms) using the Consumer Price Index (CPI) obtained from the Statistical Center of Iran, with 2016 as the base year. The choice of 2016 (1395 SH) as the base year is based on the standards adopted by the Statistical Center of Iran for CPI calculation, aimed at maintaining consistency with official macroeconomic data. The information related to the variables and research data is presented in Table 1.

TABLE 1, DATA AND VARIABLE SUMMARY

Variable	Description	Symbol	Source	Unit
Sports Participation	Number of individuals actively engaged in sports, recorded systematically in sports club registries	SP	Statistical Center of Iran	Number
Healthcare Costs	Average annual healthcare expenditures of households, including healthcare and insurance costs	HC	Statistical Center of Iran	Constant 2016 Rials
Gross Domestic Product	The total value of goods and services produced within Iran annually	GDP	Statistical Center of Iran	Constant 2016 Rials

Active Population	Percentage of working-age individuals (15-64) who are employed or actively seeking employment.	AP	Statistical Center of Iran	Percentage
Inactive Population	Percentage of working-age individuals (15-64) who do not participate in economic activities.	IP	Statistical Center of Iran	Percentage
Physician Manpower	The number of medical doctors	PM	Statistical Center of Iran	Number
Approved Hospital Beds (B)	Number of hospital beds for which a hospital has obtained official government permission and the latest license	B	Statistical Center of Iran	Number

MODEL AND ANALYSIS

An equation is considered to estimate the study's results (EQ 1).

Eq1: $\ln(HC_{it})=\beta_0+\beta_1\ln(SP_{it})+\beta_2\ln(GDP_{it})+\beta_3\ln(AP_{it})+\beta_4\ln(IP_{it})+\beta_5\ln(PM_{it})+\beta_6\ln(B_{it})+\varepsilon_{it}$

In Equation (1), $\ln(HC_{it})$represents the natural logarithm of real healthcare costs, and $\ln(SP_{it})$, $\ln(GDP_{it})$, $\ln(AP_{it})$, $\ln(IP_{it})$, $\ln(PM_{it})$, and $\ln(B_{it})$represent the natural logarithms of sports participation, real Gross Domestic Product, active population, inactive population, physician manpower, and the number of approved hospital beds for province $i$at period t, respectively. The coefficients $\beta_1$through $\beta_6$represent the output elasticities of healthcare costs with respect to each independent variable. Finally, $\varepsilon_{it}$is the error term. Based on this specification, this study investigates the elastic relationship between sports participation, economic factors, medical capacity, and healthcare expenditures in Iran.

A potential threat to causal inference in this study is the risk of endogeneity arising from reverse causality between healthcare expenditures and economic development, as well as from omitted variable bias. To mitigate these concerns, and given that all monetary variables (HC and GDP) have been adjusted to constant 2016 prices to ensure cross-temporal comparability, this study employs panel data techniques that allow controlling for unobserved, time-invariant heterogeneity across provinces.

Specifically, the log-linear specification in Eq. 1 allows the estimated coefficients (β_1 to β_6) to be interpreted as elasticities, representing the percentage change in healthcare costs in response to a one-percent change in the independent variables. Fixed-effects estimation is utilized to account for province-specific structural characteristics that are not directly observable. Furthermore, time fixed effects are incorporated to capture macroeconomic shocks and nationwide policy changes affecting all provinces simultaneously.

To determine the most appropriate estimation method, both Fixed Effects (FE) and Random Effects (RE) models were estimated. The Hausman specification test indicated that the Fixed Effects model was preferred. However, diagnostic tests revealed heteroscedasticity and cross-sectional dependence. Therefore, the Panel Estimated Generalized Least Squares (EGLS) approach with period SUR weights was applied (incorporating both province and year fixed effects to control for provincial structural heterogeneity and temporal shocks) to obtain efficient and reliable estimates. This approach effectively addresses potential heteroscedasticity and autocorrelation that could otherwise violate the assumptions of OLS regression and bias the elasticity estimates.

To ensure the validity of our long-run estimates, we examined the integration properties of the variables using panel unit root tests (Levin-Lin-Chu and Im-Pesaran-Shin). Given that the variables were found to be $I(1)$, we proceeded to perform Pedroni's (2004) panel cointegration tests to detect the existence of a long-run equilibrium relationship. The reported results confirm that the variables are cointegrated, thereby justifying the use of the EGLS estimation method to capture the stable long-term relationship between sports participation and healthcare costs.

To address concerns regarding potential reverse causality, we incorporated lagged independent variables into our model. This dynamic specification accounts for the fact that the health benefits of sports participation—and consequently the reduction in healthcare expenditures—are not instantaneous and may materialize over time. Furthermore, as a robustness check, we considered a dynamic panel specification to assess the stability of our results against endogenous feedback loops.

Finally, to ensure the robustness of our findings, we performed several sensitivity analyses. This included excluding potential outlier provinces (e.g., Tehran) to verify that our results were not driven by idiosyncratic provincial characteristics. Additionally, we explored alternative model specifications to assess the stability of the estimated elasticities. The robustness of the model was further validated through the Pesaran Cross-Sectional Dependence (CD) test and the Jarque-Bera normality test, ensuring the reliability of our empirical framework.

RESULTS

This section presents the variables' descriptive statistics, followed by the diagnostic test results and, finally, the results of the EGLS regression.

TABLE2, DESCRIPTIVE STATISTICS

Variable	Mean	Std. Dev.	Minimum	Maximum
ln(HC)	16.32	1.91	14.41	22.86
ln(SP)	10.74	0.98	7.19	13.41
ln(GDP)	17.15	1.65	9.59	22.92
ln(AP)	3.58	0.44	3.26	4.53
ln(IP)	4.10	0.08	3.36	4.50
ln(PM)	6.58	0.91	5.57	9.10
ln(B)	7.63	1.05	6.34	11.29

Table 2 presents the descriptive statistics for the variables used in this study after applying the natural logarithmic transformation. The variable ln(HC) exhibits a mean of 16.32, with values ranging from 14.41 to 22.86, indicating significant variation in healthcare costs across provinces. The mean of ln (SP) is 10.74, with a standard deviation of 0.98, while ln (GDP) shows a mean of 17.15 and a range between 9.59 and 22.92. Regarding demographic indicators, ln (AP) and ln (IP) have mean values of 3.58 and 4.10, respectively. Finally, the infrastructure variables, ln (PM) and ln(B), report mean values of 6.58 and 7.63, respectively. This logarithmic transformation reduces the impact of scale differences and outliers, ensuring that the subsequent regression analysis provides robust estimates of the elasticities between sports participation and healthcare costs.

Before estimating the long-run elasticities of healthcare costs, we conducted a comprehensive series of diagnostic tests to ensure the validity of our econometric framework. Initially, the stationarity of all log-transformed variables—namely ln(HC), ln(SP), ln(GDP), ln(AP), ln(IP), ln(PM), and ln(B)—was examined using the Levin-Lin-Chu (LLC) panel unit root test. The results confirmed that all variables are integrated of order one, $I(1)$, at the 5% significance level, a necessary condition for exploring long-run equilibrium. Consequently, we performed the Pedroni (2004) panel cointegration test, which confirmed a stable long-run relationship among these variables, justifying the application of the Panel EGLS approach.
Furthermore, we evaluated the properties of the model's residuals to verify the reliability of our estimates. The Pesaran Cross-Sectional Dependence (CD) test yielded a statistic of 5.17 ($p < 0.01$), rejecting the null hypothesis of cross-sectional independence and indicating significant correlation across provincial error terms. Additionally, the Jarque-Bera test statistic (P<0.01) rejected the null hypothesis of normally distributed residuals.

Given these diagnostic findings—specifically the presence of cross-sectional dependence and non-normality in the error terms—the selection of the Panel EGLS method (with period SUR weights) is empirically justified. This estimator effectively

corrects for these violations, ensuring that the estimated elasticities (the coefficients $\beta_1$to β_6) are efficient and robust to the identified econometric challenges.

TABLE3, PANEL EGLS REGRESSION RESULTS

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.0385	1.0003	-3.0384	0.0025
ln(SP)	-0.1800	0.0082	-21.8628	0.0000
ln(GDP)	-0.2500	0.0462	-5.4089	0.0000
ln(AP)	-0.0500	0.1848	-0.2705	0.7869
ln(IP)	+0.2200	0.0598	3.6817	0.0003
ln(PM)	+0.3500	0.0129	27.1073	0.0000
ln(B)	-0.1200	0.0230	-5.2063	0.0000
R-squared	0.6982			
Adjusted R-squared	0.6945			
S.E. of regression	0.0842			
F-statistic	162.45			
Prob(F-statistic)	0.0000			
Durbin-Watson stat	1.98			

Table 3 presents the estimation results of the panel EGLS model (with period SUR weights) using log-transformed variables. As the variables are log-transformed, the estimated coefficients represent the long-run elasticities. The results show that ln(SP) is significantly associated with lower healthcare costs (β=-0.18,t=-21.86, p<0.01). This indicates that a 1% higher level of sports participation corresponds to a 0.18% lower level of healthcare expenditures, ceteris paribus.

Economic growth, proxied by ln(GDP), also demonstrates a statistically significant negative association with healthcare costs (β=-0.25, p<0.01). Among demographic variables, ln(IP) (inactive population) exhibits a positive correlation with healthcare costs (β=+0.22, p<0.01), suggesting that provinces with a higher proportion of inactive individuals tend to face greater healthcare financial pressure. Conversely, the association between ln(AP) (active population) and healthcare costs is found to be statistically insignificant.

Regarding infrastructure, ln(PM) (physician manpower) shows a positive elasticity of 0.35 (P<0.01). Finally, ln(B) (approved hospital beds) displays a negative elasticity of -0.12 (p<0.01), which may suggest that higher hospital capacity is linked to long-term efficiencies or reduced household out-of-pocket spending in the Iranian provincial context.

DISCUSSION

The first finding indicated that increased participation in sports is associated with a reduction in healthcare costs. The findings of studies by Codogno et al. (2020) and Karl et al. (2018) generally support this theory [10, 11]. In Iran, research has also shown that greater participation in sports is consistently associated with improved health outcomes and reduced healthcare costs, particularly in the case of chronic diseases [23]. However, other studies emphasize the increase in costs due to sports-related injuries [24]. It appears that the difference in findings may be attributed to the focus of these studies on specialized and professional sports, as well as short-term group surveys, such as those conducted with patients visiting a specific clinic. In contrast, the present study emphasizes all provinces of the country and considers the number of participants in organized sports.

Another finding indicated that a higher GDP is associated with a slight reduction in healthcare costs. This finding is consistent with studies that have shown a small but significant negative impact of economic growth on healthcare expenditures [17]. However, it somewhat contradicts other studies that suggest a positive relationship between GDP and healthcare costs [25]. The reason for this discrepancy lies in the different methods of calculating GDP in previous studies,

which considered GDP per capita, whereas the present study used the total GDP. Additionally, Iran has unique income conditions due to sanctions and economic challenges, which may differ from other countries.

Another economic finding of this study indicated that an increase in the inactive population leads to higher healthcare costs. Pakdaman et al. (2019) reported a positive and unidirectional relationship between population rate and healthcare expenditures, while Rezaei et al. (2016) showed that an increase in population leads to a reduction in healthcare costs [26, 27]. The reason for this discrepancy lies in the type of population considered in the calculations. The present study includes the percentage of household members, students, and others between the ages of 15 and 65, whereas the study by Rezaei et al. (2016) focuses on individuals aged 65 and older.

The results of the study further indicated that an increase in physician manpower leads to higher healthcare costs. This finding is consistent with the research of Gowrisankaran (2018) and Panahi et al. (2015)[21, 28].

Finally, the results of the study showed that an increase in approved hospital beds leads to a reduction in healthcare costs. Hajizadeh & Nghiem (2013) found that a higher number of hospital beds per capita is associated with better quality of care [29]. In contrast, Panahi et al. (2015) suggested that an increase in the number of physicians and hospital beds could lead to higher healthcare costs [28]. The reason for this discrepancy lies in the different time periods of the studies. Panahi et al. analyzed data from 2001 to 2010, during which Iran faced significant economic and sanction-related challenges, leading to numerous changes in both healthcare and economic sectors.

IMPLICATIONS OF THE RESEARCH FOR HEALTHCARE MANAGERS AND POLICYMAKERS

Healthcare managers and policymakers may consider implementing strategic planning to manage Iran's healthcare expenditures effectively, taking into account the factors identified in this study. Integrating healthcare and sports management could potentially expand sports participation and contribute to lower healthcare costs through preventive measures. Such an objective might be facilitated through the establishment of joint agreements or the implementation of sports-based preventive health programs within the community.

Given that Iran has faced economic challenges and a decline in household purchasing power in recent years, fluctuations in the country's GDP may be influenced by broader economic factors. Therefore, policymakers might find it beneficial to incorporate the current economic landscape into their planning for healthcare cost management. Potential strategies could include emphasizing the domestic production of medical equipment and pharmaceuticals, implementing evidence-based health policy reforms, and enhancing the overall efficiency of healthcare service delivery. As Iran's healthcare financing system faces various challenges—often resulting in increased out-of-pocket expenses—the growing demand for services among the inactive population appears to be linked to rising healthcare costs. To address this, health authorities could explore strategies such as reforming financing mechanisms for diverse population groups, expanding disease prevention initiatives, and enhancing elderly care services. Providing more robust insurance coverage for these groups may help mitigate the upward pressure on healthcare costs associated with a larger inactive population. The capacity of the medical sector is a significant factor that, if managed strategically, could influence the financial burden of healthcare on households. An increase in the number of physicians is associated with a higher volume of patient visits, which may correlate with higher overall healthcare expenses. In this regard, more comprehensive insurance coverage policies could potentially assist in reducing the financial impact on households and might transform the growing physician workforce into an opportunity by providing individuals with expanded access to care.

Finally, while an increase in the number of authorized hospital beds might initially appear to contribute to higher expenditures, it may also enhance accessibility and provide individuals with more options, potentially leading to lower long-term household healthcare burdens. Consequently, implementing optimal hospital bed management policies could potentially improve patient access to medical services while contributing to cost-containment efforts.

RESEARCH LIMITATIONS AND SUGGESTIONS FOR FUTURE STUDIES

Other economic and medical variables, such as the number of hospitals, healthcare service centers, and income inequality, can also be estimated and examined alongside sports participation in future research. It should be noted that Sports participation measure may not capture informal or unorganized sports participation. Future studies are encouraged to incorporate broader measures of physical activity if such data becomes available. Moreover, this combination of variables can be analyzed in other countries, allowing for comparisons between their results and the findings of this study The data for this research were collected from the Statistical Center of Iran, which was the only available source providing data with such a combination of variables. Consequently, decisions regarding the time frame, variable units, and the number of observations were influenced by the data published by this center. Therefore, although variables such as inflation, insurance coverage, and healthcare policies may influence healthcare expenditures, consistent provincial data for the study period were not available.

CONCLUSION

This study provides insights into the dynamics of healthcare cost management for policymakers and healthcare administrators in the Iranian context. The findings suggest that higher levels of sports participation, increased GDP, and expanded access to hospital beds are associated with a reduction in healthcare expenditures. Conversely, an increase in physician manpower and a larger inactive population are linked to higher household healthcare costs.

Based on these results, it is suggested that healthcare managers and policymakers consider comprehensive planning strategies to manage expenditures effectively. Potential solutions might include the establishment of inter-sectoral agreements to support sports-based preventive health programs, the implementation of evidence-based policy reforms, and enhancements in the efficiency of healthcare delivery. Furthermore, prioritizing domestic production of medical supplies and optimizing the management of medical capacity could serve as valuable strategies for cost containment.

In summary, to mitigate the financial burden of healthcare on households, it appears beneficial for policymakers to explore the integration of sports-based preventive initiatives with broader medical capacity and economic planning. Adopting such a multi-faceted approach may contribute to more favorable outcomes in healthcare cost management and long-term financial sustainability.

CONCFLICTS OF INTEREST:

There is no conflict of interest.

FINANCIAL SUPPORT:

This study has received no financial support.

ETHICAL DECLARATION:

This study exclusively utilized secondary, aggregated data obtained from the Statistical Center of Iran, with no access to individual-level or personally identifiable information. Consequently, formal ethical approval was not required for this research, in accordance with standard practices for studies using publicly available, de-identified datasets.

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