Kuzu, S., Kablan, A. ve Demir, İ. "Analysing Factors Leading to Catastrophic Expenditure in Surgical Health Care", Eskişehir Osmangazi Üniversitesi İİBF Dergisi, 20(1), 182 – 199.
Doi: 10.17153/oguiibf.1526481

Başvuru: 02.08.2024 Kabul: 01.10.2024 *Araştırma Makalesi/Research Article*

Analysing Factors Leading to Catastrophic Expenditure in Surgical Health Care

Serdar Kuzu[1]
Ali Kablan[2]
İbrahim Demir[3]

Cerrahi Sağlık Hizmetlerinde Katastrofik Harcamalara Yol Açan Faktörlerin Analizi	**Analysing Factors Leading to Catastrophic Expenditure in Surgical Health Care**
Öz Katastrofik sağlık harcamaları (CEH), hanelerin belirli bir dönemde sağlık hizmetlerini finanse etmek için temel harcamalarını azaltmaları ve bireylerin cepten harcamalarının hanenin harcamalarının veya gelirinin büyük bir kısmını aşması veya karşılaması durumunda ortaya çıkmaktadır. Bu çalışma, CEH düzeyi ile sağlık sisteminin yapısının ve ülkenin gelir düzeyinin temel bir göstergesi olan genel sağlık harcamalarındaki (HE) kamu sağlık harcamalarının payı arasındaki ilişkiyi analiz etmeyi amaçlamaktadır. Çalışma sonucunda satın alma gücü paritesi kullanılarak hesaplanan toplam HE'lerdeki kamu HE'lerinin oranının ve kişi başına düşen gelirin, cerrahi prosedürler için CHE'lerin riski üzerinde istatistiksel olarak anlamlı bir negatif etkiye sahip olduğunu bulunmuştur.	**Abstract** Catastrophic health expenditure (CHE) occurs when households reduce their basic expenses to finance health services in a certain period and when individuals' out-of-pocket expenses exceed or cover a large portion of the household's expenditure or income. This study analyzes the relationship between the CHE level and the share of public health expenditures in overall health expenditures(HE), an essential indicator of the health system's structure and the country's income level. The study found that the proportion of public HEs in total HEs and per capita income calculated using purchasing power parity had a statistically significant negative impact on the risk of CHEs for surgical procedures.
Anahtar Kelimeler: Sağlık Ekonomisi, Katastrofik Sağlık Harcamaları, Cerrahi Bakım, Gayri Safi Yurtiçi Hasıla	**Keywords:** Health Economics, Catastrophic Health Expenditure, Surgical Health Service, Gross domestic product
JEL Kodları: I12, I19	**JEL Codes:** I12, I19

Araştırma ve Yayın Etiği Beyanı	Bu çalışma bilimsel araştırma ve yayın etiği kurallarına uygun olarak hazırlanmıştır.
Yazarların Makaleye Olan Katkıları	Çalışmanın tamamı üç yazar ile birlikte eşit olarak oluşturulmuştur.
Çıkar Beyanı	Yazarlar açısından ya da üçüncü taraflar açısından çalışmadan kaynaklı çıkar çatışması bulunmamaktadır.

[1] Doç. Dr., İstanbul Üniversitesi Cerrahpaşa Sosyal Bilimler MYO, serdar.kuzu@istanbul.edu.tr .
[2] Doç. Dr., İstanbul Üniversitesi Cerrahpaşa Sosyal Bilimler MYO, ali.kablan@iuc.edu.tr .
[3] Doç. Dr., Yıldız Teknik Üniversitesi Fen Edebiyat Fakültesi İstatistik, idemir@yildiz.edu.tr .

1. Introduction

CHE is defined as any HE the household makes to meet and maintain its health needs by cutting back on its other needs, which may affect its financial capacity and ability (Wagstaff, 2009; Sharifa Ezati & Almualm, 2017). CHE also occurs when out-of-pocket (OOP) healthcare expense payments exceed a certain household income or expenditure threshold. Financial disaster occurs when out-of-pocket healthcare expenses equal or surpass a particular percentage of household income. In other words, CHE happens when out-of-pocket health costs exceed, to some extent, the expenditures necessary for households to meet their fundamental living needs. The World Health Organization recommends that healthcare expenditures should be called catastrophic when they are equal to or greater than 40% of disposable income. However, there is yet to be a clear consensus on this issue, as each country may adopt a higher or lower percentage in their national health policies (Zhao et al., 2020, p. 2). No standard threshold in the literature determines the occurrence of CHE. There have been several investigations on the threshold level used to define CHE.In these studies, Onoka et al. (2011) set the threshold levels from 5% to 40%, Kimman et al. (2015) set the threshold level of 30% of total household income, Wagstaff et al. (2018) reported that HEs were 10% of household consumption. They stated that it would occur if it exceeds 25% (Kimman, et al., 2015; Wagstaff et. al ,2018; Onoka et al., 2011).

As the amount of out-of-pocket HEs, which contribute to ensuring continuity in the financing of the health system within the framework of the policies and rules determined regarding the functioning of the health system, increases, households face difficulties in meeting their most basic health needs and accessing more qualified health services. The size of households' out-of-pocket HEs varies depending on the importance of countries' health services and differences in their socioeconomic structures and quality (Waldo & Helen, 1984 ; You & Kobayashı, 2012) The size of HEs and their social impact cause individuals to reduce their costs on other goods and services, and households are dragged into poverty due to the non-delayable nature of HEs.

To determine why countries have to conduct CHE, it is necessary to focus on several parameters, such as the level of welfare throughout the country, access to and use of health services, opportunities related to health insurance, structural factors related to the organization of health institutions and demographic characteristics of households. This nature of HEs increases the possibility of them being catastrophic. Therefore, identifying the factors affecting household CHEs, improving health policies, and taking measures to reduce poverty will provide essential clues to policymakers. CHE is not just due to the high costs of healthcare. Even a few HEs can result in catastrophic spending by pushing poor people to cut back on necessities like housing or schooling. In some circumstances, even if households meet the public's criteria for health spending, they may have to pay for specific quantities of health care out of pocket to access or enhance quality (Xu et al., 2003). This situation causes millions worldwide to experience financial difficulties due to their weakened ability to pay. This occurs in both low and high-income countries. The situation is aggravated by the fact that out-of-pocket payments are the most popular payment method for health care, particularly in underdeveloped or poor nations, and households are in danger of CHE and impoverishment (O'Donnell et al., 2008; Ghosh, 2010).

The main goals of the health system are to improve the health status, meet the demand, and provide fair financing. The WHO has set three main goals for health systems:

- Improving the population's health
- Improving sensitivity to the segment the health system serves
- Equitably distributing the health system's payment burden among households (WHO, 2010)

CHE can be calculated based on expenditure and income. According to the expenditure-based approach, CHE arises when out-of-pocket health spending reaches a specific percentage of people's expenditures, excluding basic living needs. Households with a 40% or above HE-to-payment capacity ratio are classified as "households making CHEs." Although this rate is open to criticism, it is generally accepted as between 45% and 55%.

In some studies in the literature, Weraphong et al. (2013) stated that CHE occurs when OOP HEs made by households reach more than 10% of the total HE of the household within one month (Weraphong et al., 2013). Xu et al. (2005) found that fewer households had to make catastrophic payments if the ratio of out-of-pocket HEs to total HEs was less than 15%. The World Health Organization recommends that healthcare expenditures should be called catastrophic when they are equal to or greater than 40% of disposable income (Xu et al., 2005).

CHE arises when out-of-pocket healthcare costs exceed those that allow households to meet their basic living necessities to some level. Although there is debate in the literature about the extent to which CHEs occur when out-of-pocket HEs exceed a certain percentage of household income, this approach states that CHEs occur when out-of-pocket HEs exceed 10% of total income. Although there is no consensus in the literature regarding this limit, it is known that the limit accepted by the WHO as the "fair financing" amount is generally taken as a basis. This represents an average threshold at which people compromise on their other needs, become indebted, and become impoverished (Xu et al., 2003).

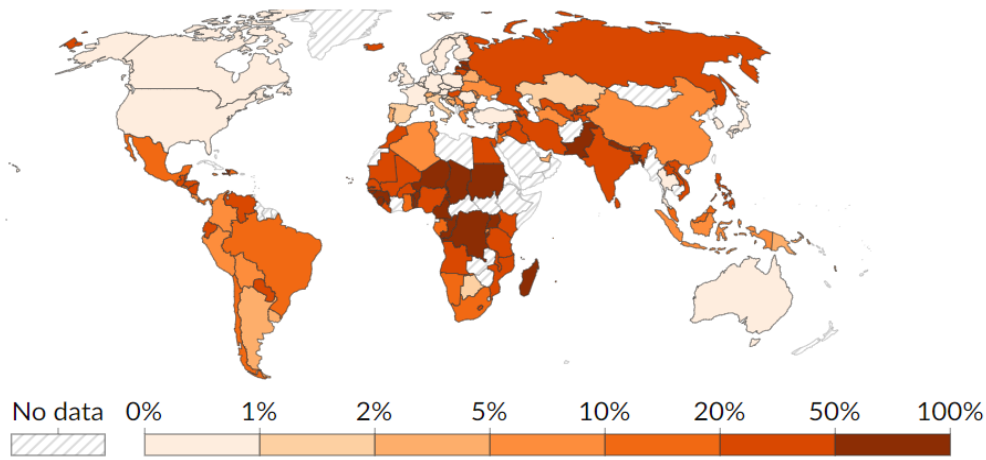
Access to healthcare is something that every individual should achieve, regardless of income level. Increasing access and affordability of health services is essential for the welfare of society. At the country level, out-of-pocket HEs are not the sole determinant of CHE. While the public provides health care financing to countries through taxes and premiums, it is provided by households directly or indirectly (private health insurance) through their out-of-pocket expenses. The shift in CHE is influenced by fundamental elements such as the countries' economic income, the number of households that utilize CHEs, the share of out-of-pocket HEs in total HEs, risk distribution, and the presence of classification systems. The factors of CHE can be identified using regression-based estimating approaches to evaluate whether a country is at higher risk of CHE. Thus, measures can be taken to protect households from financial risk (Xu et al., 2003).

Direct or indirect out-of-pocket expenses of households are closely related to the state's health policies. In countries where the social state approach prevails, households' out-of-pocket HE rates are expected to be low. The CHE is aligned with the spending indicator used in the Sustainable Development Goals and is crucial for monitoring progress towards universal health coverage.

Surgical procedures account for approximately 30 percent of global disease costs. An estimated 33 million people have access to healthcare each year. Many studies have determined that those accessing it face financial difficulties due to direct surgery costs.

However, over 5 billion people globally lack access to safe, inexpensive, timely surgical and anesthetic care (Bijlmakers et al., 2019, p. 85). Surgery is an essential component of health care, and emergency surgery is characterized by being sudden, unexpected, high-risk, and costly. Uninsured patients risk experiencing delayed, more complex disease and significant financial hardship after discharge. CHE is a validated measure of the financial burden of high out-of-pocket healthcare expenses. According to the Lancet Commission on Global Surgery's Utstein consensus report, preserving financial healthcare, which is one of the primary indicators of essential surgical intervention, is a pillar of delivering safe, equitable surgery worldwide (Meara et al., 2015; Davies et al., 2021). Approximately 5 billion people globally lack access to safe, inexpensive, timely surgical and anesthetic care (Bijlmakers et al., 2019, p. 85). Although it is known that this impact is most prevalent in middle and low-income nations, CHE is also common in developed countries with informal sectors. This situation underlines the weak economic situation in providing necessary needs. (Shrime et al., 2021)

Figure 1: Share of The Population at Risk of Catastrophic Expenditure when Surgical Care is Required (2020)



Source : (OWD, 2024)

2. Application

The most crucial stage of econometric research is data collection on variables. In particular, collecting data from reliable sources by the model increases the reliability of econometric estimates. In this context, three data types applied in econometric analysis are mentioned. These Are time series, cross-section, and panel data analysis (Das, 2019). Panel data analysis will be used in this study. Panel data provides researchers with the opportunity to work with more data. Thus, the degree of multicollinearity among explanatory variables decreases, and the reliability of econometric estimates increases.

Panel *data* are created by repeatedly reviewing a single cross-sectional sample at different periods. Since panel data consists of a combination of time series and cross-sectional data, they show change over time due to the time dimension and according to units due to the cross-sectional dimension. For this reason, panel data models are created to include both dimensions (Das, 2019)(Das, 2019). The panel data model is most generally expressed as follows:

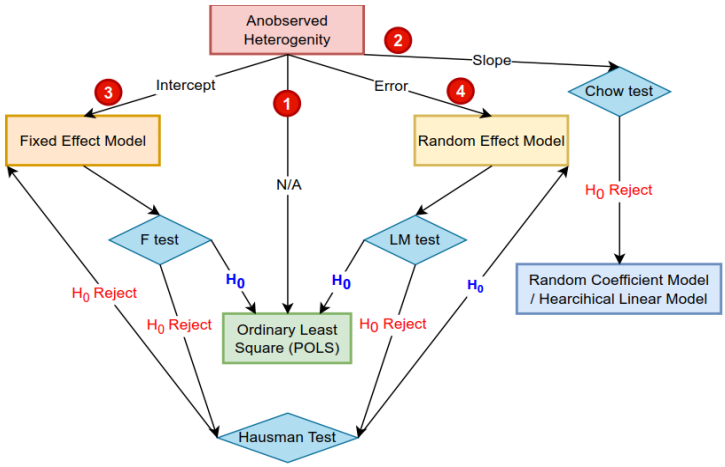
$$y_{it} = \alpha + \sum_{j}^{k} \beta_j X_{jit} + u_{it} \qquad j = 1, \dots, k; \;\; i = 1, \dots, N; t = 1, \dots, T$$

Here, the index k indicates the number of variables, the index i indicates the units, and the index t indicates time (Stock & Watson, 2007). NT denotes the sample size. In this model, the parameter α indicates that all units have a common intercept. β_j parameters show the common marginal effects of each explanatory variable on all units. In other words, it is assumed that the parameters α and β_j do not differ between units and/or over time in the model (Hsiao, 2003).

Panel data consists of N units and T number of times corresponding to each unit, thus allowing us to see group and time effects. There are many advantages to using panel data for econometric forecasts (Hsiao, 2007; Baltagi, 2013).

In this study, dynamic panel data methods are used. After a model is established, the Chow test is used to examine whether the slope coefficients of the model are constant. If the coefficients are constant, the pooled panel data model is compared with the fixed-effect and random-effect models. Whichever of these models is effective, analysis continues based on that model. The most effective model is obtained by comparing fixed and random effect models. This situation is summarized in the figure below.

Figure 2: Panel Data Modeling Process



3. Data and Model

The primary goal of this study is to look at the statistical parameters that influence CHE for surgical treatment in 24 nations from 2008 to 2020. In other words, in this study, an examination was made of the CHEs of access to different health services. The main goal is to identify CHEs due to out-of-pocket payments. The study used the CHE risk variable to proxy for CHE for surgical healthcare services. The Risk of CHE for surgical healthcare service is expressed as "the proportion of the population at risk of catastrophic expenditure when surgical care is required." However, CHE refers to direct out-of-pocket expenses for surgical and anesthesia healthcare services that exceed 10% of total annual income.

In this study, we used data on GDP per capita (current US dollars), domestic general government HE (% of total government spending), and the risk of catastrophic surgical care expenditure (% of persons at risk). We obtained data from the World Bank and income level information from the IMF Database.

Several data types can be used in econometric analyses, including panel, cross-sectional, and time series data. In panel data, observation values in the relevant period are presented for each cross-sectional unit (Wooldridge, 2010). The horizontal section reveals the observation values at a certain point in time about the data time. Time series data refers to the observation values of the variable or variables in a specific period. Panel data analysis includes horizontal and time-section observations, allowing the number of observations and freedoms to increase. While it allows heterogeneity of units with the panel data set, it does not allow heterogeneity for the unit size in the data outside (Baltagi, 2013). In addition, while other data types allow deviations in the estimation of parameters due to the error term arising from the relationship between the variables used, such deviations can be reduced in panel data analysis. In addition, various limitations of panel data analysis are also included in the literature. The most important is collecting data, correcting it, and creating observation value. While there are no problems in the unit dimension in panel data analysis, problems may occur in the time dimension. The point to note here is that in non-linear panel data analyses, if the number of observations is less than the time dimension, unbalanced panel data should be made, and if there are enough observations, balanced panel data should be made. Panel data analysis is estimated using one of the Classical Least Squares, Fixed Effects, and Random Effects approaches, depending on the assumptions regarding constant, slope, and error terms (Wooldridge, 2010).

Although we used fixed effects regression in our study, we modelled the relationship between the Risk of CHE and the share of countries' income levels and public HEs using the general or classical model.

$$RCE_{it} = \beta_0 + \beta_1 GHE_{it} + \beta_2 GDP_{it} + u_{it} \qquad i = 1, \dots, N; t = 1, \dots, T$$

The classical model is a model where both constant and slope parameters are assumed to be constant according to units and time; all observations are homogeneous. Another name for this model is the pooled model.

$$RCE_{it} = \beta_0 + \beta_1 GHE_{it} + \beta_2 GDP_{it} + \mu_i + u_{it} \qquad i = 1, \dots, N; t = 1, \dots, T$$

when unit effects.

when there are time effects. When there are both unit and time effects, the model was established as

$$RCE_{it} = \beta_0 + \beta_1 GHE_{it} + \beta_2 GDP_{it} + \mu_i + \lambda_t + u_{it} \qquad i = 1, \dots, N; t = 1, \dots, T.$$

Here, β denotes independent coefficients, i denotes countries, and t denotes time. μ_i and λ_t are unobservable units and time effects, respectively. Unobservable effects are known as unit and time effects. Unit effects models and time effects models are called one-way models. Models in which unit and time effects are combined are called two-way models. Unit effects models are taken into consideration more than these models. Data about the model are given in Table 1. We used a balanced panel data method to include countries with data in the study. For this reason, our data consists of countries available between 2008 and 2020. The study sample includes annual data from 24 countries from 2008 to 2020.

Table 1: Descriptive Variables and Statistics

Variable	Definition	Source	Mean	Min	Max
RCE	The proportion of the population at risk of catastrophic expenditure when surgical care is required for i country at t time.	World Bank Data (2019)	1.111	0	10
GDP	Gross domestic product based on purchasing power parity (PPP) per capita GDP for i country at t time.	IMF Data (2019)	15.427	8.252	24.489
GHE	Domestic general government health expenditure (% of current health expenditure) for i country at t time.	World Bank Data (2019)	50084.041	8561.064	123678.7

Country List: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkiye, United Kingdom, United States

The analysis findings are displayed in the table below once the pooling most miniature squares model has been constructed.

Table 2: Linear Regression

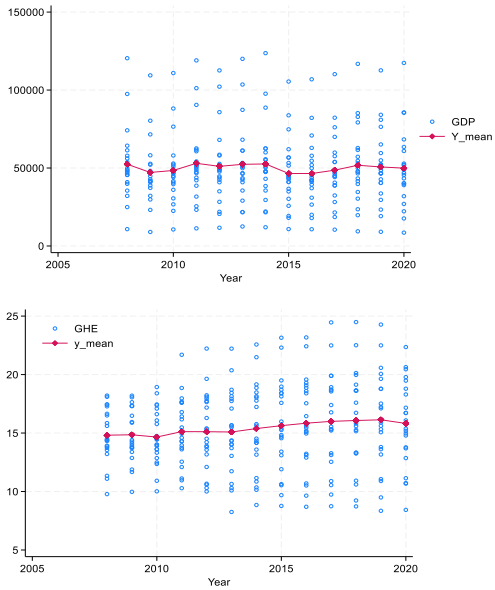
RCE	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
GHE	-.264	.027	-9.97	0	-.316	-.212	***
GDP	0	0	-4.63	0	0	0	***
Constant	6.112	.446	13.69	0	5.233	6.99	***

Mean dependent var	1.111	SD dependent var	1.844
R-squared	0.317	Number of obs	286
F-test	65.596	Prob > F	0.000
Akaike crit. (AIC)	1057.591	Bayesian crit. (BIC)	1068.559

**** p<.01, ** p<.05, * p<.1*

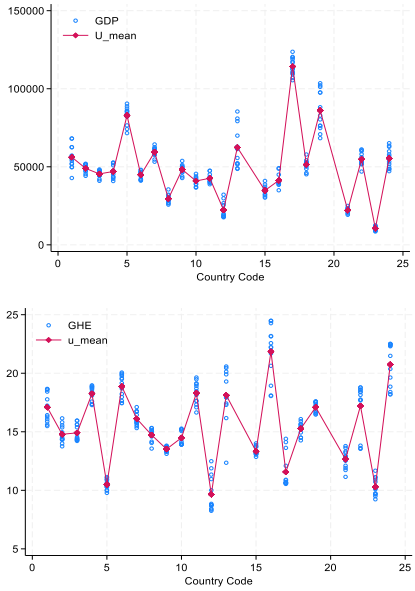
When the model is examined, it is statistically significant ($F = 65.596$; $p < 0.01$). Accordingly, it is seen that expenditures are negatively affected by GDP ($p < 0.01$) and GHE ($p < 0.01$). Considering all countries, it is seen that these variables have a severe contribution to HEs. Here, the GDP coefficient value is (-0.0000185). According to the model, if there is a one-unit increase in GHE value, there will be a 0.264-unit decrease in RCE.

Figure 2: Fixed effects; Heterogeneity Across Years



If we interpret this graph, when we ignore the countries and take 2008 as a reference, it can be seen that the GDP and GHE values do not vary significantly over time. In other words, average GDP and GHE do not change over time.

Figure 3: Fixed effects; Heterogeneity Across Countries



If we interpret this graph, it can be seen that the GDP and GHE values vary significantly depending on the country, regardless of time.

Before presenting our model in our paper, we tested its structure using the F and LR tests. The primary purpose of revealing the time and unit effects here is to reveal the existence of regression in our model. The least squares estimator made under these effects and used to estimate the regression will not give reliable results. The alternative hypothesis states that the effect exists, and the null hypothesis states that it does not exist (Das, 2019).

This link must be found if the modelling includes a unit or time effect. If a possible relationship exists, using fixed effects model estimators will give more accurate results.

When unit and temporal effects are unrelated to the independent variables in the established model, utilize a random effects model rather than a fixed effects model. The Hausman test determines if the time series is a fixed effect or random effects model (Das, 2019; Hübler, 2005).

Table 3 shows the results of the F, LR, and Hausman tests, which reveal the scenarios described above. According to the test results, the F and LR test results were statistically significant, indicating the presence of a unit or time impact in the developed model.

Table 3: F, LR and Hausman Test Results

	F test	**LR test**	**Hausman test**
Unit effect model	F=108.97(0.0000)	LR=524.11(0.0000)	H=1.94(0.3786)
Time effect model	F=0.53(0.8942)	LR=0.0 (1.0000)	
Twoway model	F=---	LR=542.33(0.0000)	

The time effect is not significant in the model, but the one-way unit effect is substantial, as demonstrated by the F and LR tests, and this condition is depicted in Table 2. Following this, it is required to determine whether the unit effect is constant or random. Specifically, the Hausman test determines whether or not the criterion E(α_i,x_it=0) occurs. The investigation results revealed no significant difference between the fixed and random effects. The Hausman test determines if the time series is a fixed or random effects model (Park, 2011). This test determines whether there is a relationship between the error term and explanatory variables due to the unit effect; if there is none, the random effects model suggests that it be utilized. Because the within-group estimate approach was utilized in the study, the random effects model is deemed inappropriate, and the fixed effects model should be used instead.

In the study, within the scope of panel data analysis, after determining that the fixed effects method (fixed effects model) is more suitable for analysis based on the Hausman test results, the basic assumptions of the model, namely varying variance, autocorrelation, and inter-unit correlation, were revealed and tested for the reliability of the results. If at least one of these assumptions is not met, our model will not produce statistically significant findings, preventing us from proceeding securely. At this point, the Pesaran CD was used for inter-unit correlation, the LBT and Durbin-Watson tests for autocorrelation, and the Wald test for heteroscedasticity. Model assumptions were explored. The Walt test revealed considerable heteroscedasticity ($p < 0.01$). In other words, our model exhibits heteroscedasticity. The autocorrelation test was performed using the LBT and Durbin-Watson tests, which revealed positive autocorrelation. The Breusch-Pegan Lagrange Multiplier Test was used to see whether there was any correlation between units. The examination revealed that the null hypothesis was rejected ($\chi^2=595.407$; $p<0.001$). Tests in our model revealed the presence of inter-unit correlation, autocorrelation,

and heteroscedasticity. When they were present, the Driscoll and Kraay standard error correction estimator, a robust estimator, was employed instead of direct fixed effects. This approach generates standard errors consistent in heteroskedasticity, even for large N and T situations, and is resistant to generic spatial and temporal correlation patterns. Briefly, it corrects any divergence from the assumption. The final model prediction results are presented in Table 4 below.

Table 4: Analysis of Fixed Effects Model Estimate Results with Driscoll-Kraay Standard Errors

RCE	Coef.	t-value	p-value
GDP	-.0000146(0.0000579)	-2.52	0.027
GHE	-.153944 (.0222947)	-6.90	0.000
Constant	4.218228(.4818592)	8.75	0.000
Number of obs	286		
F statistic	25.50		
Prob > F	0.000		
Method	Fixed effects regression		
Within R-squared	0.1521		

**** p<.01, ** p<.05, * p<.1*

The model's F statistic was 25.50, and it was determined that it was statistically significant. The R-square value indicated that the model's independent variables had 15% explanatory power in predicting the probability of CHE for surgical healthcare services.

The model's coefficient for the general government HE variable revealed a statistically significant inverse association. In other words, it has been determined that increasing the public HE rate by one unit reduces the risk of CHE for surgical services by 0.153 units. Second, the Gross Domestic Product variable included in the model had statistically equivalent findings to the general HE variable. In other words, assuming all other variables stay constant, a one-unit increase in country wealth is predicted to reduce the risk of CHE for surgical services by 0.00001 units. The additional table shows how country effects influence the model.

In conclusion, the GHE variable was determined to have a statistically significant and unfavorable impact on 24 countries between 2008 and 2020. It was also determined that per capita income computed using PPP had a statistically significant negative impact on the risk of CHE in surgical procedures.

4. Discussion

Health and healthcare services are essential human rights that contribute to human life and capability development. Equity in healthcare has long been regarded as an essential goal (Paul et al., 2018). In their study, Njuguna et al. (2017) found that good health is essential for personal growth and long life and that the availability and cost-effectiveness of health facilities determine the quality of life in any country (Njuguna et al., 2017). Thus, financial access to health is crucial. CHE is an essential financial indication of access to health care. From this perspective, CHEs are very important in terms of evaluating the citizens' restriction of access to health services when they feel that they have difficulty paying for care services rather than showing how difficult it is for citizens to pay the costs of health care services (Papanicolas and Smith, 2013, p.21). Because, considering that CHEs increase with the existence of out-of-pocket payments, it is thought that the affluent segment is more exposed to CHEs because they can access health services more efficiently.

On the other hand, there is a misconception that people with low incomes are not exposed to CHEs because they try to handle simple applications that require medical services themselves. The most critical devastating effects of CHEs are being impoverished, leading to a decrease in living standards and the loss of education, etc., in low-income households. It prevents them from incurring necessary expenses in critical areas. Therefore, studies of CHE are essential for individuals and health systems. It is thought that with economic growth and increased welfare, individuals' demand for more special and prioritized health services has been effective in the increase of catastrophic expenditures.

CHE is a significant obstacle to surgical care. Even in low-income and developing countries, a health insurance policy that eliminates financial risk is a significant obstacle. In non-high-income countries, factors that may pose a risk of CHE include people with disabilities, being unemployed, and not having health insurance. Within the framework of sustainable development goals set out in the world, goals such as economic growth and reducing or even eliminating poverty worldwide will only go beyond being achievable if the risk of CHE is addressed. Population and modeling-based studies show that CHE has a significant destructive effect. Nearly 45% of the world's population is at risk of CHE if they undergo surgery. In addition, the costs of surgical procedures can push many patients from all over the world to the point of not being able to undergo surgery, and inadequacy causes many bad scenarios to occur.

Most studies on CHEs in the literature discuss personal and financial disasters at the micro level. For example, Paul et al. (2018) concluded in their study that the poorest segment, as well as the poor and middle-income segment, are still exposed to financial shocks in HEs (Paul et al., 2018). In addition, Azzani et al. (2019) concluded that socioeconomic injustice significantly impacts the incidence of HEs in all countries (Azzani et al., 2019). Although the literature reached similar results in our study, we concluded a significant relationship between income level, one of the indicators of socioeconomics, and CHE, and a negative relationship between income level and disaster risk.

In their analysis of 59 countries, Xu et al. (2003) discovered three significant CHE criteria: payment-based health services, low fee capacity, and the absence of copayment or health insurance. Our study found that the structure of a country's health insurance system, including public health insurance rates and income levels, impacts the cost of surgical procedures. It demonstrates that our results are consistent with the findings of Xu et al.

Lee and Yoon (2019) revealed many vital points in their study. First of all, they concluded that CHE increases with age and that this condition is higher in those with national health insurance than in those with medical care and is observed at a higher rate in those without private health insurance. In short, this situation is a buffer against the devastating health expenses arising from private health insurance. (Lee, 2024)

Although private health insurance was not directly included in the model, our findings revealed that public HEs, which reflect health insurance, impacted CHEs. From this standpoint, any public or commercial insurance system will lower the likelihood of catastrophic healthcare costs. Protecting people from CHEs in developing countries, which requires a multidisciplinary partnership, such as politics and economics, is accepted as the desired goal of the health system. Accordingly, universal health insurance is accepted as a regulation that can provide everyone with access to health care and financial protection (Kim et al., 2015, p.241). CHEs have advantages as well as disadvantages. To reduce the devastating impact on the population, countries encourage expanding health insurance options by providing a range of complements.

Health insurance provides adequate compensation, especially for increasing catastrophic expenses, and institutions are established to provide palliative care services. Thus, even in countries where social insurance exists, vulnerable households can be protected from the devastating effects of diseases, and their access to services can be increased.

Atake and Amendah (2018) revealed that the most critical factors of CHE are hospitalization duration, health insurance type, socioeconomic position, and household size. Furthermore, while it is known that this impact is most prevalent in medium and low-income nations, CHE is also relatively common in developed countries with informal economies (Atake & Amendah, 2018).

Although many general factors affect CHEs, it is observed that the level of CHEs in some countries does not yield the desired results. For example, Fazaeli et al. (2016), in their study in Iran, reported that a meager percentage of households faced devastating HEs and that the implemented policies did not significantly change the development of justice in the health system financing (Fazaeli, et al., 2016). This indicates that CHEs are affected by many factors and may vary by region, place, and time. Among catastrophic expenses, CHEs stand out. However, CHEs occur more in middle and low-income countries and in informal economies where the Health System Is Inadequate (Wagstaff, 2018, p.766). Our study empirically demonstrated that the above factors affect CHE.

Although the primary purpose of the state is to establish a comprehensive health system in order to prevent threats that may arise, especially for citizens whose income levels are below a specific limit in public health expenditures, the share of out-of-pocket expenditures in health expenditures decreases, but its share in income does not decrease. From this perspective, states need to increase the funds covering public health expenditures to reduce the risk of CHE. Another way to reduce CHE risk is to increase individuals' income levels. However, since it involves many problems, ensuring this is comprehensive and widespread requires a long time. Because increasing the share of health expenditures in current incomes can be achieved in a shorter time than increasing the income levels of countries. When the study's primary results are examined, it has been determined that the increase in health expenditures on a unit basis has a significant effect on surgical CHE expenditures.

It should be noted that the returns will become more beneficial as countries that attach importance to deregulation in terms of health increase the share of health expenditures in the income levels they achieve. The increase in the number of the aging population in the world shows that the share of health expenditures in income will increase. When considered on a country basis, the share of health expenditures in countries below these indicators is low compared to countries with good health indicators, and the share of health expenditures in total income is low, which increases the risk of CHE. In addition, since health expenditures are high in developed countries with high income levels, CHE risks are lower.

Our study has shown that as financial deregulations and fund amounts increase in countries within the scope of health, CHE decreases, and the budget amount foreseen for these expenditures increases effectively. Our study overlaps with many literature studies on this subject, and in addition to increasing people's incomes, the amount of health financing can be increased. The risk of CHE can be reduced with developments such as increasing the tax amounts foreseen for the health system, economic growth and its spread to the base, and positive reflections on macroeconomic indicators. In addition, studies have shown that

expenditures made in countries with low health expenditures have a higher effect on health parameters.

When financing catastrophic health expenditures through out-of-pocket payments, an absolute balance must be established between reducing unnecessary demand and reducing costs, as well as the difficulties that low-income groups may encounter in accessing health services. Furthermore, it is recommended that catastrophic health expenditures be financed by public health insurance in countries that adopt the principle of a social state.

5. Conclusion

Health expenditures made by countries can be observed with the current health expenditure per capita variable, and with this variable, countries can be ranked and how much health expenditure per capita in each country can be seen.

Surgical health service is essential to healthcare systems in industrialized and developing countries, regardless of condition or degree of care. Advances in communication technology and medicine are continuously driving up the cost of health care. When people require surgical care, they may face these costs and the danger of catastrophic expenses. CHEs jeopardize households' everyday expenses and standard of living. CHE arises when out-of-pocket HEs surpass the expenditures required for households to meet their basic living needs by a specific percentage. As this scenario worsens, it hurts household income. The most severe negative consequences of CHEs include poverty, which leads to worse living conditions and a lack of education among low-income families. It prohibits companies from incurring necessary expenses in critical areas. As a result, studies on the drivers of CHEs are economically and socio-politically significant at both the macro and local levels.

Our study found a statistically significant negative association between the fraction of public HEs in total HEs, calculated using PPP, and per capita income, calculated using GDP parity, with the risk of CHE for surgical procedures. In other words, increasing the share of public expenditures in general HEs for surgical treatments and raising country income levels reduces the risk of CHE.

In general, CHE is more likely to occur in low-income areas and areas where public health insurance coverage is inadequate. It is essential to ensure reforms that will reduce the risk of CHE and provide access to the health system in low-income regions where the support of international organizations such as the World Bank is provided and where the insurance system is not fully developed.

On the other hand, when we look at developed countries in terms of health economics, surgical procedures, and new treatment methods, advanced technology increases the costs. Therefore, although it may be due to different reasons, surgical procedures pose the risk of CHE even in developed countries. The existence of a linear relationship between the economic level of the countries and the health system, people's financial access to health opportunities will contribute to the countries' economic growth, and the risk of CHE will automatically decrease due to increasing income.

When the direct and indirect costs of surgery are considered, patients may prefer medical treatment instead of surgical treatment. However, this situation can cause more and more costly situations. Therefore, the main goal should be to make surgical services accessible and more affordable. In addition, practices such as increasing insurance opportunities within the framework of savings plans, carrying the cost to more affordable levels, increasing growth

figures in the country's economy, and spreading it to the base should be addressed, and strategies should be created accordingly. On the other hand, sometimes surgical care applications may not be sufficient to protect people from CHE even if they are provided free of charge. The basic situation here is the problem that health care is not provided free of charge most of the time. Because there will always be a cost to providing and receiving health care, even if surgical care is provided to the patient without incurring any cost, they will face the risk of CHE due to the ancillary services (radiology, medicine, etc.). Surgical diseases can take more lives than other deadly diseases in the world. Therefore, stakeholders such as legislators, foundations, and aid organizations should implement appropriate policies and strategies to provide surgical care services and make the necessary efforts to reduce the resulting costs to reasonable levels.

CHE resulting from surgical care continues to be a problem that concerns the world. Dealing with this problem requires many efforts. In these efforts, to raise academic awareness and offer solution opportunities to many stakeholders, studies should be conducted to investigate, reduce, and find solutions to the risk of CHE for surgical care.

In our study, the significant obstacles are the different health service systems, reporting standards, and variability in cost formation in each country. As stated before, government support will make surgical care more accessible through strategies such as reducing the expenses for surgical care, creating policies and strategies, reducing costs, or bringing costs to reasonable limits. This will enable the costs that patients endure or can endure to be brought to more reasonable levels. No single-sided effort or treatment can respond to each person in the world; academic studies and solution suggestions on this subject raise awareness that these efforts should be addressed with more than one care process to increase the possibility of realization. Here, many stakeholders have to make progress in efforts to achieve the same result and to awaken the same idea for everyone. Although surgical care is addressed and expressed differently in the world, the inadequacy in meeting the needs of patients or households who may face the risk of CHE continues.

References

Atake, E., & Amendah, D. (2018). Porous Safety Net: Catastrophic Health Expenditure and Its Determinants among Insured Households in Togo. *BMC Health Services Research, 18*(175). https://doi.org/10.1186/s12913-018-2974-4 , (Accessed: 01.07.2024).

Azzani, M., Roslani, A., & Su, T. (2019). Determinants of Household Catastrophic Health Expenditure: A Systematic Review. *Malaysian Journal of Medical Sciences, 26*(1), 15-43.

Baltagi, B. H. (2013). *Econometric Analysis of Panel Data.* West Sussex UK: Wiley.

Bijlmakers, L., Wientjes, M., Mwapasa, G., Cornelissen, D., Eric Borgstein, E., Henk Broekhuizen, H., Gajewski,J. (2019). Out-of-pocket payments and catastrophic household expenditure to access essential surgery in Malawi - A cross-sectional patient Survey. *Annals of Medicine and Surgery*(43), 85-90.

Das, P. (2019). *Econometrics in Theory and Practice Analysis of Cross Section, Time Series and Panel Data with Stata 15.1.* Springer Nature, Singapore.

Davies, J., Gelb, A., & Gore-Booth, J. (2021). Global surgery, obstetric, and anaesthesia indicator definitions and reporting: An Utstein consensus report. *Plos Med. Article, 18*(8), e1003749.

Fazaeli, A. A., Ghaderi, H., Salehi, M., & Fazaeli, A. R. (2016). Health care expenditure and GDP in oil exporting countries: Evidence from OPEC data, 1995-2012. *Global Journal of Health Science, 2*(8), 93-98.

Ghosh, S. (2010). Catastrophic payments and Impoverishment due to Out-of-Pocket health spending: The effects of recent health sector reforms in India. *Asia Health Policy Program Working Paper No. 15,* . https://ssrn.com/abstract=1658573 (Accessed: 01.07.2024)

Hsiao, C. (2003). *Analysis of Panel Data.* Cambridge: Cambridge University Press.

Hsiao, C. (2007). *Panel Data Analysis- Advantages and Challenges.* Cambridge: Cambridge University Press.

Hübler, A. W. (2005). *Predicting complex systems with a holistic approach: The "throughput" criterion.* Wiley The Simply Complex. doi:https://doi.org/10.1002/cplx.20071

Kimman, M., Jan, S., & Kingston, D. (2015). Catastrophic Health Expenditure and 12-Month Mortality Associated with Cancer in Southeast Asia: Results from a Longitudinal Study in Eight Countries. *BMC Med,, 13*, 1-11.

Kimman, M., Jan, S., Yip, C., Thabrany, H., Peters, S., & Bhoo-Pathy, N. (2015). Catastrophic Health Expenditure and 12-Month Mortality Associated with Cancer in Southeast Asia: Results from a Longitudinal Study in Eight Countries. *BMC Med*(13), 1-11.

Lee, M. L. (2024). *Health Insurance and Consumption Risk.* University of Virginia and NBER. https://leelockwood.droppages.com/AI.pdf

Meara, J., Leather, A., & Hagander, L. (2015). Global Surgery 2030: Evidence and Solutions for Achieving Health, Welfare, and Economic Development. *The Lancet*(386), 569-624.

Njuguna, S., Yan, X., Gituru, R., Wang, Q., & Wang, J. (2017). Assessment of macrophyte, heavy metal, and nutrient concentrations in the water of the Nairobi River, Kenya. *Environmental Monitoring and Assessment* , 454.

O'Donnell, O., Van, D. E., Rannan, E. R., Somanathan, A., Adhikari, S., & Akkazieva, B. (2008). Who pays for health care in Asia? *J Health Econ, 27*(2), 460-475.

Onoka, C., Onwujekwe, O., Hanson, K., & Uzochukwu, B. (2011). Examining Catastrophic Health Expenditures at Variable Thresholds Using Household Consumption Expenditure Diaries. *Trop Med Int Health, 16*, 1334-1341.

OWD, O. W. (2024). https://ourworldindata.org/grapher/share-of-the-population-at-risk-of-catastrophic-expenditure-when-surgical-care-is-required (Accessed: 05.07.2024)

Park, H. (2011). *Practical Guides to Panel Data Modeling: A Step-by-Step Analysis Using Stata.* Minami Uonuma.: Tutorial Working Paper, International University of Japan.

Paul, A., Malick, S., Mondal, S., & Saibendu, L. (2018). Exploring the determinants of catastrophic health expenditure and socioeconomic horizontal equity in relation to it: a rural community based longitudinal study in West Bengal. *Int J Community Med Public Healty, 5*, 2522-2528.

Sharifa Ezati, W., & Almualm, Y. (2017). Catastrophic Health Expenditure among Developing Countries. *Health Syst Policy Res, 4*.

Shrime, M., Dare, A., Alkire, B., O'Neill, K., & Meara, J. (2015). Catastrophic expenditure to pay for surgery worldwide: a modelling study. *Lancet Glob Health, 27*(3), 38-44. doi:doi: 10.1016/S2214-109X(15)70085-9.

Smith, P. C., & Papanicolas, I. (2013). Health system performance comparison: an agenda for policy, information and research. *LSE Research Online Open University Press,*, 1-51.

Stock, J., & Watson, M. (2007). *Introduction To Econometrics.* Boston: Pearson Addison Wesley.

Wagstaff, A. (2009). Measuring Financial Protection in Health". *In: Smith P(ed.). Performance Measurement for Health System Improvement: Experiences, Challenges, and Prospects.Performance Measurement for Health System Improvement: Experiences, Challenges, and Prospects. Cambridge: Cambridge University Press.*

Wagstaff, A., Flores, G., & Hsu, J. (2018). Progress on Catastrophic Health Spending in 133 Countries: A Retrospective Observational Study. *Lancet Glob Health*(6), 169-179.

Waldo, D., & Helen, C. L. (1984). Demographic Characteristics and Health Care Use and Expenditures by the Aged in the United States: 1977-1984. *Health Care Financing Review, 6*(1), 1.

Weraphong, J., Pannarunothai, S., Luxananun, T., Junsri, N., & Deesawatsripetch, S. (2013). Catastrophic health expenditure in an urban city: seven years after universal coverage policy in Thaıland. *Southeast Asian J Trop Med Public Health, 44*(1), 124-136.

WHO, W. H. (2010). *The World Health Report: Health Systems Financing: The Path to Universal Coverage.* February 5, 2024 tarihinde https://apps.who.int/iris/handle/10665/44371 (Accessed: 01.07.2024)

Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data* (Cilt 2). The MIT Press.

Xu, K., Evans, D., Carrin, G., & Aguilar-Rivera, A. (2005). Designing Health Systems To Reduce Catastrophic Health Expenditure. *World Health Organization, Department of Health Financing. Health Financing Policy, Genava,*. June 24, 2024 tarihinde https://iris.who.int/handle/10665 adresinden alındı

Xu, K., Evans, D., Kawabata, K., Zeramdini, R., Klavus, J., & Murray, C. (2003). Household catastrophic health expenditure: a multicountry analysis. *The Lancet* (362), 111-117.

You, X., & Kobayashı, Y. (2012). Determinants of Out-of-Pocket Health Expenditure in China. *Applied Health Economics and Health Policy, 9*(1), 39-49.

Zhao, J., Langerman, A., & Schneider, D. F. (2020). The Value of the Surgeon Informatician. *252*, 264-271.

Appendice:

Regression Results

RCE	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
GDP	0	0	-2.19	.03	0	0	**
GHE	-.212	.03	-7.03	0	-.272	-.153	***
Country Code : bas~S	0	.	.	.	.	.	
AUT	-.871	.199	-4.38	0	-1.263	-.479	***
BEL	-1.173	.202	-5.81	0	-1.57	-.775	***
CAN	-.132	.203	-0.65	.515	-.533	.268	
CHE	1.111	.362	3.06	.002	.397	1.824	***
DEU	-.277	.215	-1.29	.199	-.701	.147	
DNK	-.639	.192	-3.34	.001	-1.017	-.262	***
ESP	-.055	.247	-0.22	.825	-.542	.432	
FIN	-1.35	.212	-6.36	0	-1.768	-.932	***
FRA	-1.304	.213	-6.13	0	-1.723	-.885	***
GBR	-.468	.216	-2.17	.031	-.893	-.044	**
GRC	2.865	.312	9.18	0	2.25	3.48	***
IRL	.592	.191	3.09	.002	.215	.969	***
ITA	-.573	.236	-2.43	.016	-1.037	-.109	**
JPN	.757	.275	2.76	.006	.216	1.298	***
LUX	.464	.505	0.92	.359	-.531	1.458	
NLD	-.971	.194	-5.00	0	-1.353	-.589	***
NOR	-.079	.271	-0.29	.771	-.613	.455	
PRT	4.977	.283	17.57	0	4.419	5.535	***
SWE	-.433	.187	-2.31	.021	-.802	-.065	**
TUR	-1.644	.347	-4.73	0	-2.328	-.96	***
USA	.88	.218	4.04	0	.451	1.309	***
Constant	5.029	.527	9.54	0	3.991	6.067	***

Mean dependent var	1.111	SD dependent var	1.844
R-squared	0.941	Number of obs	286
F-test	173.452	Prob > F	0.000
Akaike crit. (AIC)	397.137	Bayesian crit. (BIC)	484.881

**** p<.01, ** p<.05, * p<.1*

Extended Summary

Analysing Factors Leading to Catastrophic Expenditure in Surgical Health Care

Ensuring equal access to and use of health services is fundamentally essential for the well-being of individuals and the overall prosperity and stability of a country. Health services, while undeniably critical, can impose unpredictable and substantial financial burdens on both individuals and nations. Catastrophic health expenditure (CHE) arises when households are compelled to significantly cut down on their basic necessities and everyday living expenses to finance essential health services within a certain period. This situation typically occurs when out-of-pocket expenses for healthcare exceed a substantial portion of a household's total expenditure or income, leading to a financial crisis. As the amount of these expenses increases, households may find themselves in a state of impoverishment, facing severe financial difficulties and devastating long-term consequences. Although this issue is more prevalent in middle- and low-income countries, it is increasingly evident that CHE is also significant and problematic in industrialized countries, particularly those with informal economies where the social safety nets might not be as robust.

The distribution of health expenditures between the public and private sectors, as well as the proportion of out-of-pocket spending, holds great importance in understanding the broader impact of healthcare costs. Health, as an indispensable aspect of life, often constitutes an expense that cannot be postponed or neglected under any circumstances. In situations where the public sector fails to provide the necessary and adequate health conditions, individuals are often forced to cut down on other critical expenses to cover their health needs out of pocket. To enhance a country's welfare level and improve human living standards, it is crucial to understand the conditions under which individuals incur health-related expenses. This understanding is particularly important because human health is one of the most significant factors driving sustainable economic development in any country.

As highlighted in various academic studies and reports, CHE manifests itself more prominently and aggressively in middle- and low-income countries. This situation becomes even more problematic and severe in countries where effective health policies cannot be implemented due to the significant segmentation of financial risk groups. When examining the relationship between individuals' ability to pay and CHE, it becomes clear that any potential increase in healthcare costs could have a direct and catastrophic impact on these households, pushing them into deeper financial distress. However, it is important to note that catastrophic health expenditures do not always result solely from increased healthcare costs or the absolute expense of medical services. Other factors, such as a country's health financing system, government policies, and overall health infrastructure, can also significantly influence the likelihood and impact of CHE. For instance, while the cost of a surgical procedure may be high, if it is fully covered by public funding and does not require any out-of-pocket payment by the individual, it would not be classified or considered as CHE, thus highlighting the importance of a well-structured health financing system.

Health care is in constant demand because it is a non-substitutable and unpredictable necessity. Due to this inherent unpredictability and the vital nature of healthcare, postponing or abandoning necessary medical care poses a significant and severe threat to public health. This, in turn, can have detrimental effects on a country's economy, including a notable loss of workforce productivity, increased absenteeism, and a reduction in access to a qualified labor force, which are critical for economic growth. At this juncture, it becomes evident that decision-making and implementation in key areas, such as financing within a country's health system, assessing the impoverishing effects of CHE, and evaluating the broader economic situation, cannot and should not be treated in isolation. These areas are deeply interconnected and must be addressed comprehensively to mitigate the risks associated with CHE.

Health care financing typically involves either public spending or out-of-pocket expenses, including private health insurance payments. The distribution and balance of these expenditures are directly influenced by the country's health policies and the broader economic context. In countries where the concept of a social state is strong and well-implemented, individual health expenditures tend to be lower, reflecting the government's role in providing accessible healthcare. Health expenditures are one of the most critical economic factors in any society, shaping both individual well-being and national economic stability. In countries where the social state approach is weak or ineffective, individual health expenditures can vary significantly depending on the quality, availability, and perceived importance of the services provided. At this point, the economic situation of the population becomes a crucial factor. Since health expenses cannot be deferred or ignored without risking severe consequences, individuals may be forced to sacrifice other essential expenditures or even incur debt to meet their healthcare needs, leading to catastrophic health expenditures. Therefore, identifying the factors influencing CHE, implementing appropriate measures, and formulating relevant policies are of utmost importance for decision-makers who are responsible for maintaining public health and economic stability.

The World Health Organization (WHO) recommends that healthcare expenditures should be deemed catastrophic when they equal or exceed 40% of disposable income. However, there is no global consensus on this threshold, as different countries may adopt higher or lower percentages based on their national health policies and economic conditions. Consequently, no standardized threshold exists in the literature to define the occurrence of CHE, making it a complex issue to address uniformly across different contexts.

In this study, we utilized comprehensive data on GDP per capita (measured in current US dollars), domestic general government health expenditure (HE) as a percentage of total government spending, and the risk of catastrophic surgical care expenditure as a percentage of persons at risk. This valuable data was obtained from the World Bank, while income level information was sourced from the IMF Database, ensuring a robust and reliable foundation for analysis.

The study meticulously analyzes the relationship between the level of CHE and the share of public health expenditures in total health expenditures—an essential indicator of the health system's structure—and the country's income level. Specifically, the causes of catastrophic health costs related to surgical health services were investigated using a detailed panel regression analysis for 24 countries from 2008 to 2020, providing a broad and insightful overview of the issue. Most studies on CHE in the literature focus on personal and financial disasters at the micro level. For instance, Paul et al. (2018) found that the poorest segments of society, as well as those in the middle-income bracket, continue to face significant financial shocks due to health expenditures, highlighting the pervasive nature of this issue. Additionally, Azzani et al. (2019) concluded that socioeconomic inequalities significantly impact the incidence of health expenditures in all countries. Our study reached similar results; however, we also identified a significant relationship between income level, as a socioeconomic indicator, and CHE. Moreover, we observed a negative relationship between income level and the risk of catastrophic health expenditures. The study ultimately concluded that the proportion of public health expenditures within total health expenditures and per capita income, calculated using purchasing power parity, had a statistically significant negative impact on the risk of CHE for surgical procedures, underscoring the importance of income and public health spending in mitigating these risks.