Analysing the Factors Affecting the Cost of Health Insurance in Egyptian Market

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Abstract

This research paper aims to analyze the factors influencing the cost of health insurance in Egypt, with a focus on the private healthcare sector. The study recognizes the importance of achieving Universal Health Coverage (UHC) and the role of private health insurance in supporting this goal. By investigating the complex and multifaceted drivers of health insurance costs, this research develops a robust model that identifies and quantifies the factors affecting insurance costs in Egypt. Moreover, the paper provides insights for policymakers, insurance companies, and healthcare providers by utilizing empirical models to understand and manage health insurance costs effectively. Employing Multivariate Analysis of Variance (MANOVA) and Ordinal Logistic Regression, the findings can inform the design of policies and interventions aimed at controlling and reducing health insurance costs in Egypt.

Keywords: health insurance, cost factors, private healthcare sector, Universal Health Coverage, Multivariate Analysis of Variance (MANOVA), Ordinal Logistic Regression, Egyptian healthcare system

1. Introduction

Health is a crucial concern for countries worldwide, significantly impacting their economic and social development. Ensuring a healthy population is vital for national progress, making it imperative for governments to prioritize health expenditure. A key aspect of this focus is the goal of achieving Universal Health Coverage (UHC), which aims to provide all individuals with access to quality health services without financial hardship. By investing in health infrastructure and services, countries can promote overall well-being, enhance productivity, and foster sustainable development, ultimately contributing to a more prosperous and equitable society.

Egypt's private healthcare sector plays a crucial role in healthcare provision. Despite challenges in obtaining comprehensive data due to the predominance of out-of-pocket payments, the private sector is perceived to offer higher quality services than public facilities. Healthcare financing in Egypt is predominantly out-of-pocket, accounting for around 59% of current health expenditure. The system's reliance on fragmented and multiple funding sources contributes to inefficiencies and significant variations in service quality. The heavy dependence on out-of-pocket payments poses financial risks to households, with a notable proportion of the population facing catastrophic expenditures and impoverishment due to healthcare costs. Regional comparisons reveal that Egypt's healthcare spending is below average for middle-income countries, underscoring the need for policies that promote more equitable and efficient healthcare financing.

Many countries have adopted universal health coverage (UHC) to provide comprehensive healthcare services to all individuals, minimize out-of-pocket expenses, and ensure access without financial burden, requiring robust and adaptable health systems that prioritize individual needs. Comprehensive healthcare insurance in Egypt is still in its early stages of implementation. Drawing from the experiences of advanced countries, private health insurance is utilized to support and facilitate the implementation of universal healthcare. Therefore, it is crucial to continue improving the quality and efficiency of private insurance while identifying the factors that have the most significant impact on the cost of private

healthcare insurance. This is essential to ensure its effectiveness as a supporting mechanism for comprehensive healthcare in the future.

2. Research purpose

Despite extensive research on health insurance, the cost drivers in the Egyptian context remain complex and multifaceted. Several factors, including demographic characteristics, health status, and medical history, contribute to the cost variations in health insurance. However, there is a lack of comprehensive models that integrate these diverse factors to predict and explain health insurance costs accurately in Egypt. This research aims to fill this gap by developing a robust model that identifies and quantifies the factors affecting health insurance costs in Egypt, providing valuable insights for stakeholders.

3. Significance of the Study

Understanding the factors that influence health insurance costs in Egypt is critical for improving the healthcare system's efficiency, equity, and sustainability. This study is significant for several reasons:

- The use of empirical models to better understand and manage the cost of health insurance has several potential implications. It provides a comprehensive understanding of the factors driving health insurance costs in Egypt, which is crucial for policymakers, insurance companies, and healthcare providers.
- The findings can inform the design of policies and interventions aimed at controlling and reducing health insurance costs in Egypt.
- The research contributes to the academic literature by developing a robust model that integrates various factors affecting health insurance costs in the Egyptian context.

4. Overview of Healthcare System in Egypt

Regarding the Egyptian context, Egypt is a densely populated African nation with a population of 109.2 million people as of 2021, according to the World Bank (2023). It is classified as a lower-middle-income country (LMIC) in the Middle East and North African (MENA) region by the World Health Organization and World Bank. As of 2021, Egypt's Gross Domestic Product (GDP) per capita is 3,698 USD, as per the World Bank (2023).

The goals of a healthcare system may vary by country, region, or organization, but common objectives include improving health, ensuring

access to quality care, and promoting wellness. The primary aim is to enhance the population's health by reducing mortality and morbidity, improving quality of life, and extending life expectancy (WHO, 2010). Access to quality healthcare is also crucial, ensuring individuals can obtain preventive care, diagnostic services, treatments, and medications when needed (Kamel, 2020). Additionally, promoting health and wellness through education, public health campaigns, and other interventions helps prevent chronic diseases and improve overall health outcomes (World Bank, 2018). Furthermore, fostering innovation by developing new medical technologies, treatments, and procedures is essential for improving health outcomes and enhancing healthcare delivery efficiency (National Academies Press, 2018).

4.1 Health care sectors: Who Provides Health Care

Egypt has a highly pluralistic health care system, with many different public and private providers and financing agents (MOH, 2010; MOHP, 2003). This includes different sectors relating to service provision; however, primary healthcare services are mostly provided by the public sector while the private sector represents the largest share of the total health expenditure in the country (Nakhimovsky, 2011; Ghannam & Sebae, 2021).

4.2 Public healthcare system

The government sector represents activities of ministries that receive funding from the Ministry of Finance (MOF). As in many lower- and middle-income countries, the government health services in Egypt are organized as an integrated delivery system in which the financing and provider functions are included under the same organizational structure (Gericke et al, 2018).

4.3 Private healthcare system

With the emergence of cross-country datasets, it has become increasingly evident that the private sector plays a significant role in both financing and provision of healthcare services in low- and middle-income countries (WHO, 2014). The role of private insurance in healthcare varies depending on the wealth and institutional development of a country. In many lower and middle-income countries, private insurance is the only form of risk pooling available and provides primary coverage primarily to employed individuals (Sekhri & Savedoff, 2004).

Egypt's private healthcare sector consists of both non- profit and for- profit providers, such as private clinics, hospitals, pharmacies, mosques and churches (Gericke, 2018; Ghannam & Sebae, 2021). However, statistics on the delivery of care within Egypt's private sector are generally more difficult to obtain because the financing of private health services occurs as out- of- pocket payments by the patient and on a fee- for service basis to the provider for both ambulatory and inpatient care (Haley et al., 2010). This is because private sector facilities are often rated much higher in terms of quality, clinical effectiveness, and consumer satisfaction, relative to MOHP facilities (El-Saharty, 2004).

The significant growth of Egypt's private healthcare system can be attributed to increased privatization as well as inadequate maintenance of the public healthcare system. Due to these factors, the private healthcare system in Egypt has been able to establish a reputation for providing high-quality services within the country (Gericke et al, 2018).

The poor maintenance of public care is another factor that has contributed to the development of the private healthcare system in Egypt. Public hospitals and clinics are often overcrowded and understaffed. They also lack the necessary resources to provide quality care. As a result, many Egyptians are turning to the private sector for their healthcare needs (Tawfik et al, 2019).

The development of the private healthcare system in Egypt has had a number of positive and negative consequences. On the one hand, it has led to an increase in the availability of healthcare services. On the other hand, it has also led to an increase in the cost of healthcare. Additionally, the development of the private healthcare system has widened the gap between the rich and the poor. Those who can afford to pay for private healthcare are able to receive high-quality care, while those who cannot afford to pay are often forced to rely on the poor public system.

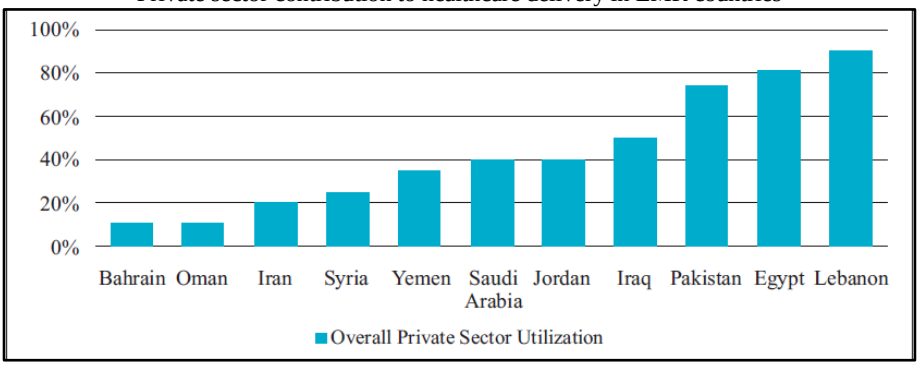
5. Analyses of the Egyptian private insurance market

5.1 Egypt in regional context

Recent surveys and reports from the World Health Organization and other sources have recognized the increasing impact of the private health sector in the health systems and service delivery of Eastern Mediterranean Region (EMR) member states. The utilization of health services provided by the private sector ranges from 10% to 90% across these countries, with some

low and middle-income nations accounting for as much as 50% to 90% of private health service utilization as shown in figure (1).

Figure 1
Private sector contribution to healthcare delivery in EMR countries



Source: (Zaidi et al, 2012)

The figure shows that there is a significant variation in the level of private health utilization across the EMR countries. It shows the percentage of private health utilization in various countries in the EMR, with Egypt ranking second with 80%. This indicates a significant reliance on private healthcare delivery in Egypt, which can have both positive and negative implications for the country's healthcare system and its citizens. The growth of the private sector in healthcare delivery will have a number of implications, including the need for better regulation of the private sector and the need to ensure that the private sector is providing high-quality care.

5.2 Egypt's healthcare market context

Medical insurance provides financial support for healthcare expenses, including costs associated with medical treatments, procedures, and medications (Sekhri and Savedoff, 2005). With the rising cost of healthcare services and the increasing prevalence of chronic diseases, medical insurance has become a crucial form of protection for many Egyptians.

With regard to the Egyptian’s medical insurance market, table (1) provides a detailed overview of the growth rates of direct premiums and direct compensations for the medical insurance branch in the Egyptian insurance market from 2008 to 2022.

Table 1
The evolution of premiums and compensations for the medical insurance branch in the Egyptian insurance market in thousand pounds (2008: 2022).

Years	Direct Premiums	Development Rate%	Direct Compensation	Development Rate%
2008	257805	-	169310	-
2009	223035	-13.5	155038	-8.4
2010	235461	5.6	134842	-13.0
2011	314689	33.6	179807	33.3
2012	366626	16.5	196412	9.2
2013	480816	31.1	280874	43.0
2014	568685	18.3	347817	23.8
2015	698796	22.9	360370	3.6
2016	963083	37.8	514556	42.8
2017	1517044	57.5	859128	67.0
2018	2127327	40.2	1188499	38.3
2019	3078799	44.7	1634367	37.5
2020	3800352	23.4	2228552	36.3
2021	4146073	9.0	3077908	38.1
2022	5199690	25.4	3364435	9.3

Source: The annual statistical book on insurance activity (2008: 2022). (The Financial Regulatory Authority, 2022)

The data suggests that both direct premiums and direct compensations have experienced significant growth over the years, with varying rates of development. Direct premiums increased from 257,805 thousand pounds in 2008 to an estimated 5,199,690 thousand pounds in 2022, with a growth rate of 25.4%. Similarly, direct compensation increased from 169,310 thousand pounds in 2008 to an estimated 3,364,435 thousand pounds in 2022, with a growth rate of 9.3%. The table shows that there was a significant decline in direct annuities in 2009, followed by a recovery in 2010. This decline was likely due to the global financial crisis, which had a negative impact on the Egyptian economy.

Overall, the data highlights the importance of medical insurance as a key type of insurance in Egypt, providing critical support for healthcare expenses. It also emphasizes the need for continued investment in and

development of Egypt's healthcare sector and insurance industry to ensure that individuals and families have access to quality healthcare services and financial protection.

The study of Sekhri and Savedoff, 2005 interduces that there are several ways in which private health insurance can play a positive role in improving access and equity in developing countries:

First in developing countries, out-of-pocket spending on health services is the most prevalent form of health financing and often poses a considerable financial strain on
households. Private insurance can offer households a chance to mitigate the impact of substantial out-of-pocket expenses and provide access to financial protection that may otherwise be unavailable.

Second, developing countries struggle to generate sufficient tax revenue for healthcare, often spending less than $10 per person annually, with large informal sectors complicating tax collection. Regulated private insurance can support prepayment and risk-pooling, allowing public funds to focus on the most vulnerable. Proper regulation ensures private coverage remains accessible and affordable, preventing increased healthcare inequality.

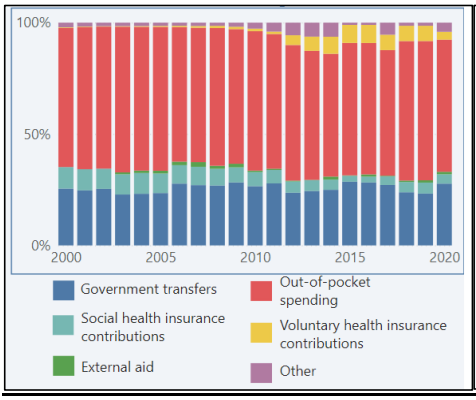
Third, the evolution of social insurance in many developed countries began with voluntary private insurance schemes from professional guilds or communities (Mansour et al, 2022). These historical lessons show the gradual expansion of financial protection and institutional development. Developing countries can learn from these experiences to inform their policy debates, adopting effective strategies to transition towards public insurance systems and achieve universal health coverage.

Finally, it is worth noting that private health insurance remains relevant even in countries where universal coverage has been achieved. Policymakers who anticipate this supplementary role can better prepare to ensure that private coverage complements public systems as they develop, and that private insurance remains accessible and affordable for all. By recognizing the continued importance of private health insurance and taking proactive steps to regulate it, countries can maximize their healthcare coverage and achieve equitable access to healthcare services for all their citizens.

6. Healthcare financing in Egypt

Egypt's health care system is predominantly financed by out-of-pocket payments (OOPS), which account for around 59% of the Current Health Expenditure (CHE), with 32% coming from general government health expenditure (GGHE) and the remainder from firms and NGOs (Mathauer, 2019). The system is pluralistic and fragmented, with numerous sources of financing, financing agents, and providers (Ismail, 2018; Mathauer, 2019; Ahmed et al, 2020; Fasseeh et al, 2022). Health care in Egypt is financed by four different sources household payments (out-of-pocket), government sector, public sector, and private organizations (Gericke et al,2018; Ahmed et al, 2020).

Figure 2
Egypt's Current Health Spending by Funding Sources and Egypt's health expenditure profile.



	2005	2010	2015	2020
Health spending US$ per capita (CHE)	61	107	174	151
Government health spending % Health spending (GGHE-D%CHE)	32.3%	32.9%	31.2%	31.9%
Out-of-pocket spending % Health spending (OOPS%CHE)	64.6%	62.6%	59.5%	59.3%
Priority to health (GGHE-D%GGE)	5.2%	4.4%	5.1%	5.2%
GDP US$ per capita	1,239	2,586	3,252	3,457

Source: Global Health Expenditure Database (WHO.2023)

Figure (2) above illustrates that Out-of-pocket (OOP) expenditures remain the primary source of current health expenditure (CHE) in Egypt, accounting for over 60% of current health spending for the past two decades, rising to around 63% in 2019. Government transfers constitute the second source of CHE, with a range of 25-30% over the past 20 years. In 2019, health insurance contributions made up 12% of CHE, with approximately 5% coming from SHI contributions and 7% from voluntary health insurance. The Health Insurance Organization (HIO) is the main public insurer in Egypt, covering 59% of the population through fund pools that cater to different population groups (Maait, 2023).

Additionally, the data presented in the figure above highlights the trends in Egypt's health expenditure profile between 2005 and 2020. The per capita health spending has increased significantly over the years, with a peak of $174 in 2015, followed by a slight decline to $151 in 2020. However, the proportion of government health spending (GGHE-D%CHE) has remained relatively stable, hovering around 32% over the years. On the other hand, out-of-pocket spending (OOPS%CHE) has decreased gradually from 64.6% in 2005 to 59.3% in 2020, indicating a shift towards other sources of health financing. The priority given to health (GGHE-D%GGE) has remained consistent at around 5%, indicating the government's continued commitment to healthcare. Finally, the GDP per capita has also increased steadily over the years, reaching $3,457 in 2020. Overall, these trends suggest some positive developments in Egypt's healthcare system, including a slight reduction in out-of-pocket spending and a sustained commitment to health from the government.

7. Challenges Facing Egypt's Healthcare System

The cost of health insurance is a significant concern for individuals, families, policymakers, and insurance companies worldwide (World Bank, 2020; Dcode & the American University of Cairo, 2021). In Egypt, the healthcare system faces unique challenges, including high out-of-pocket expenses, limited coverage of health insurance, and significant disparities in healthcare access and quality between urban and rural areas (Ahmed et al 2020). Health insurance plays a critical role in providing financial protection against high medical costs, ensuring access to necessary healthcare services, and improving overall health outcomes. However, the rising cost of health insurance in Egypt poses challenges for affordability and accessibility (Shawky & Abalkhail, 2017). Understanding the factors that influence the cost of health insurance in the Egyptian context is essential for designing effective policies and interventions to control costs and enhance the sustainability of the health insurance system.

8. Research Methodology

To meet the objectives of this study, which seeks to develop a comprehensive model to understand the factors affecting the cost of health insurance in Egypt, it is imperative to gather data on the relevant factors influencing health insurance costs. Consequently, pertinent data has been collected from the health insurance branches. This dataset includes detailed

information about insured individuals, obtained through insurance applications, and extensive data on claims. This comprehensive data collection facilitates the accurate determination of the dependent variable and the various factors influencing health insurance costs, thereby ensuring the robustness and validity of the developed model.

Dependent Variable:

In this study, the dependent variable is the approved claim amount, denoted as "y." This variable represents the average cost level of group medical insurance and is categorized into three levels: low cost, medium cost, or high cost. The categorization is based on specific conditions. If the approved claim amount is less than or equal to the lower mean of claims, it is categorized as y = 1. If the approved claim amount is greater than the lower mean of claims but less than or equal to the upper mean of claims, it is categorized as y = 2. For all other cases, the approved claim amount is categorized as y = 3.

Independent Variables:

The independent variables in this study consist of factors that affect the cost of health insurance. These factors can be classified into three main categories: insured-related factors, medical service provider-related factors, and factors related to the insurance company and fraud.

The insured-related factors in this study include the age of the insured employee, the person beneficiary of the insurance policy, the gender of the insured employee, and the marital status of the insured employee. The age variable is measured on a continuous scale, representing the age of the insured employee. The person beneficiary variable is a categorical variable that classifies the beneficiaries into four categories: primary insured, spouse, son/daughter, and parents. The gender variable is also categorical, representing the gender of the insured employee. Lastly, the marital status variable categorizes the insured employee into two categories: married and single. These insured-related factors provide insights into the demographic profile of the insured and how it may impact the cost of health insurance.

The medical service provider-related factors in this study include the policy class and the type of medical benefits covered by the insurance policy. The policy class variable categorizes the insurance policy into three classes: Class A, Class B, and Class VIP. The benefit type variable classifies the

medical benefits covered by the insurance policy into six categories: outpatient, inpatient, dental, optical, dialysis, and maternity. Service type is a categorical variable classifies the type of medical services utilized by the insured employee into eight categories: Ambulance, Consultation, Physiotherapy, Lab, Pharmacy, Package deal, Radiology, and Surgical procedure. These variables provide information about the level of coverage and the type of medical services utilized by the insured employee, which can impact the cost of health insurance.

The factors related to the insurance company and fraud in this study include the medical service providers utilized, the occurrence of fraud in insurance claims, the deductible amount, and the rejected claims amount. The medical service providers variable categorizes the providers into three categories: Provider A, Provider B, and Provider C. The fraud variable indicates the occurrence of fraud in insurance claims. The deductible amount variable represents the deductible amount for the insurance policy. Lastly, the rejected claims amount variable measures the difference between the claim amount and the approved claim amount. These variables provide insights into the role of the insurance company and fraud in determining the cost of health insurance.

8.1 Empirical Model

Since the dependent variable in this study represents levels of the cost of healthcare, which is an ordinal variable with multiple responses (low, medium, upper), it is appropriate to use one of the quantitative models that allow us to calculate the probabilities of each response occurring. In this context, Ordinal logistic regression models are commonly used in such cases (Frank, 2015; Field, 2024; Menard, 2010).

8.2 Ordinal Logistic Regression

Ordinal logistic regression, also known as ordered logit, is used when the dependent variable has more than two categories that are ordered. Unlike multinomial logistic regression, the order of the categories carries meaning, but the distances between them are not assumed to be equal (Frank, 2015; Lattin, 2003; Menard, 2010; O'Connell, 2006). The ordinal logistic regression model estimates the cumulative probabilities of being at or below a certain category.

However, to confirm the differences in levels of the cost of health insurance and apply ordinal logistic regression, the researcher will perform a Multivariate Analysis of Variance (MANOVA) prior to applying the proposed model. This preliminary analysis helps researchers identify significant predictors, ensuring a more focused and meaningful analysis in subsequent modeling stages.

8.3 Mathematical Formulation

The ordinal logistic regression model, also known as the proportional odds model, models the log odds of the cumulative probabilities of the ordinal outcome variable. Mathematically, the ordinal logistic regression model uses the cumulative logit link function (Hartmann et al. 2023; Menard, 2010; O'Connell, 2006). This approach models the log odds of being at or below a certain category, considering the ordered nature of the categories. The basic form of the cumulative logit model for an ordinal outcome variable Y with J ordered categories is expressed as follows:

$$\log\left(\frac{P(Y\leq j|X)}{P(Y>j|X)}\right) = \beta_{0j} + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k$$

where: Y is the ordinal response variable, j represents the category of the ordinal outcome, where j=1, 2..., J−1, β0j is the threshold (or intercept) for the j-th cumulative logit, and β is the vector of regression coefficients associated with the predictor variables X.

In ordinal logistic regression, the coefficients represent the change in the log-odds of moving from one category to the next higher category. Therefore, the magnitude and direction of the coefficients provide information about the impact of the independent variables on the likelihood of moving up the cost categories.

The cumulative logit model can be formally expressed as follows. Suppose we have an ordinal outcome variable Y with g ordered categories. Let X1, X2, …, Xk be a set of k predictor variables. The model estimates the probability of Y falling into a particular category or below, given the predictor variables.

The cumulative logit model that the ordinal outcome is less than or equal to a particular category g (for g=1, 2, …, g-1) is given by (Kleinbaum, 2002):

$$ln\left[\frac{P(y \geq g/X)}{P(y < g/X)}\right] = \alpha_g + \sum_{i=1}^{p} \beta_i x_i$$

The left-hand side of the above equation is referred to as the logit, which represents the logarithm of the odds ratio, i.e., the ratio of the odds of $y \geq g$ compared to the odds of $y < g$. Therefore, the odds ratio is expressed as follows:

$$odds = \frac{p(y \geq g/X)}{P(y < g/X)} = e^{\alpha_g + \sum_{i=1}^{p} \beta_i x_i}$$

Thus, we can calculate the odds ratio of $y \geq 2$ compared to $y < 2$ as follows:

$$odds = \frac{p(y \geq 2/X)}{P(y < 2/X)} = e^{\alpha_2 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p}$$

Furthermore, we can compute the odds ratio of $y \geq 1$ compared to $y < 1$ as follows:

$$odds = \frac{p(y \geq 1/X)}{P(y < 1/X)} = e^{\alpha_1 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p}$$

From the two previous equations, it can be observed that the right-hand side of each equation is identical, differing only in the cutoff value on the y-axis. In other words, only α_1 and α_2 are the varying components, while the remaining regression coefficients βi are consistent in both equations. This similarity is a distinguishing characteristic of the ordered logistic regression model compared to other logistic regression models (Noruši, 2010). The model assumes that the relationship between the predictors and the log-odds of being in or below a particular category is constant across all categories, which is the proportional odds assumption.

According to the ordered logistic regression model, it is possible to calculate the probabilities associated with the responses of the dependent variable as follows:

$$P(y \geq g/X) = \frac{1}{1 + e^{-(\alpha_g + \sum_{i=1}^{p} \beta_i x_i)}}$$

Where g= 1,2, 3…, G-1

8.4 Estimation of Model Parameters

To estimate the regression coefficients, maximum likelihood estimation (MLE) is typically used. MLE finds the values of the regression coefficients that maximize the likelihood of observing the data given the specified ordinal logistic regression model (Field, 2024; Kleinbaum, 2002; Noruši, 2010). Consequently, when the dependent variable has multiple responses g, the likelihood function takes the following form:

$$L(Y) = \prod_{i=1}^{n} \prod_{g=0}^{g-1} P(Y = g/X)^{y_{ig}}$$

8.5 Model Goodness-of-Fit

Once the parameter estimates are obtained, it is crucial to assess the model's fit and the validity of the assumptions. Several diagnostic tools and goodness-of-fit measures are used for this purpose:

1. Likelihood Ratio Test: This test compares the fit of the ordinal logistic regression model to that of a null model (a model without predictors) to determine whether the predictors collectively have a significant effect on the outcome (Kleinbaum, 2002).
   Mathematically, the likelihood ratio statistic is computed using the formula:

   $$\chi^2 = -2(\log L_{\text{reduced}} - \log L_{\text{full}})$$

   where $(-2\ log\ L_{reduced})$ and $(-2\ log\ L_{full})$ represent the log-likelihood values of the reduced and full models, respectively. This test statistic follows a chi-square distribution with degrees of freedom equal to the difference in the number of parameters between the full and reduced models.

2. Pseudo R-squared: Although traditional R-squared is not suitable for ordinal logistic regression, pseudo R-squared measures such as McFadden's R-squared provide an indication of the model's explanatory power (Kleinbaum, 2002). McFadden's R-squared is based on the likelihood function. It is defined as:

   $$McFadden\ R^2 = 1 - \frac{log\ L_{full}}{log\ L_{reduced}}$$

Where $(log\ L_{full})$ is the log-likelihood of the fitted model, and $(log\ L_{reduced})$ is the log-likelihood of the null model, which includes only the intercept. The null model serves as a baseline for comparison, as it assumes that no explanatory variables are influencing the outcome.

3. Wald Test: This test assesses the significance of individual predictors by examining whether the estimated coefficients differ significantly from zero. For each coefficient βj in the model, the Wald test statistic is calculated as (Kleinbaum, 2002, Noruši, 2010).

$$W_j = \left(\frac{\hat{\beta}_j}{SE(\hat{\beta}_j)} \right)^2$$

where β^j is the estimated coefficient, and SE(β^j) is the standard error of the estimated coefficient.

8.6 Research Hypotheses

Hypothesis 1: There is no statistically significant difference among the mean levels of group health insurance claims for each of the following independent variables:

- Age
- Person beneficiary
- Gender
- Marital status
- Policy class
- Benefit Type
- Service Type
- Medical service providers
- Deductibles
- Rejected Amount
- Fraud

Hypothesis 2: Group health insurance claims are not affected by the following demographic factors of the insured:

- Age
- Gender
- Marital status

Hypothesis 3: Group health insurance claims are not affected by the following factors:

- Person beneficiary
- Policy class
- Benefit Type
- Service Type
- Medical service providers
- Deductibles
- Rejected amount claims.
- Fraud

To test these hypotheses, a Multivariate Analysis of Variance (MANOVA) is employed for the first hypothesis, while ordinal logistic analysis is used for the second and third hypotheses.

9. Data Analysis and Results

A random sample of 109,178 claims was obtained from an insurance company during the year 2023. This sample was based on random numbers generated to gather detailed data on group health insurance claims, including age, gender, marital status, beneficiaries, policy class, benefit type, service type, provider, claim amount, deductible, rejected claim amount, and fraud. The data was analyzed using Cluster Analysis, Multivariate Analysis of Variance (MANOVA), and Ordinal Logistic Regression.

Multivariate Analysis of Variance (MANOVA) tests whether there are differences among the mean claim amounts across the three risk groups for each independent variable. Here's a refined explanation of the study's hypotheses:

$$H_{0,1}: \mu_1 = \mu_2 = \mu_3$$
$$H_{0,2}: \mu_1 = \mu_2 = \mu_3$$
$$\vdots$$
$$H_{0,11}: \mu_1 = \mu_2 = \mu_3$$

These hypotheses propose that there is no statistically significant difference in the mean claim amounts among the low, medium, and high-risk groups across each independent variable considered in the study. The MANOVA test evaluates these hypotheses simultaneously, considering the relationships among multiple dependent variables (claim amounts) and independent variables (risk groups). If the null hypotheses are rejected, it would indicate

that there are significant differences in claim amounts across risk groups for at least one independent variable, prompting further investigation into these variations.

Table 2
MANOVA tests the differences among the mean of claims for the risk groups.

Effect		Value	F	Hypothesis df	Sig.
Intercept	Pillai's Trace	1.000	2.087E7	31.000	.000
	Wilks' Lambda	.000	2.087E7	31.000	.000
	Hotelling's Trace	5939.625	2.087E7	31.000	.000
	Roy's Largest Root	5939.625	2.087E7	31.000	.000
Y	Pillai's Trace	.285	1401.332[a]	31.000	.000
	Wilks' Lambda	.715	1401.332[a]	31.000	.000
	Hotelling's Trace	.399	1401.332[a]	31.000	.000
	Roy's Largest Root	.399	1401.332[a]	31.000	.000

Table 2 presents the results of the MANOVA testing for differences among the mean claim amounts across risk groups. All significance values for these tests are reported as less than the specified significance level (0.05) for the study. This leads to the conclusion that the null hypotheses can be rejected with confidence. Therefore, it is concluded that there are statistically significant differences in the mean claim amounts among the risk groups across each independent variable considered in the study. This finding underscores the variability in claim amounts across different risk levels, providing valuable insights for understanding and managing group health insurance claims effectively.

Results of Ordinal Logistic Regression

Table 3 presents the estimated parameters for this regression analysis, offering insights into the factors that influence the likelihood of a policyholder falling into a specific risk group.

Table 1
Parameters estimated for Ordinal Logistic Regression

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[Y = 1.00]	1.537	.713	4.645	1	.031
	[Y = 2.00]	2.480	.713	12.090	1	.001
Location	X1	.005	.001	21.879	1	.000
	X21	-.168	.053	9.843	1	.002
	X22	.807	.107	57.277	1	.000
	X23	-.110	.044	6.268	1	.012
	X24	-.529	.090	34.657	1	.000
	X3	-.430	.028	240.879	1	.000
	X41	-.379	.310	1.494	1	.222
	X42	-.584	.312	3.505	1	.061
	X51	.274	.042	41.955	1	.000
	X52	.465	.043	114.122	1	.000
	X53	.884	.048	334.375	1	.000
	X61	-.315	.452	.487	1	.485
	X62	1.656	.453	13.380	1	.000
	X63	.376	.456	.679	1	.410
	X64	-.135	.835	.026	1	.872
	X65	1.974	.545	13.093	1	.000
	X66	-.314	.455	.476	1	.490
	X71	.765	.177	18.621	1	.000
	X72	.204	.034	35.657	1	.000
	X73	4.431	.236	353.672	1	.000
	X74	-.164	.035	21.598	1	.000
	X75	-1.499	.035	1887.891	1	.000
	X76	.790	.370	455.196	1	.000
	X77	1.161	.046	642.041	1	.000
	X78	5.348	.345	240.715	1	.000
	X81	-.835	.455	3.374	1	.066
	X82	.645	.455	2.007	1	.157
	X83	-.640	.458	1.952	1	.162
	X9	-5.668	.146	1513.185	1	.000
	X10	.005	5.283E-5	8347.685	1	.000
	X11	-6.087E-5	1.252E-5	23.621	1	.000

Table 3 provides the estimated parameters for the Ordinal Logistic Regression model, highlighting the relationships between the independent variables and the risk groups. Location Parameters is described as follow:

- Various independent variables (X1, X21, X22, etc.) are listed with their corresponding estimates, standard errors, Wald statistics, and degrees of freedom.

- Significant predictors (e.g., X1, X22, X23, X3) have p-values less than 0.05, indicating that they significantly contribute to the likelihood of a policyholder being in a particular risk group.
- Non-significant predictors (e.g., X41, X61, X63) have p-values greater than 0.05, indicating that they do not significantly influence the risk group classification in this model.

The table indicates that many variables significantly impact the probability of policyholders falling into different risk groups. For instance, X1, with an estimate of 0.005 and a p-value of 0.000, is a significant predictor. Conversely, X41, with a p-value of 0.222, is not a significant predictor. This detailed breakdown helps in understanding which factors are most influential in determining risk group affiliation and supports the model's overall interpretation and predictive capabilities.

From the above table we can driving the following:

- **Odds ratio models:**

$$\left[\frac{\mathrm{P(y \le \text{lower mean of claims})}}{1-\mathrm{P(y \le \text{lower mean of claims})}}\right] = 1.537 + 0.005\mathrm{X}_1 - 0.168\mathrm{X}_2 + \cdots - 0.0000608\mathrm{X}_{11}$$

$$ln\left[\frac{P(lower\ mean\ of\ claims < y \le uper\ mean\ of\ claims)}{1-P(lower\ mean\ of\ claims < y \le uper\ mean\ of\ claims)}\right] = 2.480 + 0.005X_1 - 0.168X_2 + \cdots - 0.0000608X_{11}$$

- **Models for calculating the probabilities of the policyholder's affiliation to different risk groups:**

Model for calculating the probability of the policyholder's affiliation to low-risk group:

$$\mathrm{P(y \le \text{lower mean of claims})} = \frac{1}{1+\mathrm{e}^{-(1.537+0.005\mathrm{X}_1-0.168\mathrm{X}_2+\cdots-0.0000608\mathrm{X}_{11})}}$$

Model for calculating the probability of the policyholder's affiliation to medium-risk group:

$$P(lower\ mean\ of\ claims < y \le uper\ mean\ of\ claims) = \left[\frac{1}{1+e^{-(2.480+0.005X_1-0.168X_2+\cdots-0.0000608X_{11})}}\right] - P(y \le lower\ mean\ of\ claims)$$

Model for calculating the probability of the policyholder's affiliation to high-risk group:

$$P(y > uper\ mean\ of\ claims) = 1 - P(lower\ mean\ of\ claims < y \leq uper\ mean\ of\ claims)$$

Goodness of fit

Likelihood Ratio Test

Table 4 provides the model fitting information for the likelihood ratio test. The table shows that negative two times the log likelihood for the reduced model (intercept only) is 121,225.008, while for the full model, it is 72,069.960. The difference between these values is 49,155.049, which represents the chi-square statistic.

Table 2
Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	121225.008			
Final	72069.960	49155.049	31	.000

The chi-square test, with 31 degrees of freedom, yields a p-value of 0.000. This indicates that the test statistic is highly significant. Therefore, we can reject the null hypothesis and conclude that the independent variables included in the full model are statistically significant at the 0.05 level. This significance suggests that the independent variables contribute meaningfully to the model and help explain the variability in the outcome variable. This analysis confirms that the inclusion of the independent variables significantly improves the model fit, validating their importance in predicting the risk groups.

Wald testing for the significance of ordinal logistic regression coefficients*:*

We test the null hypothesis that the model regression coefficients do not differ from zero, as follows:

$$H_0\colon\ \beta_i = 0; i = 1,2,3,\dots,11$$

It is noted from the table 4 that the significance levels accompanying the Wald test statistics indicate that many coefficients are statistically significant (p-value < 0.05). This result allows us to reject the null hypothesis for these coefficients, affirming that they contribute meaningfully to the model. The Wald test thus supports the relevance of

these independent variables in predicting the risk group affiliation of policyholders.

McFadden R^2

$$McFadden\ R^2 = 1 - \frac{log\ L_{full}}{log\ L_{reduced}}$$

The pseudo-R-squared values provide insights into the explanatory power of the ordinal logistic regression model regarding the variation in the degree of risk explained by the independent variables. Nagelkerke R-squared indicates that approximately 51.6% of the maximum possible variation in the degree of risk is explained by the independent variables. Cox and Snell R-squared suggests that around 36.3% of the variation in the degree of risk is explained by the model. McFadden's R-squared, another important pseudo R-squared measure in ordinal logistic regression, indicates that about 37.1% of the variation in the degree of risk can be attributed to the independent variables in the model. These measures collectively indicate that the ordinal logistic regression model is effective in explaining and predicting the degree of risk based on the included independent variables.

10.Discussion and Conclusion

The analysis revealed several key points. The study's dependent variable is the approved claim amount, categorized into three levels: low cost, medium cost, or high cost. The independent variables consist of factors that affect the cost of health insurance, including insured-related factors, medical service provider-related factors, and factors related to the insurance company and fraud.

The study employed Multivariate Analysis of Variance (MANOVA) to examine the relationships between the independent variables and the approved claim amounts. The results of the MANOVA highlighted any significant differences among the groups. The study then utilized Ordinal Logistic Regression to delve deeper into the data. This analysis includes the results of the regression analysis, parameter estimates, model fit diagnostics, and a thorough interpretation of the findings. The use of this regression technique allows for a comprehensive understanding of the factors influencing group health insurance claims.

Group health insurance claims are influenced by numerous factors, each contributing differently to the overall cost. The study revealed that fraud has

the most significant impact on health insurance costs. This finding aligns with the characteristics of health insurance markets globally, where fraudulent claims are a major cost driver.

Surgical operations emerged as the type of medical service with the highest impact on costs, despite their relatively low frequency. This is attributed to the inherently high expenses associated with surgical procedures. Within the classification of services, VIP services were found to have a substantial influence on medical costs. This can be explained by the elevated expenses associated with VIP services, even though they are utilized less frequently.

When examining the impact based on the beneficiary, it was discovered that the spouse has a notable influence on medical costs. This may be due to spouses potentially having more time to utilize healthcare services compared to the primary insured. In terms of the type of benefit, inpatient treatment significantly affects medical costs, whereas outpatient clinic visits do not have a similar impact. This discrepancy can be attributed to the high costs associated with inpatient care, including accommodation in health units.

Interestingly, the study found that medical service providers do not significantly impact medical costs. This could be due to agreements between insurance companies and medical providers that establish cost limits for approved claims. Additionally, marital status was found to have no effect on medical costs. This may be because other factors, such as age and health status, play more critical roles in determining healthcare expenses.

In conclusion, the findings presented in this research contribute to the overall understanding of the factors affecting the cost of health insurance. The analysis provides insights into the distribution of claims among different medical service providers, the characteristics of the approved claim amount, age distribution, person beneficiary, and gender distribution within the study sample. These findings provide a nuanced understanding of the various elements influencing group health insurance costs and underscore the need for targeted strategies to manage these expenses effectively. Consequently, these findings serve as a foundation for further research and policy implications in the field of health insurance.

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