

Determinants of Out-of-Pocket Payments for Healthcare in Sri Lanka

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ABSTRACT

Introduction: Sri Lanka's healthcare system, though providing free public services, remains heavily reliant on out-of-pocket payments (OOPP), which accounted for about 40% of current health expenditure in 2022. The 2019 economic crisis worsened poverty and strained public services. Therefore, this study re-examines the determinants of OOPP using 2019 HIES data to understand changes in spending patterns.

AIM: This study aims to identify the determinants of out-of-pocket healthcare payments in Sri Lanka using 2019 HIES data, while also analysing the distribution of OOPP across healthcare categories and income quintiles.

Method: This study used a quantitative design with secondary data from the 2019 HIES in Sri Lanka, covering 19,911 households. A two-part model was applied: logistic regression to assess the likelihood of incurring OOPP and a Tweedie model to estimate its magnitude. Household-level variables were selected based on Andersen's behavioural model.

Results: Of the 19,911 households, 52% reported out-of-pocket healthcare payments, mainly for private medical services, medicines, and hospital charges. The relative burden of OOPP is similar across the first four quintiles. Higher income reduced both the likelihood and burden of OOPP, while members with chronic illness, economic engagement, and household expenditure were key drivers of higher likelihood and spending of OOPP.

Conclusion: The study found that higher income reduces both the likelihood and burden of out-of-pocket healthcare payments. The presence of members with chronic illness and limited access to public care increases costs, highlighting the need for policies that enhance financial protection for vulnerable households.

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ABBREVIATIONS:

CHE	Catastrophic health expenditure
DCSSL	Department of Census and Statistics, Sri Lanka
GDP	Gross Domestic Production.
HIES	Household Income and Expenditure Survey
IOPSSL	Institute of Policy Studies, Sri Lanka
LMIC	Low and middle-income country
IMF	International Monetary Fund
MMR	Maternal Mortality Rate
MOHSL	Ministry of Health, Sri Lanka
NCD	Non-Communicable Diseases
OECD	Economic Co-operation and Development
OOP	Out-of-pocket payments
SDG	Sustainable Development Goals
TB	Tuberculosis
UN	United Nations
UHC	Universal Health Coverage
UMN	Unmet medical needs
UNDP	United Nations Development Program
Unicef	United Nations Children's Emergency Fund
WHO	World Health Organization

1 INTRODUCTION

1.1. Healthcare in Sri Lanka

Sri Lanka is an island in South Asia with a population of around 22.1 million. It was categorised as a low-middle-income country (LMIC) in July 2020 (Rajapaksa et al.,2021). The Sri Lankan healthcare system is mostly based on Western allopathic medicine, with a small percentage consisting of traditional ayurvedic medicine. The civil medical department was established in 1858 in Sri Lanka, whereas the preventive services were established in 1926 with the establishment of the health unit system (Rajapaksa et al., 2021). According to the Ministry of Health [MOHSL] (2025), Preventive care as well as curative care services are provided by the public sector, and preventive care is provided by 335 MOH offices. It further states that 95% of the inpatient care and around 50% of the outpatient care is provided by the public sector.

1.1.1. Public healthcare in Sri Lanka

All public sector care is free to citizens at the point of delivery (Gamage et al, 2024), but as seen by the given percentages in the above paragraph, even though most of the inpatient services are provided by the public sector, both the public and private sectors provide outpatient care. The public healthcare provides both curative and preventive services. Public health services are provided through 335 MOH offices throughout the country. The Main function of the Ministry of Health is to formulate legislations and policies; other than these two main functions, the ministry does monitoring of programs and allocates human resources (MOHSL, 2025). As per the Ministry of Health, Sri Lanka [MOHSL] (2025), by mid-2022, Sri Lanka had 588 hospitals and 517 primary care facilities. Public curative healthcare services can be divided into three main areas, which are Primary Care, Secondary Care and Tertiary Care. Institutes that provide primary care are mostly Central dispensaries, Maternity homes, rural hospitals and divisional hospitals. In these institutes they might provide in patient services as well as outpatient services, but Central dispensaries only provide outpatient services. Institutes that provide secondary care are base hospitals, district general hospitals and provincial hospitals. In these facilities, they have general surgical and medical units in addition to primary care facilities. Tertiary care facilities compromise of teaching hospitals and some provincial hospitals; these hospitals carry out all functions mentioned in primary and secondary care, and they have specialties such as neurology and cardiology (Govindaraj et al, 2014)

1.1.2. Private Healthcare in Sri Lanka & increase in cases of Non-communicable Diseases (NCDs).

The number of private medical facilities has increased in Sri Lanka from the 1980s onwards. The private medical sector mainly focuses on curative services rather than preventive services. Therefore, these facilities are limited to hospitals, private medical practices, small clinics, laboratories, and nursing homes. Unlike public sector medical facilities that are spread throughout the country, most of the private medical facilities are aggregated around cities (Govindraj, 2014). According to the annual health bulletin, 2024, issued by the MOHSL, a directorate has been established to ensure the safety and quality of private healthcare facilities.

Private healthcare facilities operate on a profit-oriented model, and when poor households are compelled to use these services, often due to shortcomings in the public healthcare system, they face a heightened risk of financial hardship. While upper and upper-middle-class households frequently rely on private health insurance to cover healthcare expenses, low-income families typically pay out-of-pocket as per usage, increasing their economic strain (Dayarathne, 2013).

A significant number of medical doctors and some other health professionals working in private healthcare facilities are concurrently employed in the public sector. In Sri Lanka, medical staff are permitted to engage in private practice after completing their official duties in public hospitals (Institute of Policy Studies Sri Lanka [IPS], 2011). As noted by Dayarathne (2013), there have been instances where public sector consultants have encouraged patients to seek treatment in private hospitals; this type of behaviour might push poor households into financial hardship.

While Sri Lanka has achieved commendable health outcomes according to Smith (2018), the rising prevalence of NCDs such as heart disease, diabetes, kidney disease, and cancer presents new challenges. Public healthcare services face significant gaps in managing NCDs, particularly in diagnostics, essential medicines, and specialized equipment. Consequently, much of the care for NCDs is sought in the private sector which is more equipped than the public sector, resulting in substantial out-of-pocket payments (OOPPs) that place a financial strain on patients, especially the poor (Chapman & Dharmaratne, 2018)

1.2. Healthcare financing in Sri Lanka.

Most healthcare financing comes from government funds, through tax revenue and out-of-pocket payments (OOPP) (MOHSL, 2024). A very small proportion comes from health insurance schemes. Even though the government spending on healthcare has increased over the years, Sri Lanka is one of the countries that spend very little on healthcare as a proportion of the Gross Domestic Product (GDP) (Smith, 2018). As seen in the graph below, in 2023, the government has only spent 1.49 percent of its GDP on healthcare.

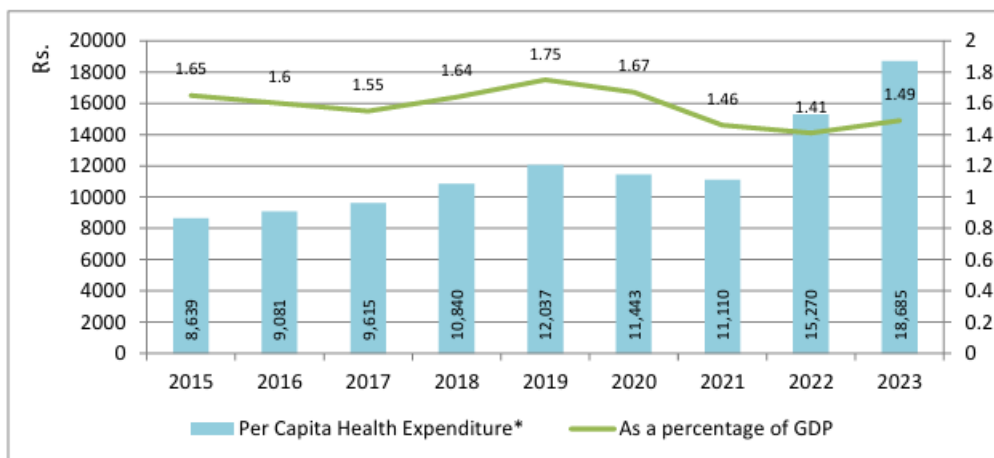


Figure 1: Per capita health expenditure and proportion of GDP spent on healthcare in Sri Lanka.

Source: Annual Health Bulletin 2022-2023(MOHSL,2024)

Shown below is Sri Lanka's health spending as a proportion of its GDP when compared to other South Asian countries.

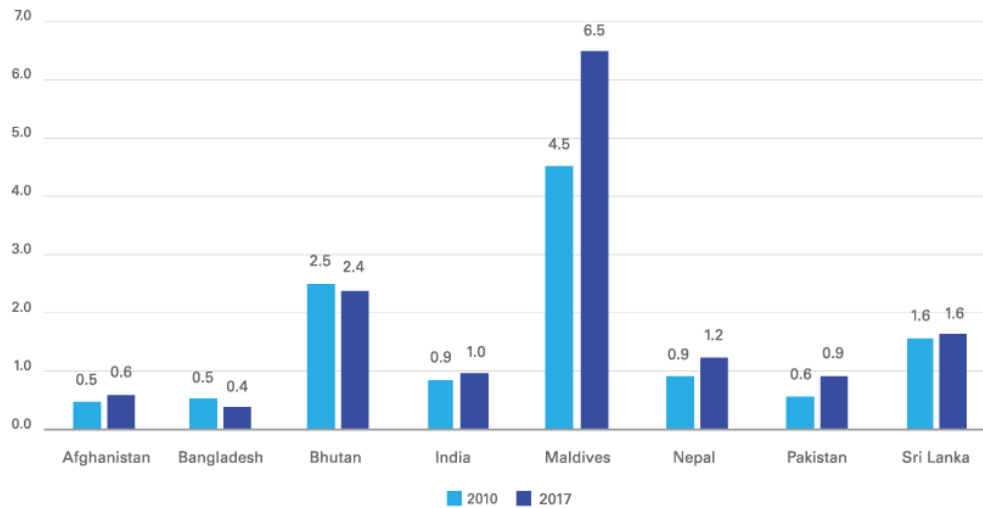


Figure 2: Healthcare spending of South Asian countries as a percentage of their GDPs (2010,2017)

Source: Yates et al (2021)

The statistics given above show that even if Sri Lanka has achieved some good health outcomes, the government’s spending on healthcare is relatively low compared to other countries such as Bhutan and the Maldives.

1.2.1. Out-of-pocket payments for healthcare in Sri Lanka.

Out-of-pocket payments are the second major source of healthcare funding in Sri Lanka. According to the World Health Organization’s [WHO] Global Health Expenditure database (April 2025), the percentage of OOP payments for healthcare was around 40% of current health expenditures in the year 2022. According to Pallegedara & Grimme (2018), there is a trend of increasing OOPP for healthcare in Sri Lanka. According to Asra & Wijesinhe. (2022) When analysing the 2016 household income and expenditure survey data (HIES) highest percentage of OOPP for healthcare was made to private outpatient practices, followed by expenditure for medical and pharmaceutical products.

The OOPP for healthcare as per HIES2016 data, is on average LKR 1,695 per household per month (United Nations Children’s Emergency Fund [Unicef], 2021). The graph below shows OOP expenditure of South Asian countries including Sri Lanka

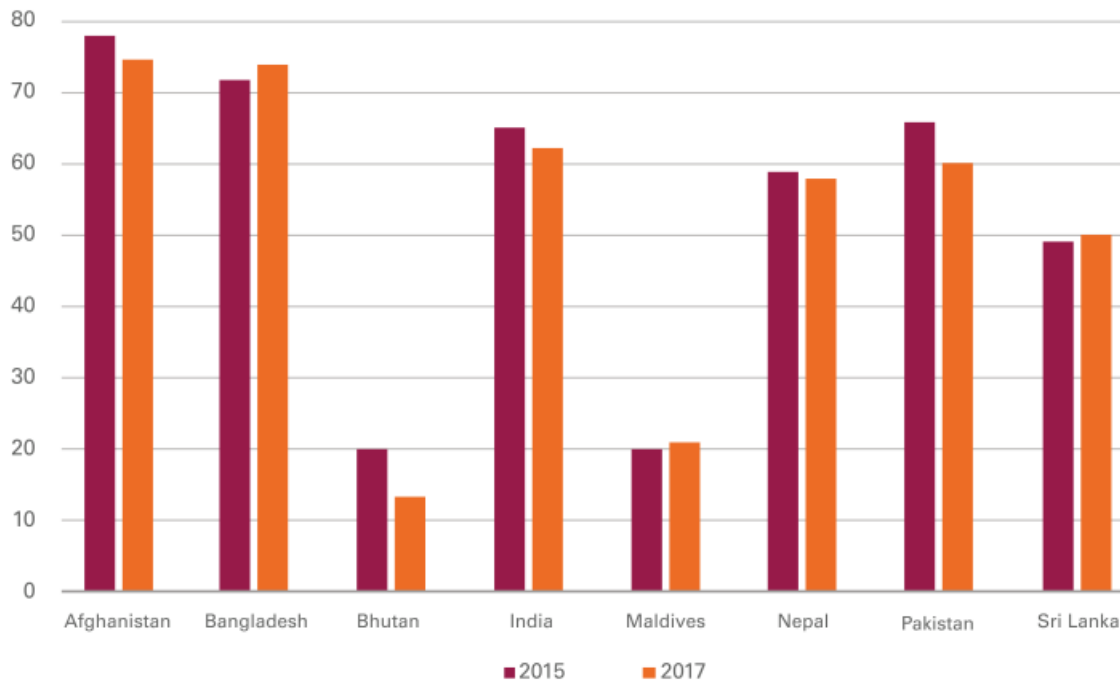


Figure 3: Out-of-pocket payments of South Asian countries 2015 and 2017.

Source: Yates et al (2021)

It can be seen that Sri Lanka has less OOPP for healthcare when compared to some of the countries in South Asia, however, it is still much higher than the global average of around 17% (WHO, 2025). In order to achieve the third goal in the Sustainable Development Goals (SDG) 2030 agenda of the United Nations, Sri Lanka should look into reducing the OOPP for healthcare and increasing government allocations for healthcare.

1.3. Sustainable Development Goals and Universal Health Coverage (UHC).

In the year 2015, the United Nations adopted the Sustainable Development Goals, which are also known as the Global Goals. These are aimed at eradicating poverty and protecting the planet so that everyone in the world can lead peaceful and prosperous lives. The 17 SDGs are a part of the 2030 Agenda for Sustainable Development. Each goal has specific targets that act as indicators to measure progress towards achieving the goals. From these goals, the third goal, “Good health and well-being”, aims at ensuring universal health coverage, increasing access to care, and reducing health disparities (United Nations [UN], 2015).

Even though Sri Lanka has been successful in achieving some of its goals, it is far from achieving Universal Health Coverage (UHC). UHC, which is point 3.8 in the 3rd Goal, states that everyone should have access to quality essential healthcare, irrespective of their financial situation.

1.4. Effect of OOPP on UHC

Heavy reliance on out-of-pocket payments (OOPP) to access healthcare often results in delayed or forgone treatment, particularly among low-income and vulnerable populations. This underutilization contributes to unmet healthcare needs (UMN) and increases the risk of catastrophic health expenditures (CHE), which can drive households into poverty. In low- and middle-income countries (LMICs), CHE is a leading cause of impoverishment (Ahmed et al., 2022). Sri Lanka, too, is an LMIC; therefore, impoverishment and CHE prevail in Sri Lanka, too. Evidence from LMICs shows that during periods of economic recession, willingness to pay OOP for healthcare decreases significantly, further contributing to UMN (Zheng et al., 2020). Similar findings were reported in a study by Madureira-Lima et al. (2018), which demonstrated that job and income losses during the 2008 global recession were positively associated with UMN across European countries. These dynamics are well explained by Andersen's Behavioral Model of Health Services Use, which categorizes the determinants of healthcare utilization into three domains: predisposing factors (e.g., age, sex, marital status, education), enabling factors (e.g., income, access to healthcare facilities), and need factors (e.g., chronic illness, perceived health status) (Andersen & Newman, 1973). According to this model, even when health needs are present, lack of enabling resources, especially financial means, can significantly deter individuals from seeking care.

The World Health Organization (2021) also identifies financial constraints as the foremost barrier to healthcare access, with an estimated 1.4 billion people worldwide facing OOPP-related financial hardship. In Sri Lanka, the absence of a universal social health insurance system means that a substantial share of healthcare financing falls on households, particularly affecting the poor. While the wealthiest income quintile contributes the most in absolute terms, lower-income households bear a disproportionately high burden relative to their limited resources. This often leads to CHE, typically defined as healthcare spending exceeding 40% of a household's non-food expenditure (Kang & Kim, 2021). These issues present a serious challenge to achieving Universal Health Coverage (UHC), as outlined in Sustainable Development Goal (SDG) 3.8, which aims to ensure access to quality health services without financial hardship. Persistent OOPP, unmet healthcare needs, and growing income-related disparities undermine both access and financial protection, the two core pillars of UHC.

1.5. Determinants of OOPP in Sri Lanka and their importance.

There have been several studies conducted to find the determinants of OOPP for healthcare in Sri Lanka. Two of the most recent studies are an analysis of HIES 2016 data by Asra & Wijesinghe. (2022) and analysis of HIES 2007 & 2010 data done by Kumara & Samaratunge. (2016). One or both of these studies show that there has been a statistically significant relationship between OOPP for healthcare and demographic factors such as the household sector. They also show a relationship between social, economic, and health factors such as education level, employment status, and the presence of household members with chronic illness.

These studies have further shown that the OOP expenditure on healthcare incurred by the richest quintile and the poorest quintile is not much different if you consider it as a proportion of total non-food expenditure.

Knowing the determinants of OOPP for healthcare is very important as it helps the policy makers to develop policies to reduce the burden of OOPP from poorer quintiles and enables the government and other institutions to provide support for households with special requirements, such as households with chronically ill members. Further, Sri Lanka has undergone a major economic crisis and it is important to know how spending patterns might have changed during the economic crisis.

1.6. Economic crisis in Sri Lanka.

Sri Lanka has undergone an economic crisis starting from the year 2019 (Nimal & Namboodiripad, 2022). The crisis deepened with the Covid-19 pandemic, and the government, under the guidance of the International Monetary Fund (IMF) has taken remedial measures that have affected the households of Sri Lanka (DCSSL, 2023). According to a survey conducted by the Unicef in 2022, approximately 77% of a sample of 3,000 households reported a decline in household income between March and November of that year. Concurrently, respondents indicated a 51% increase in out-of-pocket healthcare expenditures over the same period. Schoch (2023) reports that poverty in Sri Lanka rose significantly, increasing from 11.3% in 2019 to 25% in 2022. Over this period, approximately 2.5 million individuals fell below the national poverty line, accompanied by a rise in income inequality, with the Gini coefficient climbing from 37.7 to 39.8. These trends coincided with a deterioration in the public healthcare system in Sri Lanka, education, employment status and increased household indebtedness (DCSSL, 2023)

1.6.1. Effect of economic crisis on health.

The economic crisis affected both the healthcare system and the health-seeking behaviour of the population. The DCSSL 2023 survey on the impact of economic crisis (DCSSL,2023) illustrates how households have changed their treatment patterns. It emphasises the fact that a reduction in income and the rise of unemployment have driven households to reduce the consumption of health-related goods and services.

According to the survey, approximately 29% of individuals reported experiencing some form of illness. Among those affected, 7% altered their treatment approach in response to the prevailing economic crisis. These findings underscore the extent to which health conditions have been impacted by economic situation in the population during this period and highlight the influence of economic hardship on treatment-seeking. 35.1% have chosen a different place for treatment and 33.9% have opted to use drugs only at critical stages of the sickness.

Not only utilization of healthcare, the healthcare system itself has undergone changes during the economic crisis. The crisis led to critical shortages in medical supplies, underfunding of public health services, and the migration of healthcare professionals, including physicians and other trained staff, seeking better opportunities abroad (Silva, 2023). Additionally, Wang et al. (2018), using data from 2012, estimated that around 170 individuals were pushed into poverty annually due to out-of-pocket healthcare expenditures. This number is likely to have increased in the aftermath of the recent economic crisis.

1.7. Rationale of the study.

Sri Lanka has achieved commendable health outcomes despite being a lower-middle-income country, supported by a public healthcare system that offers free access to essential services like maternal care and inpatient treatment. However, the system remains heavily reliant on out-of-pocket payments (OOPP), which accounted for about 40% of current health expenditure in 2022 (WHO, 2024). While this is relatively low regionally, it poses significant risks amid Sri Lanka's recent economic crisis, rising poverty, and strained public health infrastructure.

High OOPP is linked to unmet healthcare needs, treatment delays, and catastrophic health expenditure (CHE), particularly among low-income households. This undermines progress toward SDG Target 3.8, which calls for universal access to quality care (indicator 3.8.1) and financial protection (indicator 3.8.2).

The lack of a universal insurance system and limitations in public service availability often push poorer households to seek private care, increasing financial vulnerability.

Following the COVID-19 pandemic and economic downturn, poverty in Sri Lanka rose sharply from 11.3% in 2019 to 25% in 2022 (Schoch, 2023), with households reporting income losses and increased healthcare spending (UNICEF, 2022). Previous studies using the 2016, 2010 and 2007 HIES data have identified key socioeconomic drivers of OOPP, but these relationships may have shifted under the current crisis conditions. Since 2019 is the year the economic crisis started in Sri Lanka, this study aims to re-examine the determinants of OOPP using 2019 HIES data: to find how the relationship between OOPP for healthcare and its determinants has shifted, and what type of healthcare households spend on. The findings may offer important insights into the socioeconomic vulnerabilities exacerbated by the country's health financing structure

2 AIM

This study aims to find the determinants that affect out-of-pocket payments for healthcare in Sri Lanka using Household Income and Expenditure Survey data from 2019 (HIES). Further, it intends to find the proportion of OOPP on each category of healthcare expenses and determine the proportion of OOPP of each income quintile.

RESEARCH QUESTIONS

1. What determinants increase the likelihood of OOPP for healthcare among households in Sri Lanka?
2. What determinants increase the amount of OOPP for healthcare in Sri Lankan households that incur OOPP?
3. How is the burden of OOPP on healthcare distributed among income quintiles?

3 METHODS

3.1. Research design.

This study uses a quantitative study design and uses secondary data from the HIES 2019 conducted by the Department of Census and Statistics, Sri Lanka. Quantitative methods were deployed to verify the relationship between the OOPP for healthcare among the households in the survey.

A quantitative approach is advantageous for this study due to the large volume of data involved. Moreover, it facilitates statistical verification of the relationship between out-of-pocket payments (OOPP) for healthcare and their determinants and reduces the risk of researcher bias.

Further, the study design provides a structured framework to test hypotheses and assess the strength and significance of relationships between variables, thereby enhancing the reliability and generalizability of the findings.

3.2. Data Collection.

The secondary data related to HIES 2019 was obtained from the Data Dissemination Division of the Department of Census and Statistics, Sri Lanka, via a formal request. The microdata related to 19,911 households in HIES 2019, Sri Lanka, is not publicly available. The micro data were sent via email and contained 31 csv data frames belonging to different categories of data, such as demography, food expenditure, non-food expenditure, etc..

DCSSL collects HIES data under the National Household Survey program. From 1990 to 2006, this survey was conducted once every five years, and after 2009, the survey has been conducted once every three years. HIES 2019, the tenth in its series, was carried out over 12 months from January to December 2019, to capture seasonal variations in income and expenditure. Although the general sample size is 25,000 housing units, the income and expenditure data are available only for 19,911 households (the total number of households in the income and expenditure data sheet provided by DCSSL). The 2019 questionnaire was revised to include indicators relevant to the Sustainable Development Goals (SDGs) and covered nine sections, including demography, education, health, income, and expenditure (Department of Census and Statistics, 2022). There was no missing data for any of the variables selected.

3.3. Variable selection.

Out-of-pocket payments (OOPP) can be a major barrier to healthcare access, especially for poor and vulnerable groups. When people must pay at the point of service, many delay or avoid seeking care even for essential or preventive services, leading to lower healthcare utilisation (Sharook et al., 2019). In Sri Lanka, where a portion of healthcare is financed through OOPP, this can place a heavy financial burden on households and discourage timely care-seeking, particularly among low-income populations. This shows the effect that OOP healthcare expenditure has on the utilisation of healthcare. Many models explain healthcare utilisation. One such model is Anderson's behavioural model of health services use. This model, developed by Ronald Anderson in the 1960s, provides a conceptual framework to realise the factors that would influence an individual's use of healthcare services (Anderson & Newman, 1973). Using this model, the independent variables were selected for the analysis.

Variables were selected at the household level rather than the individual level due to data limitations. While information on outpatient and inpatient care is available for individuals, the total out-of-pocket (OOP) healthcare expenditure cannot be accurately attributed to any one person within the household. This is because many health-related expenses, such as medicines, laboratory tests, X-rays, spectacles, scans, and hearing aids, are recorded only at the household level, without individual attribution. Furthermore, multiple members within a household may access healthcare services, but the related expenditure data are aggregated at the household level. Given these constraints, the total OOPP for healthcare was calculated at the household level. This approach is consistent with previous studies using HIES data, which also adopted a household-level analysis (Kumara & Samaratunge, 2016; Asra & Wijesinghe, 2022). As such, this study uses demographic and socioeconomic variables, most of which pertain to the head of the household. . The dependent variable is the equivalized monthly OOPP for healthcare, and the selected independent variables are described below.

3.3.1. Variable types selected.

Predisposing factors are those which are unique to individuals and would influence the likelihood of healthcare-seeking behaviour before a need arises (Anderson and Newman, 1973). From the data available, demographic variables such as age, sex, and marital status were selected. Education level, income status, and living area, such as urban, rural, were selected as socioeconomic variables.

Enabling factors are variables that affect the ability of an individual to seek healthcare; therefore, equivalized household income per month and equivalized total household expenditure per month were selected as variables that would represent the ability to seek healthcare. Further, the distance to the

nearest government dispensary and the distance to the nearest private dispensary were selected as variables that would explain the community-level resource availability. To represent the needs factor, variables such as the availability of chronically ill household members and the presence of over-65-year-old household members were selected.

3.3.2. Categorising variables

When categorising variables into subcategories, some subcategories already available in the raw data were clustered together to simplify the analysis. In the marital status, the “legally married” and “only traditionally married” were clustered together as “married”. In the income status category, the subgroups “actively engaged in economic activity” and “retired, but engaged in economic activity” were combined into the category “earning.” Similarly, “retired with government pension” and “retired with other type of pension” were grouped as “retired with income.” The remaining categories “seeking a job,” “retired without pension,” “engaged in household activities,” “students,” “unable to work,” and “other” were grouped under “no income.” However, it should be noted that this classification refers to the economic activity status of the head of household and does not reflect the equivalized household income per month, which is a separate variable. Even though many previous studies have taken employment status as a variable and not the income status, it was noted that the employment status has a large number of missing data points, unlike the economic status.

3.3.3. Calculations involved

When calculating the per-person income per month for the households, the Equivalised income method was used. In this, it adjusts for differences in household size and the makeup of its members, such as adults and children (Eurostat, 2025). Using the modified Organisation for Economic Co-operation and Development (OECD) equivalence scale, the equivalent size of the households was calculated, and this was used in calculating the equivalized income per month of the households, equivalized household expenditures per month, and equivalized household OOPP for healthcare per month.

When calculating the total OOPP cost of spectacles and hearing aids, which can be used for several years, their maximum useful life was verified, and it was used to calculate the monthly expenditure incurred. However, it was noted that in the costs for hearing aids, there were costs that were very low to be considered a direct expense for a hearing aid; these values were not converted and left as they were. When calculating each household’s total OOPP, for healthcare, the expenses of ayurvedic treatment were also included. The total OOPP was calculated using household-reported healthcare expenses, which

included costs for private medical practitioners, Ayurvedic treatments, specialist consultations, laboratory services, private hospital care, medicines and pharmaceutical products, as well as expenses for spectacles, hearing aids, diagnostic scans, X-rays, and other health-related services.

3.4. Analysis of data

All data cleaning, calculations, and analysis were done using R version 4.4.1. Before carrying out the regression analysis, the descriptive statistics of the variables were verified, and the variables such as age, education level, distance to the nearest government dispensary, and distance to the nearest private dispensary were recoded in categorical groupings to facilitate analysis. Then the data were visualised to see the distribution, skewness, and to verify if there are outliers. It was noted that the equivalized OOPP, equivalized income, and equivalized expenditure were right-skewed, therefore, these were log transformed to reduce the skewness. OOPP did not show any extreme outliers; however, equivalized income shows some extreme outliers in the upper end, but these outliers were not removed as they are valid real observations.

3.4.1. Income quintile calculation.

To analyze income-based disparities, household income data were divided into five income quintiles (Q1 to Q5) using R statistical software. This was done using the equivalized monthly household income, which adjusts for household size and composition. The quantile function in R was used to calculate cut-off points at the 20th, 40th, 60th, and 80th percentiles, dividing the sample into five equal-sized groups. Each quintile represents 20% of the population, with Q1 being the lowest-income group and Q5 the highest. All income values are reported in Sri Lankan Rupees (LKR) based on 2019 prices. For international comparison, the average exchange rate in 2019 was approximately LKR 179 = USD 1 (ExchangeRates.org.uk, 2019).

3.4.2. Regression analysis.

The total number of households in the study, as per the data available in the final household income expenditure data sheet provided by the DCSSL, is 19,911. Of these 19,911 households, 10,381 households have incurred one or more types of healthcare expenses. This shows that more than half of the households (around 52%) under consideration have incurred a healthcare expense. Considering that the data is heavily right-skewed and there are a large number of zeros in the data set, a two-part regression model was decided (Kurz, 2017) & (Bock et al, 2014).

Part 1: A logit model to estimate the probability of incurring any OOPP.

Part 2: A Tweedie model to estimate the change in the magnitude of OOPP spending, conditional on having any expenditure.

The first part of the model, is a logit model that considers the OOPP as a binary outcome.

$$\Pr(Y_i > 0) = \frac{1}{1 + \exp(-X_i' \beta)}$$

Where Y_i is the observed OOPP for the household, X_i is the explanatory variable, and β is a vector of parameters to be estimated.

The second part of the model is a Tweedie Generalised Linear Model. In this part, the magnitude of the OOPP for healthcare is modelled for positive OOPP.

$$E[Y_i | Y_i > 0, X_i] = \mu_i = g^{-1}(X_i' \gamma)$$

$Y_i | Y_i > 0$ is the positive OOPP, μ_i is the expected value of OOPP for a given variable X_i , g^{-1} is the inverse link function, and γ is a vector of coefficients to be estimated (Wu et al, 2022)

To assess the goodness-of-fit of the logistic regression model, a visual model calibration plot was used. This plot compares the predicted probabilities of incurring out-of-pocket payments (OOPP) with the observed proportions across deciles of predicted risk. Ideally, a well-calibrated model should show points closely aligned with the 45-degree reference line, indicating consistency between predicted and actual values (Harrel, 2015). (Appendix 1).

Variance Inflation Factor (VIF) values were calculated to assess multicollinearity among predictors. VIF values should be below the common threshold of 5, indicating no significant multicollinearity issues (Appendix 2).

For the Tweedie model, a Pearson residual plot was used to examine model fit and assumption validity. The residuals should appear randomly scattered around zero, with no clear patterns, supporting the assumption of homoscedasticity and a good model fit (Appendix 3). VIF analysis for the Tweedie model was carried out to find multicollinearity among predictors (Appendix 4).

3.5. Ethical Considerations.

The data used in this study are secondary data collected by the Department of Census and Statistics, Sri Lanka (DCSSL). The data was obtained through a formal request process, and as per the regulations set by the DCSSL, the data will only be used for this study. The DCSSL operates under the authority of the Census Ordinance of 1900 and is legally bound to comply with the provisions of the Right to Information

Act, No. 12 of 2016. In accordance with departmental policies, all direct and indirect identifiers were removed prior to data dissemination. To ensure further anonymity, no geographic information, such as district or province, was requested. No identifiable variables were available in the dataset given. All data received from the Data Dissemination Division will be stored securely and handled with strict confidentiality.

4 RESULTS

4.1 Descriptive Analysis of Household Characteristics and OOPP for Healthcare

The HIES 2019 dataset obtained from the DCSSL includes information on 19,911 households. Of these, 10,381 households (52%) reported having incurred out-of-pocket payments (OOPP) for healthcare services. Table 1 presents the distribution of households across selected categories of key independent variables. The demographic variables, such as age, sex, marital status, education level, and economic engagement, refer to the heads of households. For each category, the table provides both the proportion of the total household sample represented and the proportion of households within that category that reported positive OOPP. This descriptive overview serves to highlight preliminary patterns in healthcare spending across different household characteristics.

Table 1: Proportion and Number of Households Incurring Out-of-Pocket Payments by Selected Socioeconomic and Demographic Factors

Variable	Proportion of total households	Proportion of households that have OOPP
Sex		
male	74.6% (14,853)	52.62% (7,815)
female	25.4% (5,058)	50.73% (2,566)
Sector		
urban	16.09% (3,204)	58.36% (1,870)
rural	79.64% (15,858)	51.87% (8,225)
estate	4.26% (8,49)	33.69% (286)
Age in years		
<20	0.1% (19)	55.56% (5)
20-39	16.95% (3,374)	47.48% (1,602)
40-64	57.81% (11,511)	50.21% (5,780)
≥65	25.15% (5,007)	59.79% (2,994)
Marital status		
Never married	2.26% (450)	42.22% (190)
Married	78.44% (15,618)	53.14% (8,300)
Widowed	16.24% (3,233)	50.11% (1,620)
Divorced/Separated	3.06% (610)	44.42% (271)

Education level		
Never educated	3.46% (689)	42.96% (296)
Primary education	20.9% (4,161)	46.98% (1,955)
Secondary education	72.99% (14,533)	53.75% (7,811)
Tertiary education	2.61% (520)	60.38% (314)
Special education	0.04% (8)	62.5% (5)
Economic engagement		
Earning	67.58% (13,455)	49.93% (6,718)
Retired with income	5.57% (1,110)	68.92% (765)
No income	26.85% (5,346)	54.21% (2,898)
Distance to nearest Government Dispensary		
<1km	11.48% (2,286)	52.49% (1,200)
1-5 km	62.72% (12,489)	54.79% (6,843)
6-10 km	19.02% (3,788)	48.79% (1,848)
>10km	6.77% (1,348)	36.35% (490)
Distance to Private Dispensary		
<1km	30.43% (6,059)	57.40% (3,478)
1-5 km	55.25% (11,000)	52.78% (5,806)
6-10 km	9.9% (1,972)	42.75% (843)
>10km	4.42% (880)	28.86% (254)
Members with chronic illness		
None	51.71% (10296)	38.83% (3998)
1 person	33.05% (6580)	63.69% (4191)
More than 1	15.24% (3035)	72.22% (2192)
Members above 65 years		
None	65.77% (13095)	47.89% (6271)
1 person	24.04% (4786)	58.33% (2792)
More than 1	10.2% (2030)	64.93% (1318)

As shown in Table 1, approximately 75% of household heads are male, and over half of these households reported incurring OOPP for healthcare. Although the proportion of female-headed households is relatively small (25.4%) when the total number of households is considered, more than 50% of them also reported healthcare expenditures, indicating that healthcare spending is not limited to male-headed households alone. When examining the distribution in “sector”, the majority of households (around 80%) are located in rural areas. Of these, more than half reported making OOPP for healthcare. In contrast,

urban households represent only 16% of the total sample, yet approximately 58% of them reported healthcare-related spending. In the estate sector, which comprises a smaller portion of the sample, only 34% of households reported incurring OOPP, indicating a notably lower level of healthcare expenditure in this sector.

Across age categories, approximately 50% of households in all age groups reported positive OOPP. However, among households with a head aged over 65, this proportion rises to nearly 60%, suggesting that healthcare spending increases with age. The majority of household heads (78%) are married, and more than half of these households reported healthcare expenditures. In contrast, households headed by individuals who are never married or separated showed a lower proportion of OOPP(42.22%). Regarding education level, most household heads have received secondary education, accounting for approximately 73% of the sample. Notably, over 60% of households in the tertiary education category reported healthcare expenditures. While more than 60% of households in the "special education" category also reported OOPP, this finding may lack statistical significance due to the small sample size within this group.

Proximity to healthcare facilities appears to influence spending patterns. A higher proportion of households located near private healthcare facilities incurred OOPP, but a similarly high proportion was observed among those near public dispensaries, indicating a potential correlation between access and expenditure. In households with members suffering from chronic illnesses or with elderly members (aged 65 and above), the incidence of OOPP increases with the number of such individuals. Households without members with chronic illnesses or elderly members show the lowest proportion of OOPP in that category, while those with more than one of such members have the highest, suggesting that there may be a relationship between healthcare needs and out-of-pocket expenditures.

4.2. Healthcare category-wise OOPP.

The categories of health care expenditure, as mentioned in the HIES2019, are fees for private medical practitioners, Ayurveda consultation fees, consultation fees to specialists, payments to medical laboratories for test analysis, payments to private hospitals, and nursing homes, purchase of medical and pharmaceutical products, spectacles, hearing aids, scan/ultra sound, X-Ray and other. Given below in the Table is the amount of OOPP made to each healthcare category as a percentage of total OOPP payments. The low total costs associated with the purchase of spectacles and hearing aids are because the values have been adjusted to represent the monthly expenditure of the item as these have a useful life span of more than 12 months.

Table 2: Out-of-Pocket Payments by Healthcare Category: Absolute Amount (LKR) and Share of Total OOPP.

Category	OOPP (LKR)	OOPP as % of Total	Average amount spent (LKR)	Number of households
Private medical	11,712,539	29.02%	1,820.70	6433
Ayurveda	763,855	1.89%	2,808.29	272
Consultation	2,221,657	5.51%	2,360.95	941
Laboratories	3,961,575	9.82%	3,085.34	1284
Private hospitals	10,565,405	26.18%	35,936.75	294
Medicines	9,433,870	23.38%	1,736.40	5433
Spectacles	23,279.17	0.06%	306.30	76
Hearing aids	15,833.33	0.04%	2,638.89	6
Scans	456,170	1.13%	4,344.48	105
X-rays	88,260	0.22%	1,423.55	62
Other expenses	1,113,402	2.76%	11,720.02	95
All expenses	135,116.94 USD (40,940,433 LKR)	100%		

Note: The exchange rate of the USD was taken as 303.00 LKR per USD as per the selling rate given by the Central Bank of Sri Lanka as at 14/05/2025. If the currency year 2019 is considered, this value should be 229,220 USD, where the exchange rate is approximately 178.65 LKR per USD (ExchangeRates.org.uk, 2019).

The data clearly show that over 75% of total OOPP is concentrated in just three categories: private medical services, private hospitals, and medicines. From all the healthcare categories, private medical services account for the largest share of total OOPP, representing approximately 29.02% of all healthcare-related household expenditures. This is followed closely by spending on private hospitals (26.18%), suggesting that services offered by private healthcare providers constitute the most significant financial burden for households.

Expenditure on medicines is the third major component, accounting for 23.38% of total OOPP. This highlights the substantial cost burden associated with pharmaceutical purchases, which is likely to be ongoing. Laboratory services also represent a notable share, comprising 9.82% of total OOPP, indicating that diagnostic testing forms a meaningful portion of healthcare spending.

Other categories, such as specialist consultations (5.51%), Ayurveda (1.89%), and miscellaneous healthcare-related expenses (2.76%), contribute smaller proportions. Spending on spectacles, hearing

aids, scans, and X-rays each accounts for less than 2% of the total, reflecting the relatively infrequent or one-time nature of these costs.

However, when the number of households spending on each category of healthcare service is looked into, it can be seen that even though some categories like private hospitals make up for 25% of the expenditure, the number of households that have purchased the service is very low. Therefore, the large percentage of total OOPs is due to the large one-time expenses incurred.

Private medical services and medicines emerge as the most commonly utilized healthcare categories, accessed by 6,433 and 5,433 households, respectively. The average monthly expenditure for private medical care is LKR 1,820.70, while medicines cost an average of LKR 1,736.40. Consultation fees (LKR 2,360.95) and laboratory services (LKR 3,085.34) are also significant, indicating regular use of diagnostic and outpatient specialist services. Scans (LKR 4,344.48) and X-rays (LKR 1,423.55) reflect more specific diagnostic interventions, often required during acute health episodes or specialist referrals. Note that since households may utilize more than one category of healthcare services, the number of households in each category cannot be summed to determine the total number of households incurring out-of-pocket payments (OOPP).

4.3. OOPP for healthcare by income quintile.

The table below shows the OOPP across different income quintiles, which indicates how the burden of OOPP is spread across the four quintiles.

Table 3: Household Out-of-Pocket Healthcare Expenditures by Income Quintile: Levels and Financial Burden

Characteristic	Q1 (n=3,983)	Q2 (n=3,982)	Q3 (n=3,982)	Q4 (n=3,982)	Q5 (n = 3,982)
Mean OOP (LKR)	671.69	980.03	1240.0	1852.36	5390.31
Median OOP (LKR)	0	0	75	400	840
Total Income (LKR)	67,595,810	140,049,044	206,743,436	302,801,048	750,433,028
Total OOP (LKR)	2,675,330	3,902,497	4,937,694	7,376,105	21,464,219
OOP as % of Expenditure	2.75%	2.61%	2.55%	2.86%	4.19%

Note: OOPP as a percentage of total household expenditure. Mean, median, and sums are calculated within each income quintile.

There is a clear gradient in mean OOP expenditure, increasing from LKR 671.69 in Q1 to LKR 5,390.31 in Q5. The median OOP in the lowest two quintiles is zero, indicating that at least half the households in Q1 and Q2 reported no OOP healthcare expenditure during the survey period. In contrast, the median OOPP increases steadily in higher quintiles: LKR 75 in Q3, LKR 400 in Q4, and LKR 840 in Q5. Aggregated income and total OOP spending rise steeply across the quintiles. Total income increases from approximately LKR 67.6 million in Q1 to LKR 750.4 million in Q5, while total OOPP rises from LKR 2.7 million in Q1 to LKR 21.5 million in Q5. The highest income quintile (Q5) accounts for the majority of total OOP spending

Households in the higher income quintiles not only spend more in absolute terms, but are also better positioned to absorb these costs without compromising other essential needs. The burden of OOP healthcare expenditure, measured as a percentage of total household expenditure, remains relatively stable across the first four quintiles, ranging from 2.55% to 2.86%. However, this percentage increases sharply in Q5, reaching 4.19%. While the percentage is stable, the absolute amount of money spent differs significantly, with wealthier households spending more in total but still maintaining a similar percentage of their overall expenditure as the poorer households.

4.5. Results of the two-part model to verify determinants of out-of-pocket payments.

To identify the determinants of OOPP for healthcare, a two-part model was applied (Kurz, 2017) & (Bock et al, 2014). The first part uses a logit model to estimate the probability of incurring any OOPP, accounting for the large number of zero expenditures. The second part, conditional on positive spending, employs a Tweedie model to estimate the magnitude of OOPP, given its skewed and semi-continuous distribution.

4.5.1. Results of the logit model.

The table below presents the results of the logistic regression analysis examining the factors associated with out-of-pocket healthcare payments.

Table 4: Predictors of Incurring Out-of-Pocket Payments: Logit Model Results

Variable	Coefficient (Estimated)	Std. Error	z value	Pr(> z)
(Intercept)	-9.527	0.651	-14.622	0.000
Sex (Ref: Female)				
Male	-0.097	0.048	-1.997	0.046
Sector (Ref: Estate)				
Rural	0.278	0.080	3.465	0.001
Urban	0.052	0.092	0.576	0.565
Age (Ref:<20)				
>65	0.675	0.568	1.19	0.234
20-39	0.786	0.565	1.392	0.164
40-64	0.678	0.564	1.202	0.229
Marital status(Ref: Divorced/Separated)				
Married	0.301	0.094	3.222	0.001
Never married	-0.197	0.136	-1.447	0.148
Widowed	0.057	0.098	0.587	0.557
Education (Ref: Never Educated)				
Primary education	-0.027	0.091	-0.301	0.764
Secondary	-0.067	0.088	-0.764	0.445
Special education	-0.075	0.786	-0.096	0.924
Tertiary education	-0.449	0.136	-3.311	0.001
Economic engagement (Ref: Earning)				
No income	0.041	0.044	0.95	0.342
Retired with income	0.220	0.077	2.854	0.004311
Distance to nearest Government Dispensary (Ref: 1-5 km)				
6-10 Km	0.012	0.046	0.281	0.779
<1km	-0.093	0.053	-1.754	0.079
>10km	-0.151	0.073	-2.074	0.038
Distance to nearest Private Dispensary (Ref: 1-5km)				
6-10	-0.185	0.060	-3.104	0.002
<1km	-0.024	0.040	-0.625	0.532

>10km	-0.686	0.091	-7.52	0.000
Members with chronic illness (Ref: More than 1)				
None	-1.299	0.050	-25.883	0.000
1 person	-0.308	0.051	-6.019	0.000
Members above 65 years (Ref:More than 1)				
None	-0.397	0.082	-4.875	0.000
1 Person	-0.073	0.065	-1.131	0.258
log(Equivalised income)	-0.125	0.031	-4.109	0.000
log(Equivalised expenditure)	1.103	0.041	26.841	0.000

The results of the logit model reveal several significant determinants of the likelihood of incurring any out-of-pocket healthcare payments (OOPP). Households with males as head of household were slightly less likely to make OOPP compared to females ($p = 0.046$). Households situated in rural areas were significantly more likely to incur OOPP compared to those in the estate sector ($p < 0.001$). The urban-estate difference was not statistically significant. Marital status of the head of the household has also influenced OOPP likelihood, with households with a married head of household showing a higher probability of incurring such payments ($p = 0.001$) than households with a separated or divorced head of household. Households whose heads had tertiary education were associated with a significantly lower likelihood of OOPP ($p < 0.001$). Households with a retired head of household with income were more likely to report OOPP ($p = 0.004$), possibly reflecting greater healthcare needs.

Access to healthcare facilities also played a role. Longer distances to both government and private dispensaries (more than 10 km) were associated with a significantly reduced probability of making OOPP, suggesting that physical access may limit service use. The presence of chronic illness had a strong influence: households with no chronic illness conditions or with only one individual with a chronic illness were significantly less likely to incur OOPP compared to those households with multiple members with chronic illness ($p < 0.001$). Additionally, households without elderly members (over 65 years of age) were less likely to report OOPP ($p < 0.001$), while the presence of one elderly member was not significant when compared to households with more than one member who is over the age of 65 years. Interestingly, while total and mean OOP payments increased with income, the logit model indicated that higher income was associated with a lower probability of incurring any OOP payment.

However, higher equivalized expenditure was strongly and positively associated with the likelihood of incurring out-of-pocket payments ($p < 0.001$). Overall, the model suggests that healthcare needs (chronic

conditions, age), access (distance to facilities), and economic capacity (expenditure, income) are key drivers of whether households incur out-of-pocket healthcare spending.

4.5.2. Results of the Tweedie Model

The table below presents the results from the Tweedie regression model, which was used to analyze the factors associated with the magnitude of out-of-pocket healthcare expenditures, accounting for the skewedness of the data and the presence of zero expenditures

Table 5: Determinants of Out-of-Pocket Payment Magnitude: Tweedie Model Estimates

Variable	Coefficient (Estimated)	Std. Error	t value	Pr(> t)
(Intercept)	-6.059	-9.527	-5.375	0.000
Sex (Ref: Female)				
Male	0.114	0.073	1.571	0.116
Sector (Ref: Estate)				
Rural	0.258	0.142	1.825	0.068
Urban	0.128	0.155	0.827	0.408
Age (Ref: <20)				
>65	0.911	1.029	0.886	0.376
20-39	0.501	1.027	0.488	0.626
40-64	0.636	1.026	0.619	0.536
Marital status(Ref: Divorced/Separated)				
Married	-0.119	0.148	-0.806	0.420
Never married	0.343	0.217	1.582	0.114
Widowed	-0.061	0.153	-0.402	0.688
Education (Ref: Never Educated)				
Primary education	0.250	0.144	1.734	0.083
Secondary education	0.242	0.141	1.722	0.085
Special education	0.028	1.030	0.027	0.978
Tertiary education	0.440	0.195	2.253	0.024

Economic engagement (Ref: Earning)				
No income	0.233	0.063	3.705	0.000
Retired with income	0.338	0.095	3.56	0.000
Distance to nearest Government Dispensary (Ref: 1-5 km)				
6-10 km	-0.099	0.068	-1.452	0.146
<1km	0.047	0.077	0.618	0.537
>10km	0.049	0.118	0.415	0.678
Distance to nearest Private Dispensary (Ref: 1-5km)				
6-10 km	0.208	0.094	2.2	0.028
<1km	0.103	0.056	1.841	0.066
>10km	0.152	0.160	0.947	0.343
Members with chronic illness (Ref: More than 1)				
None	-0.497	-1.299	-7.523	0.000
1 Person	-0.134	-0.308	-2.143	0.032
Members above 65 years (Ref: More than 1)				
None	-0.036	-0.397	-0.337	0.736
1 Person	-0.177	-0.073	-2.074	0.0381
log (Equivalized income)	-0.144	-0.125	-2.967	0.003
log(Equivalized expenditure)	1.347	1.103	22.168	0.000

The sector the household is situated does not have a significant effect on OOPP, but as seen in the results, the rural sector has a marginally significant effect ($p=0.068$) when compared to the estate sector. Households with tertiary-educated heads had significantly higher OOPP compared to those with no formal education ($p = 0.024$), reflecting greater capacity to spend. Other education levels showed marginal significance ($p \approx 0.08$).

Households where the head reported no income or was retired with income had significantly higher OOPP ($p < 0.001$ for both), possibly reflecting greater health needs among retirees or income from pensions, enabling private care use. Further, as mentioned in the methods in the “No income” subcategory, there are several categories from the original data set aggregated together, one such category was retired without any pension, which might be one of the factors that drives high OOPP in this category and even though the head of the household does not record any income it does not

necessarily mean that the household has no income because as seen in the original data set there are adult household members that are economically active.

Among distance variables, only private dispensary access (6–10 km) was significantly associated with higher OOPP ($p = 0.028$). Other distance measures were not significant. Households with no members with chronic illness had significantly lower OOPP ($p = 0.001$), and those with only one member with chronic illness also spent less than those households with multiple members with chronic illness ($p = 0.032$), indicating a strong association between health need and spending. Both households with no elderly members and those with only one elderly member showed lower OOPP compared to households with more than one elderly member, though only the latter was statistically significant.

Log of equivalized income was negatively associated with OOPP ($p = 0.003$), meaning that, among households that do pay, those with higher income tend to spend slightly less. In contrast, the log of equivalized expenditure was a very strong positive predictor of OOPP ($p < 0.001$), indicating that households with higher spending habits are more likely to spend more on healthcare. This reflects both the capacity and willingness to pay.

These findings highlight that household economic behavior (expenditure), education, and health status are the strongest predictors of OOPP, while demographic factors of the household head (age, sex, marital status) play a more limited role once other variables are accounted for. The results emphasize that financial capacity and healthcare needs, rather than income alone, drive out-of-pocket spending among those who access care.

4.5.3. Comparison of results from the two models

The table below illustrates how various household-level predictors behave differently (or similarly) across the two parts of the model.

Table 6: Comparison of Estimates from Logistic and Tweedie Regression Models

Variable	Coefficient Tweedie	Coefficient logit	P Value logit	P Value Tweedie
(Intercept)	-6.059	-9.527	0.000	0.000
(Ref: Female)Male	0.114	-0.097	0.046	0.116
(Ref: Estate sector)Rural	0.258	0.278	0.001	0.068
(Ref: Divorced/Separated)Married	-0.119	0.301	0.001	0.420

(Ref: Never	0.440	-0.449	0.001	0.024
Economic engagement (Ref: Earning)				
No income	0.233	0.041	0.342	0.000
Retired with income	0.338	0.220	0.004	0.000
Distance to healthcare facilities (Ref: 1-5km)				
gov_dispensary >10km	0.049	-0.151	0.038	0.678
private_dispensary6-10km	0.208	-0.185	0.002	0.028
private_dispensary>10km	0.152	-0.686	0.000	0.343
Members with chronic illness (Ref: More than 1)				
None	-0.497	-1.299	0.000	0.000
1 person	-0.134	-0.308	0.000	0.032
Members above 65 years (Ref: More than 1)				
None	-0.036	0.107	0.000	0.736
1 person	-0.177	0.085	0.258	0.038
log (Equivalized income)	-0.144	-0.125	0.000	0.003
log(Equivalized expenditure)	1.347	0.061	0.000	0.000

Some variables are significant in both models and seem to have similar directions. For instance, the rural sector is positively associated with both likelihood and amount of OOPP, indicating that rural households are more likely to incur and spend more on healthcare (logit $p = 0.0005$; Tweedie $p = 0.068$). Likewise, the category retired with income is significant in both models, suggesting that retired households with income face both a higher probability of paying and tend to spend more (logit $p = 0.004$; Tweedie $p = 0.0004$). Equivalized expenditure too shows a strong positive effect in both models and is highly significant ($p < 0.000$), indicating it is the most consistent economic predictor of healthcare spending behavior. In contrast, the log-transformed income is negatively associated in both models, suggesting higher-income households may be less likely to incur or spend on OOPP. The absence of a member with chronic illness in the household and having only one member with a chronic illness in the household were strong negative predictors in both models, indicating significantly lower odds of incurring OOPP and reduced expenditure when incurred, compared to households with more than one member with a chronic illness.

Unlike the variable mentioned above, there are some variables that show opposite effects in the two models, like the households with heads who have tertiary education has a reduced likelihood of OOPP

(logit coef = -0.449 ; $p = 0.001$) but increases the amount spent when incurred (Tweedie coef = 0.440 ; $p = 0.024$). This may reflect a higher willingness to pay for quality care when needed. The other variable that shows this type of behavior is the distance to the nearest private dispensary, 6-10 km category.

Other than the above, there are some variables that are only significant in one model and have no statistical significance in the other model. One such variable is the sex male; male-headed households have a lower probability of incurring OOPP compared to female-headed ones, although the effect size is modest. In the Tweedie model, the effect seems to be positive but not significant ($p = 0.116$), indicating that once spending occurs, gender does not significantly influence the amount spent. The other two variables are distance to government dispensaries, more than 10km category, which is significant only in the logit model, and the presence of one member who is more than 65 years of age, which is significant only in the Tweedie model.

4.6. Diagnostics carried out on the two-part regression model

In the two-part model used for the regression analysis, a visual model calibration was used to evaluate the logit model, and the VIF test was carried out to find the multicollinearity in the model. In the visual model, the points closely follow the 45-degree reference line, indicating that in this study, the calibration plot demonstrated good alignment, suggesting that the logistic regression model was well-calibrated and accurately predicted the likelihood of OOPP (Appendix 1). VIF results showed that all values were below the common threshold of 5, indicating that multicollinearity is not a problem in the model (Appendix 2)

In the Tweedie model, the Pearson residuals were plotted against the fitted values, and the plot showed that the residuals were randomly scattered around zero and showed no pattern (Appendix 3). A VIF test was conducted to find if there was multicollinearity in the model, and the results showed that there was no multicollinearity (Appendix 4)

5 DISCUSSION

This study examined the determinants of out-of-pocket payments (OOPP) for healthcare in Sri Lanka using data from the 2019 Household Income and Expenditure Survey (HIES). Key findings indicate that higher household income is associated with a lower likelihood and magnitude of OOPP, while higher household expenditure increases both. Chronic illness within households, rural residence, and greater distance to public healthcare facilities also significantly influenced OOPP. The analysis revealed persistent reliance on private medical practices and pharmaceuticals.

The logit and Tweedie models provided robust insights into both the likelihood of incurring OOPP and the amount spent. Female-headed households showed a higher probability of OOPP, consistent with findings from Bertakis et al. (2000), though not previously reported in Sri Lankan literature. Rural households faced a higher probability and magnitude of OOPP, likely due to limited access to public healthcare services, a finding supported by Sato (2024). Marital status also influenced healthcare spending; households with married heads were more likely to incur OOPP, aligning with international evidence linking marital status to increased care-seeking behavior (Pandey et al., 2019).

Educational attainment, particularly tertiary education, demonstrated a nuanced effect: it reduced the likelihood of incurring OOPP but increased the magnitude when incurred. This suggests that educated individuals may better manage preventive care and service utilization but opt for higher-quality or costlier care when needed. The income status variable "retired with income" showed a strong positive association with both the likelihood and level of OOPP, likely due to greater healthcare needs and the financial ability to access services. In contrast, the "no income" group showed higher spending when healthcare was accessed, perhaps reflecting delayed or accumulated needs.

Access to healthcare was a major determinant of OOPP. Households more than 10 km from a government dispensary were less likely to incur OOPP, likely due to underutilization caused by poor accessibility. Meanwhile, those 6–10 km from private facilities showed higher OOPP incidence and amounts, underscoring the role of geographic access in shaping healthcare spending. These findings highlight the importance of addressing infrastructure gaps to promote equitable access.

The presence of chronic illness was one of the strongest predictors of OOPP. Households with no members suffering from chronic illness showed significantly lower likelihood and amounts of OOPP, while those with one or more members had significantly higher healthcare spending. Elderly presence had a mixed effect, with increased costs observed in households with one elderly member but no significant effect on the likelihood of any expenditure. These patterns emphasize the financial vulnerability posed by chronic conditions and aging populations.

Income and expenditure effects were significant and aligned with findings from Kumara & Samaratunge (2016). While higher income reduced the burden of OOPP, higher expenditure increased it, possibly

reflecting both greater need and capacity for consumption of healthcare services. The disproportionate burden of OOPP on poorer households suggests that they may be sacrificing other essentials or incurring debt to afford healthcare.

Over time, the percentage of households reporting OOPP has declined, from 70% in 2016 (Asra & Wijesinghe, 2022) to 52% in 2019, possibly reflecting shifting service utilization or early effects of policy reforms. However, private sector spending still dominates. Spending on private medical practices remains the highest category of OOPP, although its share has decreased from 50% in 2007 to 29% in 2019. The high cost but low utilization of private hospitals points to significant financial barriers for households opting for such services.

Despite the onset of Sri Lanka's economic crisis in 2019, the core determinants of out-of-pocket payments (OOPP) for healthcare appear to have remained largely consistent with those identified in previous periods. Variables such as income, household expenditure, chronic illness, and access to healthcare facilities continue to significantly influence both the likelihood and magnitude of OOPP. A study conducted by Zheng et al. (2020) states that during economic recession, willingness to pay for healthcare reduces, even though the proportion of households with OOPP has slightly reduced from 2016; this cannot be directly attributed to the ongoing economic crisis. A study conducted by Yang et al. (2001) in Korea has shown that during an economic crisis, the consumption of medicines and pharmaceutical items reduces, but this is not seen in 2019 HIES data as it records 23.38% of total OOPP for medicines which is only slightly lower than that of 2016 data which is 26.12%

These findings have important implications for achieving Universal Health Coverage (UHC). Persistent reliance on OOPP, especially among vulnerable populations, undermines financial protection goals. Chronic illness, rural isolation, and inequities in access continue to challenge Sri Lanka's progress toward UHC. Expanding social protection mechanisms, subsidizing care for chronic conditions, and improving rural infrastructure are essential steps to reducing disparities.

Strengths and Limitations

A major strength of this study is its use of a nationally representative dataset with a large sample size, enabling generalizability of findings. The application of a two-part regression model allowed for nuanced analysis of both the occurrence and level of OOPP, overcoming limitations of single-equation models like the Tobit.

However, several limitations must be noted. The data are cross-sectional, precluding causal inferences. As the data were collected through verbal recall, they may be affected by recall bias (Kibria et al., 2024). The presence of ambiguous categories such as "other" in income activity and health expenditure may introduce classification bias. Nonavailability of data on health insurance payments, which is also a type of OOPP, may slightly underestimate the total OOPP of some households. The two-part model used in

this study provides a more accurate representation of the separate processes of incurring and determining the amount of OOPP, as discussed by Herberholz et al. (2025). The Tweedie model, while effective for skewed data, assumes a specific distribution that may not capture all nuances of healthcare spending. Further coefficients are often in log function, making direct interpretations harder than in linear regression (Dunn & Smyth, 2005).

6 CONCLUSION

This study examined the determinants of out-of-pocket payments (OOPP) for healthcare in Sri Lanka using HIES 2019 data. It found that households with members with chronic illness, higher expenditures, and lower incomes are more likely to incur OOPP and face financial strain, highlighting the need for targeted policy support. Rural households and those headed by tertiary-educated individuals also showed distinct spending patterns. Despite wealthier households spending more in absolute terms, the relative burden of OOPP was similar across most income groups. The persistent reliance on private providers signals a gap in public healthcare accessibility. Comparisons with previous HIES data suggest that key determinants of OOPP remain largely unchanged, possibly due to the early stage of the economic crisis in 2019. Future research using newer data may offer further insights.

7 PUBLIC HEALTH PERSPECTIVES/IMPLICATIONS

From a public health perspective, this study highlights critical challenges in achieving equitable access to healthcare and financial protection in Sri Lanka. The findings reveal that OOPP continues to place a disproportionate burden on specific population groups, particularly households with chronically ill members, elderly dependents, and those who are in lower income quintiles. These disparities have direct relevance to global health policy commitments, particularly Sustainable Development Goal (SDG) 3.8, which calls for achieving universal health coverage (UHC) (UN, 2015), including financial risk protection and access to quality essential healthcare services for all. The study's use of a two-part model reveals that both the likelihood of incurring OOPP and the amount spent are strongly influenced by socioeconomic and demographic characteristics. The results in this study show that an increase in log-transformed income reduces the likelihood and magnitude of OOPP expenditure, indicating that the poorer households incur more OOPP expenditure than richer households (Pallegedara & Grimme, 2017). This dual burden, where disadvantaged groups are both more likely to pay and pay more, represents a form of structural inequity in healthcare financing, which needs to be addressed.

Further more the concentration of spending in the private sector, particularly among higher-expenditure households, points to a widening gap in access and expectations between income groups. In this context, equity demands not only reducing the average OOP burden but ensuring that it is shared fairly across households of differing means. At the same time, equality calls for healthcare policies that guarantee all citizens the same opportunity to access services, regardless of socioeconomic background. To advance these goals, the findings underscore the need for strengthening subsidies to protect vulnerable populations such as households with chronically ill members and elderly members, ensuring no one is left behind on the path to UHC

8 DECLARATION OF AI AND AI-ASSISTED TECHNOLOGIES.

During this study, Chat GPT was used to verify some errors in the R code during the analysis of data. Chat GPT was also used during the writing of the thesis to assist with correcting grammar, sentence structure, and increasing coherence. However, after using the tool, I have carefully read and edited the content and take full responsibility for the content of the work therein thesis study.

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REFERENCES

- Abeykoon, P. (2016). Universal health coverage and the health Sustainable Development Goal: Achievements and challenges for Sri Lanka. *WHO South-East Asia Journal of Public Health*, 5(2), 82–88. <https://iris.who.int/handle/10665/329641>
- Alahapperuma, D. (2022). Analysis of private health sector regulatory framework in Sri Lanka. *International Journal of Recent Research in Commerce, Economics and Management*, 9(3), 1–6. <https://doi.org/10.5281/zenodo.6794225>
- Andersen, R., Newman, J.F. (1973). Societal and Individual Determinants of Medical Care Utilization in the United States. *The Milbank Memorial Fund Quarterly. Health and Society*, Winter, 1973, Vol. 51, No. 1 (Winter, 1973), pp. 95-124. [Societal and Individual Determinants of Medical Care Utilization in the United States on JSTOR](#)
- Asra, M. B. F., & Wijesinghe, M.D.J.W. (2022, June). Socioeconomic Determinants of Household Out-of-Pocket Payments on Healthcare in Sri Lanka. *Wayamba Journal of Management Volume 13 Issue 1 p 165-180*. <https://doi.org/10.4038/wjm.v13i1.7557>.
- Bock, J.O., Matschinger, H., Brenner, H., Wild, B., Haefeli, W. E., Quinzler, R., Saum, K.-U., Heider, D., & König, H.-H. (2014). Inequalities in out-of-pocket payments for health care services among elderly Germans: Results of a population-based cross-sectional study. *International Journal for Equity in Health*, 13(1), 3. <https://doi.org/10.1186/1475-9276-13-3>
- Department of Census and Statistics. (April 2025). *Census of Population and Housing 2024 Enumeration Stage*. https://www.statistics.gov.lk//Resource/en/Population/CPH_2024/CPH2024_Preliminary_Report.pdf
- Department of Census and Statistics. (2023). *Household survey on impact of economic crisis – 2023*. Ministry of Finance, Economic Stabilization and National Policies, Sri Lanka. https://www.statistics.gov.lk/WebReleases/HECS_Bulletin_Final
- Department of Census and Statistics. (2022, April). *Poverty indicators—2019*. Ministry of Economic Policies and Plan Implementation. <https://www.statistics.gov.lk/Resource/en/Poverty/PovertyIndicators-2019.pdf>
- Department of Census and Statistics. (2025, May 5). *Official poverty lines by district: February 2025 (Minimum expenditure per person per month to fulfill the basic needs)*. Department of Census and Statistics, Sri Lanka. https://www.statistics.gov.lk/povertyLine/2021_Rebase#gsc.tab=0

Department of Census and Statistics. (2022). *Household Income and Expenditure Survey – 2019: Final result (January to December 2019)*. Ministry of Economic Policies and Plan Implementation, Sri Lanka. <https://www.statistics.gov.lk/IncomeAndExpenditure/StaticInformation>

Dunn, P. K., & Smyth, G. K. (2005). Series evaluation of Tweedie exponential dispersion model densities. *Statistics and Computing*, 15(4), 267–280. <https://doi.org/10.1007/s11222-005-4070-y>

Eurostat. (2025, May). Statistics Explained: Glossary: Equivalised income. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Equivalised_income

ExchangeRates.org.uk. (2019). *US Dollar to Sri Lankan Rupee history: 2019*. <https://www.exchangerates.org.uk/USD-LKR-spot-exchange-rates-history-2019.html>

Gamage, A., Darshana, N., Gunasekera, T., Attygalle, D., Sridharan, S. (2024). Variations in out-of-pocket spending and factors influencing catastrophic health expenditure of households with patients suffering from chronic conditions in four districts in Sri Lanka. *BMC Health Services Research*, 24(1), 1055. <https://doi.org/10.1186/s12913-024-11553-4>

Govindaraj, R., Navaratne, K., Cavagnero, E., Seshadri, S, R. (2014). Health Care in Sri Lanka: What Can the Private Health Sector Offer?. *Health, Nutrition, and Population (HNP) Discussion Paper, The World Bank's Human Development Network (HDN)*. <https://documents1.worldbank.org/curated/en/423511468307190661/pdf/899540WP0Box380th0Care0in0Sri0Lanka.pdf>.

Harrell, F. E., Jr. (2015). *Regression modeling strategies: With applications to linear models, logistic and ordinal regression, and survival analysis* (2nd ed.). Springer. <https://doi.org/10.1007/978-3-319-19425-7>

Herberholz, C., Saichol, P., & Damrongplisit, K. (2025). Health insurance type, healthcare utilization and out-of-pocket expenditure in the face of COVID-19: Evidence from Thai national survey data. *PLOS ONE*, 20(4), e0321468. <https://doi.org/10.1371/journal.pone.0321468>

Institute of policy, Health economics policy unit, Sri Lanka. (2011). *CENSUS of PRIVATE, CO-OPERATIVE and ESTATE HOSPITALS 2010, Series number 1, Issue number 4*. https://www.ips.lk/wp-content/uploads/2022/03/Health-Statistics-Census-of-Private-Co-operative-and-Estate-Hospitals-2010_E_Book.pdf

Jayathilaka, R., Joachim, S., Mallikarachchi, V., Perera, N., & Ranawaka, D. (2020). Chronic diseases: An added burden to income and expenses of chronically-ill people in Sri Lanka. *PLOS ONE*, 15(10), e0239576. <https://doi.org/10.1371/journal.pone.0239576>

Kibria, A., Shimul, S. N., & Zabeen, I. (2024). Income elasticity of out-of-pocket healthcare expenditure for different provider types in Bangladesh. *International Journal of Health Planning and Management*. Advance online publication. <https://doi.org/10.1002/hpm.3883>

Kumara, A. S., & Samaratunge, R. (2016). Patterns and determinants of out-of-pocket health care expenditure in Sri Lanka: Evidence from household surveys. *Health Policy and Planning*, 31(8), 970–983. <https://doi.org/10.1093/heapol/czw021>

Kurz, C. F. (2017). Tweedie distributions for fitting semicontinuous health care utilization cost data. *BMC Medical Research Methodology*, 17, 171. <https://doi.org/10.1186/s12874-017-0445-y>

Madureira-Lima, J., Reeves, A., Clair, A., & Stuckler, D. (2018). The Great Recession and inequalities in access to health care: A study of unemployment and unmet medical need in Europe in the economic crisis. *International Journal of Epidemiology*, 47(1), 58–68. <https://doi.org/10.1093/ije/dyx193>

Malehi, A. S., Pourmotahari, F., & Angali, K. A. (2015). Statistical models for the analysis of skewed healthcare cost data: A simulation study. *Health Economics Review*, 5(1), 11. <https://doi.org/10.1186/s13561-015-0045-7>

Ministry of Health, Sri Lanka. (2025). Health Institutions In Sri Lanka. <https://www.health.gov.lk/health-institutions-in-sri-lanka>

Ministry of Health, Sri Lanka. (2024). *Annual health bulletin 2022-2023*. <https://www.health.gov.lk/annual-health-bulletin/>

Monheit, A. C., & Grafova, I. B. (2018). Education and family health care spending. *Southern Economic Journal*, 85(1), 71–92. <https://doi.org/10.1002/soej.12300>

Nimal, C. N., Namboodiripad, N. (2022). Sri Lanka economic crisis- The symptoms, causes, and possible cures. *International Journal of Business Ethics in Developing Economies* 11(2) 12-19. <http://publishingindia.com/ijbede/>

Pallegedara, A., & Grimm, M. (2018). Have out-of-pocket health care payments risen under free health care policy? The case of Sri Lanka. *The International journal of health planning and management*, 33(3), e781–e797. Advance online publication. <https://doi.org/10.1002/hpm.2535>

Pallegedara, A., & Grimm, M. (2017). Demand for private healthcare in Sri Lanka: The role of income and health status. *Health Policy and Planning*, 32(4), 495–507. [https://doi.org/10.1093/heapol/czw145:contentReference\[oaicite:9\]{index=9}](https://doi.org/10.1093/heapol/czw145:contentReference[oaicite:9]{index=9})

Pandey, K. R., Yang, F., Cagney, K. A., Smieliauskas, F., Meltzer, D. O., & Ruhnke, G. W. (2019). The impact of marital status on health care utilization among Medicare beneficiaries. *Medicine*, 98(12), e14871. <https://doi.org/10.1097/MD.00000000000014871>

Rajapaksa, L., Silva, P. de., Abeykoon, P., Somatunga, L., Sathasivam, S., Perera, S., Fernando, E., Silva, D de., Perera, A., Perera, U., Weerasekera, Y., Gamage, A., Wellappuli, N., Widanapathirana, N., Fernando, R., Wijesundara, C., Senevirathne, R., Weerasinghe, K. (2021). Sri Lanka health system review. *Health Systems in Transition*, 10 (1), World Health Organization. Regional Office for South-East Asia. <https://iris.who.int/handle/10665/342323>.

Reddy, K. P., Jarrell, K., Berkowitz, C., Hulse, S., Elmore, L. C., Fishman, R., Greenup, R. A., Mateo, A. M., Rothman, J. D., Sataloff, D. M., Tchou, J. C., Zafar, S. Y., & Fayanju, O. M. (2025). Association between delayed/forgone medical care and resource utilization among women with breast cancer in the United States. *Annals of Surgical Oncology*, 32(5), 2534–2544. <https://doi.org/10.1245/s10434-024-16586-x>

Shahrook, S., Mori, R., Dovey, S. M., Koyanagi, A., & Shibuya, K. (2019). Changes in out-of-pocket payments on utilisation of health care services. *Cochrane Database of Systematic Reviews*, 2019(10), CD003029. <https://doi.org/10.1002/14651858.CD003029.pub4>

Sato, S. (2024). *Access to healthcare for marginalized communities in rural South Asia: An analysis of structural inequalities in Sri Lanka and Bhutan*. Authorea. <https://doi.org/10.22541/au.173016226.62682434/v1>

Silva, D. M. H. (2023). Status of the economy and key challenges faced by the Healthcare sector in Sri Lanka. *Journal of the Ceylon College of Physicians*, 54, 139-151. <https://jccp.sljol.info/articles/10.4038/jccp.v54i2.8028>

Smith, O. (2018). *Sri Lanka: Achieving Pro-Poor Universal Health Coverage without Health Financing Reforms*. (Universal Health Coverage Study Series No. 38). The World Bank, Washington, DC. <https://documents.worldbank.org/pt/publication/documents-reports/documentdetail/138941516179080537/sri-lanka-achieving-pro-poor-universal-health-coverage-without-health-financing-reforms>

United Nations. (2015, September). Transforming Our World: The 2030 Agenda For Sustainable Development. (A/RES/70/1). United Nations. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf?_gl=1*picw5s*_ga*MTcwNjMwOTM0MS4xNzM4MjY2Nzg1*_ga_TK9BQL5X7Z*MTczODI2Njc4NS4xLjEuMTczODI2NzgwNy4wLjAuMA..

United Nations Children's Fund. (2021). *Budget Brief: Health Sector, Sri Lanka 2021*. <https://www.unicef.org/srilanka/media/2716/file/BUDGET%20BRIEF:%20HEALTH%20SECTOR%202021.pdf>

United Nations International Children's Emergency Fund. (2022). *Impact of the economic crisis on households' social and economic wellbeing round seven findings*. UNICEF. <https://www.unicef.org/srilanka/media/3146/file/Summery.pdf>

Vidanapathirana, J., Suranga, A., Kasige, R., Fayas, F., Wijegoonawardena, N., Udayantha, A., Fernando, M., Wickramasinghe, A., Nawaratne, S., & Wijewardana, K. (2022). Review of National Health Policy 2016–2022. Directorate of Policy Analysis and Development, Ministry of Health, Sri Lanka. ISBN: 978-624-5719-81-5. https://www.previousmoh.health.gov.lk/moh_final/english/public/elfinder/files/publications/list_publications/2023/Review%20of%20the%20National%20Health%20Policy%202016-2025.pdf

World Health Organization. (2024, December). *Global Health Expenditure Database*. <https://apps.who.int/nha/database/ViewData/Indicators/en>

Wu, Z., Berkowitz, S. A., Heagerty, P. J., & Benkeser, D. (2022). A two-stage super learner for healthcare expenditures. *Health Services & Outcomes Research Methodology*, 22(4), 435–453. <https://pmc.ncbi.nlm.nih.gov/articles/PMC9683480/>

Yang, L. (2024). Diagnostics for regression models with semicontinuous outcomes. *Biometrics*, 80(1), Article ujae007. <https://doi.org/10.1093/biomtc/ujae007>

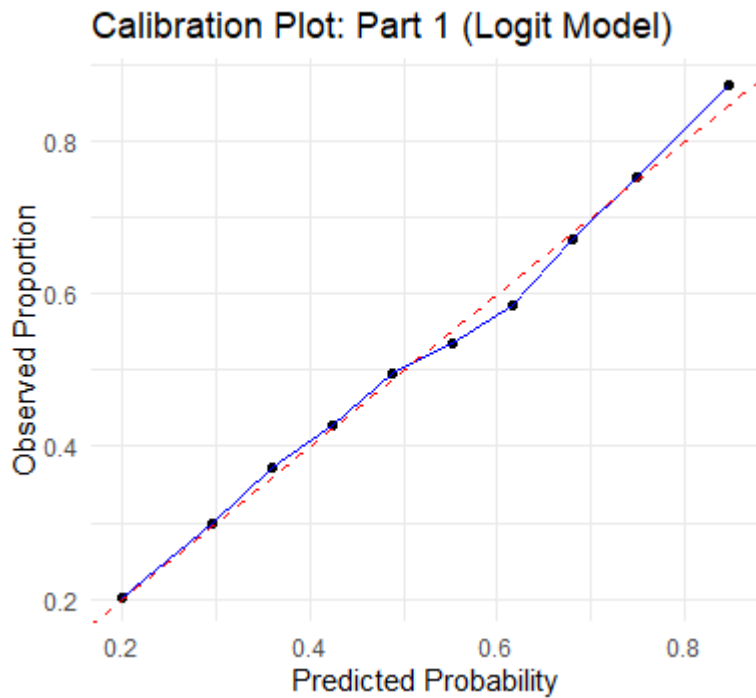
Yang, B.M., Prescott, N., & Bae, E.Y. (2001). The impact of economic crisis on health-care consumption in Korea. *Health Policy and Planning*, 16(4), 372–385. <http://www.jstor.org/stable/45089726>

Yates, R., Hamer, J., Mark van der, N., Nganizi, S. (2021). Accelerating progress towards universal health coverage in South Asia in the era of COVID-19: How universal primary care can tackle the inseparable agendas of universal health coverage and health security. *United Nations Children's Fund*. <https://www.unicef.org/rosa/media/17021/file/Accelerating%20progress%20towards%20Universal%20Health%20Coverage%20in%20South%20Asia%20in%20the%20era%20of%20Covid-19.pdf>

Zheng, Y., Huang, Z., & Jiang, T. (2020). Will the economic recession inhibit the out-of-pocket payment willingness for health care? *International Journal of Environmental Research and Public Health*, 17(3), 713. <https://doi.org/10.3390/ijerph17030713>

APPENDIX

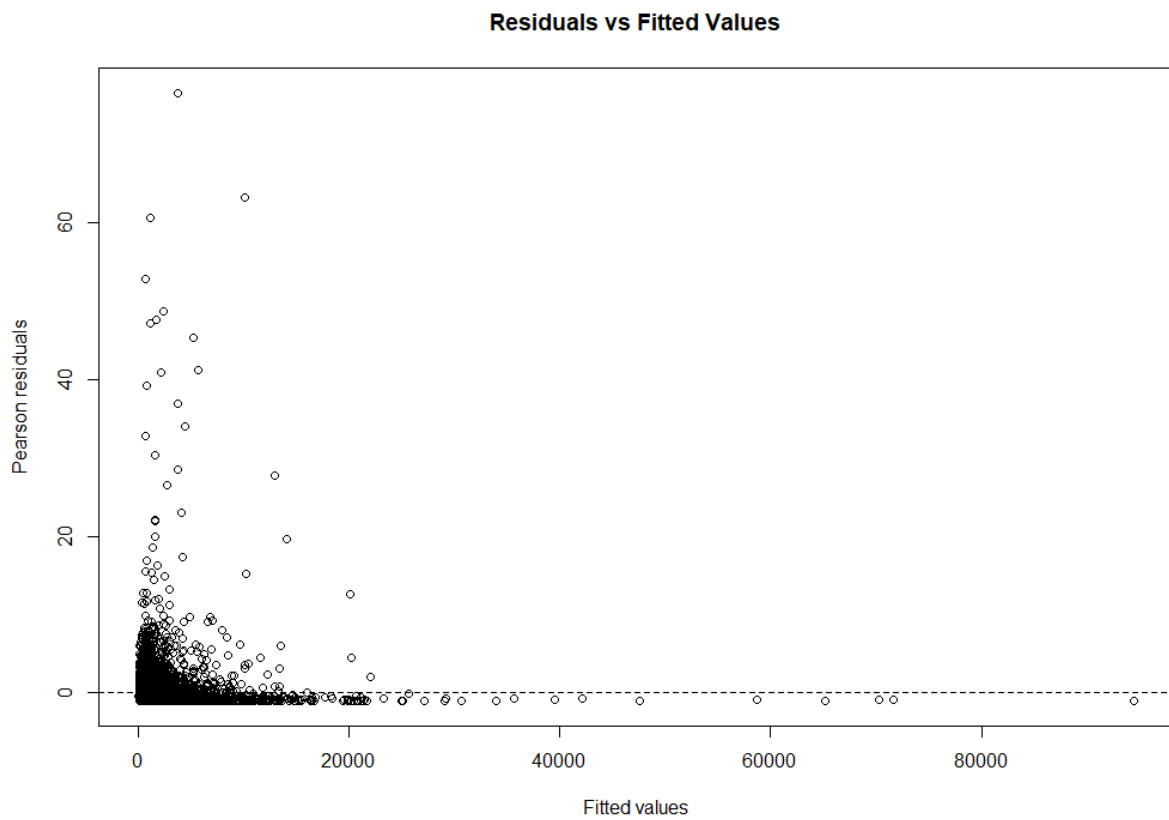
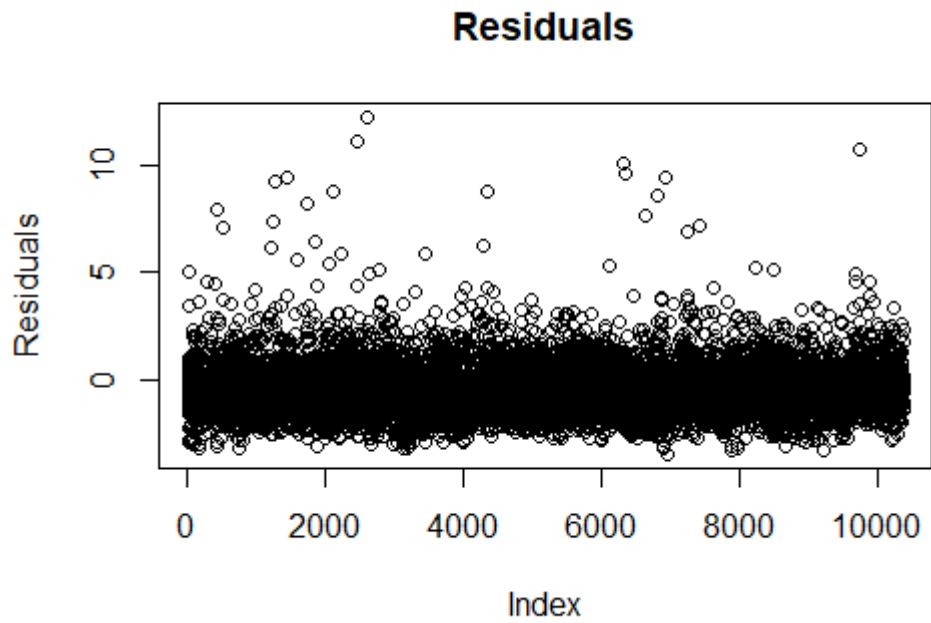
Appendix 1: The Visual model calibration of the logit model.



Appendix 2: Results of the VIF of the logit model.

```
> vif(logit_model)
              GVIF Df GVIF^(1/(2*Df))
sex           1.907790 1 1.381228
sector        1.257428 2 1.058939
age           3.928870 3 1.256159
marital_status 1.987697 3 1.121308
education     1.298608 4 1.033201
earning_category 1.679995 2 1.138484
gov_dispensary 1.942649 3 1.117032
private_dispensary 2.131169 3 1.134409
cron_cat      1.192482 2 1.044992
eldery_cat    3.577275 2 1.375270
pp_income_log 2.160024 1 1.469702
pp_expenditure_log 2.278932 1 1.509613
```

Appendix 3: Pearsons residuals plot of Tweedie model



Appendix 4: VIF results of Tweedie model.

```
> vif(vif_model)
      GVIF Df GVIF^(1/(2*Df))
sex      1.964456 1 1.401591
sector   1.322381 2 1.072356
age      3.716830 3 1.244597
marital_status 2.047481 3 1.126860
education 1.316015 4 1.034922
earning_category 1.729471 2 1.146775
gov_dispensary 1.829964 3 1.105963
private_dispensary 2.035298 3 1.125740
cron_cat 1.249151 2 1.057192
eldery_cat 3.432906 2 1.361180
pp_income_log 2.701530 1 1.643633
pp_expenditure_log 2.817471 1 1.678532
>
```