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Impact of Household's Out-of-Pocket Health Expenditures on Households' Budget Revisited: Evidence from Sudan

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ABSTRACT

This study examines the determinants and impact of health expenditure on household welfare using the most recent data set of 2015 NBHS, revisiting the analysis by Ebaidalla and Ali, which was based on the 2009 NBHS. The study used the Heckman two-step selection model to account for any potential bias in the sample selection process. The study applied ordinary least squares and probit estimation techniques to estimate the models for out-of-pocket and catastrophic health expenditure. The analysis showed that household health expenditure is significantly influenced by factors such as health insurance membership, age, gender, education, presence of elderly and under-five members, income, wealth, chronic illnesses, and accessing clean water. The analysis also revealed that these factors increase the likelihood of health expenditure exceeding certain limits and becoming catastrophic. Furthermore, the study revealed that health-care expenditure pushes a significant number of households below poverty line. These findings hold true for households in urban and rural areas, as well as those headed by males and females, thereby corroborating the earlier findings of Ebaidalla and Ali.. This highlights the role of health insurance in reducing health expenditures incurred by Sudanese households, as well as the fact that out-of-pocket health expenditure has exacerbated poverty.

ملخص

تتناول هذه الدراسة العوامل المحددة للإنفاق الصحي وتأثيرها على رفاهية الأسر المعيشية، وذلك استنادا إلى أحدث البيانات من المسح الخاص بالأسر المعيشية بناء على خط الاساس الوطني (NBHS) لعام 2015، ومن خلال مراجعة تحليل عبيد الله وعلي (Ebaidalla and Ali)، الذي استند إلى المسح الخاص بالأسر المعيشية بناء على خط الاساس الوطني لعام 2009. استخدمت الدراسة نموذج هيكمان ذو الخطوتين للاختيار للنظر في إمكانية وجود تحيز في عملية اختيار العينة. وقد طبقت الدراسة تقنيتي المربعات الصغرى العادية وتقدير بروبيت لتقدير نماذج الإنفاق الصحي

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من المال الخاص للأفراد والإنفاق الصحي الكارثي. ويظهر التحليل أن الإنفاق الصحي للأسر المعيشية يتأثر بشكل كبير بعوامل مثل العضوية في خطط التأمين الصحي، والعمر، والجنس، والتعليم، ووجود أفراد مسنين وأطفال دون سن الخامسة، ومستوى الدخل، والثروة، والأمراض المزمنة، ومستوى الحصول على المياه النظيفة. كما يكشف التحليل أن هذه العوامل تزيد من احتمال تجاوز الإنفاق الصحي حدودا معينة ويصبح كارثيا. وبالإضافة إلى ذلك، كشفت الدراسة أن الإنفاق على الرعاية الصحية يدفع بعدد كبير من الأسر إلى ما دون خط الفقر. وتنطبق هذه النتائج على الأسر سواء في المناطق الحضرية والريفية، وسواء أكان يرأسها رجال ونساء، مما يؤكد النتائج السابقة التي توصل إليها عبيد الله وعلي. وهذا الوضع يسلط الضوء على دور التأمين الصحي في تقليل النفقات الصحية التي تتكبدها الأسر السودانية، ويبرز أن إنفاق الأفراد من مالهم الخاص على الرعاية الصحية قد أدى إلى تفاقم الفقر.

RÉSUMÉ

Cette étude examine les facteurs déterminants des dépenses de santé et leur incidence sur le bien-être des ménages à l'aide des dernières données disponibles issues de l'enquête nationale sur la santé de 2015, en réexaminant l'analyse réalisée par Ebaidalla et Ali, s'appuyait sur l'enquête NBHS 2009. L'étude a utilisé le modèle de sélection en deux étapes de Heckman pour tenir compte de tout biais potentiel dans le processus de sélection de l'échantillon. Elle a appliqué les techniques d'estimation des moindres carrés ordinaires et d'estimation du probit pour estimer les modèles de dépenses de santé à la charge des ménages et de dépenses de santé catastrophiques. L'analyse a montré que les dépenses de santé des ménages sont fortement influencées par des facteurs tels que l'adhésion à une assurance maladie, l'âge, le sexe, le niveau d'éducation, la présence de personnes âgées et d'enfants de moins de cinq ans, le revenu, la richesse, les maladies chroniques et l'accès à l'eau potable. L'analyse a également révélé que ces facteurs augmentent la probabilité que les dépenses de santé dépassent certaines limites et deviennent catastrophiques. En outre, l'étude a révélé que les dépenses de santé poussent un nombre important de ménages sous le seuil de pauvreté. Ces conclusions s'appliquent aux ménages des zones urbaines et rurales, ainsi qu'à ceux dirigés par des hommes et des femmes, corroborant ainsi les conclusions antérieures d'Ebaidalla et Ali. Cela met en évidence le rôle de l'assurance maladie dans la réduction des dépenses de santé des ménages soudanais, ainsi que le fait que les dépenses de santé à la charge des patients ont exacerbé la pauvreté.

Keywords: Sudan, health insurance, chronic, poverty, Heckman, CHE.

JEL Classification: I1, I13, I31.

1. Introduction

Out-of-pocket health expenditure (OOPHE) has become a major source of funding for health care in Sudan over the last two decades (Lamloum and Campus, 2024). According to available data, OOPHE accounts for more than 75% of total health expenditure in the country (World Bank, 2020; Ebaidalla and Ali, 2019). In order to mitigate the effects of rising OOPHE, the Sudanese government introduced a health insurance scheme in 1995, in addition to raising subsidies for primary health care services. Reports from the National Health Insurance Fund (NHIF) estimate coverage at 52%, significantly falling short of the 2020 universal health insurance coverage goal. In recent years, the Chamber of Zakat, the Federal Ministry of Finance, and charities have made significant efforts to bring poor households under the protection of health insurance. Nevertheless, despite coverage expansion in the last ten years, OOPHE patterns remain extremely high when compared to countries in the Sub-Saharan Africa region with which Sudan shares the same epidemiological profile.

Using data from the 2009 national household budget survey, Ebaidalla and Ali (2019) examined the determinants of OOPHE as well as its poverty impact on Sudanese households. The authors also looked into the factors that cause OOPHE to exceed a certain limit and thus become catastrophic. Their findings confirmed that OOPHE causes a significant number of households to fall below the poverty line. These findings appear to be at odds with the current expansion of health insurance coverage. Alternately, these findings raise concerns about the potential impact of health insurance on Sudanese households' OOPHE. It is worth noting that, unlike the NBHS from 2009, the NBHS from 2015 includes information about households' health insurance status as well as crucial data on chronic illnesses, which can offer insights into the relationship between health insurance status and chronic conditions and OOPHE. Such data would aid in determining the likely contribution of health insurance to protecting households from OOPHE hardship. In a related context, Sudan has experienced a difficult economic downturn, particularly following South Sudan's secession in 2011 and the loss of oil revenues. In the last ten years, this situation has resulted in the emergence of a new economic context. This issue necessitates revisiting Ebaidalla and Ali's (2019) study to analyse the impact of post-2011 changes using

the updated 2015 NBHS data. With these concerns in mind, the purpose of this study is to determine whether the determinants of OOPHE and catastrophic health expenditure (CHE) have changed between 2009 and 2015. It also explores whether the poverty impact of OOPHE on Sudanese households
has varied.

2. Data and Methodology

2.1 Models specification

Building on the existing literature on the determinants of OOPHE (e.g. Grossman, 1972; Parker, 1997, and Su et al., 2006), the model of the determinants of OOPHE incurred by Sudanese households can be specified as follows:

$$OOPHE_i = \alpha + \beta HSE_i + \theta HD_i + \varphi HL_i + \delta PS_i + \mu_i \quad (1)$$

OOPHE is the dependent variable, measured by the logarithm of per capita health expenditure (SDG/month). OOPHE is related to a set of explanatory variables: household socioeconomic characteristics (HSE), demographic characteristics (HD), location characteristics (HL), and public services characteristics (PS). Household socioeconomic characteristics include household income, household head health insurance, household head education, and household head employment status. Demographic characteristics comprise household size, number of children under five years and elders among household members, gender and age of household head. Location characteristics include the place of residence (i.e., urban/rural) and the geographical region. Public services factors include access to piped water and the sustainability of improved sanitation. The definitions and measurements of the variables used in the analysis are presented in Appendix A.

For the second question of the study, a binary model to identify the determinants of CHE. Following Wagstaff (2007), we use two commonly adopted thresholds for CHE: 10% and 25% of total household expenditure. To derive the dependent variable (CHE), we first define the share of OOPHE as follows:

$$OOPHE_{\ share} = \frac{OOPHE_{pay}}{CTP_h} \quad (2)$$

Where $OOPHE_{pay}$ is out-of-pocket health expenditure (SDG/month), while CTP_h represents household capacity to pay. The CTP is measured by household non-food expenditure (Wagstaff and van Doorslaer, 2003).

In the next step, the CHE is defined as a binary variable that takes the value of 1 if $OOPHE_{pay}/CTP_h$ exceeds any given threshold T (i.e., 10% and 25%), and zero otherwise. Hence, the CHE can be defined as follows:

$$CHE = \begin{pmatrix} 1\ If\ OOPHE_{\ share} \geq T \\ 0\ If\ OOPHE_{\ share} < T \end{pmatrix} \quad (3)$$

To model the probability that a household may incur CHE, the study adopts the probit regression model which is expressed as follows:

$$P = Pr\ (CAT = 1|X) = \varphi\ (X'\beta) \quad (4)$$

Here, CHE is a binary variable taking values of 0 and 1, Pr is the probability, φ is a cumulative distribution function (CDF) of the normal distribution, β is a vector of unknown parameters to be estimated, X denotes the vector of the explanatory variables. The explanatory variables affecting CHE are identical to the factors that influence OOPHE in Equation 1. Thus, the variables' definitions remain as previously demarcated.

2.2 Measuring poverty impact of OOPHE

The poverty resulting from OOPHE occurs when a household that is considered to be non-poor has been pushed into poverty after incurring payments for health care. To establish an analytical framework to analyse the poverty impact of OOPHE, this study borrows heavily from the model developed by (Wagstaff and van Doorslaer, 2003).

Let us assume that z_{pov} is the poverty line and x_i be household *i*'s income. We define P_i^{pre}=1 if $x_i < z_{pov}$. Then the pre-payment poverty headcount is equal to:

$$H_{pov}^{pre} = \frac{1}{N}\sum_{i=1}^{N} P_i^{pre} = \mu_{Ppre} \quad (5)$$

Where, N represents the sample size of households. Assuming that g_i^{pre} is the pre-payment poverty gap which is equal to $x_i - z_{pov}$ if $x_i < z_{pov}$, and zero otherwise. The average pre-payment poverty gap is defined as:

$$G_{pov}^{pre} = \frac{1}{N}\sum_{i=1}^{N} g_i^{pre} = \mu_{gpre} \quad (6)$$

The normalized pre-payment poverty gap can be expressed as follows:

$$NG_{pov}^{pre} = \frac{G_{pov}^{pre}}{z_{pov}^{pre}} \quad (7)$$

The mean positive pre-payment poverty gap is:

$$MPG_{pov}^{pre} = \frac{\sum_{i=1}^{N} g_i^{pre}}{\sum_{i=1}^{N} P_i^{pre}} = \frac{\mu_{gpre}}{\mu_{Ppre}} \quad (8)$$

We, therefore, have

$$\mu_{gpre} = \mu_{Ppre}.MPG_{pov}^{pre} \quad (9)$$

Specifically, the average (pre-payment) poverty gap equals the proportion of poor households multiplied by the mean positive gap. Replacing the pre-payment poverty P_i^{pre} by the post-payment poverty (after healthcare payments) P_i^{post}, and changing all superscripts 'pre' to 'post' yields the analogous post-payment measures.

To measure the poverty impact of OOPHE, we follow Wagstaff (2007) and Wagstaff and van Doorslaer (2003) in which the poverty impact of OOPHE is defined as the difference between the relevant pre-payment and post-payment measures, as follows:

$$PI^{H} = H_{pov}^{post} - H_{pov}^{pre}, \quad (10)$$

$$PI^{G} = G_{pov}^{post} - G_{pov}^{pre}, \quad (11)$$

$$PI^{NG} = NG_{pov}^{post} - NG_{pov}^{pre}, \quad (12)$$

Based on the NBHS 2015 survey, we adopt the poverty line of 208 SDG per individual per month. This poverty line is based on total household expenditures.

2.3 Data

The data for this study were obtained from the Sudanese Central Bureau of Statistics' NBHS 2015 (NBHS, 2015). The NBHS is a nationally representative survey that collects data on household characteristics, food, and non-food expenditures. The 2015 survey included 69,828 individuals from 11,953 households (NBHS, 2015). However, because the NBHS does not contain information on individual health expenditure, we use the household as a unit of analysis. The survey reported the

household's health expenditure in the past 30 days (one month). Medical services, medical tests, pharmaceutical products, birth delivery, and hospital services are all included in health expenditure. Appendix A contains the descriptive statistics for the variables used in the analysis.

2.4 Estimation methodology

We use the Heckman selection model, probit model, and ordinary least squares (OLS) to estimate the models under consideration. It is well known that analysing households' health spending decisions using a sample that excludes those who do not pay for health care results in biased estimates (Hjortsberg, 2003, Rous and Hotchkiss, 2003). This bias can be avoided if the proportion of households with no health spending is minimized. In fact, people in poor countries generally seek health-care services only when they believe they are ill, and as a result, many of them spend money on health only when they report being sick and seek medical attention (Rous and Hotchkiss, 2003). People who report being sick but do not seek medical care and those who do not report being sick spend nothing. People who report being sick and seek medical attention will spend varying amounts of money to treat their illness. As a result, most health care expenditure data exhibit a large cluster at zero (0) and a right-skewed distribution (Oyinpreye et al, 2014). In such cases, sample selection bias may emerge, making the conventional OLS method insufficient for obtaining reliable results.

To avoid this problem, the study employs the Heckman two-step selection model (Heckman, 1979).[3] However, the results of the Heckman selection model in the appendix revealed that the coefficients of lambda (the selection terms) are insignificant across all models, implying that the model is free from the problem of selection bias (see Appendix B). This can be justified by the fact that only a small proportion of households reported zero health expenditure, with approximately 97% of households incurring OOPHE in 2015. Accordingly, we proceed with OLS estimation, as this econometric issue is not a concern.

[3] We use community development, measured by access to electricity and media, as an identifying variable in the Heckman selection equation. This variable is assumed to affect the likelihood that a household reports positive health care expenditures, but not the amount of OOPHE.

Finally, the study employs the probit model to examine the determinants of CHE. The models for OOPHE and CHE determinants are estimated using various scenarios, including the full sample, urban/rural subsamples, and quintiles subsamples.

3. Empirical Results

3.1 Determinants of OOPHE

As stated in the methodology section, the results of the Heckman two-step reject the presence of selection bias. Thus, we proceed to estimate the OOPHE models using the Ordinary Least Squares (OLS). Table 1 shows the results of OLS estimation of Equation 1 for full, urban, and rural samples.

A quick glance at the reported results confirms that the majority of the variable coefficients are significant, have correct signs, and have acceptable magnitudes. For example, and as expected, the coefficient of the health insurance variable in full and rural models is negative and statistically significant, indicating that households with health insurance spend less OOPHE than those who are uninsured. The coefficient associated with the income variable is, as expected, positive and significant. This demonstrates that increases in household income increase OOPHE, aligning with the findings of Ebaidlla and Ali (2019).

In both the full and urban models, the coefficient associated with the gender of the household head variable is insignificant. However, in the rural model, the coefficient is positive and significant, indicating that male-headed households incur higher OOPHE than female-headed households. In the full and rural models, the coefficient associated with the age variable is negative and significant, whereas it is not significant in the urban model. Although this result is consistent with the findings of Ebaidalla and Ali (2019) it contradicts the findings of previous studies in which age was found to be positively correlated with OOPHE (Murphy & Hepworth, 1996; Bertakis, et al., 2000, and You and Kobayashi, 2011). This contradiction, however, is easily interpreted. That is, the majority of household heads in Sudan are expected to be young and, as a result, have a lower risk of contracting diseases, particularly chronic ones. Moreover, this outcome may also reflect some aspects of gender variations with respect to health care utilization. Astonishingly, the coefficient of the

household size variable is negative and significant, indicating that as the number of household members increases, OOPHE decreases. Although this result agrees with Ebaidallla and Ali (2019), it contradicts previous evidence that emphasizes the positive association between household size and OOPHE (O'Donnell et al., 2005; Cavagnero et al., 2006).

Table 1: Estimation of OOPHE: Full, urban and rural samples

Dependent Variable: Logarithm of OOPHE			
Variable	**Full**	**Urban**	**Rural**
Insurance	-0.0711***	-0.0126	-0.0867***
	(0.0265)	(0.0469)	(0.0324)
Income	0.000156***	0.000210***	0.000145***
	(3.25e-05)	(6.80e-05)	(3.71e-05)
Gender	0.0475	-0.0322	0.0809*
	(0.0406)	(0.0733)	(0.0488)
Age	-0.179***	-0.0403	-0.225***
	(0.0425)	(0.0845)	(0.0496)
Married	0.0647	0.0270	0.0841
	(0.0430)	(0.0741)	(0.0530)
Household size	-0.0703***	-0.0829***	-0.0654***
	(0.00599)	(0.0108)	(0.00722)
Child under 5	0.0153	0.0377	0.00651
	(0.0144)	(0.0280)	(0.0168)
Eld65	0.196***	0.166***	0.207***
	(0.0260)	(0.0446)	(0.0321)
Chronic	0.0418	0.0399	0.0326
	(0.0272)	(0.0455)	(0.0340)
Primary	0.195***	0.176***	0.207***
	(0.0323)	(0.0568)	(0.0394)
Secondary	0.211***	0.247***	0.175***
	(0.0331)	(0.0520)	(0.0437)
Post-secondary	0.258**	0.331**	0.150
	(0.119)	(0.153)	(0.191)
University	0.180***	0.176**	0.190**
	(0.0558)	(0.0730)	(0.0932)
Wage employment	0.145***	-0.0182	0.200***
	(0.0243)	(0.0477)	(0.0283)
Wealth status	0.163***	0.167***	0.154***
	(0.0321)	(0.0616)	(0.0377)
Water	0.206***	0.353***	0.169***
	(0.0328)	(0.0576)	(0.0414)
Sanitation	0.184***	0.149***	0.232**
	(0.0483)	(0.0546)	(0.109)
Urban	-0.0400	.	.
	(0.0279)		
Central	0.0915*	0.0166	0.0743
	(0.0485)	(0.0623)	(0.0923)
Northern	0.0338	-0.0281	0.0178
	(0.0571)	(0.0906)	(0.0967)

Eastern	-0.310***	-0.229***	-0.398***
	(0.0529)	(0.0694)	(0.0973)
Kordufan	-0.140***	-0.163**	-0.171*
	(0.0536)	(0.0773)	(0.0961)
Darfur	-0.248***	-0.173**	-0.309***
	(0.0518)	(0.0714)	(0.0951)
Distance	0.0355	0.210***	0.00613
	(0.0236)	(0.0566)	(0.0261)
Constant	5.850***	4.883***	6.096***
	(0.189)	(0.381)	(0.229)
Observations	10,778	3,190	7,588
R-squared	0.101	0.121	0.095

Notes: Standard errors in parentheses; ***, **, and * denotes significance at the 1%, 5%, and 10% level, respectively.

As shown in Table 1, this study outperforms Ebaidalla and Ali's (2019) work by including chronic illnesses as OOPHE predictors. However, as indicated by the coefficient in front of the chronic variable, OOPHE appears to be unaffected by chronic illnesses hosted by household heads.

The reported findings also show that education of the household head appears to be one of the significant contributing factors for OOPHE. This conclusion, however, cannot be applied to all levels of education. For example, in all three models under consideration, educational attainment at the primary, secondary, and university levels is found to play a positive role in increasing OOPHE. Nevertheless, the coefficient of post-secondary education variable is insignificant, indicating no tangible effect on OOPHE to be paid by the rural population. This outcome, to a large extent, agrees with the results obtained by Ebaidalla and Ali (2019), according to which post-secondary education was found to have no significant influence on OOPHE incurred by rural residents.

Wage employment variable is found to be positively correlated with OOPHE, confirming the findings of Ebaidalla and Ali (2019). Combining these findings with those found with income leads us to the conclusion that an increase in household head affluence encourages households to spend more on health care.

The coefficient of the number of rooms variable is statistically significant and has the correct sign. This implies that OOPHE is associated with a higher level of wealth. It is worth noting that the variable has the same level of significance as found in Ebaidalla and Ali's (2019) analysis. Water was found to be positively correlated with OOPHE incurred by

full, urban, and rural households, mirroring the outcome of wealth status. Interestingly, the coefficient of the sanitation variable, as measured by the availability of hygienic toilets in the household house, is positive and significant, indicating a positive relationship between OOPHE and a better hygienic environment.

The location variables appear to perform differently across the three models under consideration. The coefficient of the Central variable, for example, has a positive and significant sign in the full sample model, indicating that residents of the Central region pay significantly more OOPHE than residents of Khartoum. In the full, rural, and urban models, the negative and significant coefficients associated with the Eastern variable indicate that Eastern residents spend less OOPHE than Khartoum residents. Remarkably, the coefficients of the Kordufan and Darfur variables are negative and significant in all three models, indicating that residents of these two regions spend less OOPHE than their Khartoum counterparts. This result partially agrees with the findings of Ebaidalla and Ali (2019), who found that the Kordufan variable was insignificant in the rural model while the Darfur variable was negative and slightly significant.

Finally, in the rural model, the coefficient associated with the distance variable has a positive and significant sign. This suggests that increasing the distance travelled to health care facilities, as measured by minutes travelled, increases the amount of OOPHE paid by rural residents. This finding confirms the existence of disparities in health-care distribution between rural and urban areas. Aside from that, this contradicts the findings of Ebaidalla and Ali (2019), who found that the distance variable had a positive and significant coefficient in both the full and urban models.

3.2 Results on determinants of CHE

Table 2 displays the estimates from Equation 1 for the CHE determinants. At the 10% and 5% significance levels, health insurance membership appears to have a significant impact on a household's likelihood of being exposed to CHE. For example, the negative and significant coefficient of the health insurance variable in the full sample model in column two indicates that insured households are less likely to incur CHE at a 10%

threshold than uninsured households. Furthermore, when CHE is set to 25%, the variable's coefficient is negative and significant for the full sample model. This means that having health insurance reduces the likelihood of CHE exceeding the 25% threshold for the entire sample of households. Unexpectedly, the coefficient associated with the income variable is not significant in all models estimated under the chosen thresholds.

Table 2: Marginal effect results of probit estimation

Dependent Variable: CHE (re-estimated)						
	10% Threshed			**25% Threshed**		
Variable	**Full**	**Urban**	**Rural**	**Full**	**Urban**	**Rural**
Insurance	-0.0686*	0.00333	-0.00349	-0.0216**	-0.0131	-0.0189
	(0.03657)	(0.0112)	(0.00814)	(0.00991)	(0.0179)	(0.0120)
Income	-2.41e-06	6.03e-06	-3.45e-06	7.75e-06	2.58e-05	4.46e-06
	(7.22e-06)	(1.54e-05)	(8.26e-06)	(1.19e-05)	(2.57e-05)	(1.33e-05)
Gender	-0.00139	0.00903	-0.00380	-0.00409	-0.00191	-0.00204
	(0.00952)	(0.0166)	(0.0116)	(0.0149)	(0.0276)	(0.0177)
Age	-0.0367***	-0.0224	-0.0407***	-0.0580***	-0.0631*	-0.0536***
	(0.0104)	(0.0205)	(0.0121)	(0.0159)	(0.0328)	(0.0182)
Married	0.000790	-0.0185	0.0101	0.000238	-0.0294	0.0166
	(0.00998)	(0.0172)	(0.0123)	(0.0157)	(0.0283)	(0.0190)
Household size	0.00823***	0.00419	0.00980***	0.00892***	0.00374	0.0105***
	(0.00152)	(0.00271)	(0.00185)	(0.00226)	(0.00421)	(0.00269)
Child under-5	0.0147***	0.0199***	0.0116***	0.0247***	0.0230**	0.0234***
	(0.00371)	(0.00730)	(0.00433)	(0.00546)	(0.0108)	(0.00631)
Eld65	0.0274***	0.0275**	0.0257***	0.0630***	0.0782***	0.0521***
	(0.00678)	(0.0115)	(0.00836)	(0.0101)	(0.0180)	(0.0122)
Chronic	0.0112	0.0106	0.0101	0.0459***	0.0591***	0.0701***
	(0.00700)	(0.0112)	(0.00887)	(0.0103)	(0.0175)	(0.0187)
Primary	0.0333***	0.0240*	0.0378***	0.0555***	0.0615***	0.0529***
	(0.00860)	(0.0140)	(0.0108)	(0.0124)	(0.0220)	(0.0150)
Secondary	0.0263***	0.0340***	0.0142	0.0280**	0.0425**	0.0144
	(0.00875)	(0.0129)	(0.0117)	(0.0125)	(0.0198)	(0.0165)
Post-secondary	0.0156	0.0378	-0.0215	0.0500	0.0707	0.0115
	(0.0313)	(0.0405)	(0.0476)	(0.0460)	(0.0608)	(0.0727)
University	0.00166	-0.00689	0.0402	-0.0189	-0.00528	-0.0271
	(0.0141)	(0.0168)	(0.0289)	(0.0205)	(0.0272)	(0.0343)
Wage employment	0.0261***	-0.00232	0.0346***	0.0590***	0.00328	0.0767***
	(0.00592)	(0.0113)	(0.00703)	(0.00901)	(0.0182)	(0.0104)
Wealth status	0.0115*	0.0140	0.0166**	0.0183	0.0646***	0.00738
	(0.00699)	(0.0150)	(0.00791)	(0.0120)	(0.0241)	(0.0137)
Water	0.0319***	0.0391***	0.0373***	0.0573***	0.0961***	0.0466***
	(0.00835)	(0.0131)	(0.0113)	(0.0123)	(0.0212)	(0.0156)
Sanitation	-0.00190	0.00845	-0.0264	0.00285	0.00754	-0.0240
	(0.0122)	(0.0133)	(0.0262)	(0.0179)	(0.0208)	(0.0396)
Urban	-0.0123*			-0.0353***	-	-
	(0.00684)			(0.0103)		

Central	0.0142	0.0141	-0.00928	0.0146	0.0251	-0.0275
	(0.0144)	(0.0180)	(0.0313)	(0.0189)	(0.0250)	(0.0378)
Northern	-0.0127	-0.0143	-0.0352	0.000607	0.0205	-0.0387
	(0.0165)	(0.0242)	(0.0325)	(0.0224)	(0.0364)	(0.0394)
Eastern	-0.109***	-0.0896***	-0.141***	-0.153***	-0.104***	-0.216***
	(0.0141)	(0.0167)	(0.0314)	(0.0197)	(0.0259)	(0.0387)
Kordufan	-0.0219	-0.0214	-0.0427	-0.0343*	-0.0517*	-0.0639*
	(0.0148)	(0.0194)	(0.0315)	(0.0204)	(0.0292)	(0.0388)
Darfur	-0.0245*	-0.0496***	-0.0381	-0.0240	-0.0515*	-0.0528
	(0.0144)	(0.0176)	(0.0313)	(0.0198)	(0.0271)	(0.0385)
Distance	-0.0117**	0.0179	-0.0147**	0.000267	0.0569***	-0.00719
Observations	10,134	3,040	7,094	11,953	3,040	6,089
R-squared	0.332	0.346	0.319	0.335	0.401	0.226

Notes: Standard errors in parentheses; ***, **, and * denotes significance at the 1%, 5%, and 10% level, respectively.

The socio-demographic characteristics of the household, such as household size and the number of children under-five and elders, are found to have a significant effect on the likelihood of undertaking CHE at the 10% and 25% thresholds. In contrast, the age variable is associated with a negative and significant impact on CHE in all models.

According to the findings, primary and secondary education levels of the household head has a positive effect on CHE. Having completed primary and secondary education, for example, is found to have a significant influence on the likelihood of incurring CHE at the 10% and 25% threshold levels. Post-secondary and university degrees, on the other hand, have no effect on the household's likelihood of incurring CHE at both thresholds.

Surprisingly, the coefficient of the chronic disease variable is insignificant in the three models specified at a 10% threshold. However, when CHE reaches a 25% threshold, the picture changes dramatically. That is, the coefficient of the chronic disease variable in the full, urban, and rural models is found to be positive and significant. This means that households headed by chronically ill individuals are more likely to experience CHE at a 25% threshold than households headed by healthy people.

At the 10% and 25% thresholds, the coefficient of the wage employment variable is positive and significant in the full and rural sample models, but insignificant in the urban sample. This means that, when compared

to informal workers, being a wage-employed household head increases the likelihood of incurring CHE. Improvements in household wealth status, as expected, increase the likelihood of incurring CHE at a 10% threshold across the full and rural samples studied. Improved wealth status has a significant impact only in the urban sample when CHE is defined at a 25% threshold. The greater the accessibility to improved water services, the greater the likelihood of CHE by households at both the 10% and 25% thresholds. The coefficients associated with regional variables, with a few insignificant exceptions, indicate that households residing in regions other than Khartoum are less likely to incur CHE. Residents in the Eastern and Darfur regions, in particular, are found to have a lower risk of incurring CHE than those in Khartoum.

3.3 The poverty impact of OOPHE

The results of OOPHE's poverty impact on Sudanese households are shown in Table 3. According to the 2015 NBHS, the poverty rate among Sudanese people is estimated to be 36.1%, a sharp drop from the 46.5% reported in the 2009 NBHS. However, many scholars have argued that because of the high share of OOPHE in the household budget, a significant portion of the reported poverty headcount may be attributed to cutting necessities. The poverty rate among Sudanese households is estimated to be 30.5% in the absence of health expenditure, as shown in the upper part of Table 3. After subtracting OOPHE from total household consumption expenditure, this percentage rises to 36.1%. This means that, at a growth rate of 18.7%, health spending pushed 5.7% of previously non-poor households into poverty.

Given the fact that total population in Sudan was about 36.8 million in 2015 (World Bank, 2020), an increase in poverty headcount by 5.7% is, approximately, equivalent to 2.1 million individuals. Similar outcomes can also be observed when households are classified according to the level of urbanization. Specifically, OOPHE increases poverty incidence among urban and rural households by 4.4% percentage points (from 23.6% to 28%) and 6.2% percentage points (from 33.4% to 39.6%), respectively. Based on these changes in percentages, it can be concluded that OOPHE pushes poverty incidence among each of these two social groups to grow by, approximately, 18.5%. Similarly, the OOPH widens the poverty gap between rural and urban households. The gap between rural and urban households in terms of the poverty gap index widened,

rising from 7.8% to 9.8% and from 12.3% to 16.3%, respectively. This implies that OOPHE has widened the poverty gap among rural households more than the urban population. Similarly, it is easy to see how OOPHE widens poverty gaps and worsens poverty severity among Sudanese households. According to the data, the poverty gaps for full, urban, and rural household samples are 2.7%, 2%, and 4%, respectively.

Table 3: Impoverishment impact of OOPHE

Full Sample			
	Incidence (%)	**Poverty Gap**	**Poverty Severity**
Without OOPHE	30.5	11	5.6
With OOPHE	36.2	13.7	6.9
Impoverishment	**5.7**	**2.7**	**1.3**
Percentage change	**18.7**	**24.5**	**23.2**
Urban Sample			
	Incidence (%)	**Poverty Gap**	**Poverty Severity**
Without OOPHE	23.6	7.8	3.6
With OOPHE	28	9.8	4.6
Impoverishment	**4.4**	**2**	**1**
Percentage change	**18.6**	**25.6**	**25.6**
Rural Sample			
	Incidence (%)	**Poverty Gap**	**Poverty Severity**
Without OOPHE	33.4	12.3	6.1
With OOPHE	39.6	16.3	7.8
Impoverishment	**6.2**	**4**	**1.7**
Percentage change	**18.5**	**32.5**	**27.8**

When poverty severity is taken into account, a further intensification of OOPHE-led impoverishment can be detected. As shown in Table 5, OOPHE increased poverty severity among the full household sample from 5.6% to 6.9% at a rate of 23.2%. Similarly, the severity of poverty increased from 3.6% to 4.6% for urban households and from 6.1% to 7.8% for rural households.

4. Discussion

In a broad sense, the findings of this study show that the OOPHE undertaken by Sudanese households is driven by a variety of factors. These include income, household health insurance status, household size, education, the presence of an elderly household member, wealth, official

employment, hygiene level, potable water availability, distance, and geographical location of residence. This result is not significantly different from the results obtained when estimating the model for the factors that cause OOPHE to be catastrophic. More precisely, household income, the presence of the elderly, the presence of under-five children, household size, education, geographic location, nature of employment, wealth status, distance, and access to improved water all play a role in determining catastrophic health spending. Furthermore, the findings revealed that OOPHE increases the number of households living below the poverty line, deepens the level of poverty severity, and widens the poverty gap between different categories of households.

This study, however, differs from the revisited study of Ebaidalla and Ali (2019) in several ways. First, Ebaidalla and Ali's analysis was based on 2009 NBHS data, whereas the current analysis used the most recent household budget survey in Sudan, which was conducted in 2015. Second, a recent survey captures the economic and social effects of South Sudan's secession on the performance of the Sudanese economy. Furthermore, the 2015 NBHS included data on household health insurance and chronic illness status. All of these developments and changes heighten the importance of this analysis. Despite these differences, the results presented in Tables 2 and 3 are largely consistent with the findings of the revisited study. The coefficients of the income, age, and household size variables are specifically positive and statistically significant, ratifying the outcome of the revisited study. As expected, the results in Table 1 show that enrolling in health insurance significantly reduces OOPHE in both the full and rural sample models. The insignificance of the health insurance variable in the urban model may occur because urban households usually seek high-quality health care services that health insurance windows are unlikely to provide. Furthermore, when compared to rural households, urban households are more likely to be exposed to a high incidence of diseases and sickness (Sobngwi et al., 2004; Godfrey and Julien., 2005 and Vorster et al., 2005). Living under such epidemiological conditions would increase morbidity rates, offsetting health insurance's contribution to shrinking OOPHE. Furthermore, because health insurance in Sudan is relatively new, it may take more time to be effective in reducing OOPHE. To put it another way, many institutions and charitable organizations, such as the Chamber of Zakat and the Federal Ministry of Finance, are currently working to pay health insurance subscriptions on behalf of a large segment of poor

households. Since the majority of the poor live in rural areas, they account for the lion's share of the subscriptions offered by these organizations. In general, the findings on the health insurance variable lend support to previous studies that have repeatedly highlighted the role of health insurance in mitigating OOPHE increases (WHO, 2010; Sepehri et al., 2006; Cavagnero et al., 2006; Kusi et al., 2015; Habib et al., 2016; Okoroh et al., 2018; Ali & Ebaidalla, 2019; Berhanu et al., 2024; Ali et al., 2025). However, they disagree with the findings of a subset of studies that claim health insurance membership either increases or does not affect OOPHE (Feldstein and Friedman1977; Manning et al., 1987; Newhouse, 1992; Ekman, 2007; Selvaraj & Karan, 2012).

Surprisingly, the coefficient associated with the chronic disease variable is insignificant, indicating that chronic diseases have no influence on the OOPHE of households. This finding contradicts the findings of several empirical studies, which show that chronic illnesses increase OOPHE in chronically ill people (Chatterjee et al., 2008; Dror et al., 2008; Brinda et al.,2012; Rahman et al., 2013). One reason for this result is that the majority of household heads are younger, and thus a large proportion is expected to be free of chronic illnesses when compared to older adults. When CHE is taken into account, the impact of chronic illness variable on household health spending changes. The coefficients of the chronic variable at a 25% threshold are in particular positive and statistically significant in the full and rural models, indicating that being chronically ill is likely to increase the CHE incurred by households.

Overall, the reported results on CHE determinants based on full, urban, and rural household samples differ from those obtained in the revisited study. These may include variations observed with variables such as region, education, gender, employment status, and the presence of children under the age of five and the elderly among household members. Furthermore, the inclusion of household health insurance and chronic health status as CHE-determining factors appears to provide more robustness for this analysis. The differences in results between this study and the revisited study may be due to relatively new data or because the models specified here include new variables such as chronic illness, health insurance membership, and sanitation.

According to the findings in Table 3, OOPHE pushes a large proportion of households (i.e. 5.7%) below the poverty line. The poverty impact of OOPHE, however, varies according to mode of living, as reported results show that the incidence of OOPHE-led poverty is higher among rural households. Furthermore, the poverty impact of OOPHE is greater than that obtained by Ebaidalla and Ali's analysis, which was based on the 2009 NBHS.

The obvious conclusion is that OOPHE significantly worsens the poverty status of Sudanese households. Aside from pushing a large proportion of households into poverty, it also widens and exacerbates the poverty gap. These findings are consistent with those of other researchers who have documented the negative impact of OOPHE on people's welfare (e.g. Berki, 1986; Gertler & Gruber 2002; Xu et al., 2003; O'Donnell et al., 2005; Wagstaff, 2007; van Doorslaer et al., 2007; Chuma & Maina, 2012; Tomini et al., 2012; Rahman et al., 2013; Khan et al., 2017). However, two striking conclusions about OOPHE-led poverty in Sudan can be drawn. First, the evolution of the OOPHE poverty impact appears to contradict the direction of national poverty indexes. As previously stated, overall poverty in Sudan has decreased from 46.5% in 2009 to 36.1% in 2015, indicating that the country has made significant progress in combating poverty incidence (NBHS, 2009, 2015). In contrast, the indicators of poverty reported in Table 4 show that, while poverty at the national level decreased between 2009 and 2015, the share of OOPHE in worsening households' poverty status increased at an increasing rate. Second, there is a discrepancy between the current increase in health insurance enrollment and Sudan's deterioration in poverty indicators. That is, as previously stated, health insurance membership is found to be negatively correlated with OOPHE and CHE, raising concerns about its failure to protect people from OOPHE-led poverty. Many justifications can be advanced to interpret this conclusion. Aside from OOPHE-driven poverty, increases in impoverishment among Sudanese households can be attributed to a variety of factors, including the nature of the health insurance system and socioeconomic factors. For example, the service packages offered by health insurance windows may fall short of covering all of the insured's medical needs, forcing individuals to look out private health care providers. According to Ali and Ebaidalla (2017), Sudanese households are dissatisfied with the services provided by health insurance. Implicitly, this may indicate that health insurance membership does not protect people from OOPHE hardship. Furthermore, the

escalation of OOPHE-led poverty cannot be attributed solely to the slower expansion of health insurance packages and coverage. Many factors may contribute to the upsurge of OOPHE's poverty impact. For example, the Sudan economy suffered a severe economic downturn as a result of South Sudan's secession in 2011 and the depletion of cash flows from oil exports. This had many devastating consequences for people's livelihoods, including import cuts, hyperinflation, and, most importantly, a severe collapse in infrastructure. Import cuts combined with hyperinflation drove up the prices of goods and services, including pharmaceuticals, medical checkups, and doctor visits. This reality forces households to cut a significant portion of their budget in order to purchase health-care services. Exposure to this situation may wipe out the contribution of health insurance to combating OOPHE, resulting in massive impoverishment of households, particularly those belonging to vulnerable groups.

5. Conclusion

Despite increases in health insurance coverage and efforts to reduce the catastrophic impact of health expenditure, OOPHE incurred by Sudanese households has remained very high in recent years. This study revisits the determinants and impact of OOPHE in Sudan using the most recent NBHS from 2015, replicating Ebaidalla and Ali's (2019) study, which used the 2009 NBHS. This study highlights the significance of health insurance and chronic illnesses in influencing OOPHE. The empirical findings show that the majority of the OOPHE determinants retain the same signs and significance, confirming the findings of Ebaidalla and Ali's study. This also implies that, despite changes in the data set, the OOPHE drivers persist over time, providing more robustness to previous analysis. Moreover, the study confirms that having health insurance significantly reduces OOPHE, highlighting the importance of enrolling in health insurance to lower OOPHE. Furthermore, as Ebaidalla and Ali (2019) found, OOPHE pushes a significant portion of the population into poverty, demonstrating the impoverishing impact of health spending. These results hold true in various analysis scenarios.

Based on these findings, implementing policies to expand health insurance access and affordability would be critical in mitigating the financial risk associated with health spending. Policymakers should

reconsider health-care utilization strategies, focusing on universal health insurance coverage and expanding the range of services offered through insurance. A new strategy should be implemented to provide free healthcare services to elderly household members, similar to the approach for under-five children. This reduces elders' contribution to household OOPHE and increases their utilization of healthcare services. The massive OOPHE-led poverty incidence highlights shortcomings in the provision of healthcare services through public health facilities. Policymakers should reform public health facilities to provide sophisticated and comprehensive services, particularly to the poor. Instead of relying on health insurance companies and private healthcare agents, the country should strengthen public health facilities to fill gaps in healthcare services and correct healthcare utilization, especially for vulnerable groups. Finally, policymakers should consider OOPHE-led poverty when deciding on national poverty agendas, integrating different dimensions of poverty into anti-poverty policies, especially those concerning OOPHE.

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Appendixes

Appendix A: Descriptive statistics of the variables used in the regression analysis

Variable	Definition	Mean	Std. Dev.
OOPHE	Per capita health expenditure (SDG/month)	373.307	799.316
Income	Per capita income (SDG/month)	530.645	436.074
Insurance	1= if has health insurance and 0= otherwise	0.376	0.484
Income	Per capita income in SDG	436.074	436.074
10% Threshed	1= if CHE exceeds 10%and 0= otherwise	0.549	0.497
10% Threshed	1= if CHE exceeds 25%and 0= otherwise	0.132	0.339
Gender	Gender of the head of household (1 = male; 0 = female)	0.851	0.356
Age	Age of head of household in years	46.494	14.719
Primary	Primary school, dummy	0.141	0.348
Secondary	Secondary school, dummy	0.149	0.356
Post-secondary	Post-secondary, dummy	0.009	0.093
University	University, dummy	0.047	0.212
Wage employment	Dummy variable (1= wage employment, 0= otherwise)	0.520	0.500
Household size	Number of household'members	5.842	2.502
Child under 5	Number of household 's members less than 5 years	0.723	0.867
Eld65	Number of household 's members more than 65 years	0.232	0.494
Wealth status	Number of Rooms	2.599	1.562
Urban	Dummy variable (1= urban, 0= otherwise)	0.301	0.458
Married	Dummy, (1= married; 0= otherwise)	0.881	0.324
Chronic	1= if reports a chronic disease and 0= otherwise	0.103	0.304
Water	1= if have access to piped water and 0= otherwise	0.309	0.462
Distance	Distance traveled to health care facilities (in minutes)		
Sanitation	1= have flushed toilet and 0= otherwise	0.064	0.245
Khartoum	1= if reside in Khartoum region and 0= otherwise	0.077	0.267
Central	1= if reside in central region and 0= otherwise	0.228	0.420
Northern	1= if reside in northern region and 0= otherwise	0 .084	0.277
Eastern	1= if reside in eastern region and 0= otherwise	0.277	0 .348
Kordufan	1= if reside in Kordufan region and 0= otherwise	0.179	0.384
Darfur	1= if reside in Darfur region and 0= otherwise	0 .288	0 .452

Appendix B: Estimation Results of Heckman Selection Model

	Full Sample		Urban Sample		Rural Sample	
Variables	**Outcome equation**	**Selection equation**	**Outcome equation**	**Selection equation**	**Outcome equation**	**Selection equation**
Insurance	-0.0132	0.106*	-0.0313	0.239	-0.0906***	0.401**
	(0.0569)	(0.0596)	(0.0473)	(0.307)	(0.0330)	(0.158)
Income	-2.64e-06*	8.54e-06	0.00019***	0.000271	0.00014***	0.0014***
	(1.47e-06)	(7.86e-05)	(6.85e-05)	(0.000512)	(3.74e-05)	(0.000371)
Gender	0.0507	-0.0502	-0.0282	0.292	0.0797	0.940***
	(0.0455)	(0.0547)	(0.0740)	(0.626)	(0.0493)	(0.328)
Age	-0.115*	-0.0270	-0.0396	0.764	-0.224***	0.320
	(0.0617)	(0.0726)	(0.0857)	(0.510)	(0.0503)	(0.263)
Primary	0.182***	0.139**	0.168***	0.320	0.213***	-0.193
	(0.0508)	(0.0561)	(0.0573)	(0.314)	(0.0399)	(0.188)
Secondary	0.186***	0.193**	0.240***	0.334	0.196***	-0.480***
	(0.0723)	(0.0847)	(0.0525)	(0.283)	(0.0450)	(0.153)
Post-secondary	0.173	0.634	0.315**	0.185	0.118	-1.139*
	(0.215)	(0.409)	(0.157)	(0.557)	(0.203)	(0.582)
University	0.391***	0.250**	0.159**	-0.260	0.186**	-0.207
	(0.0973)	(0.120)	(0.0739)	(0.381)	(0.0943)	(0.424)
Wage employment	0.113**	-0.142***	0.00337	0.151	0.186***	0.299*
	(0.0543)	(0.0505)	(0.0482)	(0.290)	(0.0287)	(0.163)
Household size	0.0603***	0.0582***	-0.0816***	-0.0136	-0.0652***	0.150***
	(0.0116)	(0.00939)	(0.0110)	(0.0574)	(0.00729)	(0.0429)
Child under 5	-0.0126	0.0867***	0.0382	0.114	0.00311	0.140
	(0.0230)	(0.0241)	(0.0282)	(0.192)	(0.0170)	(0.102)
Eld65	0.141***	0.120***	0.169***	-0.317	0.205***	-0.253**
	(0.0389)	(0.0464)	(0.0456)	(0.219)	(0.0329)	(0.127)
Wealth status	0.0885**	0.0656	0.200***	-0.310	0.143***	0.104
	(0.0433)	(0.0494)	(0.0641)	(0.229)	(0.0385)	(0.164)

Urban	0.0608	-0.0236	-	-	-	-
	(0.0425)	(0.0497)				
Married	0.163**	0.149**	0.0172	-1.103**	0.0774	-0.253
	(0.0667)	(0.0626)	(0.0748)	(0.475)	(0.0538)	(0.294)
Central	-0.167**	0.0324	0.0252	0.299	0.0832	-0.884
	(0.0751)	(0.101)	(0.0618)	(0)	(0.0923)	(0)
Northern	-0.198**	0.115	0.103	-7.653***	0.141	-7.797
	(0.0824)	(0.113)	(0.168)	(2.730)	(0.111)	(0)
Eastern	-0.0598	-0.646***	-0.205***	155.0	-0.388***	-0.945
	(0.158)	(0.0983)	(0.0687)	(0)	(0.0970)	(0)
Kordufan	-0.394***	0.0755	-0.172**	0.156	-0.155	90.37
	(0.0838)	(0.113)	(0.0770)	(0)	(0.0963)	(0)
Darfur	-0.348***	-0.347***	-0.154**	0.621	-0.291***	91.11
	(0.0994)	(0.104)	(0.0705)	(0)	(0.0950)	(0)
Water	0.152***	0.0226	0.217***	1.232***	0.201***	-6.512**
	(0.0432)	(0.0507)	(0.0493)	(0.369)	(0.0421)	(3.305)
Sanitation	0.151*	0.164	0.147***	-0.993***	0.237**	-0.544
	(0.0863)	(0.112)	(0.0564)	(0.248)	(0.113)	(0.427)
Distance		-0.000654		1.695***		1.402
		(0.000591)		(0.643)		(1.118)
Constant	3.297***	0.942***	7.521***	0.246	6.123***	7.491
	(0.313)	(0.290)	(0.321)	(0)	(0.214)	(0)
lambda	-0.726		-0.233		-0.253	
	(0.630)		(0.333)		(0.289)	
Observations	11953	11953	3,592	3,592	8,361	8,361

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1