Tanzanian Economic Review, Vol. 13 No. 2, December, 2023: 161–183

The Effect of Healthcare Expenditure on Maternal Mortality in Uganda

Phiona Atuhaire,* Elizabeth Ekirapa-Kiracho§ & John Mutenyo‡

Abstract

The maternal mortality rate in Uganda of 189 per 100,000 live births remains above the global target of 70 per 100,000. Evidence shows that the mode of healthcare expenditure impacts the provision of maternal healthcare services and reduction in maternal mortality. Understanding how healthcare expenditure impacts maternal health outcomes in Uganda is important for policy. Data from World Development Indicators for the period 1985-2019 were used to explore the effect of healthcare expenditure on maternal mortality using an auto-regressive distributed lag model. The findings showed that domestic government expenditure targeted on maternal health conditions significantly reduces maternal mortality. An increase in nurses was also associated with significant reductions in maternal mortality; hence, the government should increase investment in training and posting adequate nurses at public health facilities, where the majority of Ugandans seek care. Similarly, out-of-pocket health expenditure and total health expenditure per capita were both associated with a reduction in maternal deaths in the short-run. However, while out-of-pocket health expenditure is associated with a reduction in maternal mortality, it is inequitable. The Uganda National Health Insurance should ensure that financial risk protection for the poor is implemented to move towards universal health coverage.

Keywords: healthcare expenditure, maternal mortality, universal health coverage, Uganda

1. Introduction

Uganda remains one of the high-burden countries with a high rate of maternal deaths in Sub-Saharan Africa (SSA) (Orobaton et al., 2016). The level of maternal health outcomes, such as maternal mortality, is closely dependent on the performance of the health system, in addition to other social and demographic factors at the individual and community levels. The health system depends on a number of building blocks, including healthcare financing (Yip et al., 2015). Recent estimates indicate that global average health spending per capita was US$1,105 in 2019, but was only US$39 a person in low-income countries. There was wide variation across income groups (WHO, 2018). In most Sub-Sahara African countries, the budget allocation to the health sector is less than US$50 per capita (WHO, 2021). This underscores the relevance of understanding the effect of health expenditure on poorly performing health outcomes, such as

* PhD Candidate, School of Economics, College of Business and Management Sciences, Makerere University Kampala: atuphionavt@gmail.com (Corresponding author).
§ School of Public Health, College of Health Sciences, Makerere University, Kampala: ekky@musph.ac.ug.
‡ School of Economics, College of Business and Management Sciences. Makerere University, Kampala: jkmutenyo@yahoo.com

©*School of Economics, University of Dar es Salaam, 2023* ♦ https://doi.org/10.56279/ter.v13i2.161

maternal mortality. An analysis of the structure of healthcare financing mechanisms in Uganda shows that out-of-pocket (OOP) financing is the predominant form of healthcare financing ranging between 33–43 percent of current health expenditure. The form of healthcare financing predominant in a country influences access and utilisation of healthcare services, as well as equity in healthcare access. Evidence shows that reliance on private healthcare financing, such as OOP expenditure on health, reduces the likelihood of the poor accessing healthcare; and is a potential cause of inequities in healthcare and poor health outcomes, especially among the poor (Fox et al., 2019).

Evidence show that the level and mode of healthcare financing have impacts on the provision and access to maternal healthcare services (ibid.). A review of the impact of healthcare financing on maternal healthcare in Australia revealed that mothers who had access to health insurance received better healthcare, while the increasing OOP costs for obstetric care created a financial burden for women without insurance, and made them skip care altogether; which exacerbated inequity between the two groups of mothers and babies (Fox et al., 2019); In addition, out-of-pocket expenditure being a dominant form of healthcare financing in Uganda posed a risk for significant inequities in the access to maternal health services against the poor women.

2. Health Expenditure Trends in Uganda

Table 1 provides a summary of the trends in different forms of healthcare financing in Uganda. According to the report of the Ministry of Health (MoH) National Health Accounts (NHA) of 2019, private health expenditure, as a percentage of the current health expenditure, is the major source of healthcare financing, accounting for 41.4 percent in 2018/2019; followed by development partners' support (42.1%), and government financing (15.1%),

Table 1: Proportional Distribution of Current Healthcare Expenditure and Financing Schemes in Uganda (%)

Indicators	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	2017/ 2018	2018/ 2019
General Government Health Expenditure (GGHE) as percent of CHE	15.2	10.3	10.2	15.4	15.9	20.8	21.1	22.1
Private Health Expenditure (PHE) as percent of CHE	38.4	40.0	41.5	40.3	41.5	39.1	38.3	41.4
Development Partners' Funding/ Multilateral Donors (DPF) as percent of CHE	6.0	37.6	33.0	42.3	40.6	43.6	43.7	41.4
Financing Schemes								
Government Financing Schemes	47.9	26.0	26.3	14.2	14.7	15.8	16.3	15.1
Voluntary Health Insurance Schemes	10.5	1.6	1.9	2.3	2.2	2.4	3.6	4.0
Out of Pocket Expenditure	39.3	42.4	39.1	38.6	40.0	37.7	35.6	38.6
Development Partners' Support	6.0	29.4	32.4	42.3	40.6	43.9	44.2	42.1

Source: MoH, NHA, Reports 2010/11 – 2019/2020

The private health expenditure indicator comprises of payments from households, corporations, and funds from non-profit organizations either prepaid to voluntary health insurance schemes or paid directly to healthcare providers. Payments made by households through OOP payments account for over 90 percent of the private health expenditure, and over 40 percent of the total current health expenditure (MOH, 2020). Financing from other private domestic sources is minimal, with private firms (corporations) accounting for an average of 0.1–0.9 percent, and private insurance (voluntary pre-payment from individuals and employers) accounting for between 2.4 to 3.0 percent on average of the financing schemes as per the MoH National Health Accounts report of 2013/14.

Heavy reliance on OOP as a form of healthcare financing in Uganda poses a significant barrier for the poor to obtain services such as emergency obstetric care. These health services are typically provided at Health Centre IV's, general hospitals, regional and national referral hospitals: all of which are more expensive to access. Whereas studies have demonstrated that healthcare expenditure has a significant effect on access to maternal healthcare and health outcomes (Berger & Messer, 2002; Fox et al., 2019), there is a paucity of empirical evidence on the extent to which health expenditure affects maternal healthcare utilisation and health outcomes in Uganda. It is also important to assess which types of health expenditure has a greater effect on maternal health outcomes. The objective of this paper is to investigate the effect of healthcare expenditure on maternal mortality as an indicator of maternal health outcomes in Uganda, and how different health expenditure categories affect maternal mortality. Understanding how health expenditure effects maternal health outcomes in Uganda is important to inform the design of healthcare financing policy necessary to reduce maternal mortality.

3. Theoretical Review

The healthcare system performance and healthcare production framework outlined by WHO (2000) indicates that access to healthcare services by individuals and communities depends on the level of the performance of the health system, which itself depends on the amount of the inputs and how effectively they are utilized to produce a healthcare service. The ultimate goal is improvements in health outcomes among the population, which can be expressed in the form of life expectancy, morbidity and mortality rates. The health system performance framework depicts how a set of inputs—policies, financing, and organisation—affects how resources are allocated to produce health goods and services (outputs) to achieve health outcomes that include improved health status.

Inputs into the health sector are greatly determined by the financing to the health sector. Health financing frameworks demonstrate the relationship between healthcare expenditure and healthcare outcomes. The effects of healthcare financing on maternal health services and health outcomes are analysed based on the health production models suggested by Grossman (1972), and applied by Berger and Messer (2002) and Kabajulizi et al. 2019. Some forms of healthcare financing such as OOP health expenditure, which requires paying for health services at the point of use, can

be restrictive and inequitable, especially for low-income groups. This results in limited access to healthcare, and serious inequities against the poor households, and ultimately poor health outcomes. Other types of healthcare financing such as national health insurance scheme, which tend to be more equitable, enable low-income households to access care when needed, and lead to better health outcomes.

Following the theoretical model by Grossman (1972), a production function explaining health outcomes (maternal mortality) and healthcare outputs given by four or more antenatal care visits (ANC4+), and assisted-birth delivery (H) in year *t,* can be specified as:

$$H_t = f(HC_t, HB_t, X_t, DEM_t\ EDUC_t, FEMLFP_t) \quad (1)$$

Following the Grossman (1972), health (*H*) is specified as a function of a number of variables such as healthcare inputs (*HC*), health behaviours (*HB*), and other market goods (*X*). In addition, health outcomes depend on the demographic composition of the population (*DEM*) for biological reasons; and *EDUC* is education.

The female labour force participation rate for women aged between 15 and 59 years (*FEMLFP*) is used as a proxy for healthcare provided in the household. It is assumed that as female labour force participation increases when more and more women, as primary caregivers, work outside of the home, and the amount of healthcare provided within the household decreases. This argument has been made previously by Gerdtham et al. (1992). Other market goods (*X*) are measured using GDP per capita.

Assuming an underlying nonlinear relationship between income and health at the micro level, then the distribution of income is expected to affect aggregate health measures (Judge et al., 1998). To control for this possible variation over time and variations in the consumption of market goods, a measure of income inequality (Gini-coefficient) is also included in the model. Health behaviours (*HB*) are controlled by using per capita tobacco consumption and alcohol consumption among females aged 15–59. Education (*EDUC*) is a crucial variable as a determinant of health status. According to Grossman, the marginal efficiency of investment in health for educated people is higher compared to other groups. This implies that more educated individuals can produce health more efficiently, leading to a positive correlation between education and health. Thus, more educated females are more likely to make decisions to access maternal health services, as well as take actions, such as better nutrition during pregnancy, that result in better health outcomes. The *EDUC* variable is proxied by the female literacy rate.

4. Empirical Review

Several studies have examined the relationship between health expenditure and health outcomes to draw insights on how healthcare financing arrangements (public versus private) impact on health outcomes (Aziz et al., 2021; Gallet & Doucouliagos, 2017; Manyika et al., 2019; Rahman et al., 2018; Ullah et al., 2021). The health outcomes indicators that have been widely studied include life expectancy, infant

mortality rate, all-cause mortality crude death rates, and maternal mortality rate. Of these health outcomes, infant mortality rate is perhaps the most studied in both developed and developing countries. However, a few studies assess this relationship by focusing on narrowly defined health conditions, such as smoking prevalence and sexually transmitted disease (Chesson et al., 2005; Tauras et al., 2005).

Gallet and Doucouliagos (2017) conducted a meta-analysis of studies which examined the effect of healthcare financing on health outcomes. They found that most studies used mortality rate or life expectancy as the indicator of health outcomes (Costa-Font et al., 2011; Doucouliagos et al., 2012). They further noted that healthcare spending has a greater impact on mortality rate than on life expectancy because this is influenced by a number of factors outside of the healthcare system; whereas healthcare expenditure has a more direct effect on health outcomes, such as on mortality. Using meta-regression analysis, their review found that the spending elasticities on mortality were sensitive to data aggregation, specification of the health production function, and on the type of healthcare expenditure. Gallet and Doucouliagos (2017) further reported that mortality studies addressing infant or under-5 mortality suggest that health returns to spending are higher among children, ceteris paribus. Similarly, healthcare spending elasticities were greater for less developed countries. This implies that health returns to spending are higher (lower) in less (more) developed countries. These findings further imply that there is a relatively higher return on each dollar spent towards the healthcare of children and in low-income countries than among adults and developed countries.

Aziz et al. (2021) explored the role of healthcare spending on maternal mortality using penal data for eight South Asian countries including Pakistan, Bangladesh, Bhutan, Nepal, Sri Lanka, India, Maldives and Afghanistan for the years 2000–2017. The study used fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) models for the empirical analysis. They found that a one percentage point increase in health expenditure was associated with an increase of 1.95 percent in the maternal mortality rate in the case of FMOLS estimator, and 0.16 percent in the case of DOLS estimator. This finding was contrary to expectations and suggested that health expenditure played a minimal role in reducing maternal mortality compared to other factors in these countries. However, they found that population growth had a long-term negative effect on maternal mortality; whereas economic growth, sanitation and clean fuel technologies led to a reduction in maternal mortality. These findings reinforce the observations from the meta-analysis by Gallet and Doucouliagos (2017): that healthcare spending tends to have small (or no effect) in reducing mortality compared to other factors in the health production function.

Rana et al. (2018) examined how the relationship between healthcare expenditure and health outcomes varies across countries at different income levels using panel data for 161 countries for the period 1995–2014. The study used infant mortality, under-five, and maternal mortality along with life expectancy at birth as the health

outcome measures. The findings of this study showed that the link between health expenditure and health outcome was stronger for low-income countries compared to developed countries. This finding reaffirms the concept of diminishing returns to health investment in the case of high-income countries, highlighted in other studies (Aziz et al., 2021; Gallet & Doucouliagos, 2017). There was a negative and significant relationship between health expenditure and child mortality but an insignificant relationship with maternal mortality at all income levels. They recommend examining the influence of other confounding factors such as female education, access to family planning and consumption of tobacco and alcohol, as well as minimum access to healthcare services to reduce maternal mortality.

Some studies have examined the relationship between healthcare expenditure and health outcomes by examining the differential effect of private and public healthcare spending. Rahman et al. (2018) examined the relationship between public and private healthcare spending using panel data for a group of 16 countries in the region of South Asian Association for Regional Cooperation (SAARC) and Association for Southeast Asian Nations (ASEAN). They found that total health expenditure, public health expenditure and private health expenditure significantly reduced infant mortality rates. The extent of the effect of private health expenditure on IMR was greater than that of public health expenditure. A one percentage point increase in total health expenditure as percentage of GDP led to a reduction in infant mortality rate by around 0.27 per 1000 live births (or 27 infants saved for every 100,000 live births). The extent of the effect on infant mortality rate was higher with private health expenditure (0.24) than public health expenditure (0.09). Examining the separate effects of private and public health expenditures on health outcomes underscores the relative influence of both types of healthcare expenditures on the attainment of universal health coverage, and for improving the population's health. Other factors that had a significant role in reducing IMR and the crude death rate were per capita income growth and improved sanitation facilities.

A few studies have examined the relationship between healthcare financing and maternal mortality in SSA and other low-income settings. Manyika et al. (2019) examined the association between government health expenditure and maternal mortality in Zimbabwe between the period 1980 and 2011. This followed the economic hardships in Zimbabwe that saw public expenditure on healthcare dwindling rapidly in the 2000s. Using multiple regression analysis to control for confounders, they found that an increase in government health expenditure reduced maternal mortality. Specifically, a 10 percent increase in government healthcare expenditure (as a percentage of total health expenditure) led to a 5 percent reduction in maternal mortality. While in their estimation the study did not adopt the ARDL model to control for endogeneity problems and examine the short-run and long-run relationships, this study is insightful in expounding the importance of public expenditure on health in low-income settings, where due to extreme poverty and economic hardships, very few people can afford to finance their healthcare needs. Other confounders examined in this study included: female literacy, household income, access to improved sanitation facilities, skilled birth attendant, and place of delivery.

Ullah et al. (2021) examined the effect of public healthcare spending on health outcomes, following years of increased healthcare budget in Pakistan. Their study found that public healthcare spending significantly impacts health outcomes both in the short-run and long-run. Using quantile ARDL model estimation, their findings show that a 1 percent increase in healthcare spending increased life expectancy for the 3rd quantile by 0.002 percent in the short-run and by 0.27 percent for the 4th quantile in the long-run. Overall, their study found that public healthcare spending had improved life expectancy and reduced death rate and infant mortality in Pakistan. The study concluded that public healthcare expenditure enables the provision of better healthcare facilities that leads to improved health outcomes and quality of health, which might have spillover effects on the growth and development of the country.

5. Methodology

5.1 Theoretical Model

To examine the relationship between health expenditure and maternal health outcomes, a model similar to that applied by Gallet and Doucouliagos (2017), and Berger and Messer (2002), is used. This is a health production model developed by Grossman (1972). However, the model is modified: the behavioural variables of tobacco and alcohol consumption that are dropped in the estimation, and the three health systems supply-side factors that influence healthcare delivery, are introduced. These include number of nurses/midwives per 1000; number of hospital beds /1000, and number of physicians/doctors per 1000 people.

Thus, the maternal health outcome model is specified as follows:

$$H_t = f(Y_t, Z_t, e_t) \qquad (2)$$

Where: Y_t is a vector of the healthcare expenditure (OOP, public health expenditure, and private healthcare expenditure), and Z_t is a vector of control variables, including demand side (income, education, etc.) and supply-side factors such as bed capacity and availability of health workers (e.g., doctors and nurses per 1000 population), and the error term.

The estimation model for maternal mortality (health outcome) is given as follows:

$$H_t = \beta_0 + \theta HE_t + \Psi Z_t + e_t \qquad (3)$$

Where: H is maternal mortality rate; HE_t is healthcare expenditure, which can be categorised into domestic government expenditure on maternal conditions, public health expenditure to total health expenditure; total health expenditure per capita, and OOP to total health expenditure. Z is a vector of control variables, including number of hospital beds, number of physicians, education proxied by literacy rate for females aged 15 to 59 years, and GDP per capita as a proxy for income. θ, and Ψ are coefficients to be estimated, while e is the random errors. The constant β_0 represents the initial health outcome, analogous to the initial stock of health in the Grossman's model of health capital.

5.2 Empirical Model

As part of the pre-estimation diagnostics in estimating the effect of healthcare expenditure on maternal mortality, a pairwise correlation matrix involving all the estimation variables will be constructed to determine the linear relationship between any two of the variables in the models. The correlation matrix also gives an indication of the possibilities of multi-collinearity in the model. If the correlation coefficients between the predictors are less than 0.8, model estimation will proceed without serious problems of multi-collinearity.

Stationarity of each data series was done before estimating the model specified in equations (2) and (3). Testing the stationarity of economic time-series is important since regressing non-stationary variables on stationary variables without any valid relationship (co-integration) may easily result in spurious results. Consequently, the usual statistical tests are likely to be inappropriate, and the inferences drawn are likely to be erroneous and misleading. The study adopted the augmented dickey fuller (ADF) and the Phillips-Perron (PP) tests for unit root. The results of the unit root test informed the functional transformation required for the estimation and the choice of the model to estimate the relationship between healthcare financing arrangements and access to healthcare services. Based on the literature reviewed, a number of studies have used the Autoregressive Distributed Lag (ARDL) model to estimate the relations between healthcare financing and healthcare outcomes; an estimation technique that is also proposed for this study.

The ARDL model to be estimated is specified as follows:

$$\Delta H_t = \beta_0 - \alpha[H_{t-1} - \theta HE_{t-1} - \Psi' Z_{t-1}] + \sum_{i=1}^{p-1} \gamma_i \Delta H_{t-i} + \sum_{i=0}^{q-1} \lambda_i' \Delta HE_{t-i} + \sum_{i=0}^{r-1} \lambda_i' \Delta Z_{t-i} + e_t \quad (4)$$

Where: H_t is maternal health outcome (MMR); HE is healthcare expenditure; Z is a vector for other cofounding factors; α is the speed of adjustment coefficient; θ and Ψ are the long-run coefficients; γ and λ are the short-run coefficients; the term in the brackets is the error correction term; while p, q and r are optimal lags. The cofounding factors include: female labour force participation, health worker per 1000, teenage mothers, female tobacco consumption, per capita female alcohol consumption, hospital bed capacity, GDP per capita, and poverty headcount ratio.

When using the ARDL approach, there is need to test for the existence of long-run relationship using bounds test. The bounds test is a Wald test (F-statistic) that tests whether all the long-run coefficients are statistically equal to zero. If the computed F-statistic exceeds the upper critical value, the null hypothesis is rejected; indicating that there is co-integration. If the computed F-statistic is lower than the lower bound critical value, we fail to reject the null hypothesis, and

conclude the absence of co-integration. The bounds test was conducted to assess the existence of a long-run relationship between the healthcare financing arrangements considered in the model and access to healthcare services in Uganda.

5.3 Data Sources

The time-series data was obtained from the World Bank, World Development Indicators (WDI), and WHO databases. These included data on maternal deaths, and other control variables such as literacy rate for females aged 15–59 years, and alcohol consumption among women. These data sources also provided data on GDP per capita, public and private health expenditure, nurses and physician per 1000 population, hospital beds per 1000 teenage mothers, and female labour force participation. The data covered the period 1985–2019. While health expenditure, hospital beds per 1,000, physicians per 1000 population, and per capita GDP had complete data points for time-series analysis. However, other variables were short by 3–5 years. To resolve this hurdle, back casting and imputation using linear interpolation was carried out. The data gaps were addressed through linear interpolation, i.e., new data points were constructed using the range of the existing data points.

5.4 Variable Description

Table 2: Description of Variables

Variables	Description
Maternal deatths/100,000	Maternal mortality ratio (maternal deaths per 100,000 live births)
Government Expenditure on maternal health conditions	Domestic government expenditure on maternal health conditions (in logs)
EHE/THE	External health expenditure as a percentage of total health expenditure (in logs)
OOP/THE	Ratio of OOP to Total health expenditure (in logs)
HE/capita	Health expenditure per capita (in logs)
PHE/THE	Public Health expenditure as a percentage of total health expenditure (in logs)
PHE/Total Budget	Public health expenditure as a percentage of total budget (in logs)
FEMLFP	Female labour force participation rate:
Doctors/1000	Number of physicians per 1000 people
Nurses/1000	Number of nurses and midwives per 1000 people
Poverty	Poverty headcount ratio at $1.90 a day
FEMLFP (ILO)	Female labour force participation rate (ILO modelled):
Teen Mothers	Teenage mothers
Bank Account	Percentage of people owning a bank accounts
GDP/capita	GDP per capita (2005 constant prices) in logs
Female Literacy	Literacy rate for adult females (15+ years)
Hospital beds/1000	Hospital bed capacity per 1000 people
Female alcohol consumption	Per capita female alcohol consumption
Tobacco production Index	Production index (beverage, tobacco):
Female Tobacco Consumption	Female tobacco consumption

5.5 Statistical Analysis

We used the ARDL model given its advantages over the Johansen co-integration techniques to establish the short-run and long-run relationships between healthcare expenditure and maternal mortality. The ARDL model is the more statistically significant approach to determine the co-integration relation in small samples (Ghatak & Siddiki, 2001) compared to the Johansen co-integration techniques that requires large data samples for validity. It also does not require that all the regressors are of the same order of integration, and avoids the pre-testing problems associated with standard co-integration, which requires that the variables be classified into I(1) or I(0) (Pesaran et al., 2001). The ARDL model is also appropriate if the unit root properties of the data are not clearly known (Pahlavani et al., 2005). We run models for four categories of health expenditure: domestic government expenditure on maternal conditions; public health expenditure to total health expenditure; total health expenditure per capita, and OOP to total health expenditure.

We carried out the bounds test and estimated the F-statistic of the Wald test to examine whether all the long-run coefficients are statistically equal to zero. The computed F-statistic was greater than the upper critical value, suggesting that the null hypothesis could not be rejected; thus indicating that there is a variable cointegration. We performed diagnostic tests for serial correlation, heteroscedasticity, omitted variable test (Ramsey RESET), normality test, and multicollinearity (VIF) test.

6. Results and Discussion

6.1 Descriptive Analysis

The summary statistics in Table 3 show that the mean MMR over the estimation period 1995–2019 of 447 per 100,000 live births is far greater than the current rate of 336 per 100,000 live births. This depicts high MMR rates in previous periods.

Table 3: Summary Statistics of the Estimation Variables

Variable	Mean	Median	SD
Maternal mortality ratio (MMR) (per 100,000 live births)	447.60	436.00	65.80
Log of Expenditure on maternal Health Condition	9.28	9.10	1.14
Donor health Expenditure to total health expenditure (%)	26.80	23.64	10.93
OOP to Total Health Expenditure (THE) (%)	39.66	41.18	4.74
Health Expenditure per capita (USD)	35.94	33.47	16.45
Public health expenditure to total health expenditure (%)	26.34	25.82	1.96
Public health expenditure to total budget (%)	12.80	12.57	2.68
Female labour force participation (LFP) (%)	47.58	47.55	1.21
Doctors (per 1000 persons)	0.08	0.08	0.04
Nurse (per 1000)	1.30	1.31	0.26
Poverty (headcount ratio-%)	55.39	58.30	11.70
Female LFP (ILO modelled) (%)	66.16	66.21	1.43
Teenage mothers (%)	28.80	24.85	7.66
Bank account Ownership (%)	41.37	44.45	19.55
GDP per capita (in 2005 constant prices) (USD)	279.89	261.82	85.61
Education for female 15 years above (%)	60.54	62.02	8.68
Hospital beds per 1000 persons	0.85	0.92	0.33
Female alcohol consumption (%)	5.66	5.61	0.25
Female tobacco consumption (%)	5.80	5.55	1.57

Also, Table 3 shows that the health system supply-side parameters in terms of the number of nurses, doctors and hospital beds per 1000 persons are very low; meaning that the health system faces significant input constraints in providing care. About 6 in 10 women aged 15 years and above are literate, which provides an opportunity for good uptake of health education campaigns to reduce maternal mortality. The percentage of teenage mothers is high; with one in four mothers having a birth before the age of 18 years, which possess a significant risk factor for maternal deaths. The average public health expenditure to total budget remains below the 15 percent of the Abuja target, and depicts the long-standing underfunding to the health sector in Uganda.

6.2 Diagnostic Tests

The results of the diagnostic tests are shown in Table 4. The p-values for all the tests are greater than 0.05, suggesting that the estimated model does not suffer from serial correlation, there is no heteroscedasticity, the model is well specified, and the residuals are normally distributed. The Variance Inflation Factor (VIF) is less than 10: suggesting that there is no multicollinearity amongst the explanatory variables included in the model.

Table 4: Diagnostic Test Results

Test	**Model: ($H_t = MMR$)**	
	Test Statistic	**P-Value**
Serial correlation	Chi2(1) = 0.598	0.4502
Heteroscedasticity	Chi2(1) = 0.86	0.3630
Ramsey RESET	F(3, 19) = 2.18	0.1600
Normality	Chi2(1) = 2.109	0. 3484
Multicollinearity	VIF= 7.61	

6.3 Bounds Test

To use the ARDL approach for model estimation, it is necessary to test for the existence of long-run relationship between MMR and healthcare expenditure using the bounds test. The results of the bounds test are presented in Table 5; and they show that the computed F-statistic was greater than the upper critical value, implying that there is variable co-integration.

Table 5: Bounds Test Results

	Model: ($H_t = MMR$)
F-statistic	22.926
1 percent bounds	(4.29, 5.61)
5 percent bounds	(3.23, 4.35)
10 percent bounds	(2.72, 3.77)

Source: Author's computations

6.4 Regression Analysis

The effect of health expenditure on maternal mortality was assessed for each of the four categories controlling for confounders. Some of the explanatory variables that

were highly correlated to others—as shown in the correlation matrix in the Appendix—were automatically dropped during model estimation; and estimation coefficients are reported for only those that were retained.

The short-run estimates for the relationship between domestic government expenditure on maternal conditions and maternal mortality rates is shown in Table 6. The estimated coefficient for the speed of adjustment of the model in the long-run is negative and statistically significant; suggesting there is convergence, which is desirable. The estimates show that a 1 percentage point increase in domestic government expenditure on maternal health conditions is associated with a 0.06 percentage point reduction in MMR. This suggests that an increase in government spending on maternal health programs reduces the maternal mortality rates in the country. Similarly, for every 1 percentage point increase in MMR experienced in the past 2 years, there is a corresponding 0.02 percentage point increase in MMR in the current period. However, the effect of MMR experience in the past 1 year is much greater than that of 2 years earlier.

Table 6: Short-run and Long-run Effects of Domestic Health Expenditure on Maternal Health Conditions on MMR

Variables	(1) ADJ	(2) LR	(3) SR
Maternal deatths/100,000 (lag-1)			1.148**
			(0.144)
Maternal deatths/100,000 (lag-2)			0.552**
			(0.076)
Expenditure on MH Conditions			-0.061**
			(0.006)
Expenditure on MH Conditions (lag-1)			0.019*
			(0.005)
Female Alcohol Consumption			-0.223**
			(0.029)
Female Alcohol Consumption (lag-1)			-0.041
			(0.017)
Female labour force participation			0.025
			(0.017)
Female labour force participation (lag-1)			0.003
			(0.011)
Expenditure on MH Conditions		-0.002	
		(0.001)	
Female Alcohol Consumption		0.010	
		(0.018)	
FEMLFP (ILO)		-0.004	
		(0.008)	
Maternal deatths/100,000	-0.321***		
	(0.221)		
Constant			0.016
			(0.008)
Observations	33	33	33
R-squared	0.999	0.999	0.999

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

The long-run estimations show an inverse relationship between domestic government expenditure on maternal health conditions and MMR, as expected, although the coefficient is not statistically significant. The sign for the estimated coefficient for female alcohol consumption in the short-run is contrary to the expectation. Alcohol consumption during pregnancy is associated with an increased risk of complications towards the health of the pregnant mother, and hence likely to result in undesirable outcomes during child-birth. In the long-run, the estimated coefficient suggests that female alcohol consumption is associated with an increase in maternal mortality, although the coefficient is not statistically significant.

Estimates for the effect of total health expenditure per capita on MMR are shown in Table 7. The findings show that total health expenditure per capita has no significant effect on MMR neither in the short-run nor in the long-run.

Table 7: Short-run and Long-run ARDL Estimations of the Effect of Total Health Expenditure per Capita on MMR

Variables	(1) ADJ	(2) LR	(3) SR
Maternal deaths/100,000 (lag-1)			0.843**
			(0.395)
Maternal deaths/100,000 (lag-2)			0.733**
			(0.263)
HE/capita			0.002
			(0.021)
Female Alcohol Consumption			-0.129
			(0.098)
Female Alcohol Consumption (lag-1)			-0.018
			(0.069)
Female labour force participation			0.039
			(0.038)
Female labour force participation (lag-1)			0.016
			(0.027)
Nurses/1000			0.002
			(0.018)
Nurses/1000 (lag-1)			-0.023*
			(0.013)
HE/capita		0.012	
		(0.011)	
Female Alcohol Consumption		-0.008	
		(0.051)	
Female labour force participation		-0.021	
		(0.020)	
Nurses/1000		-0.003	
		(0.009)	
Maternal deaths/100,000	-0.237***		
	(0.494)		
Constant			-0.001
			(0.002)
Observations	33	33	33
R-squared	0.872	0.872	0.872

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

However, the estimates show that a 1 percentage point increase in the number of nurses per 1000 is associated with a 0.023 percentage point reduction in MMR in the short-run. The experiences in MMR in the past two periods also have an effect on MMR in the current period. The estimates further show that a 1 percentage point improvement in MMR in the past one year is associated with a 0.84 percentage point reduction in MMR. Likewise, a 1 percentage point improvement in MMR two years earlier is associated with a 0.73 percentage point reduction in MMR. This could imply that interventions implemented in past periods to address maternal mortality have trickle-down effects in the corresponding periods.

The estimates on the association between public health expenditure and OOP as a percentage of total health expenditure (THE), and MMR are shown in Table 8.

Table 8: Short-run Estimations on the Effect of Public Health Expenditure and OOP to Total Health Expenditure on MMR

Variables	(Model 1) SR	(Model 2) SR
Maternal deaths/100,000	-0.561**	-0.577**
	(0.246)	(0.216)
Maternal deaths/100,000 (lag-1)	0.059	0.111
	(0.250)	(0.219)
Maternal deaths/100,000 (lag-2)	-0.551**	-0.270
	(0.240)	(0.211)
PHE/THE{OOP/THE}	0.011	0.009
	(0.018)	(0.018)
PHE/THE{OOP/THE} (lag-1)	0.008	-0.045**
	(0.017)	(0.017)
Female Alcohol Consumption	-0.164**	-0.178**
	(0.075)	(0.063)
Female Alcohol Consumption (lag-1)	0.131	0.11*
	(0.076)	(0.067)
Female Alcohol Consumption (lag-2)	0.050	0.092
	(0.070)	(0.061)
Female labour force participation	-0.008	-0.024
	(0.029)	(0.026)
Female labour force participation (lag-1)	-0.018	-0.001
	(0.029)	(0.025)
Female labour force participation (lag-2)	-0.017	-0.018
	(0.029)	(0.025)
Nurses/1000	-0.005	-0.009
	(0.012)	(0.010)
Nurses/1000 (lag-1)	-0.031**	-0.034***
	(0.013)	(0.011)
Nurses/1000 (lag-2)	0.020	0.012
	(0.013)	(0.011)
Constant	0.000	-0.000
	(0.001)	(0.001)
Observations	33	33
R-squared	0.589	0.695

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

Model 1 shows the estimates of the effect of total health expenditure on MMR in the short-run. A 1 percentage point increase in public total health expenditure is associated with a 0.011 percentage point reduction on MMR, controlling for other confounders (i.e., female alcohol consumption, female labour force participation, number of nurses per 1000 people). Whereas the reduction in MMR is small in absolute sense, these findings conform to the theoretical relationship between healthcare expenditure and health outcomes; whereby an increase in health expenditure on maternal health results in a reduction in MMR. Such small changes are still clinically important since they would still contribute to the saving of some maternal lives.

Model 2 shows the estimates for the effect of OOP as a ratio of total health expenditure on MMR. In the short-run, a one percentage point increase in OOP/total health expenditure in the previous period is associated with a 0.05 percentage reduction in MMR. A one percentage point increase in nurses per 1000 people a year earlier is associated with a 0.03 percentage point reduction in MMR in the current period. A one percentage point reduction in female alcohol consumption per capita one year earlier is associated with a 0.11 percentage point reduction in MMR. These results imply that alcohol consumption in the past periods is associated with a high risk of maternal deaths. The estimates of alcohol consumption in the current period show contradicting findings, whereby an increase in consumption is associated with improvements in maternal deaths contrary to the expectation. This is rather a surprising finding since there is no known literature which suggests that consuming alcohol during pregnancy can reduce (but rather increases) the risk of underlying factors for maternal death such as severe haemorrhage and obstructed labour.

Discussion

This paper examined the relationship between health expenditure and maternal health outcomes, and how the different forms of health expenditure affect maternal mortality. The categories of health expenditure considered in the analysis included domestic government expenditure on maternal conditions, health expenditure per capita, public health expenditure as a percentage of total health expenditure, and OOP as a percentage of total health expenditure.

The findings showed that an increase in government spending on maternal health programs reduces maternal mortality. The 2015/16 Uganda National Health Accounts report shows that expenditure on maternal health conditions, as a percentage of current health expenditure, was 7.1 percent in 2012/13; and increased to 11.6 percent by 2015/16. Similarly, an increase in health expenditure per capita is associated with a reduction in MMR in the short-run. Findings on the effect of domestic government health expenditure on maternal health conditions showed that an increase in this form of expenditure is associated with a reduction in maternal mortality. This implies that increasing domestic health expenditure on maternal health conditions is a key intervention for addressing maternal mortality. Thus, expenditure directed specifically to maternal health conditions has a greater potential to realize the desired effect than overall total health

expenditure. This is perhaps because in the cases of limited financial resources for the health sector, general health expenditure tends to be spread so thinly over many interventions, thereby resulting in limited positive effects than when financing is dedicated to specific health conditions/interventions. This implies that the government should increase domestic expenditure on maternal health to reduce maternal mortality. Targeted interventions such as voucher schemes, free birth kits for poorer and rural women should be implemented to improve the utilisation of maternal health services for the poor and those in rural areas to address the existing inequalities.

An increase in OOP as a ratio of total health expenditure was found to be associated with a reduction in MMR. However, a reliance on OOP reduces access to healthcare when households have limited capacity to pay for health among other household consumption needs. This arises when households face catastrophic household expenditure, and their budget allocations towards health reduces. A high private to government expenditure ratio implies that households contribute more to health expenditure compared to the government, which drives them into catastrophic health expenditure: reducing their utilisation of healthcare. Conversely, this situation can also arise when households deplete their income sources to finance healthcare in the short-run, and therefore can access healthcare. This financing strategy is not sustainable over the long-run, thereby leading to a reduction in access to healthcare. Similar findings are reported by Kabajulizi et al. (2022), who found that a unit increase in the ratio of private to government health expenditure increased health access and quality index by 0.74 points in the short-run, but reduced the access and quality of care index by 0.91 points in the long-run. The study concluded that the government ought to increase the share of public health financing in the long-run for the country to achieve universal health coverage by 2030 (Kabajulizi et al., 2022).

A number of studies have examined the relationship between healthcare financing and maternal mortality at a macro level in other settings, but not in Uganda. Fox et al. (2019) reviewed the impact of financing mechanisms on maternal healthcare in Australia, and found that increasing OOP costs associated with obstetric care created a financial burden for women to access the necessary care. A study by Owusu et al. (2021) used time-series data for the period 2000–2015 for 177 low- and middle-income countries to examine the relationship between mortality and healthcare expenditure. They found a negative relationship between health expenditure and mortality across all percentiles. A 1 percentage point increase in health expenditure led to a decline in maternal mortality ranging from 0.09 percent to 1.91 percent. The study concluded that enhanced healthcare expenditure, especially in developing countries, is required to curb the high levels of maternal deaths, highlighting the need to increase healthcare expenditure in developing countries. Al-Azri et al. (2020) explored the healthcare expenditure and health outcome nexus in Oman using the World Bank WDIs. They found that the effects of health expenditures on infant mortality rate, child mortality rate and maternal mortality rate were negative and statistically significant, implying that the public health expenditures is essential for improving population's health (Al-Azri et al., 2020).

An earlier study by Berger and Messer (2002) examined the relationship between public health expenditure, insurance, and health outcomes in OECD countries. They examined the health outcomes within the health production models using 1960–1992 data across 20 OECD countries. The findings showed that an increase in in-patient and ambulatory insurance coverage was associated with reduced mortality. However, they found that increases in publicly financed share of health expenditures were associated with increases in mortality. The study deduced that as OECD countries increase the level of their health expenditures, they should consider avoiding increasing the proportion of their expenditures that are publicly financed and instead increase insurance coverage. The study further found that tobacco use, alcohol use, and fat consumption were associated with increased mortality. These findings are similar to the results of this study: that female alcohol consumption was associated with increases in the maternal mortality ratio.

The study by Kabajulizi et al. (2022) explored the relationship between healthcare financing arrangements and access to healthcare in Uganda. Although this study was not specific to maternal health outcomes, the findings are consistent with those of this study. They found that compared to private healthcare financing, an increase in government health expenditure resulted in an increase in access to healthcare as a desired health output measure. Using the ARDL model specification as applied in this study, they found that an increase in the ratio of private to government healthcare financing has different impacts in the short-run and long-run. While in the short-run it increases access to healthcare, over the long-run a reliance on private healthcare financing reduces access to healthcare. This is because OOP is the dominant financing component of private financing.

Despite the above studies which found a negative relationship between healthcare expenditure and maternal mortality, there are a few others that report contradicting results (Aziz et al., 2021; Berger Mark & Messer, 2002). Aziz et al. (2021) examined the role of health expenditure on maternal mortality in a group of South Asian countries. They found that an increase in healthcare expenditure was associated with increases in maternal mortality, contrary to expectations. Instead, the study found that economic growth, sanitation, and clean fuel technologies showed significant long-term negative effects on maternal mortality; implying that these factors were more significant in reducing maternal mortality than healthcare expenditure per se. The study concluded that the prevailing healthcare system in those countries was not adequate for reducing maternal mortality. They argued that this is because the system was highly elastic and did not consider the needs of the poor and the powerless, thereby leading to a worsening of maternal mortality, despite an increase in healthcare expenditures. These findings suggest that an equitable health system is important for increases in health expenditure to generate the desired health outcomes. The study of public financing of healthcare in OECD countries by Berger and Messer (2002) found that increasing the share of government financing of healthcare was associated with increased mortality, whereas it was the reverse for insurance. They argued for increasing insurance coverage within the OECD and other richer countries to reduce all-cause mortality.

Overall, empirical evidences from studies in the LMICs generally suggest that increases in healthcare expenditure reduces maternal deaths. The overall results of this study have demonstrated that increased domestic government expenditure on maternal health conditions reduce maternal deaths in Uganda; hence underscoring the importance of increased government expenditure on health, especially in the absence of a social health insurance scheme.

Conclusion

This study has shown that an increase in health expenditure is associated with a reduction in maternal mortality generally, but the form of health expenditure matters for reducing maternal deaths in Uganda. Targeted domestic government health expenditure on maternal conditions significantly leads to a reduction in maternal mortality in the long-run. Thus, the government should increase health expenditure, especially on maternal health conditions, to achieve significant reduction in maternal mortality. This is particularly important in the case of low-income countries that face huge financial resource constraints for health. Although an increase in OOP as a percentage of total health expenditure was associated with a decline in MMR, this financing option is inequitable and can lead to catastrophic expenditure for the poor. Given that the national social insurance scheme is yet to become operational, government financing remains the most equitable and sustainable health expenditure for maternal health specifically, and healthcare interventions in general. Other forms of health expenditure were not associated with a reduction in maternal mortality. This is perhaps because the total health expenditure is spread over many interventions, and the current per capita expenditures remain far below the national targets required to provide adequate healthcare services. More nurses are also required to beef up the health workforce, which is associated with a reduction in maternal mortality in Uganda. This is in line with the current government strategy to increase the number of health-workers and functional health facilities at the Health Centre III sub-county level to make maternal health services, and in particular facility-assisted births, more accessible.

Acknowledgements

We thank the participants in the school of economics seminar series and the anonymous reviewers who provided valuable comments to drafts of this manuscript.

Competing interest

There is no competing interest declared.

References

Al-Azri, M., Al-Mamari, F. & Mondal, S. (2020). Healthcare Expenditure and Health Outcome Nexus: Exploring the Evidences from Oman. *Journal of Public Affairs*, 20(4): https://doi.org/10.1002/pa.2329

Aziz, N., He, J., Sarker, T. & Sui, H. (2021). Exploring the Role of Health Expenditure and Maternal Mortality in South Asian Countries: An Approach towards Shaping Better Health Policy. *Int. J. Environ. Res*, 18*:* 11514. https://doi.org/10.3390/

Berger, M. C. & Messer, J. (2002). Public Financing of Health Expenditures, Insurance, and Health Outcomes. *Applied Economics*, 34(17): 2105–2113. Https://doi.org/10.1080/ 00036840 210135665

Berger Mark, C. & Messer, J. (2002). Public Financing of Health Expenditures, Insurance, and Health Outcomes. *Applied Economics*, 34(17): 2105–2113. Https://doi.org/10.1080/ 00036840210135665

Chesson, H. W., Harrison, P., Scotton, C. R. & Varghese, B. (2005). Does Funding for HIV and Sexually Transmitted Disease Prevention Matter? *Evaluation Review*, 29(1): 3–23.

Costa-Font, J., Gemmill, M. & Rubert, G. (2011). Biases in the Healthcare Luxury Good Hypothesis? A Meta-regression Analysis. *Journal of the Royal Statistical Society Series A: Statistics in Society*, 174(1): 95–107.

Doucouliagos, C., Stanley, T. D. & Giles, M. (2012). Are Estimates of the Value of a Statistical Life Exaggerated? *Journal of Health Economics*, 31(1): 197–206.

Fox, H., Topp, S. M., Callander, E. & Lindsay, D. (2019). A Review of the Impact of Financing Mechanisms on Maternal Healthcare in Australia. *BMC Public Health*, 19(1): 1540. Https://doi.org/10.1186/s12889-019-7850-6

Gallet, C. A. & Doucouliagos, H. (2017). The Impact of Healthcare Spending on Health Outcomes: A Meta-regression Analysis. *Social Science & Medicine*, 179*:* 9–17.

Gerdtham, U. G., Søgaard, J., Andersson, F. & J"onsson, B. (1992). An Econometric Analysis of Healthcare Expenditure: A Cross-section Study of the OECD Countries. *Journal of Health Economics*, 11(1): 63–84.

Ghatak, S. & Siddiki, J. U. (2001). The Use of the ARDL Approach in Estimating Virtual Exchange Rates in India. *Journal of Applied Statistics*, 28(5): 573–583. Https://doi.org/ 10.1080/02664760120047906

Grossman, M. (1972). On the Concept of Health Capital and the Demand for Health. *Journal of Political Economy*, 80(2): 223–255.

Judge, K., Mulligan, J. A. & Benzeval, M. (1998). Income Inequality and Population Health. *Social Science & Medicine*, 46(4–5): 567–579.

Kabajulizi, J., Lin, Q. & Matovu, F. (2019). *To What Extent do Public and Private Financing Sources Affect Access and Quality of Healthcare?* Experiences from Uganda's Healthcare System. Https://publication.aercafricalibrary.org/server/api/core/bitstreams/800939a7-f879-4162-854d-9710a1c505d9/content

Manyika, W., Gonah, L., Hanvongse, A., Shamu, S. & January, J. (2019). Health Financing: Relationship between Public Health Expenditure and Maternal Mortality in Zimbabwe Between the Years 1980 to 2010. *Medical Journal of Zambia*, 46(1): 61–70.

MOH. (2020). Annual Health Sector Performance Report Performance Report. *Annual Health Sector Performance Report*, 4(8): 6–7. Https://www.health.go.ug/cause/annual-health-sector-performance-report-financial-year-2019-20/

Organization, W. H. (2021). Global Expenditure on Health: Public Spending on the Rise? *Geneva: World Health Organization;*, 2021. http://apps.who.int/iris.)

Orobaton, N., Austin, A., Fapohunda, B., Abegunde, D. & Omo, K. (2016). Mapping the Prevalence and Sociodemographic Characteristics of Women who Deliver Alone: Evidence from Demographic and Health Surveys from 80 Countries. *Global Health Science and Practice*, 4(1): 99–113. Https://doi.org/10.9745/GHSP-D-15-00261

Owusu, P. A., Sarkodie, S. A. & Pedersen, P. A. (2021). Relationship Between Mortality and Healthcare Expenditure: Sustainable Assessment of Healthcare System. *PLoS ONE*, 16*:* 2. Https://

Pahlavani, M., Wilson, E. & Worthington, A. C. (2005). No Title. *Trade-GDP Nexus in Iran: An Application of the Autoregressive Distributed Lag (ARDL) Model*, 2005. Https:// ro.uow.edu.au/commpapers/144

Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16*:* 289–326.

Rahman, M. M., Khanam, R. & Rahman, M. (2018). Healthcare Expenditure and Health Outcome Nexus: New Evidence from the SAARC-ASEAN Region. *Globalization and Health*, 14(1): 1–11.

Rana Rezwanul Hasan, Alam, K. & Gow., J. (2018). Health Expenditure. *Child and Maternal Mortality Nexus: A Comparative Global Analysis, BMC International Health and Human Rights*, 18*:* 29. Https://doi.org/10.1186/s12914-018-0167-1

Tauras, J. A., Chaloupka, F. J., Farrelly, M. C., Giovino, G. A., Wakefield, M., Johnston, L. D., O'Malley, P. M., Kloska, D. D. & Pechacek, T. F. (2005). State Tobacco Control Spending and Youth Smoking. *American Journal of Public Health*, 95(2): 338–344.

Ullah, I., Ullah, A., Ali, S., Poulova, P., Akbar, A., Shah, H., M., R. & A., Z. (2021). M. and Afridi, F. *E.A Public Health Expenditures and Health Outcomes in Pakistan: Evidence from Quantile Autoregressive Distributed Lag Model*, 3893–3909.

World Health Organization. (2018). Public Spending on Health: A Closer Look at Global Trends:Geneva: World Health Organization. In *Reporte Global OMS*. Http:// apps. who. int/bookorders.

Yip, W., Hafez, R. & Organization, W. H. (2015). Improving Health System Efficiency: Reforms for Improving the Efficiency of Health Systems: Lessons from 10 Country Cases (No. *WHO/HIS/HGF/SR/*, 15*:* 1.

Appendices

Table A1: Correlation Coefficients for the Variables, Level 1 All Variables

Variable	MMR1	prenatal1	birthattended1	maternaldeathno1	anc1_1	anc4_1	sba1	LogMH_ Cond_Exp	donorhe_ pTHE1	oop_p THE1	HE_per_ capita1
MMR1	1										
prenatal1	-0.942***	1									
birthattended1	-0.679***	0.751***	1								
maternaldeathno1	0.991***	-0.931***	-0.590***	1							
anc1_1	0.446**	-0.623***	-0.891***	0.374*	1						
anc4_1	0.687***	-0.506**	-0.32	0.694***	0.0963	1					
sba1	-0.692***	0.772***	0.923***	-0.626***	-0.861***	-0.251	1				
LogMH_Cond_Exp	-0.982***	0.934***	0.792***	-0.951***	-0.560***	-0.669***	0.779***	1			
donorhe_pTHE1	-0.952***	0.915***	0.711***	-0.935***	-0.471**	-0.664***	0.716***	0.949***	1		
oop_pTHE1	0.430**	-0.21	0.0947	0.478**	-0.316	0.469**	0.0198	-0.341*	-0.348*	1	
HE_per_capita1	-0.879***	0.805***	0.813***	-0.814***	-0.506**	-0.612***	0.741***	0.930***	0.891***	-0.247	1
pub_he_THE1	0.279	-0.528***	-0.696***	0.216	0.836***	-0.207	-0.669***	-0.363*	-0.28	-0.457**	-0.339*
pubhe_tbudget1	-0.0981	-0.19	-0.389*	-0.122	0.717***	-0.425**	-0.423**	0.0301	0.0919	-0.544***	0.162
Female_LFP1	-0.952***	0.914***	0.842***	-0.909***	-0.619***	-0.608***	0.816***	0.984***	0.931***	-0.313	0.933***
Doctors_1000_1	-0.717***	0.802***	0.858***	-0.644***	-0.716***	-0.189	0.811***	0.781***	0.712***	0.0372	0.825***
Nurse_1000_1	-0.992***	0.911***	0.591***	-0.993***	-0.348*	-0.701***	0.616***	0.957***	0.926***	-0.493**	0.848***
pov1_1	0.329*	-0.248	-0.740***	0.207	0.503**	0.255	-0.578***	-0.476**	-0.373*	-0.0876	-0.690***
femllfpILO1	-0.933***	0.877***	0.849***	-0.881***	-0.605***	-0.607***	0.809***	0.974***	0.908***	-0.313	0.949***
teenagemoth1	0.678***	-0.523***	-0.644***	0.606***	0.345*	0.480**	-0.556***	-0.735***	-0.625***	0.407*	-0.827***
bankaccown1	-0.981***	0.944***	0.805***	-0.948***	-0.579***	-0.646***	0.791***	0.998***	0.950***	-0.324*	0.930***
gdpcapita2005_1	-0.921***	0.877***	0.874***	-0.864***	-0.630***	-0.596***	0.829***	0.970***	0.911***	-0.254	0.960***
educfem15above1	-0.993***	0.966***	0.723***	-0.978***	-0.515***	-0.628***	0.736***	0.983***	0.950***	-0.380*	0.883***
hospbeds1000_1	0.662***	-0.543***	-0.0331	0.722***	-0.209	0.698***	-0.0713	-0.556***	-0.644***	0.545***	-0.434**
acoholconsfem1	0.817***	-0.697***	-0.148	0.869***	-0.088	0.611***	-0.221	-0.706***	-0.716***	0.650***	-0.566***
indexprodbevtobac1	-0.709***	0.794***	0.709***	-0.678***	-0.594***	-0.409*	0.696***	0.740***	0.715***	0.0765	0.686***
tobaccoconsfem1	0.984***	-0.943***	-0.794***	0.953***	0.562***	0.652***	-0.781***	-0.998***	-0.952***	0.337*	-0.930***

Table A2: Correlation Coefficients for the Variables, Level 2

Variable	pub_he_THE1	pubhe_tbudget1	Female_LFP1	Doctors_1000_1	Nurse_1000_1	pov1_1	femllfpILO1	teenagemoth1
MMR1								
prenatal1								
birthattended1								
maternaldeathno1								
anc1_1								
anc4_1								
sba1								
LogMH_Cond_Exp								
donorhe_pTHE1								
oop_pTHE1								
HE_per_capita1								
pub_he_THE1	1							
pubhe_tbudget1	0.791***	1						
Female_LFP1	-0.421**	-0.0276	1					
Doctors_1000_1	-0.736***	-0.264	0.829***	1				
Nurse_1000_1	-0.204	0.182	0.917***	0.669***	1			
pov1_1	0.304	-0.0289	-0.559***	-0.593***	-0.264	1		
femllfpILO1	-0.402*	0.00935	0.996***	0.833***	0.898***	-0.624***	1	
teenagemoth1	0.213	-0.25	-0.789***	-0.708***	-0.672***	0.751***	-0.834***	1
bankaccown1	-0.391*	0.00319	0.987***	0.801***	0.953***	-0.478**	0.976***	-0.732***
gdpcapita2005_1	-0.429**	-0.0117	0.990***	0.844***	0.880***	-0.649***	0.995***	-0.815***
educfem15above1	-0.379*	0.0153	0.962***	0.779***	0.979***	-0.340*	0.941***	-0.682***
hospbeds1000_1	-0.278	-0.465**	-0.435**	-0.0778	-0.706***	-0.216	-0.399*	0.159
acoholconsfem1	-0.102	-0.421**	-0.634***	-0.373*	-0.879***	-0.118	-0.606***	0.454**
indexprodbevtobac1	-0.496**	-0.235	0.700***	0.624***	0.657***	-0.319	0.674***	-0.261
tobaccoconsfem1	0.378*	-0.0201	-0.986***	-0.796***	-0.959***	0.470**	-0.975***	0.733***

Table A3: Correlation Coefficients for the Variables, Level 3

Variable	bankaccown1	gdpcapita2005_1	educfem15above1	hospbeds1000_1	acoholconsfem1	indexprodbevtobac1	tobaccoconsfem1
MMR1							
prenatal1							
birthattended1							
maternaldeathno1							
anc1_1							
anc4_1							
sba1							
LogMH_Cond_Exp							
donorhe_pTHE1							
oop_pTHE1							
HE_per_capita1							
pub_he_THE1							
pubhe_tbudget1							
Female_LFP1							
Doctors_1000_1							
Nurse_1000_1							
pov1_1							
femllfpILO1							
teenagemoth1							
bankaccown1	1						
gdpcapita2005_1	0.974***	1					
educfem15above1	0.985***	0.931***	1				
hospbeds1000_1	-0.541***	-0.391*	-0.604***	1			
acoholconsfem1	-0.697***	-0.568***	-0.784***	0.825***	1		
indexprodbevtobac1	0.748***	0.708***	0.722***	-0.442**	-0.392*	1	
tobaccoconsfem1	-1.000***	-0.971***	-0.987***	0.554***	0.711***	-0.744***	1