Health expenditure in Africa and its determinants, 2005 - 2014

Mini-dissertation: Master of Science in Public Health

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Co-supervisor: Prof. Brendan Girdler-Brown

The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.
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Title: Health expenditure in Africa and its determinants, 2005 - 2014

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Yours sincerely

Dr R Sommers; MBChB; MMed (Int); MPharMed,PhD
Deputy Chairperson of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria

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DECLARATION OF ORGINALITY

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Date: 15 February 2018

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Part A

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Mini-dissertation Part A: Health expenditure in Africa and its determinants, 2005 - 2014

LIST OF ACRONYMS (FOR PARTS A-C)

AIDS	Acquired immune deficiency syndrome
CRS	Creditor Reporting System
ExtHE	External funding of health care
FE	Fixed effects
GDP	Gross domestic product
GGE	General government expenditure
GGHE	General government health expenditure
GHED	Global Health Expenditure Database
GHO	Global Health Observatory
GNP	Gross national product
HIV	Human immunodeficiency virus
HLTF	High-Level Taskforce on Innovative International Financing for Health Systems
HTA	Health technology assessment
IMF	International Monetary Fund
IMR	Infant mortality rate
LIC	Low-income country
LMIC	Lower middle-income country
MDGs	Millennium Development Goals
MIC	Middle-income country
MMR	Maternal mortality rate
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary least square
PPP	Purchasing power parity
PvtHE	Private health expenditure
RE	Random effects
SDGs	Sustainable Development Goals
SSA	Sub-Saharan Africa
TB	Tuberculosis
THE	Total health expenditure
UHC	Universal health coverage
UIC	Upper-income country
UMIC	Upper middle-income country
UN	United Nations
USD	United States Dollar
WHO	World Health Organization

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INTRODUCTION

In 2005, the members of the World Health Organization adopted a resolution committing them to ensure that all people can access health services and should not suffer from financial hardship in doing so.[1] This goal is generally referred to as universal health coverage (UHC), and has become one of the most widely used terms for countries' ambitions to expand the scope and improve the performance of their health systems. Arguably one of the most important document with regards to UHC is the 2010 World Health Report called *Health systems financing – the path to universal coverage.* This landmark report recognises that while financing is not the only critical aspect of UHC, it is nevertheless impossible to achieve UHC without sufficient funding. It therefore called for increased efficiency of revenue collection, reprioritisation of government budgets towards healthcare, innovative financing mechanisms and increased development assistance focusing on low income countries (LIC).[2]

A further indication of the emergence of UHC as a global priority, is its inclusion in the recently adopted Sustainable Development Goals (SDGs). While the millennium development goals (MDGs) for health focused mainly on improving basic health indicators, such as maternal and child mortality rates,[3] the SDGs have brought about a stronger emphasis on health systems strengthening and UHC. SDG 3 is to "ensure healthy lives and promote well-being for all at all ages" and includes targets to achieve UHC through financial risk protection and access to quality essential health-care services as well as to substantially increase funding for health in developing countries.[4] There is overwhelming evidence that increased health expenditure is associated with better health outcomes, particularly in LICs.[5,6,7,8,9,10] There are significant disparities across countries in terms of how much is spent on health,[5] and many appeals have been made to mobilise more funding for healthcare in low- and middle-income countries[11], and in Africa in particular.[12,13,14,15]

There are many factors that influence how much countries spend on health services. Such factors include the size of the economy measured by gross domestic product (GDP), fiscal effort/capacity measured by the percentage of GDP which is spent by government, government prioritisation of health in comparison to other areas, the level of funding available from development partners, and the healthcare needs of the population. While much research has gone into determinants of health expenditure in Organisation for Economic Co-operation and Development (OECD) countries, evidence from developing countries is relatively scarce.[16] Most publications on health expenditure in the developing world in general and Africa in particular are limited to describing expenditure trends, often broken down by financing and implementing agents, such as government, development partners, private insurance and out-of-pocket payments by individuals.[5,17,18]

The primary aim of this research project was to add to the emerging pool of analysis of African health financing by (1) reviewing government health expenditure trends in Africa between 2005 and 2014, (2) comparing government health expenditure in 2014 to various international norms and benchmarks and (3) to investigate which are the key determinants of general government health expenditure (GGHE) on the continent. In order to achieve these aims, the following primary objectives were identified:

1. To describe trends in key health expenditure indicators in the region for 52 countries in the region, by income group and for the region as a whole, such as:
    a. GGHE per capita in real purchasing power parity (PPP) adjusted international dollars (Int$)
    b. GGHE as a percentage of total health expenditure (THE)
    c. GGHE as a percentage of GDP
    d. GGHE as a percentage of general government expenditure (GGE)
2. To present the latest available (2014) estimates of GGHE in relatiion to various health financing norms and targets agreed to by the international community, relating to per capita expenditure on health in US dollars (US$), the percentage of government budgets that is allocated to health and the percentage of GDP that governments spend on health.
3. To identify the most important determinants of government health expenditure in Africa.

The above objectives and aims are presented in a draft journal article, which constitutes Part B of this dissertation. A set of secondary objectives were also identified and are addressed in Part C. These objectives are:

1. To describe trends in other key health expenditure indicators in the region by income group and for the region as a whole, such as:
    a. THE per capita
    b. Out-of-pocket payments (OOP) per capita and as a percentage of THE
    c. External funding for health (EXT) per capita and as a percentage of THE
2. To assess the impact of government health expenditure per capita on three key health outcome indicators, namely: life expectancy at birth (LE); infant mortality rate (IMR); and under 5 mortality rate (U5MR).

LITERATURE REVIEW

HEALTH FINANCING NORMS AND TARGETS

While the health needs and availability of funds for health care differs significantly across countries, various attempts have been made to develop international benchmarks and targets for government health expenditure. The most widely cited benchmark is that of the High Level Task Force on Innovative International Financing for Health Systems (HLTF)[19], which is also the one used in the 2010 World Health Report.[2] It surveyed 49 low-income countries and assumed a relatively comprehensive range of health services, including costs of certain health systems strengthening activities. The HLTF estimated that low-income countries, on average (unweighted), need to spend at least US$44 per capita, expressed in 2005 prices, and argued that such funding level could by 2015 achieve 21 hospital beds per 10 000 population and 1.9 nurses/midwives per 1 000 population.[2,19] The estimates differed between the 49 countries and a caveat was given that for individual countries this figure could differ significantly.[2] The weighted average presented in the HTLF report was US$54,[19] which was later independently updated by McInctyre and Meheus to US$86 per capita in 2012 prices using a rather complex methodology based on local inflation and exchange rates for each of the 49 countries.[20] It is not explicitly stated in the HTLF or the 2010 World Health

Report whether these targets should relate to public or total health expenditure. However, there is a growing consensus that the public expenditure should be the main unit of analysis in terms of financing UHC.[8,20,21,22,23]

In addition to these per capita benchmarks, some relative targets have developed, such as the 2006 commitment by African Union members states to allocate at least 15% of government budgets to health, commonly referred to as the Abuja target.[24] Some have argued that targets measuring expenditure as a percentage of gross domestic product (GDP) are more useful because, unlike absolute targets, they can be more easily applied across different income levels and, unlike the Abuja target, they do not compromise finance ministries' integrity to make allocative decisions.[8] The 2010 World Health Report found that achieving UHC will require at least 4-5% of GDP[2] and more recently, McIntyre, Meheus and Røttingen argued that domestic public funding of 5% of GDP is an appropriate target to make progress towards both financial risk protection and health service coverage.[8] A Lancet commission in 2013 found that as little as 3% of GDP could significantly improve health outcomes in LICs by 2035, based on projected GDP growth.[25] Finally, the 2010 World Health Report provided a benchmark for OOPs by stating that "it is only when direct payments fall to 15–20% of total health expenditures that the incidence of financial catastrophe and impoverishment falls to negligible levels".[2]

Although levels of public spending are central to improving healthcare coverage and financial protection, it is also important not to have a too simplistic view on spending targets. In a 2016 WHO publication, Jowett et al. showed how UHC performance, measured by (1) immunization coverage, (2) family planning coverage, (3) tuberculosis treatment coverage, (4) antiretroviral treatment coverage, (5) live births attended by a health professional and (6) general government health expenditure as a percentage of total health expenditure, can vary greatly across of countries with similar spending levels. They argued that all countries, even those at very low spending levels (<40$)/capita) can make progress towards better coverage and health outcomes.[9] Nevertheless, while the various international targets and benchmark are crude and should not be seen as universal,[9,26] they do serve an important purpose in highlighting resource gaps and in advocating for additional investments in health.

DESCRIPTIVE STUDIES OF HEALTH EXPENDITURE IN AFRICA

The 2013 WHO Africa publication "The State of Health Financing in the African Region" notes that, although government health expenditure has increased, African countries on average are still very far from the Abuja target of spending 15% of government budgets on health. Out-of-pocket payments are still extremely high in many LICs and 22 African states had *total* health expenditure of less than the 44US$ per capita set by the HLTF. It also notes that many countries struggle to raise domestic public revenue due to the informal nature of their economies. Therefore, external funds are still likely to be required in many countries in the foreseeable future to enable them to provide basic health services.[17]

More recently, in a 2016 publication, Barroy et al. found that most countries in WHO's African region have made progress towards the Abuja target by increasing the proportion of public budgets allocated to health and that they, on average, have more than doubled per capita public spending from Int$70 in the early 2000s to over Int$160 in 2014 (PPP-adjusted). However, they noted that distribution of health expenditure is extremely unequal and the median for this indicator was only Int$55. Although health is still predominantly funded by domestic resources (76% of total health expenditure), the development assistance has also increased substantially and increased its proportion of THE from 13% to 24% since the early 2000s. They further highlighted 3 key areas where improvement is required in order to improve health outcomes and make progress towards UHC. Firstly, the public allocations towards health need to increase, primarily by strengthening revenue collection efforts and by prioritising healthcare budgets within available public resources. Secondly, budget execution must improve, i.e. reducing underspending of health budgets. This can be done by increased predictability, e.g. through multi-year budgeting and planning, improved financial management in the public health sector and addressing bottlenecks within the health system. The third area is to support and evaluate the effective utilisation of public funds to ensure that expenditure results in actual progress, by monitoring and evaluating the effects of public expenditure with particular attention to catastrophic expenditure at the household level.[27]

DETERMINANTS OF HEALTH EXPENDITURE

The study of determinants of health expenditure dates back at least as far as 1974,[28] but most of this research has focused only on developed countries, particularly members of the OECD. Although the body of literature focusing on developing countries has grown somewhat over the past decade, it is still far behind that of developed countries, both in volume and detail. In this section, some of the most important studies in this field are briefly presented.

GLOBALLY

Musgrove et al. analysed national health accounts estimates for 191 WHO member states for 1997 by source, covering out-of-pocket spending, social health insurance contributions, general government revenues and private health insurance and found that high income countries spend a significantly higher proportion of their GDP on health than low income countries. However, within the income groups, there is considerable variation. They found a negative correlation between GDP per capita and out-of-pocket expenditure as proportion of total health expenditure, but a positive correlation between GDP per capita an OOP in absolute terms. Public health financing increases as a share of GDP with higher income.[29] This increasing GGHE and decreasing OOPs as a percentage of THE as countries income increase is sometimes referred to as the health financing transition. [30]

Ke et al, in a working paper for WHO, note that fairly extensive research exists on the determinants of health expenditure in OECD countries, and attempts to fill the gap that exists for developing countries by exploring data for 143 countries, both developed and developing, over the period 1995 - 2008. As would be expected, they found that increasing GDP led to increased government health spending, and there was also a positive relationship between general government expenditure as share of GDP and total health expenditure. No statistically significant association was found between disease burden, measured by TB incidence, and domestic GGHE although a marginally significant association was found between TB incidence and THE, potentially indicating that development partners focus their resources on countries with high disease burdens.[16]

DEVELOPED COUNTRIES

A substantial body of literature exists on determinants of health expenditure in developed countries. The ground-breaking paper by Newhouse in 1977 found that 90% of cross-country variations in per capita health expenditure could be explained by variations in per capita GDP.[31] While there is wide agreement that income is the most important factor, evidence of the exact income elasticity is not conclusive. Some studies have found income elasticity to be above unity,[32,33] others have found it to be below unity,[34,35] and yet others have found it to be very close to unity.[36,37,38]

Research in this area is particularly common amongst OECD countries, given the extensive financial data collected from member states by the organisation. The most recent and perhaps most comprehensive study of determinants of health expenditure in OECD countries was done in 2016 by de la Maisonneuve et al..[19] Besides looking at the most commonly used determinants, such as income levels, prices, and age structure of the population, the authors conducted a cross-sectional analysis of how 20 different institutional variables influenced public health expenditure between 2000 and 2010. Their main findings were that GDP per capita was the most important determinant of public health expenditure but that income elasticity was slightly below unity. Furthermore, a higher age dependency ratio was positively associated with public health expenditure and the correlation was significant. The analysis of institutional variables revealed that stronger regulation of capital investment and prices for hospital services, as well as having a defined health benefits package, were negatively associated with public health expenditure, while control of volumes, gatekeeping and health technology assessment (HTA) were (surprisingly) positively associated.

While health expenditure in developing countries is often too low and in need of additional resources, studies focusing on developed countries have largely a different perspective. Given the aging population and constrained fiscal climate following the global economic downturn in 2008, the concern is more on the effectiveness of various mechanisms to contain health expenditure for purposes of sustainability.[39,40]

DEVELOPING COUNTRIES

In a recent (2017) WHO publication, Barroy et al. looked into the association between public health expenditure (both total public and domestically funded) and GDP per capita and general government expenditure per capita, disaggregated by income group and WHO region. They found income elasticity for government health expenditure (all sources) to be 1.35 in low- and middle-income countries and 1.47 when only including domestic sources. These elasticities were the highest in LIC at 1.61 (total public) and 2.24 (domestic public), followed by LMICs (1.35 total public and 1.69 domestic public). In the WHO African Region, the elasticities were also very high at 1.59 (total public) and 1.81 (domestic public). Interestingly, and perhaps somewhat unexpected, is that the overall elasticity against general government expenditure in low- and middle-income countries was higher for total public health expenditure (1.07) than domestically funded public health expenditure (1.01). This difference was particularly marked in LICs (1.13 and 0.93 respectively). In the WHO African Region, the elasticity against general government expenditure was found to be very close to unity, both for total and domestic public expenditure. All the elasticities presented in the publication were the medians for each subgroup.[21]

Studies focusing specifically on developing countries have often focused on the association between development assistance for health and domestic public funding. While health expenditure using public funds is scarcely populated in WHO's Global Health Expenditure Database (GHED), various attempts have been made to arrive at estimates of such spending. Lu et al. estimated donor assistance for health to government using detailed project descriptions acquired through the OECD Creditor Reporting System (CRS), development banks, and bilateral and multilateral donor organisations, and subtracted this from GGHE in order to arrive at estimates for government health spending as a source in developing countries between 1995 and 2006. They found that domestic public financing for health almost doubled over this period, largely as a result of rising GDP. In LICs in sub-Saharan Africa (SSA) the increase was 132% and for middle-income countries (MICs) it was 92%. Although the share of GDP spent by government decreased slightly, this was compensated by increased prioritisation of health within government budgets. Foreign aid for health channelled through government was found to have a negative impact on domestic public funding as a percentage of GDP as each US$1 of development assistance for health to government, resulted in reduced government domestic sources by between $0.46 and $1.14. However, $1 of foreign aid to NGOs was associated with increases in governments' own spending by $0.69. The authors found no significant correlation between domestic public funding as percentage of GDP and HIV prevalence, income level or debt relief.[41]

Dieleman and Hanlon examined the effect of development assistance for health channelled through government on domestically financed government health expenditure in 119 countries over 16 years. They separated the effects of increases and decreases in development assistance and found considerable donor substitution and that in the short run, each US$1 increase in development assistance displaces 0.62$ of domestic funding. Of great concern is that while increases in development assistance over time has similar effects, decreases do not seem to have the reverse effect. Temporary increases in development assistance for health can therefore cause donor dependency and, in the longer term, have a detrimental impact on funding for health. This highlights the fungibility of aid and the dangers of displacement and unpredictable aid flows. They also found that domestically funded general government expenditure has a one-to-one correlation with domestically funded government health expenditure. In other words, when domestic government expenditure increases by 1%, domestically funded government health expenditure also increases by 1%.[42]

While the majority of foreign assistance is programme or project-based, significant amounts are also given to developing countries as general budget support (GBS). Fernandes Antunes et al.[43] reviewed how GBS and health specific aid impact government health expenditure. They found that GBS has no significant impact on either total government health expenditure or domestically funded government health expenditure, which was interpreted as GBS being mostly utilised for other sectors than the health sector. Health specific aid, however, increases total government health expenditure but is negatively correlated with domestically funded health expenditure, which echoes the findings of Lu et al.[41] and Dieleman and Hanlon.[42]

AFRICA

While research on determinants of health expenditure in Africa is relatively scarce there are some studies worth mentioning. The earliest study of determinants of health in Africa found in this literature review was a cross-sectional study of 30 African countries done by Gbesemete & Gerdtham is 1992. They used multiple linear regression on cross-section of expenditure data from 1984 to assess the associations between total health expenditure per capita (dependent variable) and gross national product (GNP)/capita, percentage of births attended by skilled staff, percentage of population under 15 years, crude birth rate, foreign aid received per capita and urbanisation ratio (independent variables). They found that that GNP/capita was by far the most important determinant, although the elasticity was only close to unity. 78.3% of variance in health expenditure per capita could be explained by GNP/capita, foreign aid per capita and the percentage of births attended by skilled staff. No significant association was found with the other three independent variables. [44] While monumental in being the first study of its kind, the study also had several limitations, such as the relatively low number of countries included and questionable selection of independent variables (e.g. percentage of births attended by skilled staff, which is more likely to be an outcome than a predictor of the level of health expenditure).

Using cross-sectional data for 2001, Murthy and Okunade[45] investigated determinants of total health expenditure per capita in 44 African countries, which they argued was the largest data set used in an African health expenditure model at the time of their study (2008). The determinants they investigated were GDP/capita, donor funding per capita, physicians per 1,000 population, percentage of population above 65 years of age and maternal mortality rate (MMR). They found that the first two variables can explain 84% of the THE/capita and that both are statistically significantly correlated with THE/per capita. The coefficients for the remaining three independent variables were not found to be statistically significant.

The most recent study found in this literature focusing specifically on determinants of health expenditure in Africa was that of Lv and Zhu[46], who used semiparametric panel data analysis to determine to what extent GDP/capita, infant mortality rate (IMR) and ratio of population above 65 years influenced THE/capita (stated in real PPP adjusted Us$) in 42 African countries between 1995 and 2009. They found that income elasticity of THE was close to unity for MICs but below unity for LICs. No correlation between population above 65 years and THE/capita was found. The authors found IMR to be negatively correlated to THE/capita, and drew the conclusion that high IMR causes low health expenditure. However, they did not motivate the direction of the causality they assumed, and it is possible (and perhaps more likely), that it is low health expenditure that causes high IMR.[46]

The studies found in this literature review focusing on Africa are summarised in Table 1.

Table 1. Summary of studies of determinants of health expenditure in Africa

Author(s)	Year	Design	Sample	Time period	Dependent variable(s)	Independent variables	Main findings	Limitations
Gbesemete & Gerdtham[44]	1992	Cross-sectional	30	1984	• THE/ capita	• GNP/capita • % births attended by skilled staff Foreign aid received per capita • Crude birth rate • % population under 15 years of age • Urban population as % of total	• GNP/capita, birth attendance and foreign aid explain 78.3% of the variance in THE. • GNP/capita the most significant factor and income elasticity close to unity.	• Small sample size • Questionable selection of independent variables, e.g. % of births attended by skilled staff, which is more likely dependent on health expenditure • Only measuring THE – not GGHE • Only data for one year • Outdated (1984)
Murthy & Okunade[45]	2009	Cross-sectional	44	2001	• Real THE/capita	• Real per capita GDP • Real per capita donor funding • Physicians per 100,000 population • % of pop aged 65 • MMR	• Both real per capita GDP and real per capita donor funding are significantly correlated to real THE/capita • Health in Africa is a necessity, not a luxury good. • Provides GDP elasticity for each country • 84% of THE/capita can be account by GDP and foreign aid.	• Only data for one year • Relatively old data (2001) • Questionable selection of independent variables, e.g. number of physicians and MMR, which are more likely dependent on health expenditure • Only measuring THE – not GGHE
Lv & Zhu[46]	2014	Semiparametric panel data analysis	42	1995 - 2009	• Real THE per capita, PPP adjusted	• GDP per capita • IMR • Population above 65 years	• Elasticity is less than 1 in LICs but close to unity in MICs • IMR has a significant negative correlation with THE • No significant correlation between population above 65 and THE	• Found that high IMR causes low THE, while causality is most likely in opposite direction • Only measuring THE – not GGHE

SUMMARY OF LITERATURE REVIEW

Some relatively recent publications have examined health expenditure trends in Africa, but generally focus only on the countries of the WHO African Region, thus excluding the countries on the continent that form part of the Eastern Mediterranean Region.[17,27,47] General findings of these have been that government health expenditure has increased in the new millennium but that the distribution of health expenditure is extremely unequal. Health expenditure as a percentage of total government spending has also increased but countries are, on average, still very far from reaching the Abuja target of spending 15% of government budgets on health.[27]

The study of determinants of health expenditure has focused mainly on developed countries, particularly member states of the OECD. While there is wide agreement that income is the most important factor, evidence of the exact income elasticity is not conclusive. Some studies found income elasticity to be above unity,[32,33] others found it to be below unity,[34,35] and yet others found it to be very close to unity.[36,37,38]

Some studies have attempted to fill the research gap for developing countries. Ke et al. looked at data for 143 countries across all income groups between 1995 and 2008 and found that government health expenditure is driven by availability of resources, such as GDP per capita and relative fiscal capacity rather than demographic and epidemiological factors.[16] Another prominent study by Lu et al. analysed determinants of domestically financed public expenditure as a percentage of GDP and found that development assistance to government for health had a statistically significant negative impact on domestic government funding, while development assistance to NGOs and fiscal capacity measured by government expenditure as a fraction of GDP had positive impact. Debt relief, GDP per capita and HIV prevalence were all found to be statistically non-significant. A subset analysis found that these results held also for the Sub-Saharan African Region.[41] Some studies have focused specifically on the relationship between development assistance for health and government financing and echo the finding that fungibility of health-specific aid is a serious concern. [42,43]

In a more recent paper, Barroy et al. looked at elasticity of total GGHE and domestically funded GGHE against GDP per capita and GGE per capita and found these elasticities to be above or very close to unity in all income groups. Elasticity against GDP per capita was the highest in LICs, at 1.61 when including all GGHE and 2.24 when only including domestically funded GGHE. For the WHO African region the same elasticities were 1.59 and 1.81. Elasticities against general government expenditure were somewhat lower in the region, at 1.04 for total GGHE and 0.95 for domestic GGHE.[21]

The literature review only found three studies focusing exclusively on determinants of heath expenditure in African countries [44,45,46], of which one is more than 20 years old.[44] All three investigate determinants of THE, which includes significant amounts of private health expenditure that is often very inequitably distributed and is arguably less important for the achievement of UHC than GGHE. The two more recent studies found that the correlation with THE per capita was positive for GDP per capita,[45,46] and donor funding health[45] but negative for infant mortality rate[46]. The causality of the last covariate is however questionable as it is possible, if not likely, that infant mortality rate is an outcome of health expenditure rather than a determinant. No statistical significance was found for maternal mortality rate, physician to population ratio or population above 65 years.

The literature review showed that there is a clear research gap to fill. Firstly, while extensive research exists for OECD countries, and to a lesser extent for developing countries, there are reasons to believe that the determinants of health expenditure might differ in the African context because of factors such as low income, high donor dependency and high, but unevenly distributed, disease burden. Secondly, the few existing studies that focused specifically on Africa used THE as their dependent variable, while this dissertation focuses on GGHE, given its importance for public health and UHC. Thirdly, the only relatively recent study focusing exclusively on Africa was Lv & Zhu,[46] which looked at data up to 2009, but besides the fact that they looked at determinants of total health expenditure, their independent variables were limited to GDP/capita, IMR and percentage of the population that are above 65 years of age, of which the latter two may not be appropriate. This dissertation uses data up to 2014 and has a more exhaustive set of independent variables.

RELEVANCE AND MOTIVATION FOR THE STUDY

While the millennium development goals (MDGs) for health focused mainly on improving basic health indicators, such as maternal and child mortality rates,[3] the recently adopted sustainable development goals (SDGs) has brought about a stronger focus on health systems strengthening and UHC. SDG 3 is to "ensure healthy lives and promote well-being for all at all ages"[4] and two targets are of particular relevance for this study:

- "Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all."[4]
- "Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States"[4]

Addressing the low expenditure levels is an important priority and it is therefore important for countries, donors, international organisations and other stakeholders to understand the underlying reasons for the differences in levels of health expenditure. Although the literature review above showed that there is a substantial body of research into determinants of health expenditure in developed countries, Africa differs significantly from other continents in that it is the continent with the lowest income per capita (also in relation to other regions in the developing world) and that it is highly dependent on foreign aid to fund its health systems. It also has by far the poorest health outcomes. A study focusing specifically on the determinants of health expenditure in Africa is therefore highly relevant and can be important to inform policy, both for developing countries themselves and the development partners that support them financially and through technical assistance.

METHODS

SOURCES OF DATA

Health expenditure data for all African countries except Somalia were retrieved from the Global Health Expenditure Database (GHED)[48], which is seen to "contain best available estimations/data of the variables to date".[49] GHED is a database maintained by WHO and provides internationally comparable national health expenditure data for the vast majority of the world's countries. It is updated annually based on publically available reports from ministries of finance, health, statistical offices, the World Bank, International Monetary Fund (IMF) etc. The data is sent to the respective government departments for validation before publication. Further information on the methodology for gathering the data, as well as procedures for imputing missing data can be found on the GHED website.[49] All other data were downloaded from the World Bank Open Data interface.[50]

STUDY DESIGN

This research is an observational study using publically available secondary data and both descriptive and analytical methods. The health expenditure trends and the comparison of health expenditure to international targets and benchmark are descriptive in nature while the section on determinants of health expenditure is analytical, using panel data regression to determine which underlying factors have statistically significant impact on GGHE and whether this impact is positive or negative. Part C provides some additional results, both descriptive and analytical, relating to other important health expenditure indicators and the impact of government health expenditure per capita on health outcomes.

HEALTH EXPENDITURE TRENDS

Trends in GGHE per capita and as percentages of THE, GDP and GGE between 2005 and 2014 are presented as weighted averages by income group and for the continent as a whole. The per capita trends are presented in real 2010 Int$. Countries were assigned income groups based on their World Bank classifications at the time of writing (Table 2). The weighted averages were calculated for each indicator by dividing the sum of the relevant country numerators by the sum of the relevant country denominators. Besides Somalia, the trends analysis excludes South Sudan because of unavailability of data in Int$. Trends for high income countries (HIC) are not presented as there is only on country in this income group in Africa. The GGHE trends are presented in Part B of this mini-dissertation.

Table 2. Countries by income group and income group thresholds

	Low income (LIC)	Lower middle-income (LMIC)	Upper middle-income (UMIC)	High income (HIC)
Threshold in gross national income (GNI) per capita (US$)	<= 1,005	1,006-3,955	3,956-12,235	> 12,235
Number of countries	26	17	9	1
Countries	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, South Sudan, Togo, Uganda, United Republic of Tanzania, Zimbabwe	Cabo Verde, Cameroon, Congo, Côte d'Ivoire, Djibouti, Egypt, Ghana, Kenya, Lesotho, Mauritania, Morocco, Nigeria, Sao Tome and Principe, Sudan, Swaziland, Tunisia, Zambia	Algeria, Angola, Botswana, Equatorial Guinea, Gabon, Libya, Mauritius, Namibia, South Africa	Seychelles

Trends in other key health expenditure indicators were retrieved and presented according to the same methodology and presented in Part C. These include total health expenditure (THE) per capita, external resources for health per capita and as a percentage of THE and out-of-pocket-payments per capita and as a percentage of THE.

HEALTH EXPENDITURE AGAINST NORMS AND TARGETS

Health expenditure in 2014 was reviewed by individual country and compared to various international norms and targets. The HTLF target of US$44 per capita was updated to US$54 in 2014 prices using consumer price inflation (CPI) from the US Bureau of Labour Statistics,[51] and the independently updated US$86 target was updated to US$89 in 2014 prices. Government health expenditure as a percentage of general government expenditure was measured against the 15% target set by the African Union in the Abuja Declaration as well as a threshold of 7.5%, which is half of this target. Government health expenditure as a percentage of GDP was compared was compared to 2%, 3% and 5% benchmarks. Given its importance for the interpretation of government health expenditure levels, external resources for health as a percentage of total health expenditure for health is also presented by country in Part B. Part C includes an additional benchmark not covered in the journal article, which is the 2010 World Health Report recommendation to reduce OOPs to 15–20% of THE to avoid or limit catastrophic and impoverishing health expenditure.

DETERMINANTS OF GOVERNMENT HEALTH EXPENDITURE

Panel data methods were used for the analysis of the determinants of government health expenditure. Panel data are a combination of cross-sectional and time series data. Through repeated measurements of the same subjects, the data consists of a series of cross-sections (panels) surveyed over a set time period.[52] While conventional multiple linear regression (ordinary least square – OLS) is in principle possible to use on panel data (in such cases referred to as pooled OLS), it does not take advantage of the fact that the data have multiple observations of the same individuals and simply treats the entire dataset as a large pool of independent observations. Furthermore, it is more likely that the errors will be correlated, i.e. the errors for an individual in one year is likely to be correlated with the error for the same individual for other years.[53]

To address the weaknesses of pooled OLS, statistical models designed specifically for panel data analysis have been developed, which take advantage of the fact that the observations are not independent from each other. The two most commonly used are fixed effect (FE) and random effects (RE) models. The most important benefit of these models compared to the pooled OLS model is that they are able to identify dynamic relationships, i.e. what happens to the outcome variable for a specific individual when the predictor variable changes for that individual. They do this by allowing each observational unit to have its own y-intercept. FE models are sometimes also referred to as "within" models, meaning that they only measure the association between predictor variables and the outcome variable within each individual and not between them. The unique y-intercept of each observational unit represents its individual unobserved effect and it is assumed that this effect does not change over time, hence the term "fixed effect". A benefit of this is that it inherently controls for omitted variables, even if these are unknown and unmeasured.[52] It further assumes that the individual unobserved effects are correlated with the predictor variables. A RE model measures both "within" effects and "between" effects and its coefficients represent the weighted average of these effects. Contrary to a FE model, it assumes that the individual unobserved effects are uncorrelated to the predictor variables.

There are three important tests that one can use to determine which of the above methods is appropriate:

- The F-test for individual effects tests is used to choose between pooled OLS and FE models. Its null-hypothesis is that the individual fixed effects are equal to zero. A significant p-value indicates that there are fixed effects in the data and that the FE model is preferable to pooled OLS.
- The Breusch-Pagan Lagrange multiplier (LM) test for random effects is used to compare a RE model to pooled OLS. It tests whether there is a significant difference across cross-sectional units (i.e. a panel effect). If a significant p-value is returned, one can be certain that there is a panel effect and that the RE model is superior to pooled OLS.
- Finally, the Hausman test can be used to choose between a FE model and a RE model. It tests whether the individual unobserved effects are correlated to the other x-variables. The null-hypothesis is that they are uncorrelated, which is the assumption of the RE model. If the null-hypothesis is rejected (i.e. p-value less than 0.05), the individual unobserved effects are correlated with the x-variables, which is the assumption of the FE model and this model should be chosen instead of the RE model.

In addition, the choice between FE and RE models also depends on whether one wants to explore the differences over time within countries over time, in which case FE is useful, or if one wants to also explain differences between countries, in which case RE should be used. The next sections describe the variables that were considered during the research process and a brief description of the approach used to arrive at the final model.

Dependent variable

The dependent variable used in the analysis was *general government health expenditure (GGHE) per capita,* stated in nominal US$. There are various reasons for focusing on GGHE. The literature review showed that all previous studies of determinants of health in Africa used total health expenditure (THE)[44,45,46]. THE includes large amounts of private health expenditure, which is arguably less desirable from a UHC perspective as it is often inequitably distributed and can, if spent as out-of-pocket expenditure, subject households to financial hardship and catastrophic health expenditure.

Some studies of developing countries have focused on domestic public health expenditure[16,41], which is undeniably of great importance from a sustainability and government priority point of view. However, donor funding is an important revenue stream for many LIC and LMIC governments and contributes greatly to the provision of public healthcare services. Excluding donor funding from the analysis does not provide a comprehensive picture of the resources available to governments. Data availability also influenced the choice of GGHE per capita as the dependent variable. Data on domestic government financing is scarcely populated in the GHED and the research focusing on this variable have had to use intricate methods to estimate the proportion of government spending which is domestically financed. GGHE per capita in US$ was available in the GHED for 52 African countries over the entire time period under review (except South Sudan, for which data was only available from 2012).

By looking at expenditure per capita rather than total expenditure, the impact of population changes is already compensated for. Finally, in some of the previous research in this area, the authors have opted to use real and/or PPP adjusted dollars, which has merits in that it better reflects the purchasing power of the money spent. However, to avoid potential confounding from the use of PPP-adjustors and deflators, spending in nominal US$ was chosen for this model.

Because the distribution of GGHE per capita was found to be very skewed (SWILK-test p-value <0.001) it was $\log_e$ transformed to reduce the variance and generate a more normal distribution. Histograms for the data before and after $\log_e$ transformation can be found in the statistical annexure.

Independent variables

Both financial and non-financial (demographic and epidemiological) indicators were used as independent variables. The variables considered were:

- Gross domestic product (GDP) per capita in nominal US$
- General government expenditure (GGE) as a percentage of GDP
- Development assistance for health (ExtHE) per capita in nominal US$
- Birth rate, crude (per 1,000 people)
- Population under 14 years (% of total)
- Population ages 65 and above (% of total)
- Prevalence of HIV (% of total population ages 15-49)
- Incidence of tuberculosis (per 100,000 people)
- Total debt service cost as a percentage of gross national income (GNI)
- Time in years

The choice of variables to be included in the final model was based on availability of data as well as hierarchical backwards stepwise selection. If data for a variable were unavailable for a specific country for the entire time period, that country was automatically entirely excluded from the model. If data were missing for a country in certain years, the country was excluded from the model for those years. In order to have as many countries as possible included in the model, those variables where data were very scarce were therefore disregarded upfront. Hierarchical backwards stepwise selection is an approach by which one runs the model iteratively, starting with a wide set of independent variables. For each iteration, the variable with the highest p-value is removed until a final model is identified. This was done using FE and RE separately and both methods resulted in the same set of variables, with the exception that HIV prevalence was found to be significant using RE but non-significant using FE. HIV prevalence was included in the final model.

Final model

The covariates included in the final model are summarised in Table 1. Because some countries lacked data for one or more covariates for the entire time period, these countries could not be included at all in the model (and it was also not possible to impute these). The final model included 46 countries (25 LICs, 15 LMICs and 6 UMICs) and 445 observations. Where data in specific years are missing for any of the included 46 countries, this is indicated in the last column and the entire list of excluded countries is provided in the statistical annexure. In addition, no observations for South Sudan are available before 2012, as the country only became independent in 2011. GDP per capita and external resources per capita were $\log_e$ transformed to ensure linear relationships with the outcome variable.

Table 1: Covariates included in the panel

Abbreviation	Full name	Source	Missing data
ln(gghecapus)	Log_e of General government health expenditure on health in current US$ per capita	GHED[48]	
Time	Year (2005 – 2014)	N/A	
ln(gdpcapus)	Log_e of gross domestic product in current US$ per capita	GHED	
ggeofgdp	General Government Expenditure (GGE) as % of Gross Domestic Product (GDP)	GHED	
ln(extcapus)	Log_e of rest of the world funds / External resources in current US$ per capita	GHED	Cameroon (2011), Uganda (2014), Egypt (2013), Sudan (2012), Tunisia (2005)
hivprev	Prevalence of HIV (% of total population ages 15-49)	World Bank Data[50]	
pop14	Population ages 0-14 (% of total)	World Bank Data	Eritrea (2012-2014)

The Breusch-Pagan LM-test was highly significant (p-value: <0.0001), meaning that the RE model was superior to pooled OLS. Similarly, the F-test for individual effects for the covariates in Table 1 was highly significant (p-value: <0.0001), meaning that also the FE model is preferable to a pooled OLS model. Finally, a Hausman test was done on the fixed and RE models to determine which of the two is the most appropriate. The test was non-significant (p-value: 0.1885), meaning that the null-hypothesis that the individual unobserved effects are uncorrelated to the predictor variables could not be rejected. Hence the RE model was chosen as the final model, also because describing and explaining differences between countries are central to the aims of the article. While the journal article (Part B) only presents the results of the RE model, Part C also presents and discusses the results of the pooled OLS and FE models.

The final RE model is specified as:

$$ln(gghecapus)_{it} = \beta_{ln(gdpcapus)}*ln(gdpcapus)_{it} + \beta_{ggeofgdp}*ggeofgdp_{it} + \beta_{ln(extcapus)}*ln(extcapus)_{it} + \beta_{hivprev}*hivprev_{it} + \beta_{pop14}*pop14_{it} + \beta_{time*}time_{it} + \alpha_i + u_{it}$$

where i is the country, t is the year, α_i is the random effect, and u_{it} is the error term. The resultant coefficients for the two log_e transformed predictors represent the elasticity (i.e. the % increase of y associated with each % increase in x), while the semi-elasticities (i.e. the % increase of y associated with each *unit* increase in x) for the non-transformed variables were calculated using the formula suggested by Wooldridge: $\%\Delta y = 100*[exp(b-1)]$.[54] All elasticities and semi-elasticities stated are controlled for the other variables in the model.

Table 2 shows the variables excluded from the model together with their p-value in the last step of the hierarchical backwards stepwise selection before they were dropped.

Table 2. Dropped variables with p-values in last step before dropped

Variable	P-value
Total debt service cost as a percentage of gross national income (GNI)	0.769
Incidence of tuberculosis (per 100,000 people)	0.920
Birth rate, crude (per 1,000 people)	0.440
Population ages 65 and above (% of total)	0.145

GOVERNMENT HEALTH EXPENDITURE AND HEALTH OUTCOMES

Panel data regression analysis was also conducted to determine the impact of government health expenditure on health outcomes. FE and RE models were fitted to regress life expectancy, infant mortality rate and under-5 mortality rate on government health expenditure per capita, controlling for GDP per capita. The life expectancy models included 49 countries and 463 observations, while the IMR and U5MR models each included 47 countries and 483 observations. The results of these models are presented in Part C of this dissertation.

ETHICAL CONSIDERATIONS

The World Medical Association's Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects,[55] adopted in 1964 and most recently amended in 2013, is the most well-known policy document on health research ethics. As the title reveals, its main focus is on research involving human subjects, but a few of its principles is applicable to other types of health research. Below are the principles that were found to be relevant for this dissertation and how they were considered:

- *The privacy and consent of the individuals providing information to be used in the research project:* All data that was used in the research are in the public sphere and published by two reputable international organisations, WHO and the World Bank. This data are widely used in research, and approval to use these data was not required as long as they are referenced.
- *The need for a scientifically sound research protocol:* All necessary efforts to ensure that the research protocol was scientifically sound. It was reviewed and approved by the Academic Advisory Committee the Health Sciences Research Ethics Committee of the University of Pretoria.
- *Conflict of interest:* The author does not have any conflict of interest in relation to this research project.

In summary, the research project was not found to be problematic from an ethical point of view. It relied solely on secondary publically available data and the research protocol was approved by the University of Pretoria's Academic Advisory Committee and Ethics Committee. The approval letter from the Ethics Committee is provided as an annexure.

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Health expenditure in Africa and its determinants, 2005 - 2014

Mini-dissertation: Master of Science in Public Health

Part B (draft journal article)[1]

[1] Prepared for submission to Lancet Global. Authors' guidelines are annexed

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Abstract

Background

There is limited research focusing on determinants of health expenditure in African countries. The objectives of this study were to analyse the levels and determinants of government health expenditure (GGHE) for the years 2005 to 2014

Methods

Key expenditure indicators for 52 countries and 10 years from the Global Health Expenditure Database were analysed by three income groups (low-income, lower middle-income and upper middle-income). GGHE for 2014 was analysed by country and compared to three international benchmarks. Determinants of GGHE per capita were analysed using a random effects model with 46 countries and 445 observations.

Findings

Real 2010 Int$ GGHE per capita increased by 3.7% on average per annum between 2005 and 2014. The highest growth of 5.7% was found in upper middle-income countries and the lowest (1.9%) in low-income countries. In 2014, 34 (65%) out of 52 countries did not reach the level of expenditure that has been estimated as a minimum to provide a set package of health services. The random effects model showed that GDP/capita, fiscal effort, external resources for health and adult HIV prevalence had statistically significant positive impact on GGHE per capita. The percentage of population under 14 had a significant negative impact, while time was not statistically significant.

Interpretation

Despite growth in real terms, government health expenditure in most African countries is arguably insufficient to provide a basic service package. Greater mobilisation of resources is needed. The study confirmed earlier findings on the role of macroeconomic factors in determining health expenditure and generated novel evidence on the impact of age structure and HIV prevalence.

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Introduction

In 2005, the members of the World Health Organization adopted a resolution that committed them to ensure that all people can access health services and should not suffer from financial hardship in doing so.[1] This goal is generally referred to as universal health coverage (UHC). The 2010 World Health Report recognises that UHC cannot be achieved without raising sufficient funding for health, and therefore called for increased efficiency of revenue collection, reprioritisation of government budgets, innovative financing and increased development assistance focusing on low income countries (LIC).[2] While the millennium development goals (MDGs) for health focused mainly on improving basic health indicators, such as maternal and child mortality rates,[3] the recently adopted sustainable development goals (SDGs) has brought about a stronger focus on health systems strengthening and UHC. SDG 3 is to "ensure healthy lives and promote well-being for all at all ages" and includes targets to achieve UHC, including financial risk protection and access to quality essential health-care services as well as to substantially increase funding for health in developing countries.[4] There is overwhelming evidence that increased health expenditure is associated with better health outcomes, particularly in LICs,[5,6,7,8,9,10] but there are significant disparities across countries in terms health expenditure per capita,[4,5] and many appeals have been made to mobilise more funding for healthcare in low- and middle-income countries[11], and in Africa in particular.[12,13,14,15]

Various attempts have been made to develop international norms and targets for government health expenditure. The most widely cited is that of the High Level Task Force on Innovative International Financing for Health Systems (HLTF), which is also the target referred to in the 2010 World Health Report.[2] It surveyed 49 low-income countries and assumed a relatively comprehensive range of health services and includes costs of health systems strengthening activities. The HLTF estimated that low-income countries, on average (unweighted), need to spend at least US$44 per capita, expressed in 2005 terms, and argued that such funding level could by 2015 achieve 21 hospital bed per 10 000 population and 1.9 nurses/midwives per 1 000 population.[2,16] The target was later independently updated to US$86 per capita in 2012 terms using a rather complex methodology based on local inflation rates and exchange rates for each of the 49 countries.[17] While it is not explicitly stated in the HTLF or the 2010 World Health Report whether these targets should relate to public or total health expenditure, there is a growing consensus that the public expenditure should be the main unit of analysis in terms of financing UHC.[8,17,18,19,20] In addition to these absolute per capita targets, some relative targets have developed, such as the commitment by members of the African Union in 2006 to allocate at least 15% of government budgets to health, commonly referred to as the Abuja Target.[21] Some have argued that a target measured as a percentage of gross domestic product (GDP) is a more powerful tool because, unlike absolute targets, it can be more easily applied across different income levels and, unlike the Abuja Target, it does not compromise finance ministries' integrity to make allocative decisions.[8] The 2010 World Health Report found that achieving UHC will require at least 4-5% of GDP[2] and more recently, McIntyre, Meheus and Røttingen argued that domestic public funding of 5% of GDP is an appropriate target to make progress towards both financial risk protection and health service coverage.[8] A Lancet commission in 2013 found that as little as 3% of GDP could significantly improve health outcomes in LICs by 2035, based on projected GDP growth.[22] While it is often pointed out that the various international targets and benchmark are very crude and should not be seen as universal,[9,23] they arguably do serve an important purpose in highlighting the need for additional investments in health.

Some relatively recent publications have examined health expenditure trends in Africa, but generally focus only on the countries of the WHO African Region, thus excluding the seven countries on the continent that form part of the Eastern Mediterranean Region.[24,25,26] General findings of these have been that government health expenditure has increased from $70 per capita in the early 2000s to over $160 in 2014 (in nominal PPP-adjusted international dollars). However, the distribution of health expenditure is extremely unequal and the median for this indicator is only $55. Health expenditure as a percentage of total government spending has also increased but countries are, on average, still very far from the Abuja target of spending 15% of government budgets on health.[26]

The study of determinants of health expenditure dates back at least as far as 1974,[27] but most of this research has focused only on developed countries, particularly members of the OECD. The ground-breaking paper by Newhouse in 1977 found that 90% of cross-country variations in per capita health expenditure could be explained by variations in per capita GDP.[28] While there is wide agreement that income is the most important factor, evidence of the exact income elasticity is not conclusive. Some studies have found income elasticity to be above unity,[29,30] others have found it to be below unity,[31,32] and yet others have found it to be very close to unity.[33,34,35]

In an attempt to fill the research gap for developing countries, Ke et al. looked at data for 143 countries across all income groups between 1995 and 2008 and found that government health expenditure is driven by availability of resources, such as GDP per capita and relative fiscal capacity, rather than demographic and epidemiological factors.[36] Another prominent study by Lu et al.. analysed determinants of domestically financed public expenditure as a percentage of GDP and found that development assistance to government for health had a statistically significant negative impact on domestic government funding, while development assistance to NGOs and fiscal capacity measured by government expenditure as a fraction of GDP had positive impact. Debt relief, GDP per capita and HIV prevalence were all found to be statistically non-significant. The subset analysis found that these results were also applicable to the Sub-Saharan African Region.[37] Some studies have focused specifically on the relationship between development assistance for health and government financing and echo the finding that fungibility of health-specific aid is a serious concern. [38,39] In a more recent paper, Barroy et al. looked at elasticity of total GGHE and domestically funded GGHE against GDP per capita and GGE per capita and found these elasticities to be above or very close to unity in all income groups. Elasticity against GDP per capita was the highest in LICs, at 1.61 when including all GGHE and 2.24 when only including domestically funded GGHE. For the WHO African Region the same elasticities were 1.59 and 1.81. Elasticities against general government expenditure were somewhat lower in the region, at 1.04 for total GGHE and 0.95 for domestic GGHE.[18]

This literature review only found three studies focusing exclusively on determinants of heath expenditure in African countries [40,41,42], of which one is more than 20 years old.[40] All three investigate determinants of *total* health expenditure (THE), which includes significant amounts of private health expenditure that is often very inequitably distributed and is arguably less important for the achievement of UHC than government expenditure. In summary, the two more recent studies found that the correlation with THE per capita was positive for GDP per capita,[41,42] and donor funding for health[41] but negative for infant mortality rate[42]. The causality of the last covariate is however questionable as it is possible, if not likely, that infant mortality rate is an outcome of health expenditure rather than a determinant. No statistical significance was found for maternal mortality rate, physician to population ratio or population above 65 years.

The literature review shows that there is still a significant research gap, particularly in terms of government health expenditure in Africa. Thus, in order to help filling this gap, and to contribute to the emerging pool of research on African health financing, this paper has three main objectives:

- Describe how levels of government health expenditure have developed in Africa during the decade between 2005 and 2014.
- Benchmark government health expenditure levels in 2014 against a set of internationally agreed norms and targets.
- Analyse determinants of government health expenditure per capita.

Methods

Health expenditure data for all African countries except Somalia were retrieved from WHO's Global Health Expenditure Database (GHED).[43] Trends in government health expenditure between 2005 and 2014 are presented as weighted averages in real 2010 international dollars (Int$) per capita by income group and for the continent as a whole. Income groups were assigned to countries based on their World Bank classifications at the time of writing (Table 1). The trend for high-income countries is not presented, as there is only one country in Africa (Seychelles) belonging to that income group. The development over time of government health expenditure as a percentage of total health expenditure (THE), gross domestic product (GDP) and general government expenditure (GGE) was also reviewed.

	Low income (LIC)	Lower middle-income (LMIC)	Upper middle-income (UMIC)	High income (HIC)
Threshold in gross national income (GNI) per capita (US$)	<= 1,005	1,006-3,955	3,956-12,235	> 12,235
Number of countries	26	17	9	1
Countries	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, South Sudan, Togo, Uganda, United Republic of Tanzania, Zimbabwe	Cabo Verde, Cameroon, Congo, Côte d'Ivoire, Djibouti, Egypt, Ghana, Kenya, Lesotho, Mauritania, Morocco, Nigeria, Sao Tome and Principe, Sudan, Swaziland, Tunisia, Zambia	Algeria, Angola, Botswana, Equatorial Guinea, Gabon, Libya, Mauritius, Namibia, South Africa	Seychelles

***Table 1.* Countries by income group and income group thresholds**

2014 expenditure for each of the countries were compared against various international norms and targets. The HTLF target of US$44 per capita was updated to US$54 in 2014 prices using consumer price inflation (CPI) from the US Bureau of Labour Statistics,[44] and similarly the independently updated US$86 target was updated to US$89 in 2014 prices. Government health expenditure as a percentage of general government expenditure was measured against the 15% target set by the African Union in the Abuja Declaration as well as a threshold of 7.5%, which is half of the Abuja target. Finally, government health expenditure as percentage of GDP was compared was compared against 2%, 3% and 5% benchmarks. Given its importance for the interpretation of government health expenditure levels, external resources for health as a percentage of total health expenditure in 2014 is also presented by country. Data in US$ were not available for Sao Tome and Principe.

To analyse the determinants of government health expenditure, data for additional indicators were retrieved from the World Bank Open Data portal[45] and a random effects model was fitted with the $\log_e$ of government health expenditure per capita in US$, ln(ghecapus), as outcome variable. None of the pre-log values was zero. A range of different variables, found in existing literature and elsewhere was identified and the final model was determined using hierarchical backwards stepwise selection. GDP per capita and external resources per capita were $\log_e$ transformed to ensure linear relationships with the outcome variable. The model was run both as a fixed effects and random effects model and using the Hausman test, the random effects model was found to be preferable (p-value = 0.1885). The covariates included in the final model are summarised in Table 2. Where data were missing for one or more covariates, that entire observation was automatically removed by Stata. Because some countries lacked data for one or more covariates for the entire time period, these countries were not included at all in the model. The final model included 46 countries (25 LICs, 15 LMICs and 6 UMICs) and 445 observations. Where data in specific years are missing for any of the included 46 countries, this is indicated in the last column of Table 1. In addition, no observations for South Sudan are available before 2012, as the country only became independent in 2011. More details on missing data and excluded countries can be found in the statistical annexure.

Abbreviation	Full name	Source	Missing data
ln(gghecapus)	Log_e of General government health expenditure on health in current US$ per capita	GHED	
Time	Year (2005 – 2014)		
ln(gdpcapus)	Log_e of gross domestic product in current US$ per capita	GHED	
ggeofgdp	General Government Expenditure (GGE) as % of Gross Domestic Product (GDP)	GHED	
ln(extcapus)	Log_e of rest of the world funds / External resources in current US$ per capita	GHED	Cameroon (2011), Uganda (2014), Egypt (2013), Sudan (2012), Tunisia (2005)
hivprev	Prevalence of HIV (% of total population ages 15-49)	World Bank Data	
pop14	Population ages 0-14 (% of total)	World Bank Data	Eritrea (2012-2014)

Table 2: **Covariates included in the panel**

The final random effects model is specified as:

$$Ln(gghecapus)_{it} = \beta_{gdpcapus}*ln(gdpcapus)_{it} + \beta_{ggeofgdp}*ggeofgdp_{it} + \beta_{extcapus}*ln(extcapus)_{it} + \beta_{hivprev}*hivprev_{it} + \beta_{pop14}*pop14_{it} + \beta_{time*}time_{it} + \alpha_i + u_{it}$$

where *i* is the country, *t* is the year, α_i is the random effect, and u_{it} is the error term. Variables that were excluded from the final model because of statistical non-significance were: Total debt service cost as a percentage of gross national income (GNI); Incidence of tuberculosis (per 100,000 people); Birth rate, crude (per 1,000 people); and population ages 65 and above (% of total). Their respective p-values in the last step of the hierarchical backwards stepwise selection before they were dropped can be found in the statistical annexure. The resultant coefficients for the two $\log_e$ transformed predictors represent the elasticity (i.e. % increase of y associated with each % increase in x), while the semi-elasticities (i.e. % increase of y associated with each unit increase in x) for the non-transformed variables were calculated using the formula given by Wooldridge: $\%\Delta y = 100*[\exp(b-1)]$. [46]

Results

Government health expenditure trends and targets

As shown in Figure 1, GGHE per capita in the 52 countries included has increased in real PPP-adjusted terms during the 10-year period, from Int$82.3 in 2005 to Int$114.5 in 2014. This is an increase of 39% in total, equivalent to an annual average of 3.7%. The increase was the strongest in UMICs at 5.7% growth per year, while LMICs and LICs had more moderate annual growth rates of 3.3% and 1.9% respectively. The differential growth rates have resulted in increasing disparities in GGHE. Whereas in 2005 UMIC governments spent 10.3 times more per capita than LIC governments after adjusting for purchasing power, by 2014, this ratio had increased to 14.2.

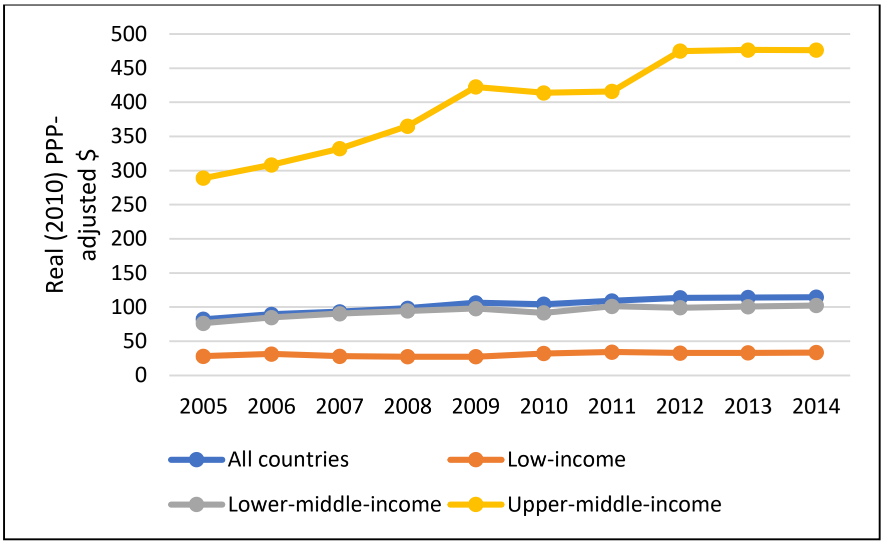

***Figure 1*: Government health expenditure per capita in 52 African countries, 2005 - 2014**

Although real GGHE per capita increased over the period it still constitutes less than half of total health expenditure (Figure 2). The percentage of health expenditure spent by governments increased slightly from 43.4% in 2005 to 45.9% overall, but this is only driven by the increase in UMICs, where this percentage increased from 50.8% to 58.4%. In LMIC it remained stable just below 37% and in LIC it decreased from 46.5% in 2005 to 44.1% in 2014. The decrease is partially explained by an increase in development assistance (much of which is channelled through NGOs) over this period, which in LICs increased its share of total health expenditure from 26.2% to 31.7% over this period.[43]

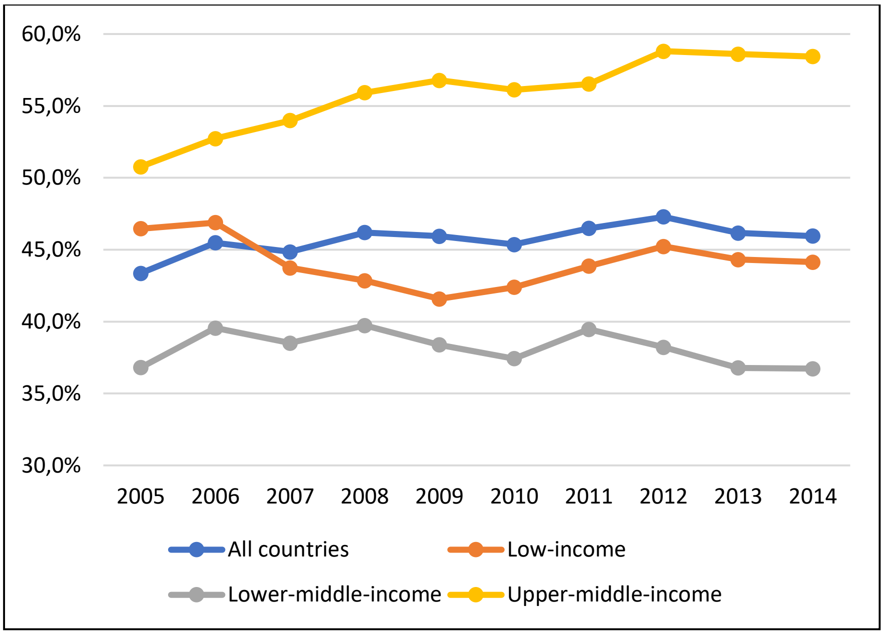

Figure 2: **Government health expenditure as percentage of total health expenditure in 52 African countries, 2005 – 2014**

In the Abuja Declaration of 2006, African governments committed to allocate at least 15% of their state budgets to health. Eight years later, one can see that on average this target has not been met overall or in any of the income groups (Figure 3). While there has been a moderate increase over the 10-year period from 8.6% to 8.9% overall, this is only the case in UMICs and LMICs, while LICs allocated 2% *less* of their budgets to health in 2014 as compared to 2005. Furthermore, there was a decrease across all income groups in the last 3-4 years leading up to 2014.

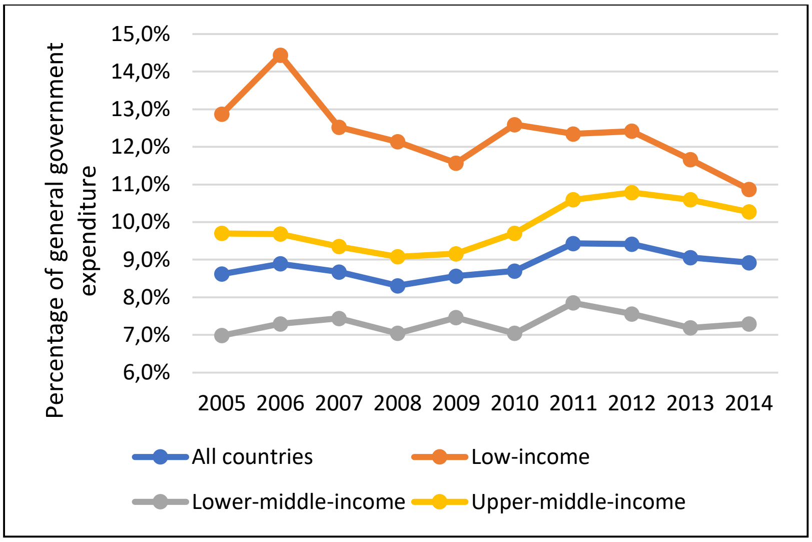

Figure 3: **Government health expenditure as percentage of general government expenditure in 52 African countries, 2005 - 2014**

Government health expenditure as a share of GDP increased from 2.1% in 2005 to 2.6% in 2014, but again largely driven by a rapid increase from 2.6% to 4.2% in UMICs, while it in LMICs only increased marginally from 1.7% to 1.8% and in LICs decreased slightly from 2.6% to 2.5%. It is worth noting that the percentage is higher in LICs that LMICs. Both LICs and LMICs, as well as Africa as a whole, are far off the 4-5% percent recommended in the 2010 World Health Report and, given that these estimates include development assistance to governments, they are even further off the 5% domestically financed public spending recommended by McIntyre et al..

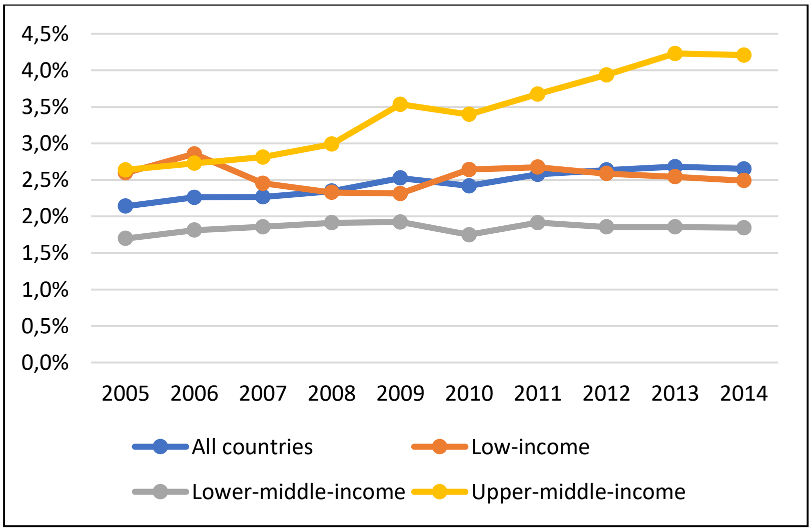

***Figure 4:* Government health expenditure as percentage of GDP for 52 African countries**

Figure 5 illustrates the continent's wide disparity of health expenditure per capita, which ranges from US$6.6 in Madagascar to US$511.2 in Equatorial Guinea. None of the LICs had reached US$54 (i.e. HLTF US$44 target in 2014 prices), the lower of the two benchmarks. In fact, not even the highest spending country in this group, Senegal at US$25.7, achieved half of this target and the median (US$14.7) is only at 27% of the target. The median for LMICs was US$56.0 but had a very wide spread, ranging from US$13.4 in Cameroon to US$187.7 in Swaziland. Eight of the LMICs spent less than the US$54 benchmark and 11 spent less than the $89 benchmark, despite the fact that these benchmarks were set for LICs. Government health expenditure in UMICs ranged from a low of US$115.2 in Angola to US$511.2 in Equatorial Guinea, with a median of US$200.5. The government of Seychelles, the only HIC in Africa, spent US$455.6 per capita.

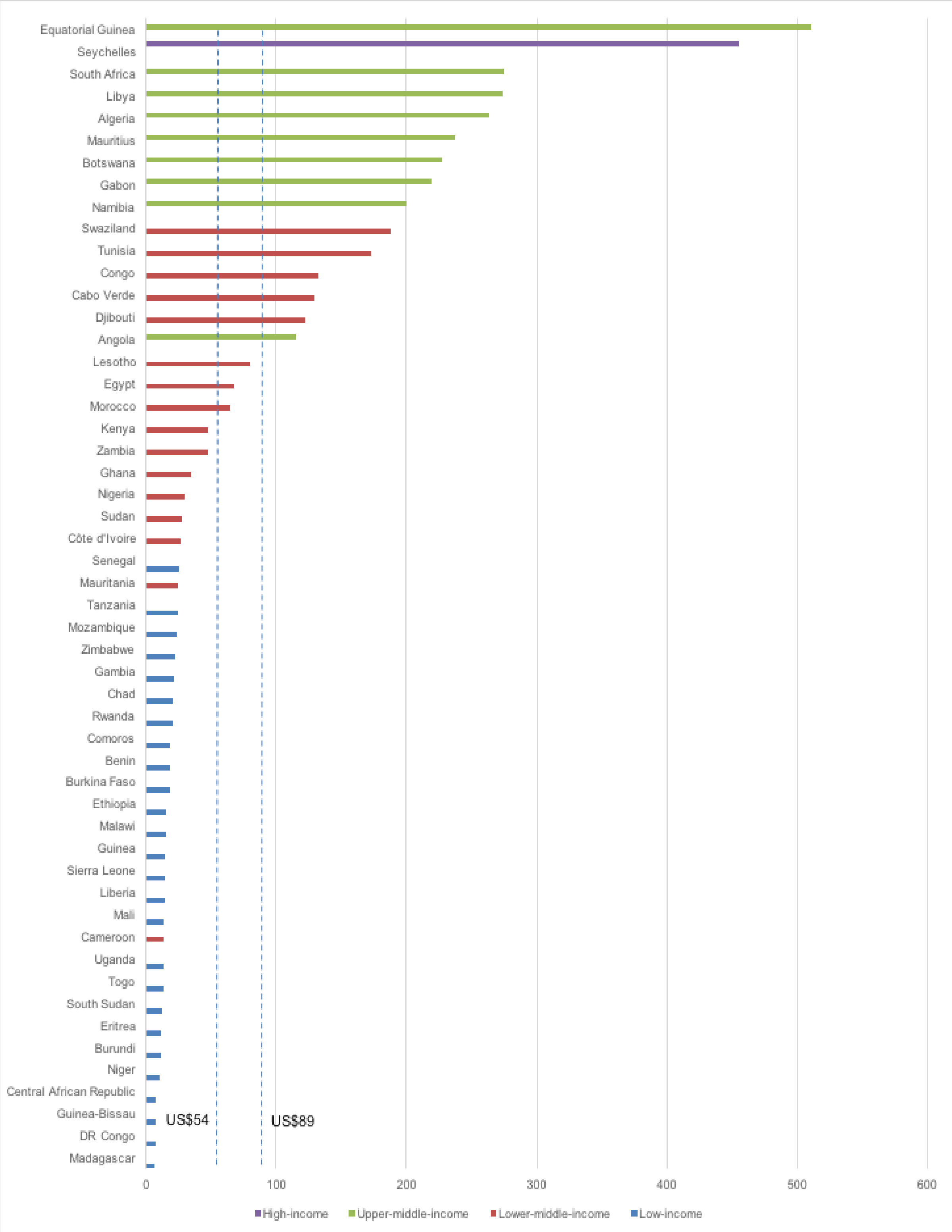

Figure 5: **Government health expenditure per capita in US$, 2014**

Only three countries (Malawi, Swaziland, Ethiopia and Gambia) achieved the Abuja target in 2014 (Figure 6). The median for this ratio was 9.7%, but it is ranging from a low of 3.6% in Eritrea to a high of 16.8% in Malawi. 14 countries were below the lower benchmark at 7.5% (half of the Abuja target).

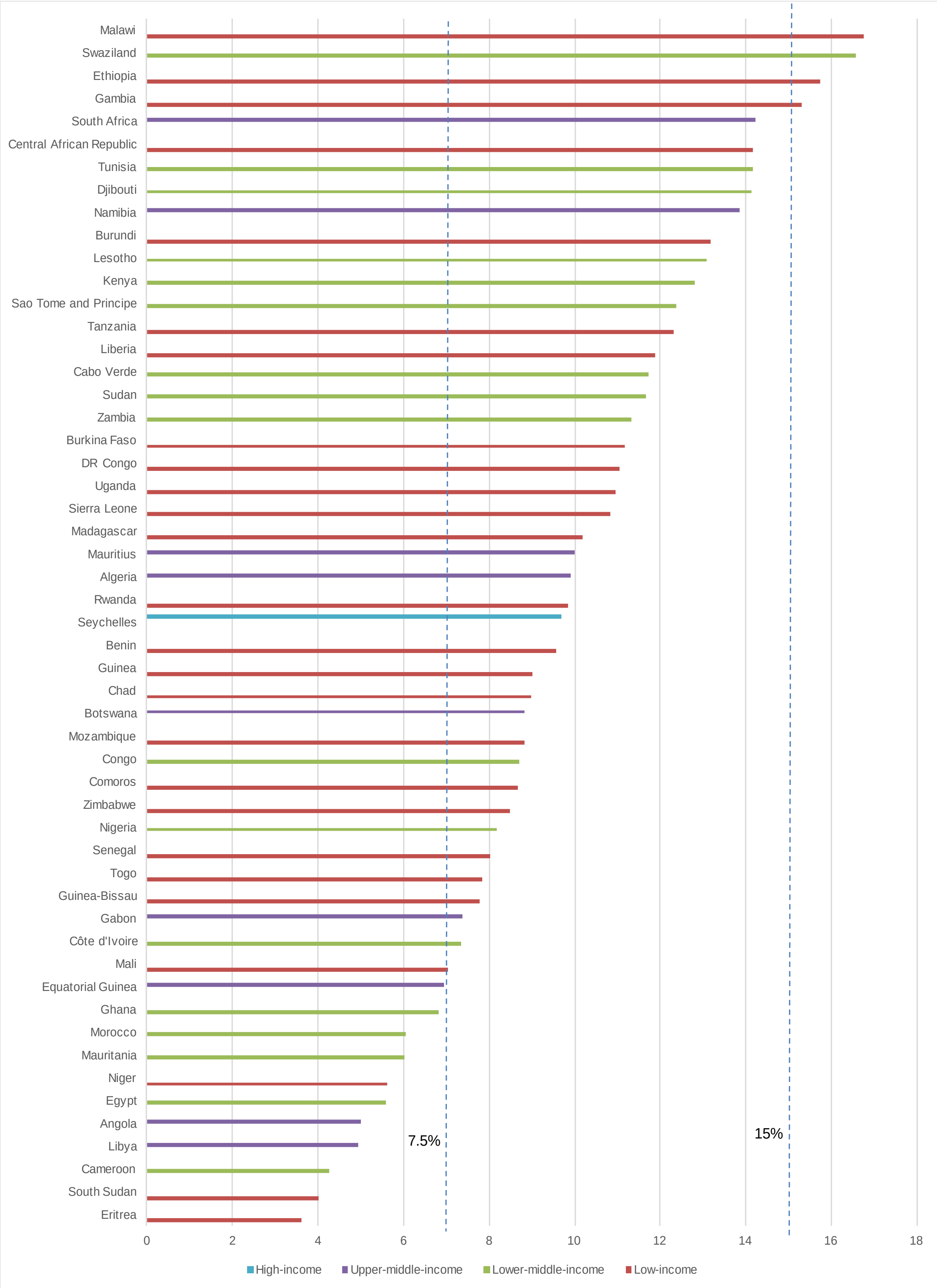

Figure 6: Government health expenditure as percentage of general government expenditure, 2014

Government health expenditure as a percentage of GDP varied widely across countries, also within income groups. While Figure 4 showed that, as a weighted average, this percentage was the lowest in LMICs, Figure 7 shows that this income group included both the lowest and the highest ranked countries (0.9% in Nigeria and 8.1% in Lesotho). Only 7 countries were above the 5% threshold (Table 3), 5 of which are countries with small populations (less than 2.5 million). 34 (64%) of the 53 governments spent less than 3% of their GDP on health and 214 (26%) spent less than 2%.

0 - 2%	***2 - 3%***
Nigeria, Cameroon, South Sudan, Guinea-Bissau, Madagascar, Eritrea, Democratic Republic of the Congo, Côte d'Ivoire, Uganda, Sudan, Mauritania, Sierra Leone, Mali, Chad	Morocco, Togo, Central African Republic, Angola, Ghana, Egypt, Comoros, Benin, Gabon, Mauritius, Niger, Senegal, Zimbabwe, United Republic of Tanzania, Burkina Faso, Guinea, Zambia, Ethiopia, Rwanda, Equatorial Guinea
3 - 5%	**> 5%**
Seychelles, Liberia, Botswana, Kenya, Cabo Verde, Sao Tome and Principe, Libya, Mozambique, Tunisia, Burundi, Congo, South Africa	Gambia, Algeria, Namibia, Malawi, Djibouti, Swaziland, Lesotho

Table 3: **Countries grouped by thresholds of government health expenditure as % of GDP, 2014**

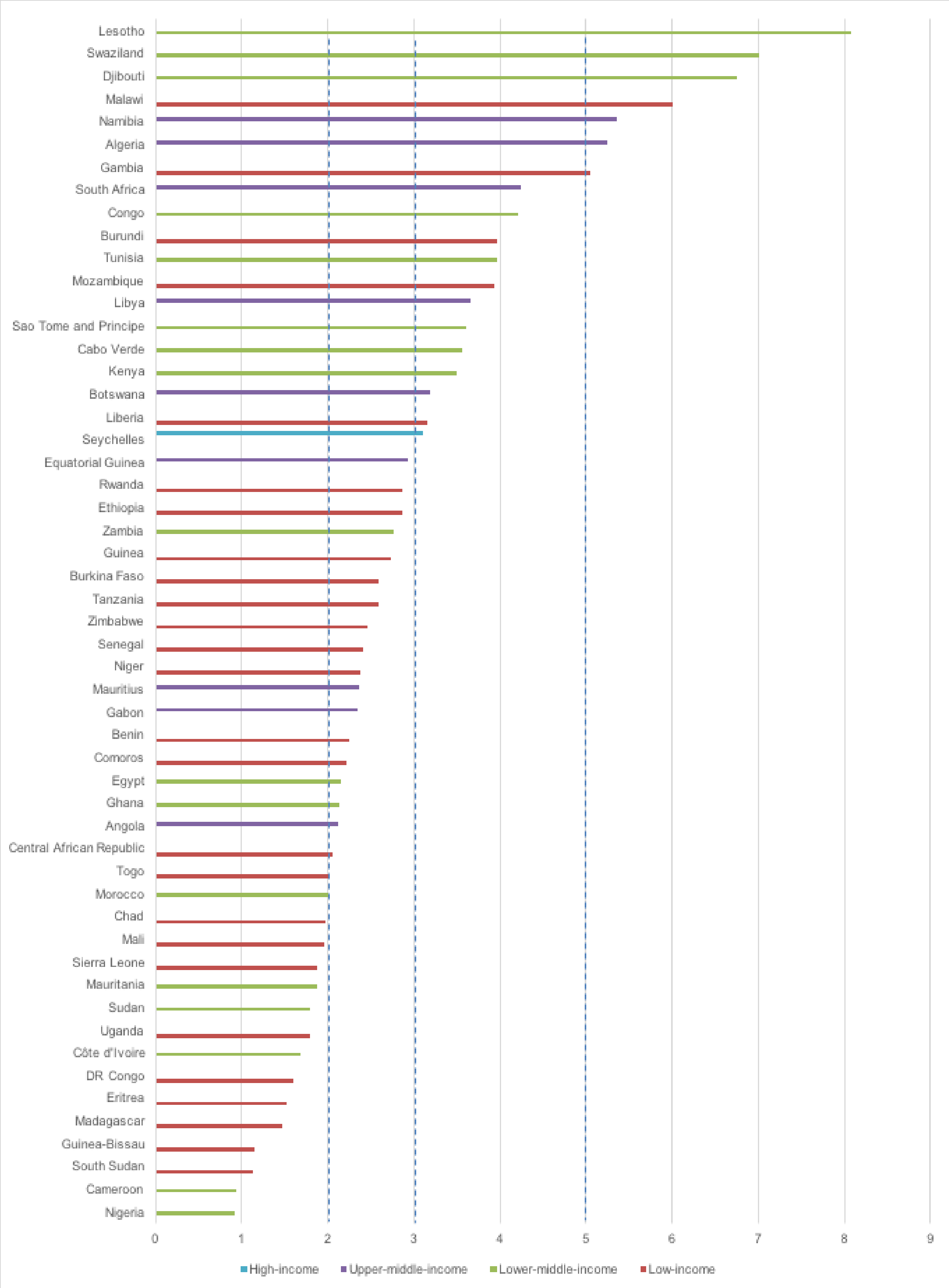

Figure 7: **Government expenditure on health as a percentage of GDP, 2014**

Many countries in Africa are still highly dependent on development assistance to finance healthcare. In 15 countries, external resources accounted for more than 30 percent of total health expenditure in 2014 (Figure 8). Malawi was a major outlier in this regard at incredible 73.8%, followed by Lesotho and Burundi, both above 50%. 15 countries financed less than 10% of their total health expenditure from external resources, none of which were LICs. 2014 data for Uganda and Zimbabwe were not available in the GHED for this indicator.

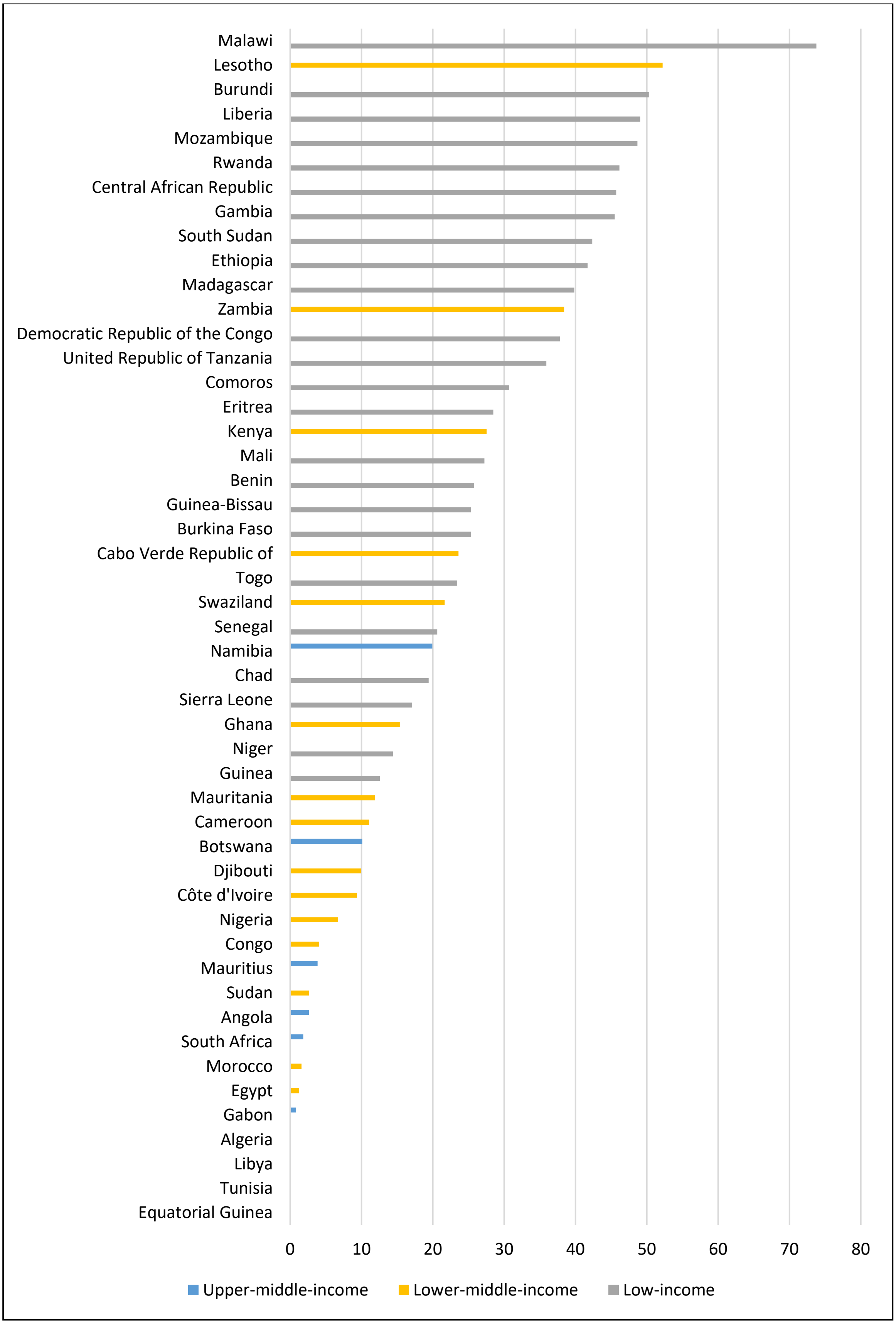

Figure 8: **External resources for health as a percentage of total health expenditure, 2014**

Determinants of government health expenditure

The coefficient, standard error, p-value and 95% confidence interval for each covariate in the final RE model against the $\log_e$ of GGHE per capita are presented in Table 3. The model had a very high R^2 (overall) of 0.9264, meaning that the model explains 92.6% of the variance of GGHE per capita in the dataset. Results of the model for each income group individually can be found in the statistical annexure, although some key observations are mentioned here.

	Coefficient	SE	p	95% confidence interval		Semi-elasticity (% change in y for 1 unit increase in x)
Ln(gdpcapus)	0.8345	0.0450	< 0.001	0.7463	0.9226	N/A
Ln(extcapus)	0.1183	0.0239	< 0.001	0.0715	0.1651	N/A
ggeofgdp	0.0221	0.0023	< 0.001	0.0175	0.0267	2.24
pop14	-0.0276	0.0091	0.002	-0.0453	-0.0098	-2.72
hivprev	0.0184	0.0074	0.012	0.0040	0.0328	1.86
time	0.0037	0.0050	0.464	-0.0062	0.0136	0.37
_cons	-9.7747	9.9915	0.328	-29.3577	9.8082	N/A

Table 3: **Results of the random effects model with $\log_e$ of GGHE per capita as outcome variable**

Ln(gdpcapus) = Log_e of gross domestic product in current US$ per capita, Ln(extcapus) = Log_e of rest of the world funds / External resources in current US$ per capita; ggeofgdp = General Government Expenditure (GGE) as % of Gross Domestic Product (GDP); pop14 = Population ages 0-14 (% of total); hivprev = Prevalence of HIV (% of total population ages 15-49); time = Year (2005 – 2014); _cons = constant; SE = standard error; and p = p-value of z-test. Hausman prob>chi2 = 0.1885. Overall R-squared = 0.9164.

The positive association between GDP per capita and GGHE per capita was highly significant (p-value < 0.001), but the income elasticity, controlling for the other variables in the model, was below unity (0.8345). The significance and elasticity below unity was consistent across all income groups. External resources for health per capita was highly significant overall and in LICs and LMICs but only marginally significant in UMICs (p-value 0.096). The overall elasticity was 0.1183. GGE as a percentage of GDP was found to have a statistically significant positive association with GGHE per capita, overall and in all income groups. For each percent increase in GGE of GDP, GGHE per capita increased by 2.2%. The semi-elasticity was the highest in LMICs at 3.1%.

Adult HIV prevalence was found to be significantly and positively associated with GGHE per capita with a semi-elasticity of 1.86%. However, it was not found to be significant in any of the income groups individually. Perhaps surprisingly, population aged 0-14 years as a percentage of total population was significantly and negatively associated with GGHE per capita. The association was significant in LMICs and UMICs, but not in LICs.

Time was not found to be statistically significant overall (p-value: 0.464), but it was significant in UMICs (p-value: 0.038), with a semi-elasticity of 2.4%, as might be expected from the appearance of Figures 1, 2 and 4.

Discussion

Before discussing the actual findings, some important limitations are worth mentioning. The expenditure data in the GHED vary in quality and some instances of very significant fluctuations from year to year may hint at partially inconsistent expenditure tracking over time, rather than actual changes in expenditure. In addition, some of the data, both from GHED and the World Bank Open Data have been adjusted or imputed by the two organisations[47] or, in some cases, were completely missing. In cases where data was missing for the entire time-period for one or more covariates in the RE model, these countries were automatically excluded. It is theoretically possible that this may have biased the results somewhat as data may be scarcer in countries with weak health systems. However, the six countries that were completely omitted due to lack of data (see statistical annexure) were almost equally spread across all income groups so it was deemed unlikely that this would have caused any significant bias. As mentioned, the GHED does not separate domestically financed government health expenditure from that financed by development assistance and Barroy et al. have pointed out that this may skew certain analyses, e.g. ratios against GDP and GGE are likely to be overestimated for countries with high reliance on donors.[18] The results seem to support this argument, as many of the countries with the highest government health expenditure as a percentage of both GDP and GGE (Figures 6 & 7) are countries that are highly donor dependent (Figure 8). Another limitation is that, although the trends analysis was done in Int$, differences in healthcare input costs may vary differently across countries than the purchasing power parity estimates. The country-level analysis for 2014 was not adjusted for purchasing power at all in order to enable comparison with the HTLF targets, which were originally developed in US$. Finally, in terms of the random effects model, no time-lags were used in the model, and simultaneous causality in both directions could potentially exist for some covariates, although it is unlikely to be a major concern.

Government health expenditure in African countries saw a total increase between 2005 and 2014 of 39%, or 3.7% per year, in real terms after adjusting for purchasing power and an increase could be seen in all income groups although at different rates. However, the growth was the lowest in LICs at 1.9% per year and spending in these countries is arguably still much too low to enable governments to provide the range of services costed specifically for this income group by the HLTF. The fact that none of the LICs reached even half of this target indicate that public healthcare for the poorest people in the region is still severely underfunded. The picture looked slightly better for LMICs, but the spread in this group was very wide and while countries like Swaziland and Tunisia spent over three times the lower benchmark of US$54 per capita, 8 LMICs had not yet reached this level in 2014, despite the fact that the benchmark was set for LICs. The picture for UMICs looked more positive, much thanks to a very strong expenditure growth over the 10-year period. The data also reveal that the disparities in government health expenditure remain extremely wide. Even when adjusting for purchasing power, the highest spending country spent 67 times more per capita than the lowest spending country. Within income groups, this ratio is of course smaller, but still remarkable at 7:1 for LICs, 16:1 for LMICs and 6:1 for UMICs.

The results also show the importance not to look at targets and norms in isolation. The countries with the highest ratios of government health expenditure to GDP and GGE were not necessarily countries with high per capita expenditure. Countries like Malawi and Gambia were among the highest ranked countries for both these ratios but only spent US$15 and US$21 per capita respectively, far below the international benchmarks proposed by WHO and others. This arguably indicates that the economies and fiscal capacity of these and several other countries on the continent are not sufficient to finance a comprehensive package of health services with only domestic resources. Development assistance will continue to be required, but it is important that such financing does not replace domestic efforts, which previous research has shown is often the case[38,39]. Mechanisms to prevent this, such as the co-financing requirements and incentives of the Global Fund[48] could be a potential way forward.

While this article has shown that most African governments need to significantly increase their expenditure on health, it is also important to ensure that available resources are spent effectively so that value for money is optimised. Jowett et al.[9] have shown that significant progress in terms of both access to healthcare and financial protection can be made at very low levels of expenditure. Many countries, such as Bangladesh and Thailand have made considerable progress in improving health outcomes with limited resources. While continued efforts to mobilise funding are very much needed, it is critical to also improve allocative and technical efficiency to maximise the health returns on financial investments.

This article has focused primarily on health expenditure by government, because of its importance to distribute its available resources equitably and ensure maximum coverage for its population. However, it is important to note that this is not the only financing agent in Africa. In fact, 54.1% of total health expenditure in 2014 was private, including 37,9% out of pocket expenditure. These percentages are particularly high in LMICs, where 63.3% of THE was private and 56.9% out-of-pocket. While this can be seen as a failure by governments to adequately fine healthcare, it also shows that there is enormous potential for African governments, particularly LMICs, to better pool available resources and distribute them more equitably.

It is commonly said that “all models are wrong, but some are useful”.[49] It would be impossible for a model to capture all phenomena impacting government health expenditure, and the final random effects model was limited to covariates where the association was significant, with the exception of time, which is common to include as a control variable. Nevertheless, the model had a very high overall R^2 value of 0.92, meaning that the included covariates explain 92% of the variation in government health expenditure per capita. The literature review found no previous studies of determinants of GGHE in Africa, except for the very interesting elasticities against GDP and GGE for the WHO African Region presented by Barroy et al..[18] However, it is still worthwhile to reflect on how the results compare these elasticities and to studies of a similar nature, even if the units of analysis differ to some extent. While there is agreement that countries' income levels are fundamentally important for government health expenditure levels, the elasticity of this relationship has differed significantly between the studies. In developed countries some studies found income elasticity to be above unity,[29,30] others found it to be below unity,[31,32] and yet others found it to be very close to unity.[33,34,35] Barroy et al. found income (GDP) elasticity of GGHE per capita (all sources) to be 1.59 in the WHO African Region between 2000-2014. Ke et al. found income elasticity of domestic GGHE to be 1.3 in LICs but below unity in all other income groups[36] On the contrary, Lv & Zhu found the income elasticity of THE in Africa between 2005 and 2009 to be the lowest in LICs and close to unity in MICs.[42] Our model found overall income elasticity of GGHE, controlling for the other variables to be notably below unity (0.83) and even lower in LICs (0.73) and UMICs (0.68), while it was relatively close to unity in LMICs (0.92). The overall income elasticity was thus found to be very different from that of the WHO African region according to Barroy et al., which is unexpected given that they used the same outcome variable (GGHE all sources). This potentially could be explained by the fact that our elasticities were controlled for a number of other variables, that we used a partially different time period (Barroy et al. mentioned that their elasticities varied over time), that we used a slightly different set of countries, or a combination of the above. The low elasticity in LICs in our model is likely partly explained by their relatively heavy reliance on donor funding, both by means of replacement[37,38,39] and because development assistance may be focused on the poorest countries within this group, thereby partly offsetting the effect of income differences. Despite elasticity being below unity, it is still clear that income is the most important determinant of government health expenditure and that pursuing economic growth paths is critical to substantially increase resources available for healthcare.

In addition to the size of the economy, government health expenditure is also determined by the proportion of the economy that is in the hands of governments, through tax and other revenue. GGE as a percentage of GDP had a highly significant (p-value < 0.001) association with the outcome variable in each of the income groups, which is also in line with previous research.[36,37] For each percentage point this ratio increased, GGHE per capita increased by 2.2% overall and, again, this effect was the strongest in LMICs at 3.1%.

While most of the literature reviewed found demographic and epidemiological indicators not to have statistically significant impact on health expenditure, we found both HIV prevalence and population under the age 14 to be significant, although in different directions. As adult HIV prevalence increased by one percentage point, GGHE per capita increased by 1.3%. However, this association was only significant in the overall model and not in the individual income groups, perhaps due to the smaller number of countries in each income group compared to the overall model. Lu et al.[37] did not find HIV prevalence to have a significant effect on domestic GGHE as a percentage of GDP. However, their study included 111 countries across five continents and arguably HIV has a higher impact in Africa because of its uniquely high HIV burden. Given that the outcome variable in this study is inclusive of development assistance for health channeled through government, it is impossible to say to what extent this is the result of responsiveness of governments or development partners, which is a limitation of this study. A significant portion of development assistance for health focuses specifically on HIV/AIDS, which could mean that governments of countries with a high HIV burden receive more development assistance for health than countries with a low HIV burden. In either case, the results indicate that HIV is indeed a key cost driver for African health systems and that the African governments and/or development partners are to some extent responsive to the disease burden of their populations. Population under 14 had a significant negative association with GGHE/capita, which is somewhat surprising, given that one could expect that children, particularly in younger age-groups, require more healthcare than adults. There could be several reasons for this. A young population is generally associated with deprivation, which may not be fully controlled for in the GDP/capita variable. It is also possible that there is a reverse causation in that higher health expenditure leads to higher life expectancy and therefore also a lower percentage of children. Finally, it is possible that this is a type 1 error.

Time had a significant positive association with government health expenditure only in UMICs. This would indicate that the rapid expenditure growth seen in this income group (Figure 1) is not optimally explained by the other covariates alone with time excluded. In the other income groups as well as overall time was statistically non-significant.

Conclusions

This article had three main objectives, which were to describe African government health expenditure trends for the decade between 2005 and 2014; to review the extent to which the development of such expenditure had resulted in international norms and targets being reached by 2014; and to estimate determinants of government health expenditure per capita. The results showed that while government health expenditure in Africa increased in constant prices over the decade studied, there are still wide disparities and 34 (65%) of the 52 countries reviewed did not achieve the US$54 (US$44 updated to 2014 prices) per capita target for LICs set by HTLF. These countries included many LMICs. Only 15 countries reached the higher US$89 benchmark. This highlights that there is still a dire need to mobilise more funding for healthcare if countries are to make substantial progress towards achieving the SDGs, including the UHC targets. However, the results also highlight the need for benchmarks to take better into account local unit costs, either by using PPP-adjustment or by developing health specific price adjustors. Consideration should be given to developing norms also for other income groups than LICs. A further recommendation emanating from the study is to work towards improved data quality and disaggregation, including better reporting of domestic financing of healthcare. The study confirmed previous findings that income and fiscal capacity are important factors influencing government health expenditure, but also generated new knowledge in terms of the quantum of these effects on the African continent and the association between government health expenditure and HIV prevalence and demographic structure.

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Health expenditure in Africa and its determinants, 2005 - 2014

Mini-dissertation: Master of Science in Public Health

Part C

Table of Contents

Secondary results

The draft journal article in Part B focused specifically on government health expenditure and the results presented there were limited to indicators related to that. However, as shown in Figure 2 of Part B, such expenditure only constituted 45.9% of Africa's total health expenditure in 2014. While this low proportion in itself is arguably problematic, given that private health expenditure generally is less equitably distributed than government health expenditure, it also highlights the importance of considering other financing agents as well as looking at total health expenditure levels. This section presents trends for indicators that due to space limitations were not included in Part B. The section also presents more detailed results of the statistical analysis done on determinants of government health expenditure and presents some additional statistical analysis on the impact of government health expenditure on health outcome indicators.

Total health expenditure

Real PPP-adjusted total health expenditure in the 54 countries included in this study increased significantly by 66.6% (or 5.8% on average per year) between 2005 and 2014, by far outpacing the population growth of 26.9% (or 2.7% on average per year). As a result, per capita spending (Figure 1) increased by 31.3% (or 3.1% on average per year). The increase can be seen in all income groups, although most notably in UMICs where expenditure per capita increased by an annual average of 4.1%, followed by 3.3% in LMIC. The lowest increase was in LICs, where total health expenditure increased by 2.5% per year.

Figure 1: Total health expenditure per capita in real 2010 Int$ for 52 African countries, 2005 - 2014

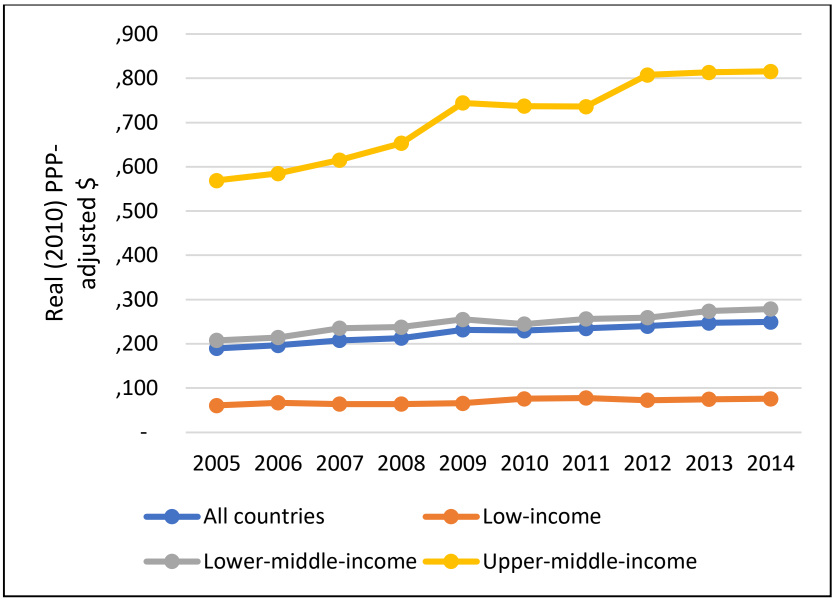
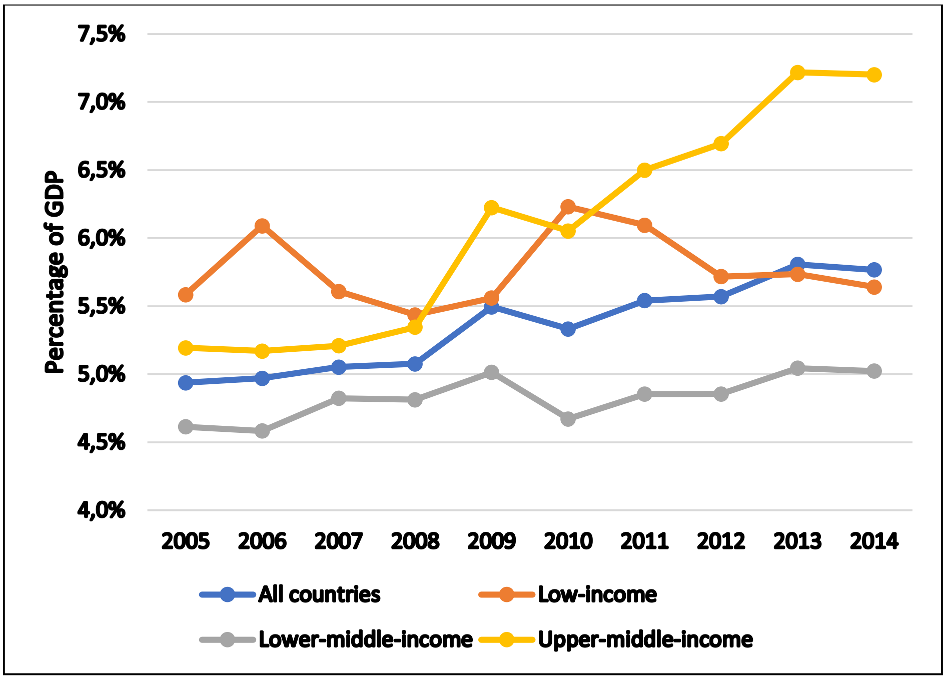


Figure 2 shows that the high increase in UMICs is explained by a remarkable increase in health expenditure as a proportion of GDP. In 2005, UMICs spent 5.2% of their GDP on health but by 2014 this proportion had increased to 7.2%. The increase is more moderate in LMICs where this ratio went from 4.6% in 2005 to 5.0% in 2014. In LICs it fluctuated significantly over the 10-year period but was at the same level (5.6%) in 2014 as it was in 2005. Overall, the ratio increased from 4.9% in 2005 to 5.6% in 2014.

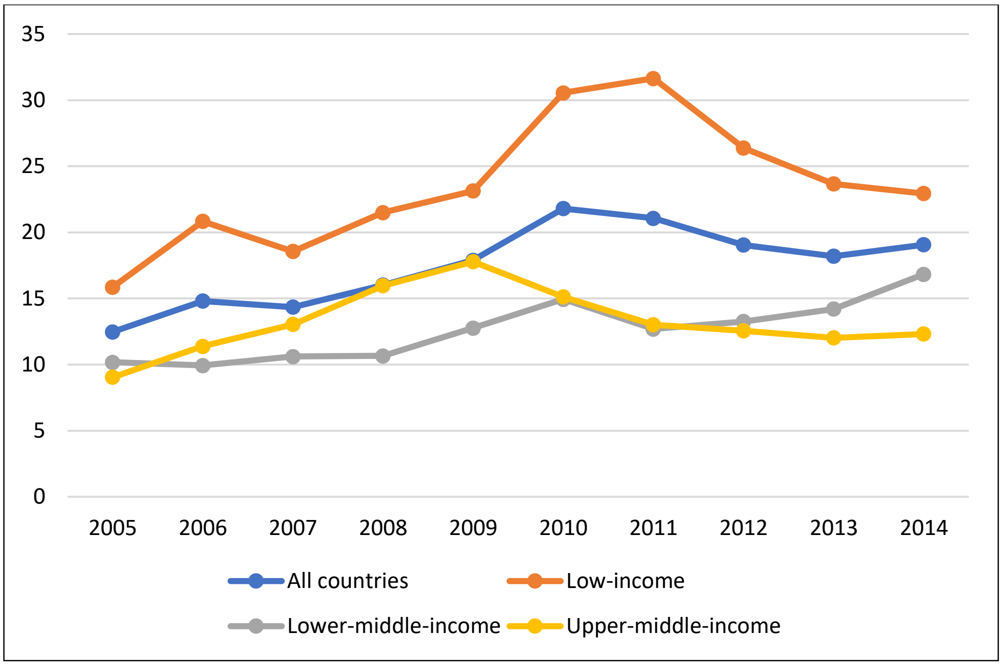
Figure 2: Total health expenditure as a percentage of GDP for 52 African countries, 2005 – 2014



External funding for health

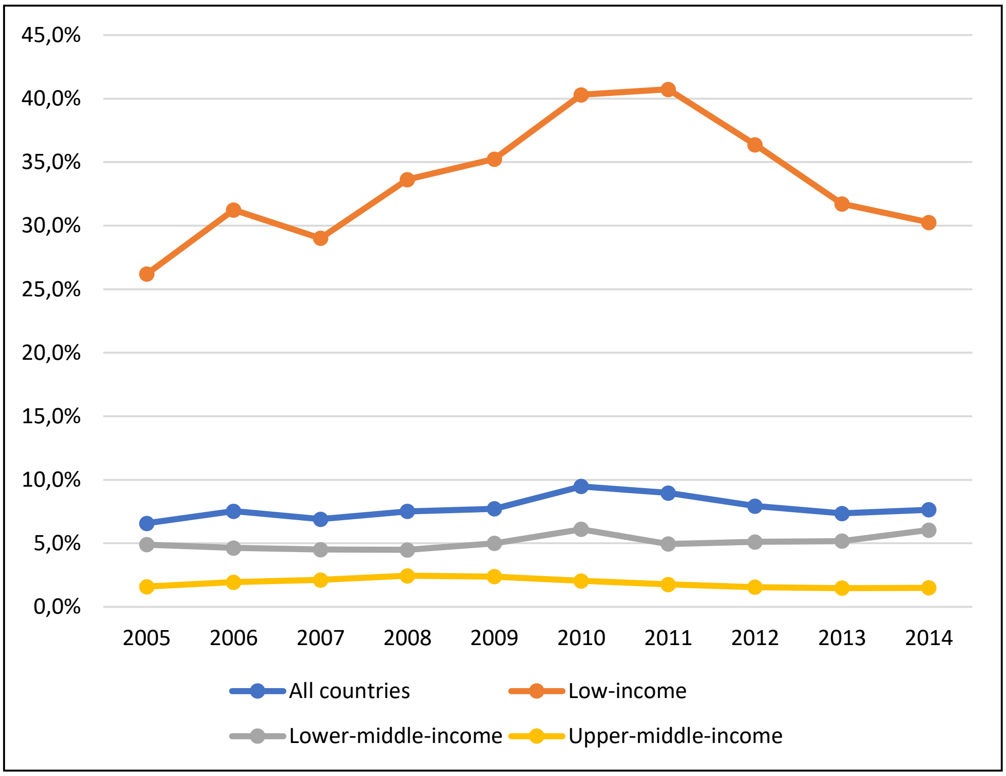
Unsurprisingly, the reliance of donor funding differs significantly between the income groups and external resources for health per capita was almost twice as high in LICs as compared to UMICs (Figure 3). There was a very strong upward trajectory, particularly in LICs, in the five years leading up to 2010 where external funding per capita increased by 47% overall and almost doubled (92.7% increase) in LICs. However, In the following 4-year period there was a notable decrease, which was particularly marked in LICs.

Figure 3: External funding for health per capita real 2010 Int$ for 52 African countries 2005 – 2014



This pattern also reflects in Figure 4, which shows external resources for health as a percentage of total health expenditure. While external funding never made up more than a tenth (peaked at 9.5% 2010) of total health expenditure in Africa during the period of study, it does play a major role in LICs. In this income group the percentage of health expenditure funded by external donors increased sharply from 26.2% in 2005 to 40.7% in 2011, similar to the increasing per capita trend during this period. As per capita expenditure decreased in the following 3 years, its percentage of total expenditure also dropped sharply to 30.3% in 2014. Similar to external funding per capita, the percentage of total follows the income levels and it only made up 1.5% of total health expenditure in UMICs in 2014.

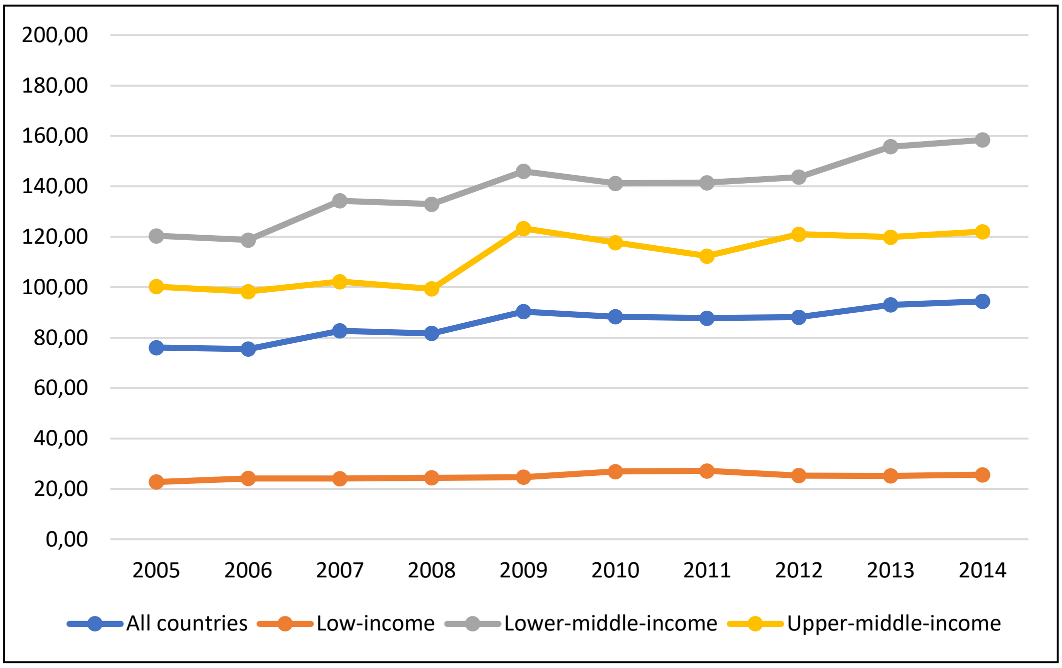
Figure 4: External funding as percentage of total health expenditure, 2005 – 2014



Out-of-pocket (OOP) expenditure

OOP expenditure per capita increased by 2.4% per annum in real Int$ between 2005 and 2014 (Figure 5) and was the highest in LMICs, more than 6 times higher than in LICs, where it was the lowest. The increase can be seen in all income groups but is particularly significant in LMICs where it increased by 3.1% per year (and 31.6% in total) from Int$120 in 2005 to Int$158 in 2014, while in LICs it only increased marginally by an average of 1.3% per year. There was a relatively strong average annual increase of 4.4% in the years leading up to 2009, after which it grew at a slower pace of 0.9%.

Figure 5. Out-of-pocket expenditure on health per capita in Int$, 2005 – 2014



Source: Global Health Expenditure Database

Out of pocket expenditure has remained relatively stable as a percentage of total health expenditure, although a slight decrease can be seen in every income group. Overall, it has decreased from 40.1% in 2005 to 37.9% in 2014, with the most notable decrease in LICs where it went from 37.6% to 33.8%. It is also worth noting that more than half (56.9%) of total health expenditure in LMICs was out of pocket in 2014 and this group experienced the smallest decrease over the 10-year period. The only income group where the weighted average of OOP as a percentage of THE was below the maximum of 20% recommended in the 2010 World Health Report was UMICs, where it was 15.0% in 2014.

Figure 6: Out-of-pocket expenditure as percentage of total health expenditure, 2005 – 2014

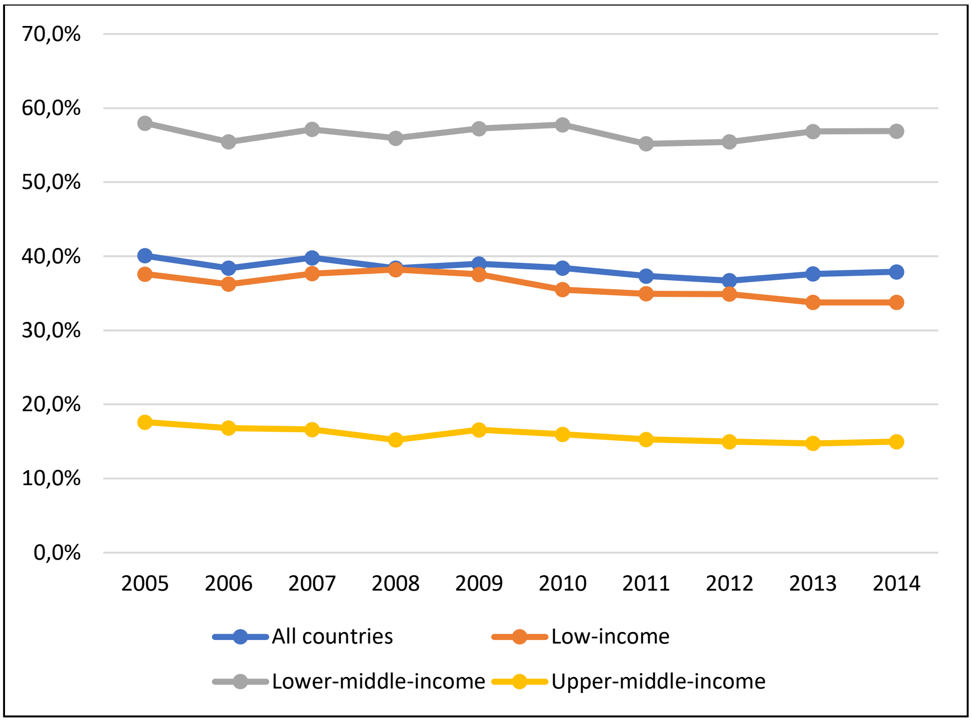
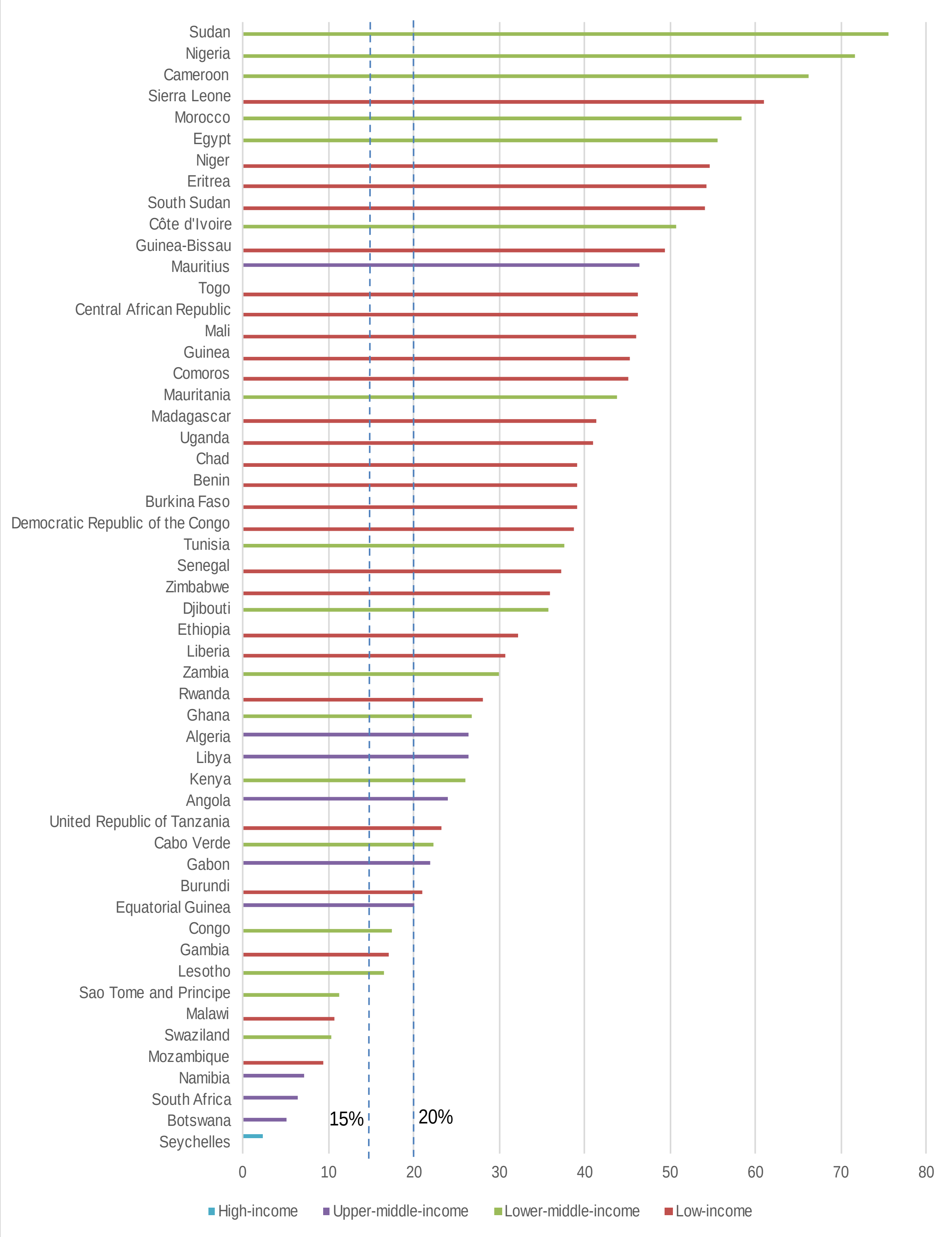


Figure 7 shows that, while there was an extremely wide spread in terms of reliance of OOPs, ranging from a low of 2.3% of THE in the Seychelles to 75.5% in Sudan, they played an important role for most African countries in 2014. Only in 11 out of the 53 countries, OOP accounted for less than 20% of THE. All UMICs were below 30%, except for Mauritius, which was a clear outlier in this income group at 46.4%. There was a considerable spread across countries within the LIC and LMIC groups. In ten countries, OOPs constituted more than half of total health expenditure, all of which were LICs or LMICs, but it is also noteworthy that there were a few countries in both these groups that achieved the recommendation from the 2010 World Health Report.

Figure 7: Out-of-pocket expenditure as percentage of total health expenditure, 2014



Detailed results from regression analysis

While the journal article in Part B only presents the results of the random effects (RE) model, this section reviews the results of the multiple linear regression / pooled ordinary least square

(OLS) and fixed effects (FE) models. The pooled OLS results (Table 1) were fairly similar to the results of the RE model (Part B, Table 3), and the variables that were significant using RE were also significant using pooled OLS. The main differences were found in the strengths of the relationships. The elasticity of external resources for health in the pooled OLS model was almost twice as high as in the RE model. On the contrary, GGE as a percentage of GDP, population ages 0-14 and HIV prevalence had higher coefficients and semi-elasticity in the RE model. As mentioned in the methods section (Part A), the Breusch-Pagan LM-test was non-significant, meaning that random effects were found to be present in the data and hence the RE is to be seen as preferable to pooled OLS. However, the pooled OLS model also had a high very R-squared value of 0.92 and arguably explains the data fairly well. The distribution of the OLS residuals were relatively normally distributed, albeit slightly bimodal and with some outliers (see histogram in statistical annexure). The Breusch-Pagan / Cook-Weisberg test found the residuals to be heteroskedastic (p-value: <0.001), meaning that the residuals did not have an equal variance over the range of the outcome variable, which puts the robustness of this model somewhat into question.

Table 1: Results of the pooled OLS model with $\log_e$ of government health expenditure per capita as outcome variable

	Coefficient	**SE**	**p**	**95% confidence interval**		**Semi-elasticity (% change in y for 1 unit increase in x)**
ln_gdpcapus	0.867	0.020	< 0.001	0.827	0.906	N/A
ln_extcapus	0.212	0.023	< 0.001	0.166	0.258	N/A
ggeofgdp	0.020	0.002	< 0.001	0.016	0.023	1.99
pop14	-0.023	0.004	< 0.001	-0.030	-0.015	-2.23
hivprev	0.010	0.003	0.002	0.004	0.017	1.02
time	-0.003	0.006	0.611	-0.015	0.009	-0.31
_cons	3.450	12.352	0.780	-20.826	27.726	N/A

Ln(gdpcapus) = Log_e of gross domestic product in current US$ per capita, Ln(extcapus) = Log_e of rest of the world funds / External resources in current US$ per capita; ggeofgdp = General Government Expenditure (GGE) as % of Gross Domestic Product (GDP); pop14 = Population ages 0-14 (% of total); hivprev = Prevalence of HIV (% of total population ages 15-49); time = Year (2005 – 2014); _cons = constant; SE = standard error; and p = p-value of t-test. R-squared = 0.9208. Number of observations: 445

Table 2 shows the results of the FE model, which were broadly in line with the other two models. The main difference was that HIV prevalence was not found to be significant (p-value = 0.321). R-squared (within) for the FE model was 0.65, which is significantly lower than in the other two models.

Table 2: Results of the FE model with log_e of government health expenditure per capita as outcome

	Coefficient	**SE**	**p**	**95% confidence interval**		**Semi-elasticity (% change in y for 1 unit increase in x)**
ln_gdpcapus	0.8520	0.0802	<0.001	0.6944	1.0096	N/A
ln_extcapus	0.1026	0.0251	<0.001	0.0533	0.1519	N/A
ggeofgdp	0.0234	0.0026	<0.001	0.0184	0.0284	2.37
pop14	-0.0591	0.0198	0.003	-0.0981	-0.0202	-5.74
hivprev	0.0313	0.0315	0.321	-0.0306	0.0933	3.18
time	-0.0006	0.0078	0.944	-0.0160	0.0149	-0.05
_cons	-0.1019	15.8598	0.995	-31.2826	31.0789	-9.68

Ln(gdpcapus) = Log_e of gross domestic product in current US$ per capita, Ln(extcapus) = Log_e of rest of the world funds / External resources in current US$ per capita; ggeofgdp = General Government Expenditure (GGE) as % of Gross Domestic Product (GDP); pop14 = Population ages 0-14 (% of total); hivprev = Prevalence of HIV (% of total population ages 15-49); time = Year (2005 – 2014); _cons = constant; SE = standard error; and p = p-value of t-test. R-squared = 0.6418. Number of observations: 445

Government health expenditure and health outcomes

Table 3 presents the association between the $\log_e$ of government health expenditure per capita and $\log_e$ of life expectancy at birth, infant mortality rate (IMR) and under-5 mortality rates (U5MR), using both FE and RE methods, controlling for the $\log_e$ of GDP per capita. The Hausman-test indicated that the FE model was preferable for life expectancy and IMR, while RE was better for U5MR. Looking at the models, supported by the Hausman-test, the associations between GGHE per capita and the outcome variables were found to be positive and significant for life expectancy with a coefficient of 0.021, meaning that for each percent increase in GGHE per capita, life expectancy increased by 0.02%. It was also significant but negative for under-5 mortality, which decreased by 0.04% for each percent increase in GGHE per capita. The association with IMR was not statistically significant in the FE model (p-value: 0.101). The coefficients were consistently stronger for GDP per capita than for GGHE per capita, indicating that income may be more important than health expenditure for health outcomes.

Table 3. Association between GGHE/capita and health outcomes

		Fixed effects						Random effects						Hausman Prob>Chi2
		Coefficient	SE	p	95% confidence interval		R-squared	Coefficient	SE	p	95% confidence interval		R-squared	
ln(le)	ln(gghecapus)	0.021	0.005	< 0.001	0.011	0.031	0.548	0.022	0.005	< 0.001	0.012	0.032	0.177	<0.001
	ln(gdpcapus)	0.099	0.008	< 0.001	0.083	0.115		0.087	0.008	< 0.001	0.072	0.103		
ln(imr)	ln(gghecapus)	-0.029	0.018	0.101	-0.064	0.006	0.266	-0.030	0.018	0.090	-0.065	0.005	0.171	0.001
	ln(gdpcapus)	-0.196	0.027	< 0.001	-0.250	-0.143		-0.199	0.027	< 0.001	-0.253	-0.145		
ln(u5mr)	ln(gghecapus)	-0.040	0.018	0.026	-0.075	-0.005	0.383	-0.041	0.018	0.022	-0.076	-0.006	0.187	0.057
	ln(gdpcapus)	-0.258	0.018	< 0.001	-0.312	-0.203		-0.260	0.018	< 0.001	-0.314	-0.205		

ln(le) = $\log_e$ of life expectancy at birth; ln(imr) = $\log_e$ of infant mortality rate; ln(u5mr) = $\log_e$ of under-5 mortality rate; ln(gghecapus) = $\log_e$ of general government health expenditure per capita (US$); ln(gdpcapus) = $\log_e$ of gross domestic product per capita (US$); SE = standard error; and p = p-value of z-test.

Discussion of secondary findings

Total health expenditure

The trend for THE per capita is relatively similar to that of GGHE per capita, in that it grew steadily over the 10-year period and that this growth was the largest by far in UMICs. 54% of the THE growth is accounted for by growth in GGHE. However, this percentage differs significantly across income groups. While in UMICs, this percentage was 76%, in LICs and LMICs it was only 35% and 37% respectively, meaning that, in the latter two groups, government health expenditure growth was outstripped by the combined growth of private expenditure and development assistance channelled through non-state actors. Perhaps the most notable trend for THE is its rapid growth as a percentage of GDP in UMICs, where it grew from 5.2% in 2005 to 7.2% in 2014. This ratio was higher in LICs than LMICs, which could potentially be explained by higher levels of development assistance in combination with lower GDP levels.

External funding for health

Figures 4, as well as Figure 8 of Part B, shows that many countries in Africa, particularly LICs, but also certain LMICs such as Lesotho and Zambia, are still highly reliant on development assistance to finance healthcare in their countries. In 2014, almost one third of total health expenditure in LICs was donor-funded. While this proportion decreased substantially between 2010 and 2014, this appears to be largely due to decreasing development assistance per capita (Figure 3) following the globally financial crisis, rather than an increase in government health expenditure per capita which remained stable over this period (Part B,

Figure 1). Expenditure from external resources per capita in LICs was approximately twice as high as such expenditure in UMICs, but in the latter group it only comprised 1.5% of THE. Of note is that despite the relative importance of development assistance in LICs, the real decrease per capita since 2011 was Int$8.7 (27.5% decrease) in 2010 prices, while in UMICs it only decreased by Int$0.7. This raises questions of whether the poorest countries, with the largest needs for development funding for health were adequately protected from funding reductions when donor countries tightened their purse strings following the global economic turndown.

Out-of-pocket expenditure

While LMICs on average are not very heavily reliant on development assistance (6.0% of THE in 2014), their heavy reliance on OOPs is of serious concern. 56.9% of THE was funded out-of-pocket in LICs in 2014, as compared to only 15.0% in UMICs. In fact, even in per capita Int$ terms LMICs were higher than UMICs throughout the 10-year period, despite their lower per capita income levels. OOP payments per capita were the lowest by far in LICs. However, this is likely a reflection of inability of poor households to pay for healthcare rather than strong financial protection. This is supported by the fact that their OOPs as a percentage of THE is still relatively high (33.8%). There was a relatively strong increase in OOPs per capita in the period leading up to the year of the financial crisis in 2009, after which it dropped for two consecutive years and starter growing again in 2012, indicating that OOP expenditure is relatively sensitive to changes in income levels. The fact that only 11 (20.7%) of the 53 countries achieved the WHO recommendation of OOPs constituting less than 20% of THE demonstrates that financial risk protection in Africa is still very weak. OOPs made up more than half of THE in 10 of the countries.

Additional models on determinants of GGHE

The three models fitted on GGHE per capita all had high R-squared meaning that they all explain variations in the outcome variable relatively well. However, the various tests to compare the models described in the methods section pointed towards RE as the most appropriate for the data. The models generated very similar results, the main exception being that that HIV prevalence was significant in RE and OLS but not in FE. This exception might indicate that HIV prevalence explains differences between countries more than it explains changes within countries, given that FE models completely ignore between-country effects.

Health outcomes

Government health expenditure per capita had statistically significant effects on life expectancy and under-5 mortality rates in Africa, which is in line with previous research in this area. For each percentage increase in GGHE per capita in nominal US$, life expectancy increased by 0.02% and U5MR decreased by 0.04%, controlling for GDP per capita. This further strengthens the case for increasing GGHE, particularly in those countries with low spending. It is noteworthy that the coefficients of GDP per capita were stronger than GGHE per capita, indicating that economic development and upliftment from poverty seems to be a more important determinant of health outcome than government health expenditure.

Limitations

The expenditure data in the GGHED vary in quality and some instances of drastic fluctuations from year to year may hint at inconsistent expenditure tracking over time, rather than actual changes in expenditure. In addition, some of the data, both from GHED and the World Bank Open Data have been adjusted or imputed by the two organisations[1] or, in some cases, were completely missing. In cases where data was missing for the entire time-period for one or more covariates in the RE model, these countries were automatically excluded. It is theoretically possible that this may have biased the results somewhat as it is possible that data are scarcer in countries with weak health systems. However, the six countries that were completely omitted due to lack of data (see statistical annexure) were almost equally spread across all income groups so it was deemed unlikely that this would cause any significant bias. These potential concerns apply for both the GGHE data in Part B and the other health expenditure indicators in Part C. However, the data used are considered the best data, which are routinely captured in standardized system for categorization.[1] In addition, as have been mentioned, the GHED does not separate domestically financed government health expenditure from that financed by development assistance and Barroy et al. have pointed out that this may skew certain analyses, e.g. ratios against GDP and GGE are likely to be overestimated.[2] The results seem to support this argument, as many of the countries with the highest government health expenditure as a percentage of both GDP and GGE (Figures 6 & 7) are countries that are highly donor dependent (Figure 8). Another limitation is that, although the trends analysis was done in Int$, differences in healthcare input costs may vary differently across countries than the general purchasing power estimates. The country-level analysis for 2014 was not adjusted for purchasing power at all in order to enable comparison with the HTLF targets, which were originally developed in US$. Finally, in terms of the modelling of determinants of government health expenditure, no time-lags were used in the model and simultaneous causality in both directions could potentially exist for some covariates. However, it is unlikely to be a major concern for the covariates included in the final models. Similarly, no time-lags were used in the models for the association between GGHE and health outcomes, but given that GGHE was positively associated with life expectancy and negatively associated with U5MR, reverse causation is unlikely to be a major concern. This concern might be somewhat greater for GDP per capita given that research has shown that improved health has a positive impact on income. [3,4]

Conclusions

This mini-dissertation had three main objectives, which were to describe government health expenditure trends for the decade between 2005 and 2014, to review the extent to which, the development of such expenditure had resulted international norms and targets being reached by 2014 and to analyse determinants of government health expenditure per capita. The results showed that while government health expenditure in Africa increased in constant prices over the decade studied, there are still wide disparities and 34 (65%) of the 52 countries reviewed did not achieve the US$54 (US$44 updated to 2014 prices) per capita target for LICs set by HTLF. These countries included many LMICs. Only 15 countries reached the higher US$89 benchmark. This highlights that there is still a dire need to mobilise more funding for healthcare if countries are to make substantial progress towards achieving the SDGs, including the UHC targets. However, the results also highlight the need for benchmarks taking better into account local unit costs, either by using PPP-adjustment or by developing health specific price adjustors. Consideration should be given to developing norms also for other income groups than LICs. A further recommendation emanating from the study is to work towards improved data quality and disaggregation, including better reporting of domestic financing of healthcare. The FE model for US$ GGHE per capita confirmed that findings of previous research on the association between government health expenditure and income and fiscal capacity also hold in Africa, which to the author's knowledge had not been documented before. It also generated new knowledge in terms of the quantum of these effects on the African continent and the statistically significant association between government health expenditure and HIV prevalence and demographic structure.

A set of secondary aims were also achieved in Part C of the mini-dissertation. These were to describe trends in other key health expenditure indicators relating to THE, OOPs and development assistance for health as well as to assess the impact of government health expenditure per capita on key health outcomes indicators. The results showed some notable trends. Firstly, development assistance for health plays a very important role, both per capita and as a percentage of THE, particularly in LICs. This is concerning from a sustainability point of view and there is a strong case for these countries to make greater efforts in improving domestic financing for healthcare, which would likely require economic growth but can also be improved through greater fiscal effort and prioritisation of health within available government budgets. Secondly, the results showed that OOPs are the dominant source of health financing in African LMICs, which is a great concern given that OOPs are regressive and often subject households to financial hardship through catastrophic and impoverishing health expenditure. Efforts to better pool funding for health should be made, particularly in countries with OOPs higher than 15-20% of THE. Finally, results confirmed findings of previous research that government health expenditure has a positive impact on health outcomes. However, growing the economy and increasing the income of households might have an even stronger effect on these.

Recommendations and policy implications

- Despite the increases in GGHE seen over the past 10 years, healthcare in Africa is still largely underfunded when comparing expenditure to internationally agreed benchmarks, and governments together with development partners still need to make concerted efforts to mobilise resources for health.

- Most LICs and some LMICs should make much greater efforts to finance government healthcare domestically to avoid over-reliance on donor funding. This is imperative in order to improve sustainability and predictability of financing of public health services.
- Development partners need to consider how they prioritise within tighter development assistance budgets. Given the relative high importance in LICs it is concerning that the decrease seen since 2011 has particularly impacted this income group.
- The high OOPs per capita and as a percentage of THE, particularly in LMICs, warrant attention and countries with high OOPs should take measures to improve financial risk protection and remove financial barriers to accessing healthcare.
- The study illustrated the importance of economic growth for both health expenditure and health outcomes. For each percent that GDP per capita increases, GGHE per capita increases by 0.83%, life expectancy increases by 0.1% and U5MR decreases by 0.26%. GDP per capita was shown to have a stronger impact than GGHE per capita on health outcomes.
- While this dissertation has statistically identified some of the key determinants of health care at a very high level, this could be complemented by in-depth country-level qualitative research into how funding decisions for health are made and what are the most important factors taken into consideration in these processes.
- Finally, a recommendation emanating from the study is the need for improved data quality and disaggregation, including better reporting of domestic public financing of healthcare.

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Health expenditure in Africa and its determinants, 2005 - 2014

Mini-dissertation: Master of Science in Public Health

Statistical Annexure

Table 1. Omitted countries by methodological component

Component	Countries omitted	Comment
Trends analyses by income group	Somalia	No expenditure data at all
	South Sudan (2005-2011)	Country independent in 2011
	Seychelles	Included in "All countries" but not in any income group, as it is the only HIC
2014 expenditure by country	Sao Tome and Principe (GDP/capita)	Expenditure not available in US$ in GHED
	Somalia	No expenditure data at all
Determinants of GGHE	Algeria	No data on external resources
	Cameroon (2011)	No data on external resources for this year
	Egypt (2013)	No data on external resources for this year
	Eritrea (2012-2014)	No pop14 data for these years
	Libya	No HIV prevalence data
	Mauritius	No HIV prevalence data
	South Sudan (2005-2011)	Country independent in 2011
	Sudan (2012)	No data on external resources for this year
	Tunisia (2005)	No data on external resources for this year
	Uganda (2014)	No data on external resources for this year
	Somalia	No expenditure data at all
	Zimbabwe	Extreme fluctuation in US$ data due to period of hyperinflation
	Sao Tome and Principe	Expenditure not available in US$ in GHED
	Seychelles	High income
Impact on health outcomes	Somalia	No expenditure data at all
	Zimbabwe	Extreme fluctuation in US$ data due to period of hyperinflation
	Mauritius (IMR & U5MR)	No data for these indicators
	Cape Verde (IMR & U5MR)	No data for these indicators
	Sao Tome and Principe	Expenditure not available in US$ in GHED
	Seychelles	High income

Figure 1. Histogram of General Government Health expenditure per capita, 2005-2014

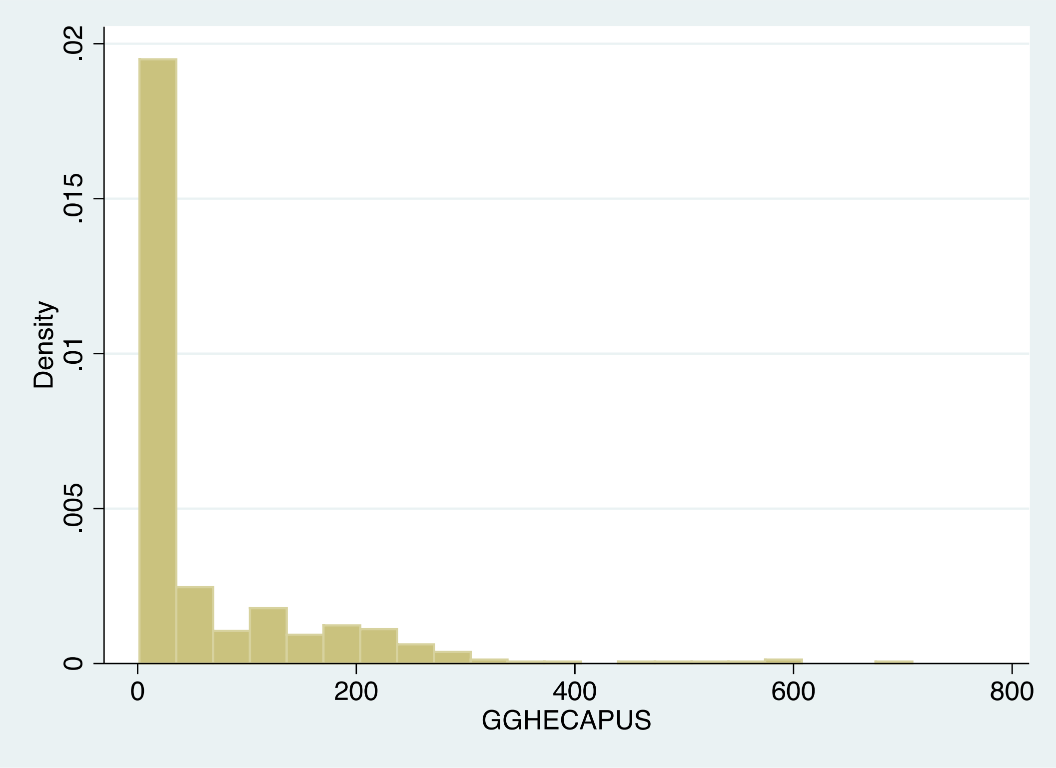


Figure 2. Histogram of $\log_e$ General Government Health expenditure per capita, 2005-2014

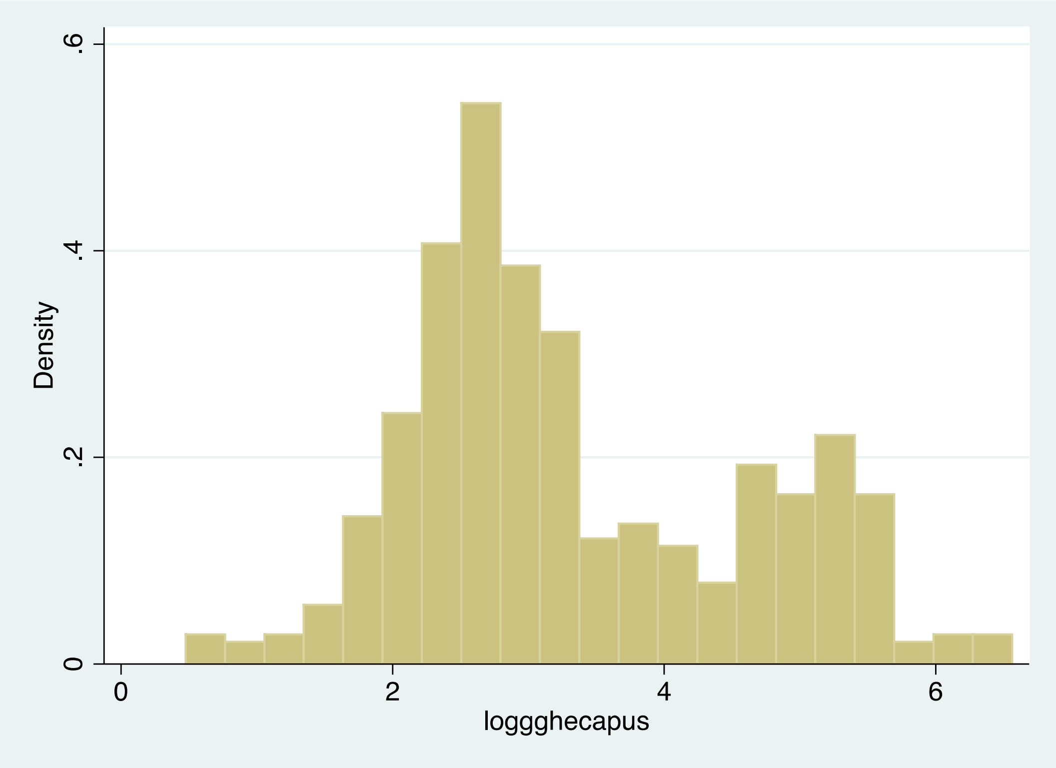


Table 2. Dropped variables with p-values in last step before dropped

Variable	P-value
Total debt service cost as a percentage of gross national income (GNI)	0.769
Incidence of tuberculosis (per 100,000 people)	0.920
Birth rate, crude (per 1,000 people)	0.440
Population ages 65 and above (% of total)	0.145

Figure 3. Histogram of GDP per capita, 2005 – 2014

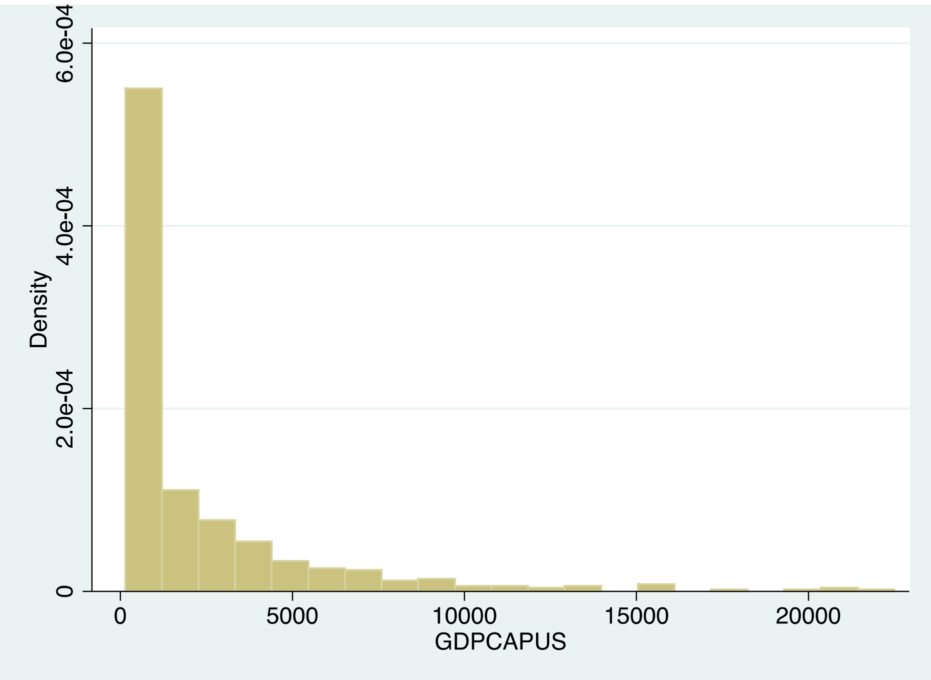


Figure 4. Histogram of $\log_e$ of GDP per capita, 2005 – 2014

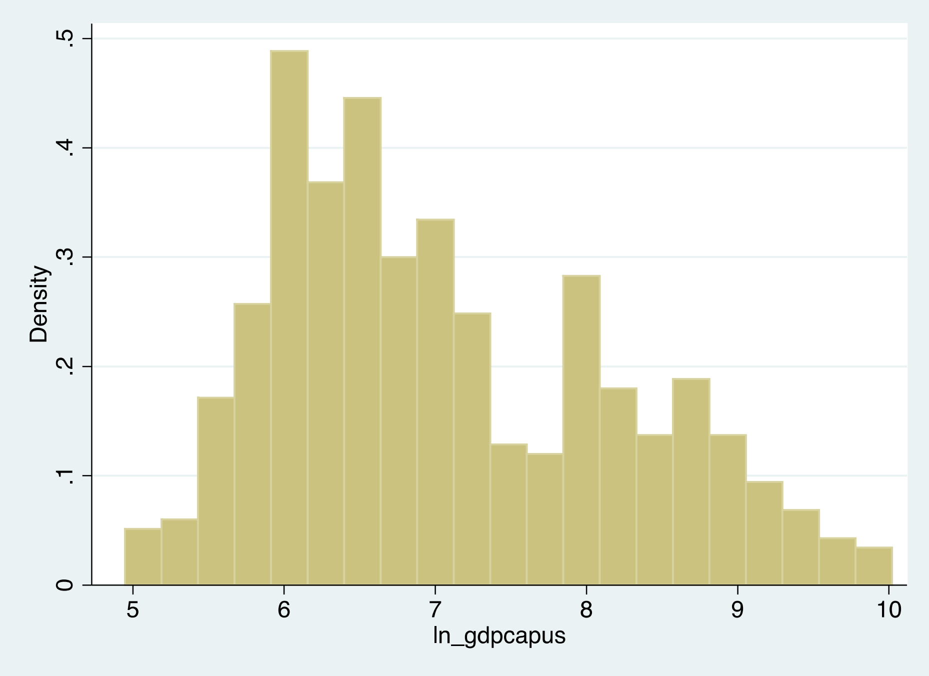


Figure 5. Histogram of external resources per capita, 2005 – 2014

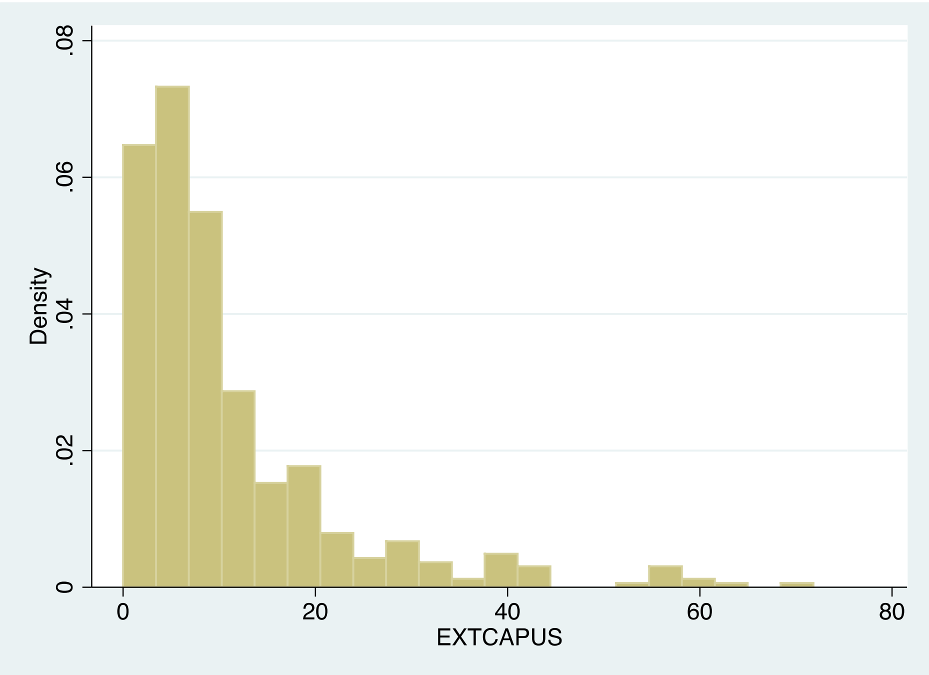


Figure 6. Histogram of $\log_e$ of external resources per capita, 2005 – 2014

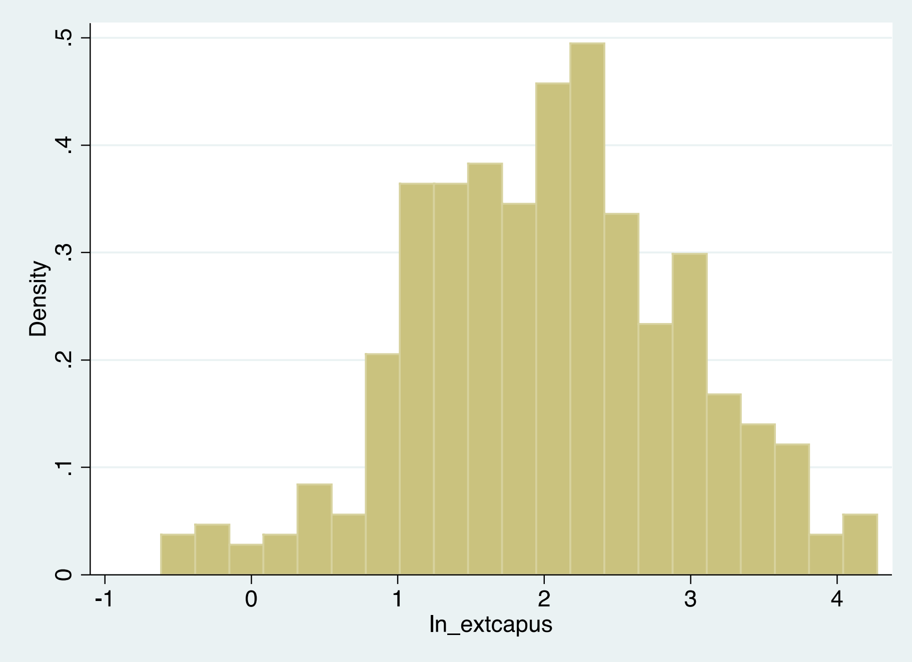


Table 3. Random effects model low income countries

	Coefficient	SE	p	95% confidence interval		Semi-elasticity (% change in y for 1 unit increase in x)
ln_gdpcapus	0.725	0.099	< 0.001	0.531	0.918	N/A
ln_extcapus	0.279	0.048	< 0.001	0.186	0.373	N/A
ggeofgdp	0.014	0.004	< 0.001	0.006	0.021	1.38
pop14	-0.001	0.021	0.980	-0.042	0.041	-0.05
hivprev	0.008	0.018	0.676	-0.028	0.043	0.77
time	-0.006	0.009	0.492	-0.024	0.011	-0.61
_cons	9.417	17.783	0.596	-25.436	44.271	

Ln(gdpcapus) = Log_e of gross domestic product in current US$ per capita, Ln(extcapus) = Log_e of rest of the world funds / External resources in current US$ per capita; ggeofgdp = General Government Expenditure (GGE) as % of Gross Domestic Product (GDP); pop14 = Population ages 0-14 (% of total); hivprev = Prevalence of HIV (% of total population ages 15-49); time = Year (2005 – 2014); _cons = constant; SE = standard error; and p = p-value of z-test. Overall R-squared = 0.6112. Number of countries = 25. Number of observations = 239.

Table 4. Random effects model lower middle-income countries

	Coefficient	SE	p	95% confidence interval		Semi-elasticity (% change in y for 1 unit increase in x)
ln_gdpcapus	0.915	0.100	< 0.001	0.719	1.110	N/A
ln_extcapus	0.129	0.032	< 0.001	0.067	0.191	N/A
ggeofgdp	0.030	0.004	< 0.001	0.023	0.038	3.10
pop14	-0.025	0.011	0.021	-0.046	-0.004	-2.46
hivprev	0.013	0.009	0.136	-0.004	0.030	1.31
time	-0.001	0.009	0.902	-0.019	0.016	-0.11
_cons	-1.097	17.530	0.950	-35.456	33.261	-66.63

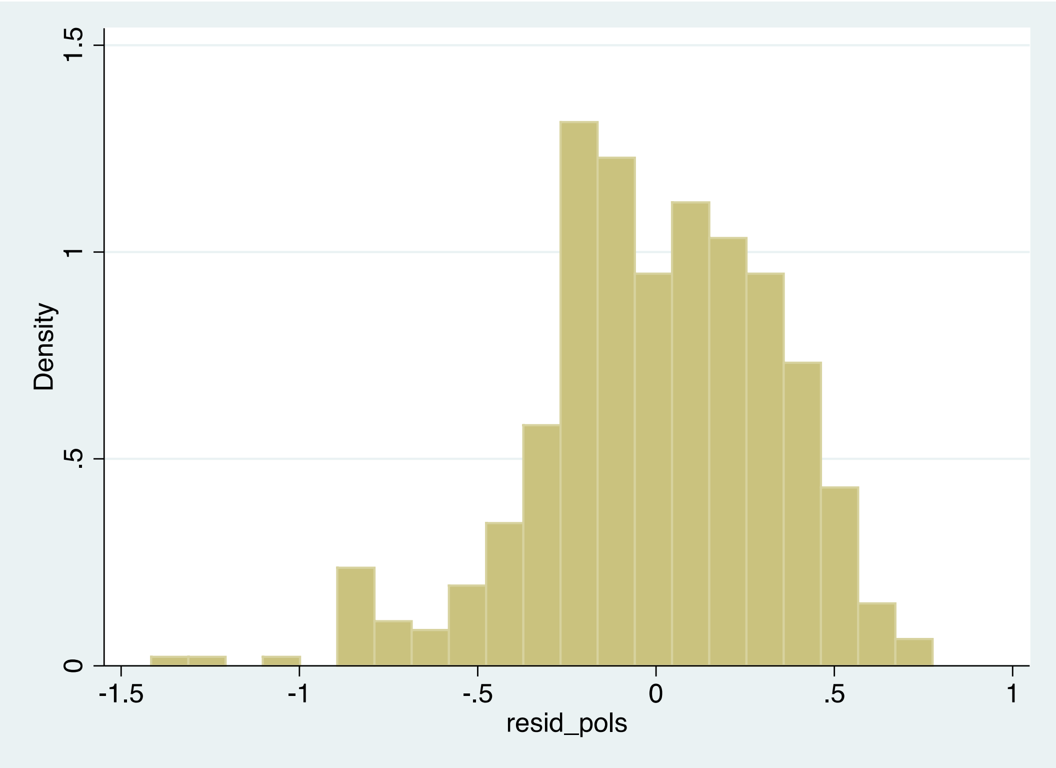
Ln(gdpcapus) = Log_e of gross domestic product in current US$ per capita, Ln(extcapus) = Log_e of rest of the world funds / External resources in current US$ per capita; ggeofgdp = General Government Expenditure (GGE) as % of Gross Domestic Product (GDP); pop14 = Population ages 0-14 (% of total); hivprev = Prevalence of HIV (% of total population ages 15-49); time = Year (2005 – 2014); _cons = constant; SE = standard error; and p = p-value of z-test. Overall R-squared = 0.8684. Number of countries = 15. Number of observations = 146.

Table 5. Random effects model upper middle-income countries

	Coefficient	SE	p	95% confidence interval		Semi-elasticity (% change in y for 1 unit increase in x)
ln_gdpcapus	0.676	0.080	< 0.001	0.518228	0.8336996	N/A
ln_extcapus	0.062	0.038	0.096	-0.0111286	0.1358789	N/A
ggeofgdp	0.023	0.004	< 0.001	0.0147452	0.0306518	2.30
pop14	-0.041	0.015	0.005	-0.0700707	-0.0125853	-4.05
hivprev	0.000	0.011	0.965	-0.0208354	0.0217774	0.05
time	0.023	0.011	0.038	0.0012509	0.0454554	2.36
_cons	-46.994	22.761	0.039	-91.60428	-2.384387	

Ln(gdpcapus) = Log_e of gross domestic product in current US$ per capita, Ln(extcapus) = Log_e of rest of the world funds / External resources in current US$ per capita; ggeofgdp = General Government Expenditure (GGE) as % of Gross Domestic Product (GDP); pop14 = Population ages 0-14 (% of total); hivprev = Prevalence of HIV (% of total population ages 15-49); time = Year (2005 – 2014); _cons = constant; SE = standard error; and p = p-value of z-test. Overall R-squared = 0.8845. Number of countries = 6. Number of observations = 60.

Figure 7. Histogram of residuals of Pooled OLS regression (Part C)



SWILK test: p-value <0.001

Table 6. Various health financing indicators by country, 2014

Country	Total Health Expenditure (THE) per Capita in US$	General Government Health Expenditure (GGHE) per Capita in US$	Gross Domestic Product in current US$ per capita	General Government Health Expenditure (GGHE) as % of Total Health Expenditure	General Government Health Expenditure (GGHE) as % of General government expenditure (GGE)	External Resources on Health as % of Total Health Expenditure (THE)	Out of Pocket Expenditure (OOPS) as % of Total Health Expenditure (THE)	General Government Health Expenditure (GGHE) as % of Gross Domestic Product (GDP)
Algeria	361.7	263.2	5019.0	72.8	9.9	<	26.5	5.2
Angola	179.4	115.2	5423.6	64.3	5.0	2.6	24.0	2.1
Benin	37.9	18.6	824.7	49.0	9.6	25.8	39.1	2.3
Botswana	385.3	227.4	7119.6	59.0	8.8	10.1	5.2	3.2
Burkina Faso	35.2	18.4	709.6	52.3	11.2	25.3	39.1	2.6
Burundi	21.6	11.4	286.0	52.7	13.2	50.3	21.0	4.0
Cabo Verde	173.3	129.5	3641.1	74.7	11.7	23.6	22.2	3.6
Cameroon	58.7	13.4	1429.3	22.9	4.3	11.1	66.3	0.9
Central African Republic	15.6	7.6	371.1	49.0	14.2	45.7	46.2	2.1
Chad	37.1	20.3	1024.7	54.6	9.0	19.4	39.2	2.0
Comoros	56.8	18.7	841.2	32.9	8.7	30.7	45.1	2.2
Congo	161.6	132.2	3137.8	81.8	8.7	4.0	17.5	4.2
Côte d'Ivoire	88.4	25.9	1545.9	29.4	7.3	9.4	50.8	1.7
Democratic Republic of the Congo	19.1	7.0	440.2	36.9	11.1	37.8	38.8	1.6
Djibouti	190.8	121.9	1805.0	63.9	14.1	9.9	35.8	6.8
Egypt	177.8	67.9	3150.7	38.2	5.6	1.3	55.7	2.2
Equatorial Guinea	663.1	511.2	17430.1	77.1	7.0	<	20.1	2.9
Eritrea	25.2	11.5	754.9	45.8	3.6	28.5	54.2	1.5
Ethiopia	26.6	15.6	545.6	58.7	15.7	41.7	32.3	2.9
Gabon	321.3	219.7	9347.9	68.4	7.4	0.8	21.9	2.4
Gambia	30.7	21.1	418.6	68.7	15.3	45.5	17.0	5.0
Ghana	57.9	34.6	1627.4	59.8	6.8	15.4	26.8	2.1
Guinea	30.5	14.8	539.6	48.5	9.0	12.6	45.3	2.7
Guinea-Bissau	37.3	7.6	666.5	20.5	7.8	25.4	49.5	1.1
Kenya	77.7	47.6	1358.3	61.3	12.8	27.5	26.1	3.5
Lesotho	105.1	80.0	990.0	76.1	13.1	52.2	16.5	8.1
Liberia	46.3	14.6	461.0	31.5	11.9	49.1	30.7	3.2
Libya	371.7	273.4	7480.9	73.5	4.9	<	26.5	3.7
Madagascar	13.7	6.6	449.5	48.4	10.2	39.8	41.4	1.5

Malawi	29.0	15.3	255.0	52.7	16.8	73.8	10.6	6.0
Mali	48.7	13.6	696.1	28.0	7.0	27.2	46.0	2.0
Mauritania	48.8	24.2	1294.5	49.6	6.0	11.9	43.8	1.9
Mauritius	482.5	237.2	10031.2	49.2	10.0	3.8	46.4	2.4
Morocco	190.1	64.4	3217.0	33.9	6.0	1.6	58.4	2.0
Mozambique	42.0	23.7	602.1	56.4	8.8	48.7	9.5	3.9
Namibia	200.5	200.5	:	60.0	13.9	8.0	7.2	5.4
Niger	25.3	10.0	419.1	39.6	5.6	14.4	54.7	2.4
Nigeria	117.5	29.6	3203.2	25.1	8.2	6.7	71.7	0.9
Rwanda	52.5	20.0	696.9	38.1	9.9	46.2	28.1	2.9
Sao Tome and Principe	:	:	:	43.2	12.4	35.4	11.2	3.6
Senegal	49.5	25.7	1061.8	51.8	8.0	20.6	37.3	2.4
Seychelles	494.1	455.6	14663.4	92.2	9.7	4.3	2.3	3.1
Sierra Leone	85.9	14.6	774.6	17.0	10.8	17.1	61.0	1.9
South Africa	570.2	275.0	6481.8	48.2	14.2	1.8	6.5	4.2
South Sudan	30.0	12.5	1097.3	41.5	4.0	42.4	54.2	1.1
Sudan	129.8	27.8	1540.5	21.4	11.6	2.6	75.5	1.8
Swaziland	247.9	187.7	2679.4	75.7	16.6	21.7	10.3	7.0
Togo	33.9	13.0	645.9	38.4	7.8	23.4	46.2	2.0
Tunisia	305.3	173.0	4359.1	56.7	14.2	<	37.7	4.0
Uganda	52.3	13.0	724.1	24.9	11.0	:	41.0	1.8
United Republic of Tanzania	51.7	24.0	926.8	46.4	12.3	35.9	23.2	2.6
Zambia	85.9	47.5	1721.6	55.3	11.3	38.4	30.0	2.8
Zimbabwe	55.9	22.1	931.2	38.3	8.5	:	35.9	2.5