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Indirect cost of maternal mortality in the WHO African Region, 2013

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Abstract

Purpose – The purpose of this paper is to estimate discounted value of potential non-health gross domestic product (GDP) losses attributable to the 167,913 maternal deaths that occurred among 45 countries in the WHO African Region in 2013.

Design/methodology/approach – A cost-of-illness method was used to estimate non-health GDP losses related to maternal deaths. Future non-health GDP losses were discounted at 3 per cent. The analysis was undertaken for countries categorized under three income groups.

Findings – The discounted value of future non-health GDP loss due to maternal deaths in 2013 is in the order of Int$5.53 billion. About 17.6 per cent of that occurred in countries in the high and upper income group, 45.7 per cent in the middle income group and 36.7 per cent in the lower middle income group, and the average non-health GDP loss per maternal death was Int$136,799, Int$43,304 and Int$19,822, respectively.

Research limitations/implications – This study omitted costs related to direct health care, direct non-health care treatment, patient time for treatment, informal caregivers' time, intangible costs such as pain and grief, lost output due to morbidity, and negative externalities on the family and community.

Social implications – The study demonstrated that maternal deaths have a sizable negative effect on non-health GDP of the region, implying that maternal mortality is not only a human rights concern but also an economic issue and that universal coverage of maternal health interventions ought to be an imperative goal in all countries.

Originality/value – This paper provides new evidence on the impact of maternal deaths on non-health GDP of 45 countries in the WHO African Region.

Keywords African region, Discounted value of potential non-health GDP loss, Maternal mortality
Paper type Research paper

Background

WHO defines maternal death as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes (World Health Organization (WHO), 2010a, b, c). Out of the 289,000 maternal deaths that occurred globally in 2013, 170,913 (59 per cent)

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were borne by the WHO African Region (World Health Organization (WHO), 2013a, b). About 28 per cent of the Region's maternal deaths were from pre-existing medical conditions such as diabetes, malaria, HIV and obesity exacerbated by pregnancy, 27 per cent from severe bleeding, 14 per cent from pregnancy-induced high blood pressure, 11 per cent from infections mostly after childbirth, 9 per cent from obstructed labour and other direct causes, 8 per cent from abortion complications, and 3 per cent from blood clots (World Health Organization (WHO), 2014a). Compared with other WHO regions, African Region's average maternal mortality ratio (MMR) of 500 per 100,000 live births was 7.4-fold that of the Americas, 29.4-fold that of Europe, 2.9-fold that of Eastern Mediterranean, 2.6-fold that of South-East Asia and 11.1-fold that of Western Pacific (WHO, 2014b).

The United Nations' fifth millennium development goal (MDG5) on improving maternal health aims to give impetus to country efforts to stem maternal morbidity and mortality (United Nations, 2000). MDG5's Target 5A has as its goal to reduce MMR by 75 per cent between 1990 and 2015, requiring a 5.5 per cent annual decline rate over that period. Table I shows that by the end of 2013, out of the 45 countries that reported data, only four were on track to attain MDG5 Target 5A, meaning that they had registered a decline in MMR of 5.5 per cent or more annually; 32 were making progress, implying that their MMR declined by 2 to 5.5 per cent per year; and nine made insufficient progress, meaning that their MMR declined by less than 2 per cent annually (WHO, 2013a, b).

In total, 71 per cent of the countries in the Region are not on track to attain the Target 5A goal and this is largely explained by the fact that they are lagging behind meeting the prerequisite Target 5B, which requires universal access to reproductive health services by 2015. The regional average prevalence of contraceptive use among married women (those 15-49 years old) in 2013 was 27 per cent, with the level higher than 50 per cent in only Algeria, Botswana, Namibia, Rwanda, Swaziland and Zimbabwe and lower than 33 per cent in 26 countries (WHO, 2014b). In the Region, 25 per cent of the family planning need is unmet, 53 per cent of pregnant women do not receive antenatal care coverage of at least four visits, 52 per cent of births are not attended by skilled health personnel, and 59 per cent of mothers do not seek postnatal care within two days of childbirth (WHO, 2014b). The poor coverage of maternal health services in the Region could to a large extent be attributed to the low per capita spending on health, which stood at Int$158 – a dismal amount when compared with

Progress status	Countries in 2013
On track	Cape Verde, Equatorial Guinea, Eritrea, Rwanda (4)
Making progress	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Chad, Comoros, Congo, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Sao Tome and Principe, Senegal, Sierra Leone, South Sudan, Swaziland, Uganda, Tanzania, Zambia (32)
Insufficient progress	Cameroon, Central African Republic, Cote d'Ivoire, Democratic Republic of Congo, Kenya, Lesotho, South Africa, Togo, Zimbabwe (9)

Notes: Data were not available for Seychelles. Mauritius with an MMR of less than 100 in 1990 is not categorized

Source: WHO *et al.* (2013)

Table I.
Progress of WHO African Region countries toward MDG5A in 2013

Int$3,542 for the Americas Region (WHO, 2014b) – and the low level of financing for maternal and child health (Schaferhoff *et al.*, 2010).

The fact that majority of countries are not on track to achieve MDG5 Targets 5A and 5B, largely owing to a paucity of requisite investments, calls for studies on the cost-of-illness such as the one reported in this paper. This can then be used by the ministries of health in advocacy to the ministries of finance, development partners and the private sector to increase investments for maternal health services (WHO Regional Office for Africa, 2008). Furthermore, Saha and Gerdtham (2013) and Islam and Gerdtham (2006) have documented the need for data to fill the global knowledge gaps in cost-of-illness studies on maternal and newborn illness and mortality.

A study in 2005 (Kirigia *et al.*, 2005) that estimated the impact of maternal deaths on gross domestic product (GDP) of the WHO African Region using econometric modelling found that maternal mortality of a single person reduced per capita GDP by US$0.36 per year. We concur with authors such as Chisholm *et al.* (2010) who have argued that if the research question is:

RQ1. What is the economic impact of maternal deaths on macro-economy (society)?

Then the quantity of interest should be the impact of maternal deaths on non-health components of GDP. This is because we are interested in the indirect effect of mortality or morbidity on non-health consumption opportunities, since the use of health services or goods does not generate utility or welfare *per se* (Grossman, 1972). In addition, as Chisholm *et al.* (2010) contend, "[…] the quantity of interest cannot be GDP, because medical care and health expenses actually form part of GDP; instead […] a more appropriate quantify of interest would be the impact of disease or injury on the non-health components of GDP" (p. 584). This is also consistent with the stipulation of the WHO guide for quantifying the economic consequences of disease and injury (World Health Organization (WHO), 2009).

The WHO Regional Committee for Africa at its 58th session in Yaoundé, Cameroon, 1-5 September 2008 adopted resolution AFR/RC58/R1 that requested the WHO Regional Office for Africa to establish a commission on women's health to generate evidence on the impact of improving women's health on socioeconomic development, for better advocacy and policy action (WHO Regional Office for Africa, 2008). This paper is an updated and refined version of the contribution made to the report of the Commission on Women's Health in the WHO African Region in 2012.

A new study on the WHO African Region's economic burden of maternal mortality was needed also to address the questions left out by the econometric study of 2005 (Kirigia *et al.*, 2005), which measured losses in GDP instead of non-health GDP as recommended by WHO guidelines. Additionally, that study is almost a decade old. Estimates of losses in non-health GDP using the latest maternal mortality figures for the African Region are needed for use in advocacy to governments, development partners and other stakeholders to ensure that domestic and external investments for tackling the maternal morbidity and mortality problem are sustained or increased in the post-2015 MDG era. The methodology used in this study could be applied, with appropriate adaption, in estimating the economic burden of deaths attributable to other causes such as childhood illnesses, neglected tropical diseases and non-communicable diseases.

This study contributes to bridging of some of the knowledge gaps by answering the question: What is the impact of maternal deaths on non-health GDP in the WHO African Region in 2013? It estimates non-health GDP losses attributable to the 167,913

maternal deaths that occurred among 45 of the 47 countries in the WHO African Region. The amounts reported in this paper do not reflect the loss of non-health GDP that occurred only in 2013 due to maternal deaths. Instead, they reflect the loss of potential GDP in the future years of lives of these women revalued relative to year 2013.

Methods

Conceptual framework

Maternal deaths lead to losses in current and future production; income; consumption of non-health goods and services and leisure time; and have adverse effect on survival of children in a family (Anderson *et al.*, 2007). The main means through which maternal deaths impact macroeconomic output include increased health expenditure, losses in labour and productivity and reduced investment in human and physical capital formation (WHO, 2009). This study uses a macroeconomic – or societal – perspective, its scope is limited to market economy losses (GDP), its quantity of interest is the impact of maternal deaths on non-health components of GDP, and its estimation method is the cost-of-illness model capturing the effects across all sectors of the economy (Chisholm *et al.*, 2010).

GDP, the total value of all marketed final goods and services produced in an economy in a year (Fischer *et al.*, 1996), can also be viewed as the sum of personal consumption expenditures, gross private investment, government consumption spending, and net exports (exports minus imports). Maternal deaths reduce spending on goods and services (effective demand); the female labour force; household savings needed by investors; number of actual tax payers, which erodes the current and future tax revenues; and quantities of exports, decreasing earnings from exports.

The potential non-health GDP loss (*TNHGDPLoss*) due to maternal deaths in a country is the sum of the potential non-health GDP loss due to maternal deaths among those under 15 years of age ($NHGDPLoss_{<15}$) and those aged 15-49 years ($NHGDPLoss_{15\text{-}49}$), i.e. the reproductive age group. Estimates on maternal deaths among adolescents aged below 15 years and women in the reproductive age group were undertaken for comparative purposes and to provide data for use in advocacy to curb early adolescent pregnancies (Gillmore *et al.*, 1997).

The potential non-health cost of maternal deaths among persons of a specific age group is the product of the total discounted life years lost, per capita non-health GDP in purchasing power parity (PPP) and the total maternal deaths. The symbolic form used for calculating each country's discounted value of potential non-health GDP loss due to maternal deaths is shown in the following equations:

$$TNHGDPLoss = (NHGDPLoss_{<15} + NHGDPLoss_{15-49}) \tag{1}$$

$$\begin{aligned} NHGDPLoss_{<15} &= \sum_{t=1}^{n} \left\{ \left[1/(1+r)^{t}\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{<15}\right] \right\} \\ &= \left\{ \left[1/(1+r)^{1}\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{<15}\right] \right\} \\ &\quad + \left\{ \left[1/(1+r)^{2}\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{<15}\right] \right\} + \ldots \\ &\quad + \left\{ \left[1/(1+r)^{n}\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{<15}\right] \right\} \end{aligned} \tag{2}$$

$$NHGDPLoss_{15-49} = \sum_{t=1}^{n} \left\{ \left[1/(1+r)^t\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{15-49}\right] \right\}$$

$$= \left\{ \left[1/(1+r)^1\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{15-49}\right] \right\}$$

$$+ \left\{ \left[1/(1+r)^2\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{15-49}\right] \right\}$$

$$+ \ldots + \left\{ \left[1/(1+r)^n\right] \times \left[NHGDPPC_{\text{Int\$}}\right] \times \left[TMD_{15-49}\right] \right\} \quad (3)$$

where: $1/(1+r)^t$ is the discount factor; r is the rate of discount expressed in decimals; $\sum_{t=1}^{n}$ is the summation from year t to n; t is the first year of life lost, and n is the final year of the total number of years of life lost per maternal death, which is obtained by subtracting the average age at death (AAD) for pregnancy- or childbirth-related causes from each country's average female life expectancy at birth; $NHGDPPC_{\text{Int\$}}$ is per capita non-health GDP in PPP, which is obtained by subtracting per capita total health expenditure (*PCTHE*) from per capita GDP ($GDPPC_{\text{Int\$}}$); $TMD_{<15}$ is the total maternal deaths among women under the age of 15 years in country j in 2013; $TMD_{15\text{-}49}$ is the total maternal deaths among 15-49 year old women in country j in 2013.

Conventionally, the GDP losses in earlier years are valued more highly than losses in later years. The process of discounting applies a weight (known as discount factor) to the GDP losses in different years to convert them to a common basis. In this study 2013 was used as the base year to which losses occurring in future years were discounted to. The magnitude of discount factor decreases as one move from the base year into the future years; and consequently, losses in successive years are given a lower value relative to the same losses in the first year. The weight (discount factor) applied to the GDP losses of different years then depends not just upon the discount rate, r, but also on the number of years, t, over which the discounting is conducted. When discounting is applied so that all GDP losses are revalued relative to year zero (i.e. 2013 in this study), the revalued resources are called present values (Curry and Weiss, 1993).

Per capita non-health GDP in PPP for each of the 45 countries in the WHO African Region was obtained by subtracting *PCTHE* from per capita GDP.

Illustration of calculation of loss in total non-health GDP

The example below on calculation of maternal death-related loss in non-health GDP uses actual information on Kenya:

(1) total maternal deaths in Kenya in 2013 = 6,300;

(2) proportion of deaths among mothers aged under 15 years = 0.0112463248322502;

(3) proportion of deaths among mothers aged 15-49 years = 0.98875367516775;

(4) $TMD_{<15} = 6{,}300 \times 0.0112463248322502 = 70.8518$;

(5) $TMD_{15\text{-}49} = 6{,}300 \times 0.98875367516775 = 6{,}229.14616$;

(6) AAD among mothers aged below 15 years ($AAD_{<15}$) = 13 years;

(7) AAD among mothers aged 15-49 years ($AAD_{15\text{-}49}$), i.e. (15+49)/2 = 32 years;

(8) Kenya's average female life expectancy at birth (LE) = 62 years;

(9) per capita GDP ($GDPPC_{\text{Int\$}}$) = Int$1,857.562;

(10) $PCTHE$ = Int$88;

(11) $NHGDPPC = GDPPC_{\text{Int\$}} - PCTHE$ = Int$1,857.562−Int$88 = Int$1,769.562;

(12) discount rate (r) = 3 per cent;

(13) undiscounted years of life lost in the group aged under 15 years ($YLL_{<15}$) = LE−$AAD_{<15}$ = 62–13 = 49 years;

(14) discounted years of life lost in the group aged under 15 years ($YLL_{<15}$) = 25.50164;

(15) undiscounted years of life lost in the group aged 15-49 years ($YLL_{15\text{-}45}$) = LE−$AAD_{15\text{-}49}$ = 62–32 = 30 years;

(16) discounted years of life lost in the group aged 15-49 years ($YLL_{15\text{-}49}$) = 19.60044;

(17) $NHGDPLoss_{<15}$ = Discounted $YLL_{<15} \times NHGDPPC_{\text{Int\$}} \times TMD_{<15}$ = 25.50164 × 1,769.562×70.8518 = Int$3,197,310;

(18) $NHGDPLoss_{15-49}$ = Discounted $YLL_{15\text{-}49} \times NHGDPPC_{\text{Int\$}} \times TMD_{15-49}$ = 19.60044 × 1,769.56 × 6,229.14616 = Int$216,052,668; and

(19) $TNHGDPLoss = (NHGDPLoss_{<15} + NHGDPLoss_{15\text{-}49})$ = Int$3,197,310+Int $216,052,668 = Int$219,249,977.

These calculations will be much simpler and less liable to estimation errors if the formulas are built in Excel software.

Data sources and analysis

The data used to estimate Equations (1)-(3) were obtained from five sources: the female life expectancy at birth data were from WHO life tables for Member States (WHO, 2014c); the proportions of maternal deaths occurring in the age groups were from the WHO disease and injury regional estimates database (World Health Organization (WHO), 2004); the total maternal deaths were from WHO *et al.* (2013); the per capita GDP in PPP value was from the International Monetary Fund database (International Monetary Fund (IMF), 2014); and *PCTHE* data were from the World Health Statistics, 2014 (WHO, 2014b).

The algorithm used in estimation of non-health GDP losses (Equations (1)-(3)) was built in an Excel spreadsheet. For the analysis, the countries were put into three economic groups as shown in Table II, with high and upper middle income countries in Group 1, lower middle income countries in Group 2 and low-income countries in Group 3. Doing the calculations for the countries by income group aimed to facilitate comparison. In addition, we wanted to test the plausibility of the common assumption that since relatively few maternal deaths occur among Group 1 countries they should not be as concerned as low-income countries about economic losses related to maternal deaths.

Results and discussion

Table III presents the WHO African Region' population and maternal deaths by economic group in 2013.

An estimated 167,913 maternal deaths incurred in 45 of the 47 countries in the WHO African Region Economic data for South Sudan and maternal deaths for Seychelles

Group	GNI per capita (US$)	Countries
Group 1: high income and upper middle income	⩾4,086	Algeria, Angola, Botswana, Equatorial Guinea, Gabon, Mauritius, Namibia, Seychelles[a], South Africa (9)
Group 2: lower middle income	1,036-4,085	Cameroon, Cape Verde, Congo, Cote d'Ivoire, Ghana, Lesotho, Mauritania, Nigeria, Sao Tome and Principe, Senegal, Swaziland, Zambia (12)
Group 3: low income	1,036 or less	Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, DRC, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, South Sudan[b], Togo, Uganda, United Republic of Tanzania, Zimbabwe (26)

Table II.
Economic classification of countries in 2013

Notes: [a]Maternal mortality data were not available, and so the country was not included in the analysis; [b]GDP data were not available and so the country was excluded from the analysis
Source: World Bank (2014)

Group/economic class	Population	Maternal deaths
Group 1: high income and upper middle income	121,453,000	7,124
Group 2: lower middle income	287,116,000	58,339
Group 3: low income	511,414,000	102,450
Grand total	919,983,000	167,913

Table III.
Population and maternal deaths by economic group in WHO African Region countries in 2013

Note: Data for Seychelles and South Sudan are not included
Sources: WHO (2014b) and WHO *et al.* (2013)

were not available, so these countries were omitted from the analysis. About 4 per cent of those deaths were borne by high and upper middle income countries (Group 1), 35 per cent by lower middle income countries (Group 2) and 61 per cent by low-income countries (Group 3). The average number of maternal deaths per country was 3,731 (STD = 6,717) with a wide variation, ranging from five in Cape Verde to 40,000 in Nigeria. The regional average female life expectancy at birth was 61 years (STD = 7), with a minimum of 46 years in Sierra Leone and a maximum of 78 years in Mauritius. The average non-health GDP per capita in the Region was Int$4,171.6 (STD = 5,996.8), varying from Int$357 in Democratic Republic of Congo to Int$24,242 in Equatorial Guinea.

Non-health GDP loss attributable to maternal deaths

As depicted in Table IV, the 167,913 maternal deaths that occurred in the African Region in 2013 resulted in a potential non-health GDP loss of Int$5,531,646,307. Out of this, 1.2 per cent occurred among women aged below 15 years and 98.8 per cent among women aged 15-49 years. About 17.6 per cent of the loss was in Group 1 countries, 45.7 per cent in Group 2 and 36.7 per cent in Group 3. The average potential non-health GDP loss was Int$32,944 per maternal death. There was a wide range in the total non-health GDP loss across the Region, varying from Int$529,651 in Cape Verde to Int $1.75 billion in Nigeria. As mentioned earlier, the estimates reported in this paper reflect discounted value of loss of non-health GDP in the future years of lives of these women.

Countries	Non-health GDP loss (Int$)
Algeria	138,273,706
Angola	400,698,515
Benin	37,721,593
Botswana	25,667,587
Burkina Faso	72,130,736
Burundi	35,113,189
Cameroon	196,462,209
Cape Verde	529,651
Central African Republic	14,420,633
Chad	216,829,543
Comoros	2,215,260
Congo	60,994,372
Cote d'Ivoire	141,156,292
Democratic Republic of Congo	116,126,197
Equatorial Guinea	33,463,936
Eritrea	12,788,534
Ethiopia	347,295,620
Gabon	49,645,321
Gambia	12,664,793
Ghana	216,097,859
Guinea	54,239,564
Guinea-Bissau	7,197,895
Kenya	219,249,977
Lesotho	8,359,179
Liberia	11,805,675
Madagascar	66,777,680
Malawi	49,541,303
Mali	73,247,780
Mauritania	18,628,698
Mauritius	4,159,024
Mozambique	89,056,989
Namibia	13,544,180
Niger	82,030,602
Nigeria	1,749,698,854
Rwanda	38,156,634
Sao Tome and Principe	636,150
Senegal	70,628,913
Sierra Leone	33,384,176
South Africa	309,106,371
Swaziland	10,403,712
Tanzania	252,774,937
Togo	21,677,796
Uganda	144,210,852
Zambia	52,696,512
Zimbabwe	20,137,308
Total loss (Int$)	5,531,646,307

Notes: The 2013 estimates are Int$160,130,164 more than those in table 5.2 of the WHO Regional Office for Africa (2012) report entitled addressing the challenge of women's health in Africa. The report contains estimates calculated using 2008 maternal mortality and GDP data

Table IV.
Discounted values of future non-health GDP losses from maternal deaths among WHO African Region countries in 2013 (Int$ or PPP)

Group 1 countries' non-health GDP loss. The 7,124 maternal deaths in Group 1 countries led to a potential loss of Int$974,558,639 in non-health GDP, which was equivalent to 0.09 per cent of the group's total GDP in 2013. The potential productivity loss varied widely, ranging from Int$4.2 million in Mauritius to Int$309.1 million in South Africa. Figure 1 presents the distribution of the Group 1 potential non-health GDP loss across the eight high and upper middle income countries. About 31.7 per cent of the group's loss was borne by South Africa.

Group 2 countries' non-health GDP loss. The 58,339 maternal deaths in Group 2 countries resulted in a potential loss of Int$2,526,292,401 in non-health GDP, equivalent to 0.3 per cent of the group's total GDP in 2013. The loss ranged from Int$529,651 in Cape Verde to Int$1.75 billion in Nigeria. Figure 2 shows the distribution of the Group 2 potential non-health GDP loss across the 12 lower middle income countries. Approximately 69 per cent of Group 2 loss was borne by Nigeria.

Group 3 countries' non-health GDP loss. The 102,450 maternal deaths in Group 3 resulted in a potential loss of Int$2,030,795,267 in non-health GDP in 2013. The loss

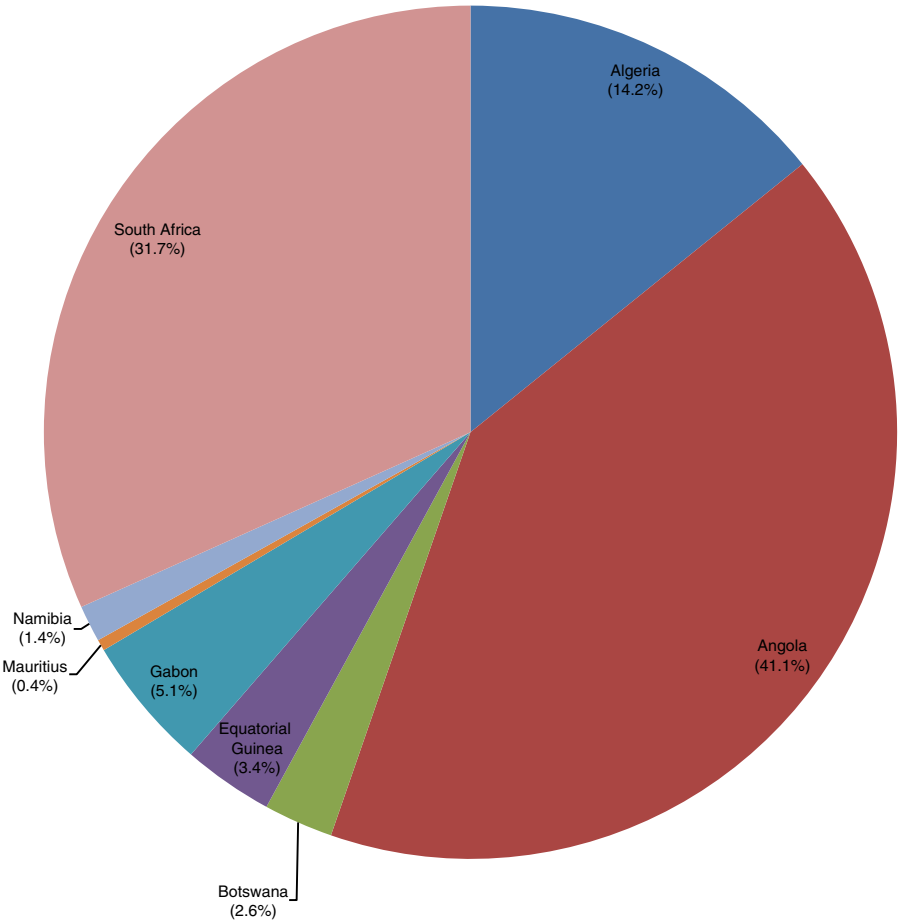

Figure 1.
Group 1 discounted value of potential non-health GDP loss across the eight high and upper middle income countries

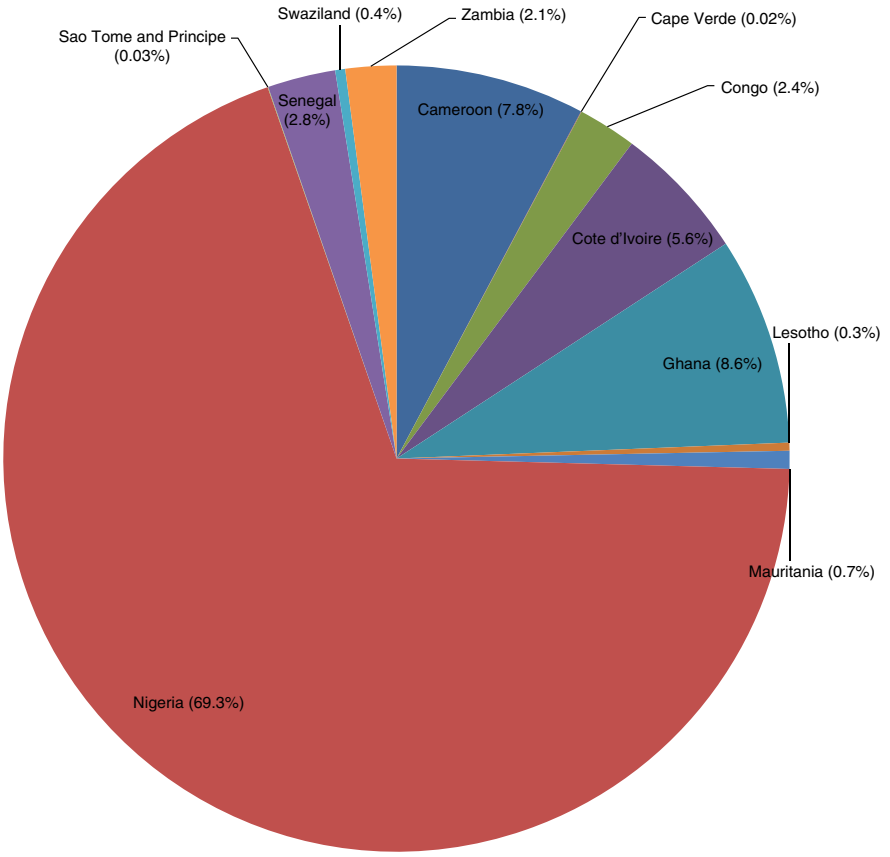

Figure 2.
Group 2 discounted value of potential non-health GDP loss across the 12 lower middle income countries

varied from Int$2.2 million in Comoros to Int$347.3 million in Ethiopia, which bore 17 per cent of the group's loss. Figure 3 portrays the distribution of Group 3 potential non-health GDP loss across the 25 low-income countries. Chad, Ethiopia, Kenya, Tanzania and Uganda combined accounted for almost 58.1 per cent of the loss in this group. Even though Group 3 has 44,111 more maternal deaths than Group 2, the non-health GDP loss of Group 2 is higher than that of Group 3 by Int$495,497,134 due to higher per capita GDP in Group 2.

Average potential GDP losses. Table V portrays averages for potential non-health GDP loss per maternal death and per person in the population for the 45 countries. These values were obtained by dividing a group's potential productivity loss by its total maternal deaths. The average potential non-heath GDP loss per person in the population for each group was calculated by dividing the group's potential GDP loss by its population (see Table II).

The average potential non-health GDP lost per maternal death was Int$136,799 for Group 1, Int$43,304 for Group 2 and Int$19,822 for Group 3. The average potential non-health GDP loss per person in the population was Int$8 for Group 1, Int$8.80 for Group 2 and Int$4 for Group 3. The average potential non-health GDP lost per maternal death in Group 1 was about three times that of Group 2 and almost seven times that of Group 3.

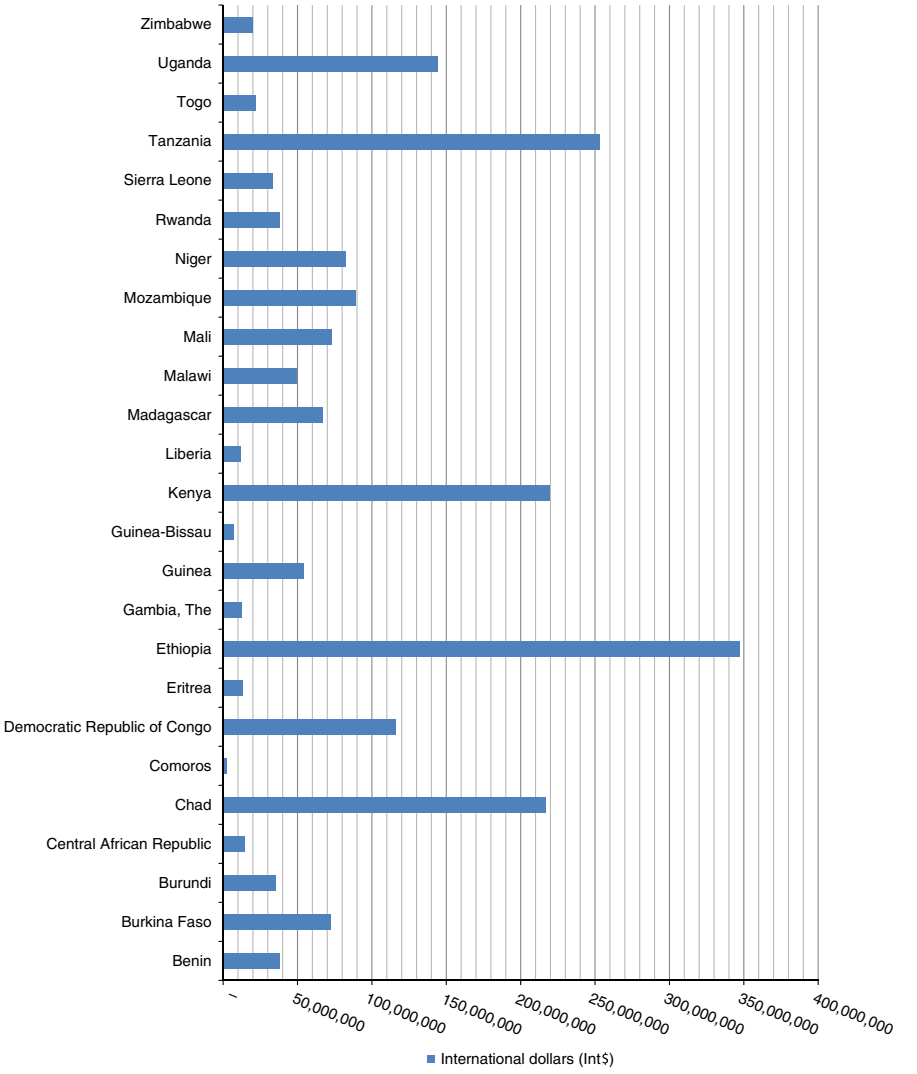

Figure 3.
Group 3 discounted value of potential non-health GDP loss across the 25 low income countries

Table V.
Discounted values of future non-health GDP lost due to maternal deaths in 2013 by economic group

Cost item	Group 1 (Int$)	Group 2 (Int$)	Group 3 (Int$)	Total cost (Int$)
Total cost of maternal deaths	974,558,639	2,526,292,401	2,030,795,267	5,531,646,307
Average cost per maternal death	136,799	43,304	19,822	32,944
Average cost per person in population	8	8.80	4	6

The main driver of productivity loss is the size of per capita GDP. For example, even though the maternal deaths in the middle income countries like Botswana, Cape Verde, Equatorial Guinea, Mauritius and Namibia totalled only 83, 5, 79, 11 and 81, respectively, the potential non-health GDP loss per maternal death for these countries were substantial at Int$309,248, Int$105,930, Int$423,594, Int$378,093 and Int$167,212, respectively. Low-income countries such as Burundi, Democratic Republic of Congo, Mozambique, Niger and Zimbabwe with relatively high total maternal deaths of 3,400, 21,000, 4,800, 5,600 and 2,100 have comparatively low-productivity losses per maternal death of Int$10,327, Int$5,530, Int$18,554, Int$14,648 and Int$9,589, respectively.

Sensitivity analysis

Economic evaluation studies in African countries such as that by Kirigia (2009) and the WHO health systems' performance assessment (World Health Organization (WHO), 2000), as well as global burden of disease studies, for example that by WHO (2013c) commonly use a discount rate of 3 per cent. That rate was used also in this study. However, to gauge the effect of the discount rate on potential non-health GDP loss estimate, a one-way sensitivity analysis was conducted at 5 and 10 per cent discount rates. Use of a 5 per cent discount rate reduced the potential non-health GDP loss by Int $1,084,264,721 (19.6 per cent) and the average potential non-health cost per maternal death by Int$6,457, whilst application of the 10 per cent discount rate decreased the potential non-health GDP loss by Int$2,684,309,763 (48.5 per cent) and the average potential non-health cost per maternal death by Int$15,986. This signifies that the magnitude of the potential economic loss is partially dependent on the discount rate used.

The under 15 years maternal deaths in Africa occur between 12 and 14 years. For this group we used 13 years (a simple average) as the AAD. For reproductive age bracket of 15-49 years, we used 32 (a simple average) as the AAD for this group. These simple averages were used due to dearth of data on age distribution of maternal deaths. However, since the distribution of maternal deaths is unlikely to be uniform over the under 15 and 15-49 years, a sensitivity analysis was conducted to determine the effect of age on the potential non-health GDP loss estimate. First, the model was re-estimated assuming under 15 average age of 12 years (i.e. the minimum) and 15 years (i.e. the minimum) for 15-49 bracket. The use of these average ages increased the potential non-health GDP loss by Int$1,950,421,091, i.e. a 35.3 per cent increase. Second, the model was re-estimated assuming average age of 14 years (i.e. the maximum) for under 15 and 49 years (i.e. the maximum) for 15-49 bracket. The use of these averages reduced the potential non-health GDP loss by Int$3,216,463,820, i.e. −58.1 per cent. This implies that the magnitude of the total economic loss is also partially dependent on the average age of onset of maternal death used. Therefore, there is need for more investments in research to come up with more reliable data on age distribution of maternal deaths in Africa.

Limitations of the study

Cost-of-illness studies like the one reported in this paper are not a basis for setting public health priorities but rather a way of highlighting the economic losses resulting from maternal deaths to balance the traditional epidemiological assessment of morbidity and/or mortality (Shiell *et al.*, 1987; Drummond, 1992). As such, the purpose of our study was not to guide priority setting but rather to raise the awareness of the

public and policy-makers in the ministries of health and finance on the impact of losses in non-health GDP attributable to maternal deaths in the Region.

Our study is a partial cost-of-illness analysis since it did not include direct health care costs related to drugs, tests, supplies, hospital personnel and facilities; direct non-health care costs of treatment such as dietary supplement, prescription and transport to and from the health service provider; patient time costs for treatment related to travel, waiting and treatment time; cost of time informal caregivers, volunteers, family or friends spend accompanying or visiting the sick person; costs of production lost due to morbidity; and intangible costs such as pain and grief (Islam and Gerdtham, 2006; Rice, 1967). Intangible costs can only be obtained through willingness-to-pay surveys (Ternent *et al.*, 2010; Kirigia, 2009).

In this study, the numbers of years of life lost were obtained by subtracting the age at death from life expectancy at birth. It could be argued that life expectancy at the age of death would be a more appropriate measure than life expectancy at death. However, this data are not readily available.

The contribution to GDP in the sense studied in this paper can vary dramatically across population groups in a country. Since the median country values for use of modern contraceptive methods, antenatal care coverage of at least four visits, and birth attendance by skilled personnel were, respectively 1.8-fold, 1.9-fold and 2.2-fold lower among women in the lowest wealth quintile than among those in the highest wealth quintile (WHO, 2014b), it is likely that maternal deaths are higher in the lower income groups whose per person contribution to GDP is lower. Therefore, using the average GDP for all wealth or income groups may impart an upward bias to the estimates, and this might be particularly large for Groups 1 and 2 countries.

This study did not quantify the impact of a woman's death on her children's health, education and economic status, and the important roles women play within their families and communities. We concur that, ideally, to be comprehensive the costs of failing to address preventable maternal mortality ought to include intergenerational impacts on nutrition, health and education of children, as well as on the economic capacity of families (Yamin *et al.*, 2013).

It is common knowledge that the vital registration systems of births and deaths in many countries in the African Region are weak and are the reason that even the maternal mortality estimates contained in the WHO, UNDP, UNICEF and World Bank reports are projections based on a combination of second-best methods, such as sisterhood methods. Weak routine information systems, inadequate vital registration and reliance on periodic household surveys as the main source of population-based data are all familiar obstacles in improving public health in poor countries (Godlee *et al.*, 2004).

Due to methodological problems stated in the paper, the estimates reported might not be taken literally, but be treated as indicative of the broad order of magnitudes.

Conclusions

The estimated potential non-health GDP loss attributed to maternal deaths of Int$5.53 billion is about 0.25 per cent of Int$2,226.39 billion, the combined 2013 GDP of the 45 African countries (IMF, 2014). The estimate signifies the loss of potential GDP in the future years of life lost among the 167,913 maternal deaths revalued relative to base year 2013, i.e. present values.

Owing partly to the various public health and development actions in Sub-Saharan Africa by governments and development partners, there has been a large reduction in maternal deaths, going from 222,000 in 1990 to 179,000 in 2013, and resulting in a

decline of the MMR from 990 to 510 (WHO *et al.*, 2013). Multiplying the 43,000 maternal lives saved between 1990 and 2013 by Int$32,944, the average potential non-health GDP loss per maternal death, yields Int$1.417 billion, the potential savings in non-health GDP in sub-Saharan Africa. The magnitude of non-health GDP losses avoided in the WHO African Region between 1990 and 2013 could not be estimated due to lack of data on total number of maternal deaths in 1990.

Majority of the maternal deaths and the associated economic loss could have been averted if all pregnant women had access to the existing and cost-effective maternal and neonatal health interventions (Adam *et al.*, 2005; Pathmanathan *et al.,* 2003; Bhutta and Black, 2013; WHO, 2010b). In a nutshell, what is needed to save more lives is functional health systems that ensure access to quality care before, during and after childbirth; essential medicines such as antibiotics and oxytocin; safe blood supplies; contraception and safe abortion services; and surveillance to ensure that every death is counted and its cause recorded (WHO, 2014a; Commission on Information and Accountability for Women's and Children's Health, 2011; Independent Expert Review Group, 2012, 2013; Ki-Moon, 2010).

The economic burden and human rights considerations underscore the urgent need for concerted efforts of governments, development partners, the private sector and civil society to fully implement decisions and resolutions on women's health from the African Union (African Union, 2003, 2010; Sambo *et al.*, 2011), the WHO Regional Committee for Africa (WHO Regional Office for Africa, 2004, 2013), the World Health Assembly (WHO, 2010c, 2012a, b), and the United Nations (United Nations Human Rights Council, 2009, 2012; United Nations General Assembly, 2011, 2012; United Nations Economic and Social Council, 2010; United Nations, 1979, 2009, 2010).

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