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Excess female mortality in Africa

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Abstract: Relative to developed countries, there are far fewer women than men in parts of the developing world. Estimates suggest that more than 200 million women are demographically 'missing' worldwide. To explain the global 'missing women' phenomenon, research has mainly focused on excess female mortality in Asia. However, as emphasized in our earlier research, at least 30 per cent of the missing women are 'missing' from Africa. This paper employs a novel methodology to determine how the phenomenon of missing women is distributed across Africa. Moreover, it provides estimates of the extent of excess female mortality within different age groups and by disease category. The empirical results reiterate the importance of excess female mortality for women in Africa.

Keywords: missing women, mortality, gender, Africa, health
JEL classification: D13, I15, J12, J13, J16

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1 Introduction

Building on and extending the detailed work of demographers on sex ratios, Amartya Sen (1990, 1992) coined the phrase 'missing women'. In parts of the developing world—notably in India and China—the ratio of women to men is low. From ratios to numbers is an arithmetically trivial but nonetheless hugely significant step. Sen showed how skewed sex ratios can be translated into absolute numbers of missing women by calculating the number of extra women who would be alive (in China or India) if these countries had the same ratio of women to men as developed countries. These latter countries therefore embody a counterfactual: presumably, the sex ratios in these countries reflect a situation in which men and women 'receive similar care'. Sen measured missing women by the departures from this baseline sex ratio for developed countries today.

The resulting estimates suggest that more than 200 million women are demographically 'missing' worldwide, presumably due to inequality and neglect leading to excess female mortality. But the numbers suggest more than an alarming aggregate; they also point to a geographical distribution. Sen's calculations pointed to missing women as a predominantly Asian and North African phenomenon. In contrast, sub-Saharan Africa, with a low male-to-female sex ratio, appeared to do remarkably well. In the words of Sen (1990), this region, 'ravaged as it is by extreme poverty, hunger, and famine, has a substantial excess rather than deficit of women'. He conjectured that high female participation in sub-Saharan Africa's labour force plays a role in 'linking women's gainful employment and survival prospects'. Subsequent research aiming to comprehend the missing women phenomenon focused almost exclusively on excess female mortality in Asia.

We begin our paper by addressing a conceptual issue. The Sen approach, comparing as it does the overall ratios across populations, computes the stock of missing women. Suppose, however, that we wanted to understand the distribution of missing women across different age categories, such as birth, youth, or old age. We would then need to study the 'flow' of missing women in each age category, by comparing age- and gender-specific death rates in the regions of interest with their counterparts in developing countries.

This is exactly the approach taken in Anderson and Ray (2010), where we explicitly examine how missing women are distributed across different age groups and developing regions. Our methodology essentially applies a variant of the Sen counterfactual to every age group and region. Briefly, we suppose (for each age group after birth) that the relative death rates of females to males are 'free of bias' in developed countries. So for each age group, we posit a 'reference' death rate for females, one that would obtain if the death rate of males in that state were to be rescaled by the relative death rates for males and females (in the same age group) in developed countries. We subtract this reference rate from the actual death rate for females, and then multiply by the population of females in that category. We describe the resulting distribution, as well as the aggregate numbers. This exercise enables us to address which age groups and developing regions account for the missing women that were first identified overall by Sen.

This disaggregated approach yields a remarkable finding. In sharp contrast with the earlier literature, disaggregation shows that the annual flow of missing women is actually largest in sub-Saharan Africa, despite the fact that their overall male-to-female ratio is less than unity. Expressed as a fraction of the female population, the sub-Saharan numbers are significantly higher than their Chinese and Indian counterparts.

How can these numbers be reconciled with the overall absence of missing women in sub-Saharan Africa? To understand this, we focus on one particular comparison in these age-specific calculations, which is the computation of missing females at birth. It is well known that more boys are born than girls. (Subsequently, males have higher age-specific death rates, with the overall sex ratio averaging out to around one over the population as a whole.) In developed countries, the sex ratio at birth is around 1.06. A higher number is prima facie cause for suspicion that girls may have been deliberately removed at birth. The reason for that suspicion is simple: there is absolutely no evidence that sex ratios of 1.08 or more are somehow 'natural' for, say, Indian populations. So if we see those numbers, it is reasonable to conclude that there are missing girls in the region of interest.

But what if the number is lower? This is indeed the case for sub-Saharan Africa, where the ratio at birth is as low as 1.03. What we must suspect now is whether there are missing *boys* instead. Once again, the answer necessarily depends on whether there is evidence that the lower sex ratio is somehow 'natural' for certain populations. But here we have a more assured answer: indeed, there do appear to be genetic differences that determine this ratio. For instance, the sex ratio at birth for whites in the United States is around 1.06 whereas for blacks it is 1.03, just as in sub-Saharan Africa. The available data for births to sub-Saharan parents in the United States suggests similar numbers as well. While there are variations within Africa (see e.g., Garenne 2004), the average of 1.03 appears to be well known and its 'natural' difference from non-African populations generally accepted. If we accept it as well, then no missing boys can be 'debited' from the corresponding age-specific category (birth). But given that on the whole sub-Saharan Africa has sex ratios comparable with the developed world, that must point to missing females in the other age categories. That explains the discrepancy.

In this paper, we explore how the phenomenon of missing females is distributed across Africa. We consider two age groups: zero to 14 years old, and 15 to 59 years old. With such high overall mortality rates in Africa, these two age groups comprise almost all of the excess female deaths on the continent. Overall, there are more than 1.7 million excess female deaths each year in Africa. Expressed as a fraction of the female population, the African numbers are significantly higher than their Chinese or Indian counterparts. Roughly 425,000 of these excess female deaths in Africa are in the younger age category (zero to 14 years old), while the remaining 1.3 million are in the older age category (15 to 59 years old). There is substantial regional variation in excess female mortality across the continent. In both age groupings, the largest numbers are in West Africa. In the younger age group there are almost 200,000 excess female deaths in a given year in that region, and more than 450,000 in the older age category. East Africa is next, with close to 100,000 excess female deaths at the younger ages each year, and almost 400,000 in the older age category. By comparison, North Africa has the lowest excess female mortality, with roughly 100,000 excess deaths each year across the two age categories. Although excess female mortality is extremely high in Southern Africa in the older age group, by contrast there is virtually no excess female mortality in this region for the younger age category. Likewise, relative to other regions, excess female mortality is lower in the younger age category compared with the older in East Africa.

Our methodology also allows us to explore which diseases are primarily responsible for this extreme excess female mortality across Africa. In the younger age category, almost all of these excess deaths are from infectious and parasitic diseases and respiratory infections. A primary cause of excess young female deaths is malaria, with roughly 110,000 excess female deaths from this cause alone each year. The secondary major cause is respiratory infections, with around 95,000 excess female deaths each year; then diarrhoeal diseases, with approximately 77,000 excess young female deaths each year. In the older age category, HIV is the primary killer. There are close to 800,000 excess female deaths from HIV each year across Africa, with the largest proportions found in Southern and East Africa. Maternal mortality is also a major cause, particularly in East and West Africa. There are close to 400,000 excess female deaths from this cause each year.

The significant regional variation in excess female mortality across the continent makes it difficult to provide a one-dimensional explanation for the phenomenon. Further research is needed to specifically identify the different pathways that explain these numbers. What the estimates make clear, though, is that excess female mortality is a vastly overlooked problem across Africa.

2 Methodology

2.1 Excess female mortality by age

The estimation of missing women across different age groups and countries in Africa employs the methodology developed in our previous work (Anderson and Ray 2010). Let a denote an age group in $\{1,\ldots,n\}$. Use the extra value $a = 0$ to indicate birth. For any age $a \geq 1$, deaths within that group a refer to all deaths between the ages of a - 1 and a. Let $d^m(a)$ and $d^w(a)$ represent the rates of death of men and women respectively at age a. The label ^ denotes these variables in the reference region.[1]

The unbiased death rate for women of age a in the region of interest (here, a country in Africa) is defined by:

$$u^w(a) = \frac{d^m(a)}{\hat{d}^m(a)/\hat{d}^w(a)} \tag{1}$$

The implicit idea behind the equation is that the relative male death rates across the region of interest and the reference region accurately reflect the relative cost of healthcare. Therefore the unbiased death rate for women 'should' bear the same ratio, relative to the prevailing female death rate in the reference region. That is, $u^w(a)/\hat{d}^w(a)$ should be the same as $d^m(a)/\hat{d}^m(a)$, which is exactly what [1] states.

Excess female mortality ('missing women') in the region at age a is then equal to the difference between the actual and unbiased death rates for women, weighted by the number of women in that age group:

$$mw(a) = [d^w(a) - u^w(a)]\pi(a) \tag{2}$$

where $\pi(a)$ is the starting population of women of age a.

To obtain the total number of missing women in a given year and country, mw, we aggregate across the age groups:

$$mw = \sum_{a=0}^{n} mw(a) \tag{3}$$

Following Anderson and Ray (2010), we do not impute any missing females at birth in Africa. There is substantial variation in the sex ratio at birth within sub-Saharan Africa, but Garenne's (2003) authoritative review based on surveys for two thirds of the region leads to an overall average

[1] We use the group of established market economies as defined by the World Bank: Western Europe, Canada, the United States, Australia, New Zealand, and Japan.

of 1.033.[2] Our reference range, from African ethnicities in the United States, lies between 1.030 and 1.035. Faced with these numbers, it is extremely hard to impute any missing females at birth. Perhaps careful disaggregation of the region (along with the corresponding reference ratios) might reveal more nuanced findings, but we do not have a reference sex ratio at birth for the different ethnic groups in the United States; hence this is the best that can be done with the data at present.

2.2 Excess female mortality by disease

We employ an entirely parallel calculation for missing women by age and disease. Consider any age $a \geq 1$, and denote by $d^m(a,k)$ and $d^w(a,k)$ the rates of death of men and women respectively from disease k at age a in the country of interest. The reference death rate of women at age a from disease k in the country of interest is then defined by:

$$u^w(a,k) = \frac{d^m(a,k)}{\frac{\hat{d}^m(a,k)}{\hat{d}^w(a,k)}} \qquad [4]$$

The number of extra female deaths in the country of interest at age a from disease k in a given period is therefore equal to

$$mw(a,k) = [d^w(a,k) - u^w(a,k)]\pi(a) \qquad [5]$$

where $\pi(a)$, as before, is the starting population of women of age a.

3 Estimates of excess female mortality

3.1 Excess female deaths by age

Using the methodology described above, we now turn to computing estimates of excess female mortality across Africa. We use data from the Global Burden of Disease (GBD) study, initiated in 1992, which is a major collaborative effort between the Harvard School of Public Health, the World Health Organization (WHO), and the World Bank. The GBD study used numerous data sources and epidemiological models to estimate the first comprehensive worldwide cause-of-death patterns in 14 age-sex groups for over 130 important diseases. The estimates reflect all of the information currently available to the WHO. We rely on the most recent data for the different countries in Africa, which is for the year 2011.[3]

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[2] Garenne (2003, 2004) uses 56 Demographic Health and World Fertility Surveys that cover 29 sub-Saharan African countries, and compares these with other studies (including birth registration) where available. Garenne concludes that the predominantly Bantu populations of Eastern and Southern Africa exhibit sex ratios at birth below 1.000, while Nigeria and Ethiopia display high, Asia-like ratios. Finally, a large group of countries such as Ghana, Mali, and Côte d'Ivoire appear to be around the 1.050 mark.

[3] 'The Global Burden of Disease Study (GBD) is the most comprehensive worldwide observational epidemiological study to date. It describes mortality and morbidity from major disease, injuries, and risk factors to health at global, national, and regional levels. Examining trends from 1990 to present and making comparisons across populations enables understanding of the changing health challenges facing people across the world in the 21st century' (The Lancet 2017).

Table 1 lists the total number of excess female deaths (in thousands) in the year 2011 for the different regions of Africa according to the UN classification. Overall, there are more than 1.7 million excess female deaths each year in Africa. The top panel considers the younger age group, zero to 14, and the lower panel the older age group, 15 to 59. We see from Table 1 that there is substantial regional variation across the continent. In both age groupings, in terms of the total number of excess female deaths, the largest numbers are in West Africa. In the younger age group there are almost 200,000 excess female deaths in a given year in that region, and more than 450,000 in the older age category. East Africa is next, with close to 100,000 excess female deaths at the younger ages each year, and almost 400,000 in the older age category. By comparison, North Africa has the lowest excess female mortality, with roughly 100,000 excess deaths each year across the two age categories. To an extent this regional variation reflects variations in population numbers across the continent. The last column of Table 1 demonstrates that as a proportion of the female population (for the respective age groups), excess female mortality is actually highest in Central Africa for the younger age group, and in Southern Africa for the older age group.

There are also some intriguing patterns across the age groups. Although excess female mortality is extremely high in Southern Africa in the older age group, by contrast there is virtually no excess female mortality in this region for the younger age category. Likewise, relative to other regions, excess female mortality is lower in the younger age category compared with the older ages in East Africa.

Table 1: Excess female mortality by UN subregion and age group: 000s

Region	Age group	Excess female deaths	% female population
East Africa	0-14	94	0.14
West Africa	0-14	196	0.32
North Africa	0-14	38	0.12
Southern Africa	0-14	0	0
Central Africa	0-14	98	0.35
East Africa	15-59	397	0.49
West Africa	15-59	452	0.59
North Africa	15-59	71	0.11
Southern Africa	15-59	207	1.18
Central Africa	15-59	191	0.61
Total		1742	

Source: authors' computation using on data from GBD (2011).

3.2 Excess female deaths by disease

To understand these numbers further, we now take a closer look by accounting for excess female deaths over age and disease groups. The WHO divides the causes of death into three categories: (1) communicable, maternal, perinatal, and nutritional diseases; (2) non-communicable diseases; and (3) injuries. Infectious disease, as well as nutritional and reproductive ailments—the Group 1 diseases—predominate in higher-mortality populations. These are replaced in low-mortality populations by chronic and degenerative diseases (Group 2), such as cardiovascular ailments or cancer. This change in mortality patterns, with chronic and degenerative diseases replacing acute infectious and deficiency diseases as the leading causes of death, is referred to as the epidemiological transition (Omran 1971).

Tables 2 and 3 list the overall death rates (across both genders) by disease category for the regions of Africa. First, Table 2 considers children (aged zero to 14). We see that overall mortality rates are highest in Central Africa, followed by West and then East Africa. They are lowest in North

Africa, and also low in the countries in the southern part of the continent. In all regions, childhood mortality is driven by Group 1 diseases. Table 2 highlights the key communicable diseases behind these high mortality rates. What distinguishes the higher-mortality regions is a higher incidence of death from diarrhoeal diseases, malaria, respiratory infections, and malnutrition to a smaller extent. By contrast, the proportion of childhood deaths attributed to perinatal causes is similar across all regions in Africa.

Table 2: Overall death rates per 1,000 individuals (aged 0–14) by UN subregion and disease

Disease	East	West	North	Southern	Central
All causes	11.2	13.8	4.2	5.5	18.7
(1) Communicable	10.1	12.8	3.2	4.8	17.2
(A) Infectious/parasitic	5.40	7.45	1.25	2.96	9.82
HIV	0.91	0.51	0.03	1.98	0.43
Diarrhoeal	1.94	2.07	0.55	0.57	3.23
Childhood cluster	0.34	0.56	0.08	0.03	0.54
Meningitis	0.32	0.34	0.08	0.07	0.47
Malaria	1.09	3.11	0.13	0.02	3.58
(B) Respiratory	1.82	2.24	0.75	0.59	3.52
(C) Perinatal	2.48	2.82	1.09	1.13	3.30
(D) Malnutrition	0.36	0.27	0.13	0.15	0.54
(2) Non-communicable	0.6	0.6	0.6	0.5	0.8
(3) Injuries	0.5	0.4	0.4	0.2	0.6

Source: authors' computation using data from GBD (2011).

Table 3 considers overall mortality rates of adults aged 15 to 59. Relative to the rest of Africa, the northern countries have the lowest overall mortality rates in this age category as well. In the case of adults, Group 1 diseases account for just over half of all deaths in higher-mortality regions. Overall mortality is highest in the countries of Southern Africa, where HIV/AIDS is the primary cause. After HIV/AIDS, other relevant infectious diseases include tuberculosis and respiratory infections. Others not listed in the table include meningitis and tropical cluster diseases.

Table 3: Overall death rates per 1,000 individuals (aged 15–59) by UN subregion and disease

Disease	East	West	North	Southern	Central
All causes	8.9	7.5	3.0	13.3	8.2
(1) Communicable	5.0	4.3	0.5	10.5	4.4
(A) Infectious/parasitic	4.1	3.3	0.3	9.3	3.3
Tuberculosis	0.6	0.9	0.1	0.4	0.8
HIV/AIDS	2.7	1.6	0.1	7.3	1.4
Malaria	0.06	0.04	0.01	0.01	0.07
(B) Respiratory	0.4	0.4	0.1	0.9	0.5
(C) Maternal	0.4	0.5	0.1	0.1	0.6
(2) Non-communicable	2.5	2.4	1.9	1.9	2.5
(3) Injuries	1.4	0.8	0.6	0.8	1.3

Source: authors' computation using data from GBD (2011).

Recall equation [4] from Section 2.2, which yields a reference death rate for women by age and disease, and the corresponding expression [5] for excess female deaths by age and disease. There are some exceptions to this approach. The most significant of these is maternal mortality, for which a male death rate is not defined, so equation [5] is invalid. We therefore construct the reference death rate for maternal mortality in each age group by using the ratio of maternal to overall female mortality in each age group in the reference region, and then scaling this by age-specific female mortality for the country in question:

$$u^w(a, mm) = \frac{\hat{d}^w(a,mm)}{\hat{d}^w(a)} d^w(a) \qquad [6]$$

where the index $k = mm$ stands for maternal mortality. Maternal mortality is very low in developed regions, so that this procedure will treat practically all maternal deaths as excess female deaths, which is as it should be. A second set of exceptions concerns diseases for which relative death rates for developed countries by age are unreliable, because there are so few deaths. Yet those diseases are widespread in Africa. Particularly important examples are malaria, childhood cluster diseases (such as measles), diarrhoeal diseases, and tuberculosis. Small changes in the developed-country numbers can cause large swings in our estimates. We therefore use the overall death rates from all communicable diseases (excluding HIV/AIDS and other sexually transmitted diseases) by age group in developed regions to compute our reference rates.

We begin with the younger age group in Table 4. We see that almost all of these excess deaths are from infectious and parasitic diseases, respiratory infections, perinatal conditions, and malnutrition. A primary cause of excess female deaths among children is malaria: there are roughly 109,000 excess female deaths from this cause alone each year. The secondary major cause is respiratory infections, with around 94,000 excess female deaths each year; then diarrhoeal diseases, with approximately 77,000 excess young female deaths each year.

We turn to the older age category in Table 5. Group 1 diseases, primarily infectious diseases and maternal complications, also form the majority of excess female adult deaths. HIV is the primary killer. There are close to 800,000 excess female deaths from HIV each year across Africa. Maternal mortality is also a major cause, particularly in East and West Africa. There are close to 400,000 excess female deaths from this cause each year.

Table 4: Excess female deaths (aged 0–14) by UN subregion and disease: 000s

Disease	East	West	North	Southern	Central
(1) Communicable	113	205	38	4	104
(A) Infectious/parasitic	76	123	18	4	65
HIV	22	11	0	4	4
Diarrhoeal	18	32	8	0	19
Childhood cluster	1	3	1	0	2
Meningitis	9	13	1	0	8
Malaria	23	55	3	0	28
(B) Respiratory	22	39	10	0	23
(C) Perinatal	5	30	7	0	7
(D) Malnutrition	5	7	2	0	5
(2) Non-communicable	0	0	0	0	0
(3) Injuries	3	4	1	0	2

Source: authors' computation using data from GBD (2011).

Table 5: Excess female deaths (aged 15–59) by UN subregion and disease: 000s

Disease	East	West	North	Southern	Central
(1) Communicable	424	341	28	206	141
Tuberculosis	18	22	3	0	13
HIV/AIDS	328	194	5	199	67
Malaria	7	3	1	0	3
Respiratory	10	11	0	6	2
Maternal	132	161	25	8	70
(2) Non-communicable	70	127	31	9	68
Malignant	32	44	11	1	11
Diabetes	10	12	4	2	6
Cardio	61	73	28	8	38
Digestive	6	12	4	1	8
(3) Injuries	0	0	0	0	0

Source: authors' computation using data from GBD (2011).

3.3 Excess deaths by country

We now consider excess female mortality by country within each region of Africa. What becomes clear is that there is an enormous variation across countries.

We begin with the countries of East Africa in Table 6. Recall from Table 1 that East Africa has close to 500,000 excess female deaths each year. For the younger age category, we see from Table 6 (in the first column) that a significant proportion of the excess female deaths come from four countries: Ethiopia, Mozambique, Somalia, and Tanzania. The second column reports the number of excess female childhood deaths as a proportion of the female population of the corresponding age group. In terms of these magnitudes, Somalia, Mozambique, and Tanzania have the greatest excess female mortality in the younger age group. Countries such as Burundi and Malawi are next. We see from the fourth column that as a proportion of the female population, excess female mortality is significantly higher in the older age group. In this age group, extremely high excess female mortality countries include Burundi, Ethiopia, Mozambique, Zambia, and Zimbabwe. By contrast, the lowest excess adult female mortality countries in East Africa are Eritrea, Madagascar, Mauritius, and Tanzania.

Table 6: Excess female deaths—East Africa: 000s

Country	Age 0 - 14	% female population	Age 15 - 59	% female population
Burundi	2.5	0.08	21.1	0.46
Comoros	0.04	0.02	0.5	0.14
Djibouti	0	0	1.0	0.21
Eritrea	0	0	2.1	0.09
Ethiopia	19.0	0.05	124.5	0.30
Kenya	1.9	0.01	44.0	0.21
Madagascar	4.2	0.05	8.1	0.08
Malawi	5.4	0.08	19.0	0.26
Mauritius	0	0	0	0
Mozambique	19.6	0.20	40.6	0.36
Rwanda	0.8	0.02	11.2	0.21
Somalia	16.0	0.40	13.2	0.29
Tanzania	33.2	0.17	32.1	0.08
Uganda	0	0	11.7	0.15
Zambia	0	0	21.4	0.35
Zimbabwe	3.3	0.06	46.0	0.68

Source: authors' computation using data from GBD (2011).

Table 7 considers the countries of West Africa, where there are close to 700,000 excess female deaths each year. We see from the first and third columns in the table that the single biggest contributor to these excess female deaths is Nigeria. This is partly driven by the very high population numbers there. But we also see from the second and fourth columns that excess female mortality is also very high as a proportion of the female population in Nigeria. For the younger age group, other big contributors are Côte d'Ivoire, Mali, and Niger. As a proportion of the female population, Burkina Faso also has high childhood excess female mortality. For the older age group, Nigeria again is the single biggest contributor, followed by Côte d'Ivoire. Sierra Leone, Guinea Bissau, Liberia, Togo, and Niger also have high adult excess female mortality as a proportion of the female population.

Table 7: Excess female deaths—West Africa: 000s

Country	Age 0 - 14	% female population	Age 15 - 59	% female population
Benin	5	0.13	2.5	0.06
Burkina Faso	0.4	0.25	2.6	0.03
Cape Verde	0	0	0	0
Côte d'Ivoire	10	0.12	43.0	0.39
Gambia	0.3	0.04	1.6	0.18
Ghana	0	0	9.0	0.07
Guinea	2	0.05	8.1	0.16
Guinea Bissau	0	0	2.8	0.34
Liberia	2	0.11	5.8	0.29
Mali	9.4	0.17	3.7	0.06
Mauritania	1.1	0.09	3.4	0.19
Niger	19.3	0.26	13.9	0.20
Nigeria	127.0	0.20	328.2	0.41
Senegal	1.9	0.03	9.0	0.14
Sierra Leone	3.6	0.15	10.4	0.35
Togo	0	0	7.9	0.22

Source: authors' computation using data from GBD (2011).

Recall from Table 1 that excess female mortality is very low in North Africa. We see from Table 8 that almost all excess female deaths in childhood take place in Sudan. Likewise, the main excess adult female deaths are in this country as well. There is some adult excess female mortality in Algeria.

Table 8: Excess female deaths—North Africa: 000s

Country	Age 0 - 14	% female population	Age 15 - 59	% female population
Algeria	0	0	11.2	0.05
Egypt	0	0	2.5	0 .005
Libya	0.5	0.02	0	0
Morocco	0	0	4.3	0.02
Sudan	46	0.28	54.1	0.24
Tunisia	0	0	0	0

Source: authors' computation using data from GBD (2011).

The countries of Southern Africa have very low excess female mortality in the childhood ages. By contrast, this region has the highest excess female mortality in the older age group. We see from the third column of Table 9 that South Africa is the single largest contributor to these excess deaths. From the fourth column, we see that as a proportion of the female population, there is also significant excess female mortality in all of the countries except Namibia.

Table 9: Excess female deaths—Southern Africa: 000s

Country	Age 0 - 14	% female population	Age 15 - 59	% female population
Botswana	0.4	0.06	4.6	0.39
Lesotho	0.3	0.04	7.5	0.68
Namibia	0	0	2.0	0.16
South Africa	0	0	190.7	0.62
Swaziland	0.4	0.08	3.9	0.62

Source: authors' computation using data from GBD (2011).

Table 10 considers the countries of Central Africa. In this region, the majority of excess female deaths are in the Democratic Republic of the Congo (DRC) for both age categories. Other countries with high excess female mortality in both age groups are Angola, Cameroon, the Central African Republic (CAR), and Chad.

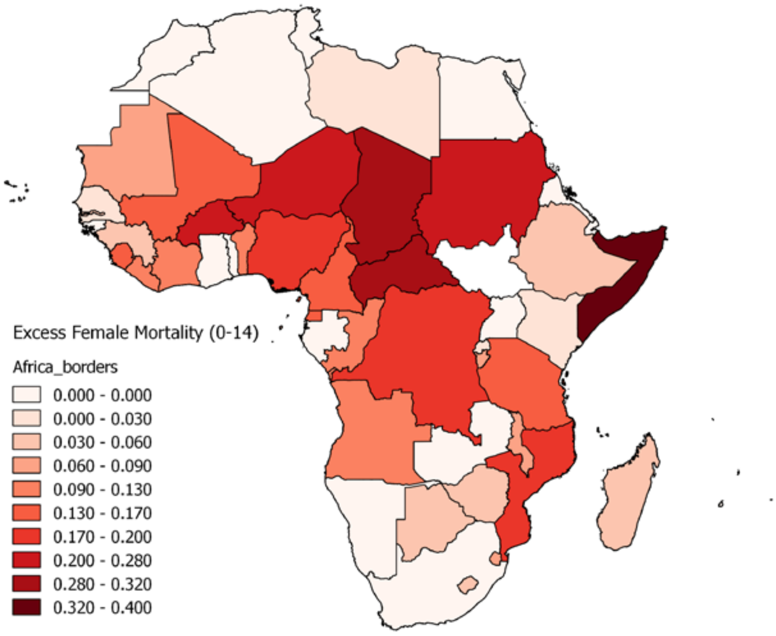
Table 10: Excess female deaths—Central Africa: 000s

Country	Age 0 - 14	% female population	Age 15 - 59	% female population
Angola	9	0.12	34.2	0.37
Cameroon	12	0.15	48.7	0.48
CAR	5.7	0.32	14.9	0.64
Chad	15	0.31	23.4	0.43
Congo	1	0.10	4.3	0.22
DRC	54	0.18	62.7	0.20
Equatorial Guinea	0.4	0.16	1.4	0.38
Gabon	0	0	1.7	0.20
Sao Tome & Principe	0	0.05	0	0.02

Source: authors' computation using data from GBD (2011).

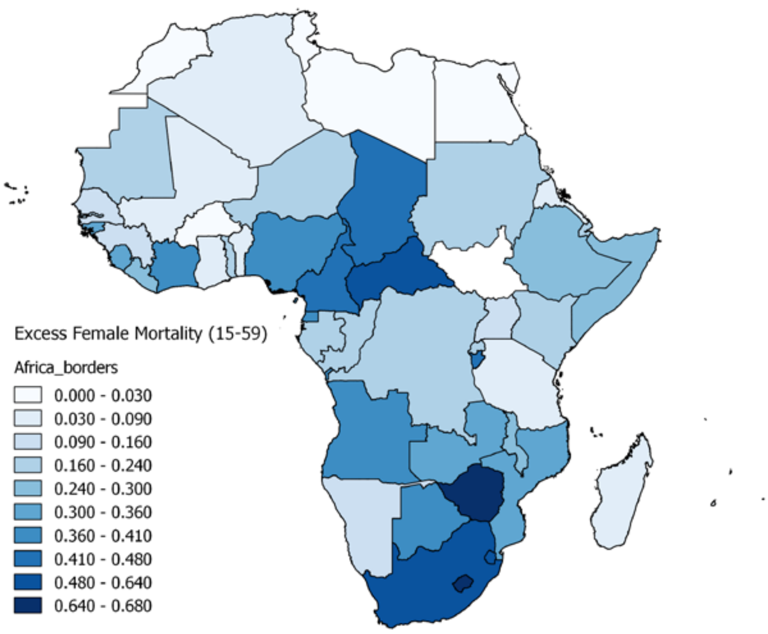
The overall distribution of excess female mortality by country across the continent is depicted in Figures 1 and 2.

Figure 1: Excess female mortality (0–14)



Source: authors' illustration using data from GBD (2011).

Figure 2: Excess female mortality (15–59)



Source: authors' illustration using data from GBD (2011).

4 Southern Africa as a benchmark

There is always the possibility that the use of developed countries as a reference group may be 'inappropriate' for poor countries in Africa. Elsewhere (Anderson and Ray 2010) we have discussed this issue in some detail, and there is little we can add here at a conceptual level. Instead, for the younger age group, we can redo our computations using the countries in Southern Africa as a benchmark. As is clear from Table 1, this is the region in Africa with the lowest excess young female mortality.

We see from Table 11 that our estimates of excess young female mortality increase somewhat using this alternative benchmark. This is because relative to the developed-country reference group, the relative death rate of young males is actually higher in the countries of Southern Africa. The overall estimates of excess female mortality using this alternative benchmark increase by roughly 25 per cent. Moreover, the estimates for some diseases increase more than others. Comparing Tables 4 and 11, we see that excess female deaths from perinatal conditions increase more than threefold using Southern African countries as a benchmark. Estimates of excess deaths from diarrhoeal diseases also increase significantly, by about 50 per cent. The number of observations we have to derive our reference death rates for perinatal conditions as cause of death are roughly similar for the Southern African countries and the developed countries, so it does not seem to be a question of data reliability for these two different estimates.[4] For diarrhoeal diseases as cause of death, the number of observations is significantly higher in Southern African countries compared with developed countries. Thus we might assume that, if anything, the estimates provided in Table 11 are the more reliable. All in all, using an alternative benchmark demonstrates that the earlier estimates are a lower bound on excess young female mortality in Africa.

Table 11: Excess female deaths (aged 0–14) by UN subregion and disease: 000s—Southern Africa as a benchmark

Disease	East	West	North	Southern	Central
All causes	137	243	45	0	126
(1) Communicable	134	228	41	0	119
HIV	7	4	0	0	1
Diarrhoeal	43	55	11	0	35
Childhood cluster	11	18	2	0	9
Meningitis	0	0	0	0	1
Malaria	26	62	3	0	32
Respiratory	34	52	12	0	32
Perinatal	72	97	21	0	42
Malnutrition	9	9	3	0	7

Source: authors' computation using data from GBD (2011).

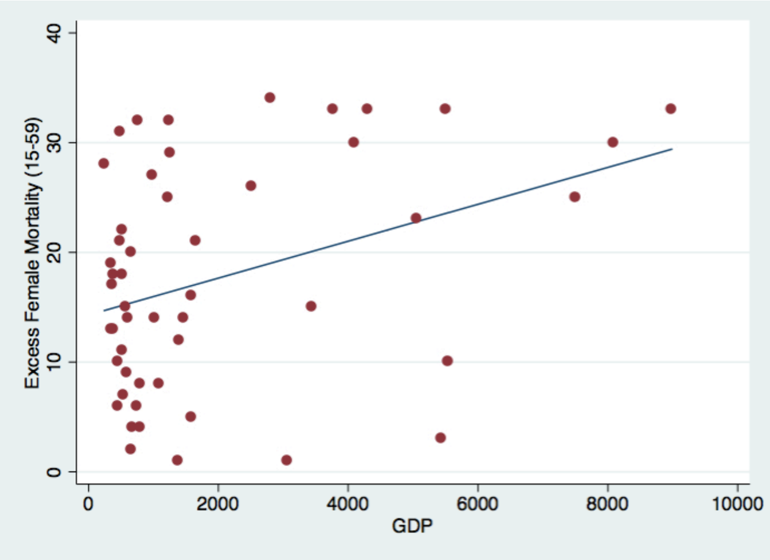
5 Mechanisms

The above sections have demonstrated significant variation in excess female mortality across the continent. If we aim to explain this variation, a first consideration is poverty. Figure 3 plots the correlation at the country level between gross domestic product (GDP) per capita and adult female

[4] Moreover, of all the sub-Saharan African countries, South Africa collects the most reliable vital statistics at the national level.

excess deaths as a proportion of the adult female population. Perhaps surprisingly, there is not a significant negative correlation between these two variables; if anything, the relationship is positive.

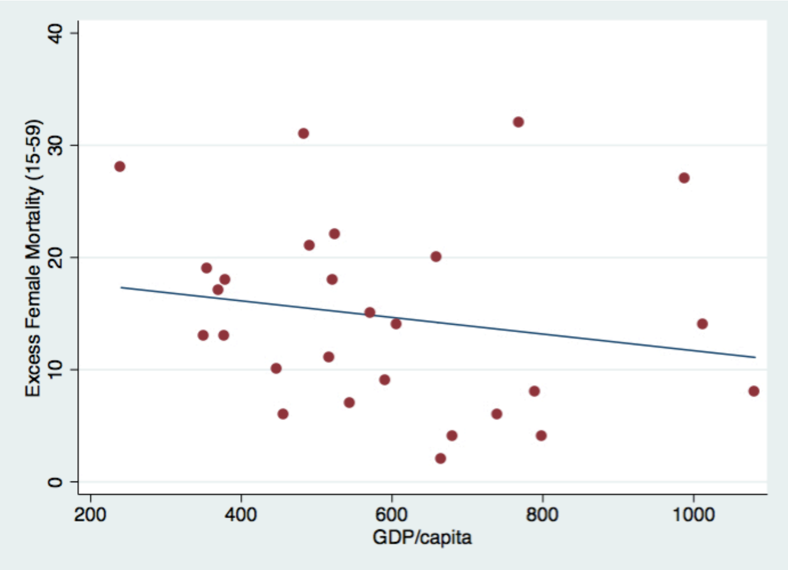
Figure 3: GDP per capita and adult excess female mortality



Source: authors' computation using data from GBD (2011) and World Bank (2011).

However, if we look to the very poorest countries in Africa (i.e. those with less than US$1,000 per capita), we do see that adult excess female mortality is lower among the better-off of that poor sample, as demonstrated in Figure 4. Although very crude, these findings are suggestive that poverty alone cannot explain the striking number of excess female deaths in Africa.

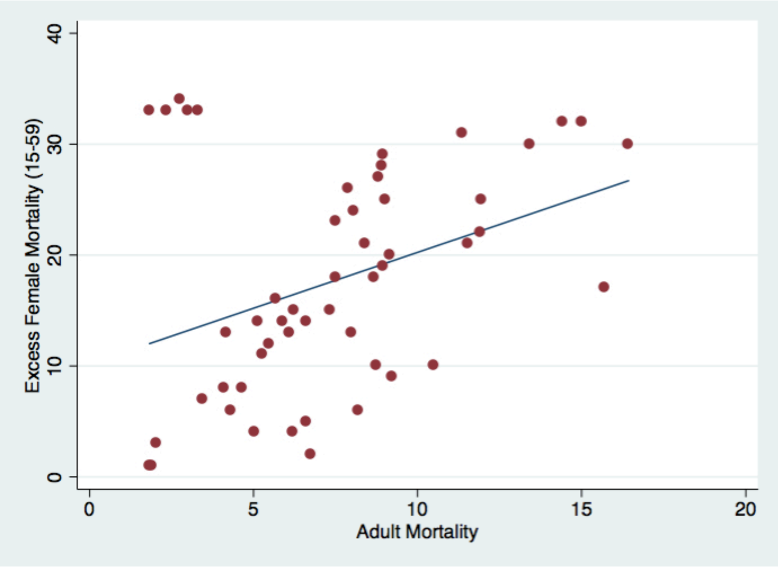
Figure 4: GDP per capita and adult excess female mortality—poorest countries



Source: authors' computation using data from GBD (2011) and World Bank (2011).

In Figure 5 we consider the correlation between overall adult mortality rates at the country level and adult female excess deaths as a proportion of the adult female population. In this case, there is a very noticeable positive relationship: higher overall adult mortality rates (i.e. for both men and women) are positively correlated with excess female mortality.

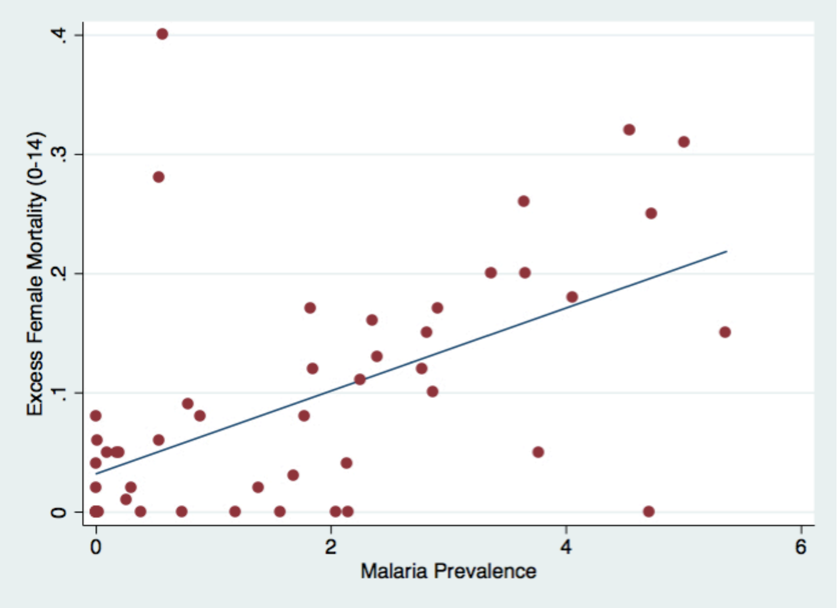
Figure 5: Overall adult mortality and adult excess female mortality



Source: authors' computation using data from GBD (2011).

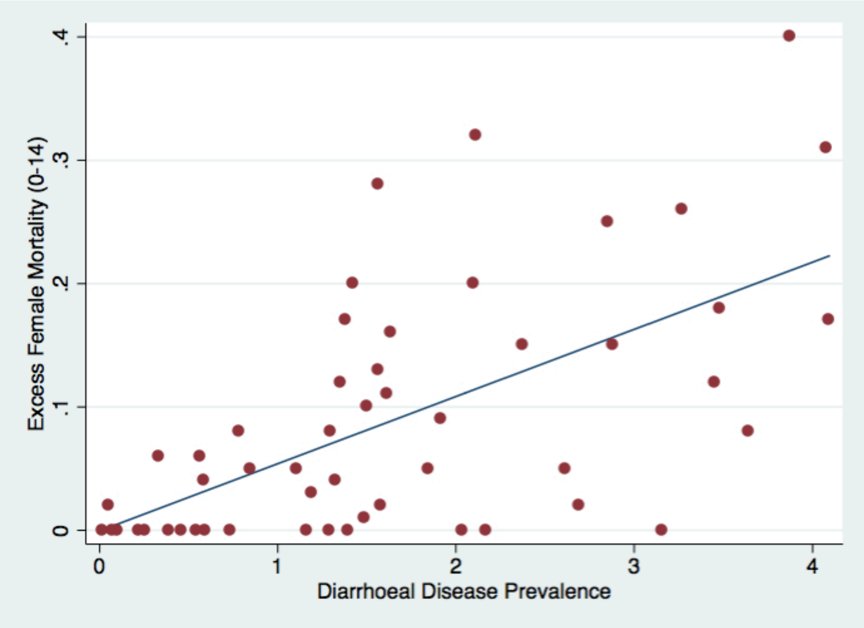
Although there is clearly a significant positive correlation between excess female mortality and overall mortality rates, it is also evident that certain diseases seem to be associated with higher rates of excess female mortality. We see this in Figures 6 and 7.

Figure 6: Malaria prevalence and young excess female mortality



Source: authors' computation using data from GBD (2011).

Figure 7: Diarrhoeal disease prevalence and young excess female mortality



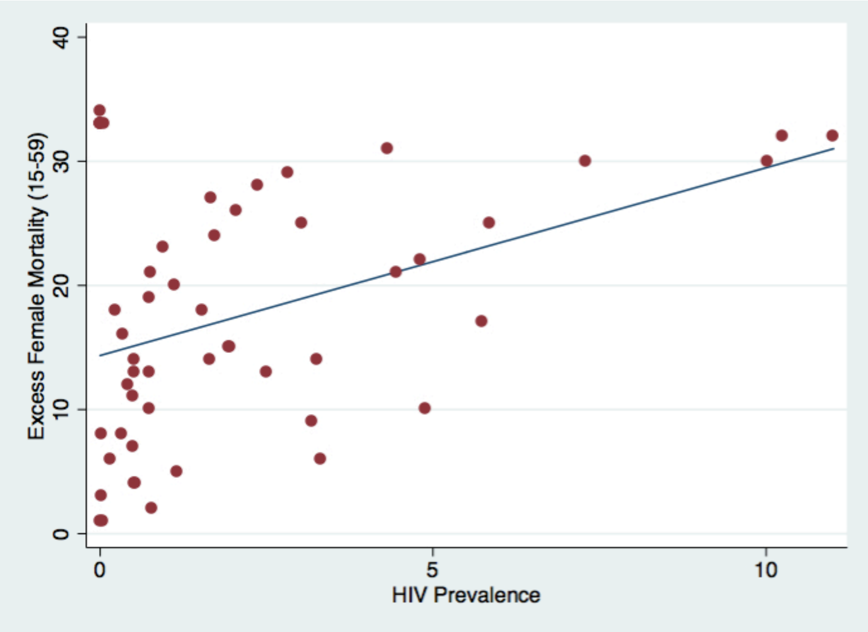
Source: authors' computation using data from GBD (2011).

We see from Figures 6 and 7, for example, that high incidences of malaria and diarrhoeal disease are strongly correlated with excess female mortality in the younger ages. However, despite this strong correlation for both of these diseases, the earlier estimates demonstrate that there are far more excess deaths from malaria than from the other childhood diseases. From Table 1 we observed that young excess female mortality was highest in Central and West Africa, which are regions plagued by high death rates from diarrhoeal diseases and malaria in this younger age category. But these regions also suffer from high death rates from respiratory infections and perinatal conditions, as seen in Table 2. In both Central and West Africa, the overall death rates from all four of these main causes of death are quite comparable within each region. However, excess female mortality is highest from malaria, which accounts for roughly 25 per cent of young premature female deaths in these regions. The next largest cause is respiratory infections, accounting for roughly 19 per cent. That is to say, even though the overall death rates in these two regions from malaria and respiratory infections are comparable to those from perinatal conditions, they lead to significantly more excess female mortality. This is the primary reason why we observe very little excess female mortality at the younger ages in Southern and North Africa, as in these two regions the primary cause of death in the younger age category is perinatal conditions.

It is also the case that a given disease can have more of an impact in some regions compared with others. For example, overall mortality rates from diarrhoeal disease are significantly higher in Central compared with Eastern Africa. However, the number of excess young female deaths from this disease is comparable across the two regions.

In the older age category, HIV is responsible for roughly 45 per cent of the excess female mortality observed—roughly 800,000 excess deaths each year. Figure 8 demonstrates this strong correlation between HIV prevalence and excess female deaths in the older age category at the country level.

Figure 8: HIV prevalence and adult excess female mortality



Source: authors' computation using data from GBD (2011) and OECD (2014).

HIV explains almost all of the excess female mortality in the countries of Southern Africa, where death rates from other diseases are relatively low. In other parts of the continent, particularly in West and Central Africa, maternal mortality is responsible for significant excess female mortality, amounting to approximately 400,000 excess deaths each year. As in the younger age category, certain diseases can have more of an impact in some regions compared with others. For example, tuberculosis seems to have more of an impact in Central Africa for adult females, while respiratory diseases have a lower impact on excess female mortality in this region compared with elsewhere.

To better understand excess female mortality in Africa, it therefore seems necessary to further explore why certain diseases lead to much higher rates of excess death than do other diseases. Moreover, we need to understand why certain diseases have a larger impact on excess female mortality in certain regions compared with others.

There is likely a host of factors—biological, social, environmental, behavioural, or economic—that explain this variation in excess female mortality across Africa. Consider for example the extreme excess female mortality as a result of the HIV/AIDS epidemic in all regions except North Africa. These extra deaths mainly occur at the reproductive ages, 15–45. The death rate from HIV/AIDS for women aged 15–29 is 2.3 times that of males of the corresponding age. The overall female death rate from the virus is 1.2 times that of males. Elsewhere in the world, by contrast, the death rate from HIV/AIDS for males is higher at all ages. The ratio is as high as four to one in high-income countries.

There is little doubt that poverty, under-nutrition, and poor healthcare play their part in the overall transmission of HIV. But our interest lies not in the overall rate of transmission, but in its reversal of male-female incidence. It is therefore hard to escape arguments such as those made by the WHO, which emphasize the role of unequal power and violence. It seems evident that the multiplicity of female sexual partners among males, the prevalence of transactional sex, the existence of violent or forced sex, and the relative inability of women to negotiate safer sex practices have much to do with this extraordinary discrepancy.

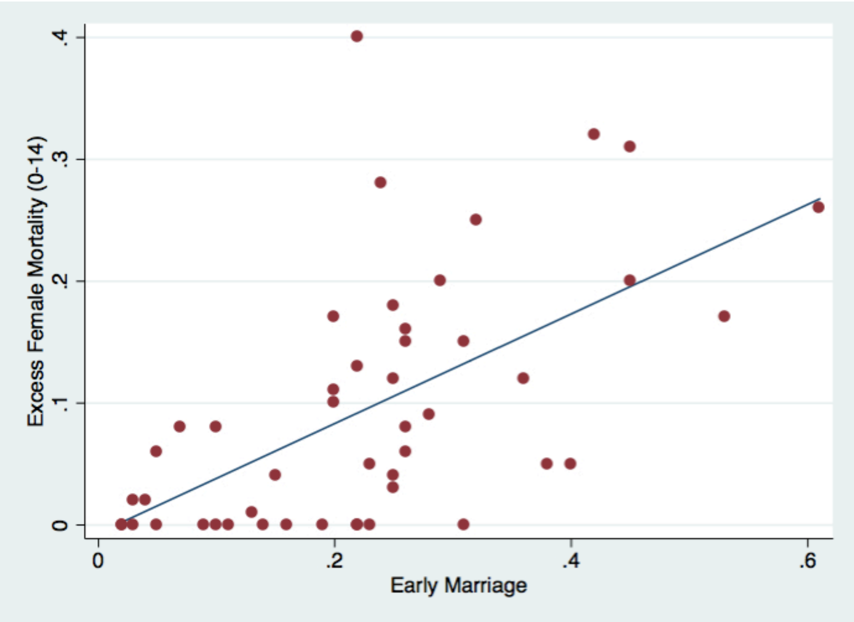
There could be other reasons for greater heterosexual transmission that have nothing explicitly to do with discrimination against women. For example, it is possible that certain aspects of poverty can create 'unintended' gender biases relative to the developed-country benchmark. The accounting methodology that we follow is entirely silent on matters of interpretation. The case for (or against) lack of similar care has to be made separately.

Among younger women, malaria plays an important role in explaining their premature deaths. In Africa, insecticide-treated mosquito nets and indoor residual spraying commonly prevent this disease. It is conceivable that resource-constrained households might provide young boys with mosquito nets before girls. Alternatively, it is also possible that females have less protective immune responses to the disease. In many countries, progress in malaria control is threatened by the rapid development and spread of antimalarial drug resistance, and there may be a gender bias component to this resistance. It is well beyond the scope of this paper to identify the key mechanisms behind these differences, but our estimates strongly suggest that it is crucial to better understand possible gender biases in the epidemiology of malaria-attributed illness and death. The magnitude and age distribution of malaria-attributable morbidity and mortality vary with the intensity of transmission (Leenstra et al. 2003). In areas with intense, stable malaria transmission, the risk of morbidity declines rapidly within the first years of life. Where transmission is less intense, clinical immunity develops at a slower pace, and children remain at risk of severe disease and death for a longer time. Under conditions of stable transmission, adolescents are at a markedly reduced risk of severe malaria morbidity and mortality compared with preschool children. Despite this reduced risk, adolescents continue to suffer from frequent asymptomatic infections and periodic clinical illness and death. The extent to which adolescent girls are also pregnant in Africa could be very relevant—there is already significant evidence that malaria infection during pregnancy carries substantial risks for the mother (Desai et al. 2007). Approximately 12 per cent of girls in sub-Saharan Africa are married before the age of 15 (UNICEF 2016). Rates of child marriage are exceptionally high (between 28 and 29 per cent) in CAR, Chad, and Niger. These countries are also amongst those with the highest rates of excess female mortality from malaria for girls aged zero to 14. Figure 9 demonstrates this positive relationship between the incidence of early marriage (i.e. the percentage of girls who are married between 15 and 19 years of age) and excess female mortality in the younger age category.

Acute respiratory infections, particularly lower respiratory tract infections, are also a leading cause of death among children under five years of age East, West, and Central Africa, and cause significant excess female mortality in these regions. In developed countries, there is some suggestive evidence of sex differences in the incidence and severity of respiratory infections. In particular, the course of most respiratory tract infections is more severe in males that in females (Falagasa et al. 2007). Relative to these differences, our estimates suggest that in parts of Africa mortality from these infections is higher for young females. However, before we draw any strong conclusions, it is clear that the epidemiology and pathogenesis of such infections, particularly in Africa, must be further studied.

Diarrhoeal disease is also a leading cause of death in children under five years old throughout the developing world. Infection is spread through contaminated food or drinking water, or from person to person as a result of poor hygiene. Interventions to prevent diarrhoea, including safe drinking water, use of improved sanitation, and hand-washing with soap, can reduce disease risk. Diarrhoea can be treated with a solution of clean water, sugar, and salt, and with zinc tablets. Most people who die from diarrhoea actually die from severe dehydration and fluid loss. Children who are malnourished or have impaired immunity are most at risk of life-threatening diarrhoea. Our estimates of excess female mortality from this cause again evoke the importance of possible sex differences in susceptibility to and treatment of these diseases.

Figure 9: Early marriage rates and young excess female mortality



Source: authors' computation using data from GBD (2011) and OECD (2014).

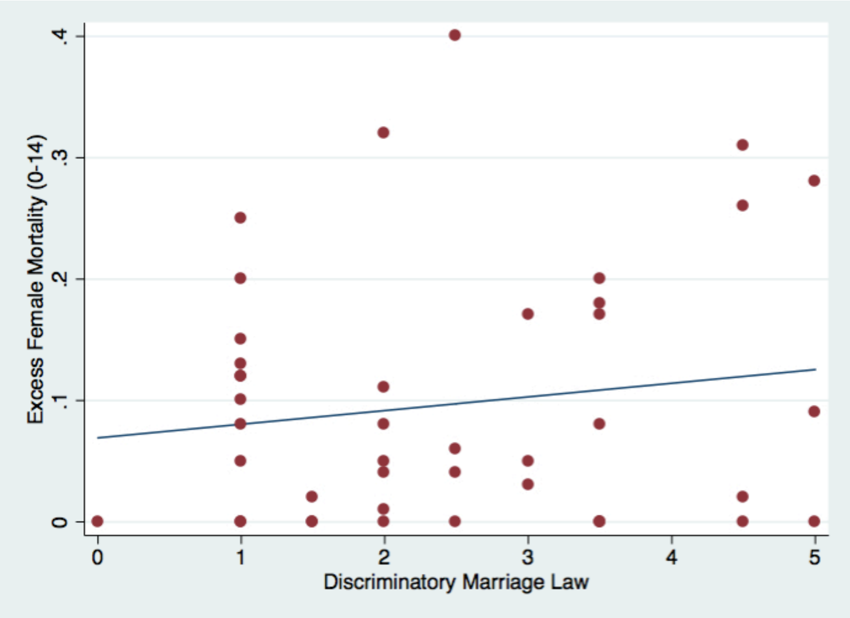
There is evidence that low levels of exclusive breastfeeding further contribute to morbidity and mortality among children in parts of Africa. For example, in East and Southern Africa only 40 per cent of babies are exclusively breastfed during the first six months, despite the fact that breast milk is the best form of nutrition for infants and significantly reduces the risk of diarrhoea, acute respiratory infection, and other child killers. A woman may fail to breastfeed exclusively due to inadequate support from her partner or family, or because of labour burdens. It is conceivable that mothers are more likely to breastfeed young sons compared with daughters.[5]

Some research points to gender inequality as an important underlying cause of female undernutrition, which is further exacerbated by poverty and lack of access to resources. Because of gender norms, women often also have limited access to and control over resources, and may therefore be excluded from household decision-making. For example, Thomas (1994) finds that a mother's education has a bigger effect on her daughter's height, whereas a father's education has a bigger impact on his son's height. Apparently there are differences in the allocation of household resources depending on the gender of the child, and these differences vary with the gender of the parent.

Legislation that discriminates against women curtails the relative bargaining power of mothers in the household, and can then impede the well-being of their daughters. Figures 10, 11, and 12 demonstrate how discriminatory laws against women in terms of marital and property rights as well as protection from violence against women are positively related to young excess female mortality.

[5] See Jayachandran and Kuziemko (2011) for evidence of this in India.

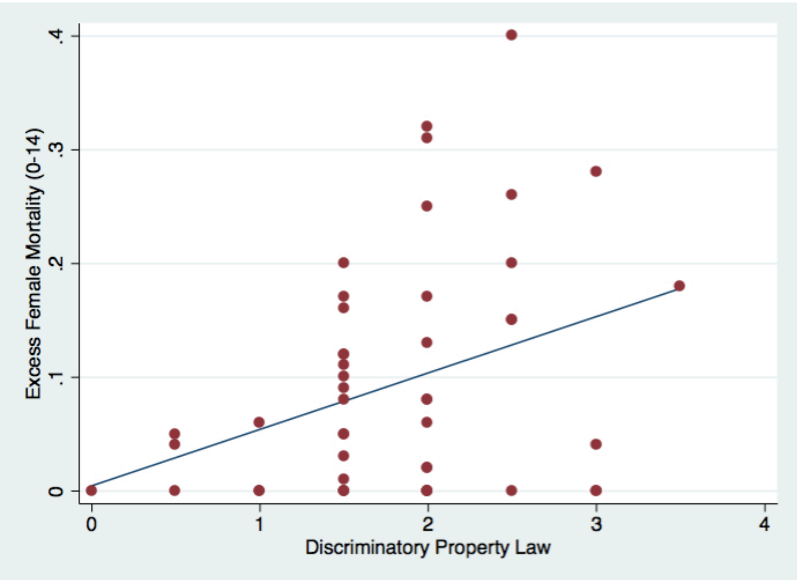
Figure 10: Discriminatory marriage law and young excess female mortality



Source: authors' computation using data from GBD (2011) and OECD (2014).

In Figure 10, discriminatory marriage law reflects an index that captures whether women and men have the same rights with regard to legal guardianship of a child during marriage or after divorce; inheritance from deceased parents or a spouse; and initiation of divorce proceedings. The index 'discriminatory marriage law' is higher when women do not have the same rights as men in these dimensions.

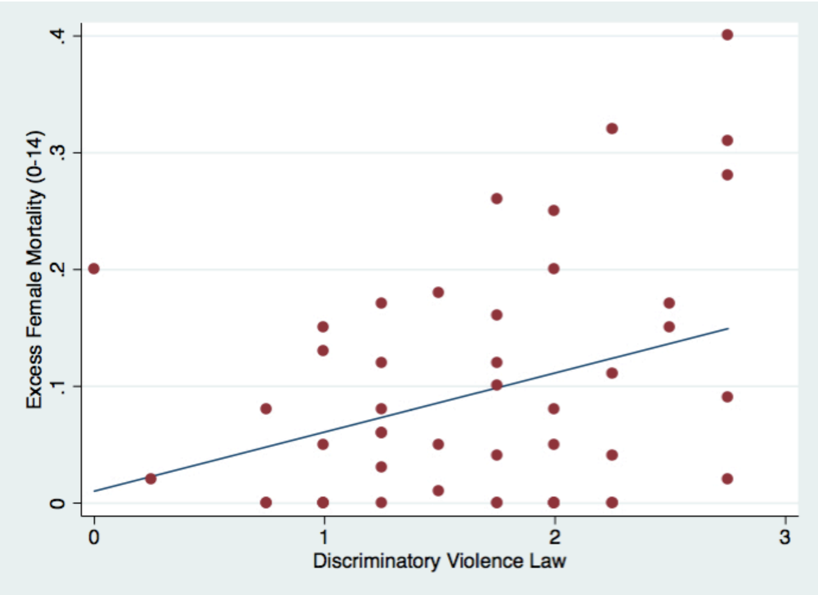
Figure 11: Discriminatory property law and young excess female mortality



Source: authors' computation using data from GBD (2011) and OECD (2014).

In Figure 11, discriminatory property law reflects an index that captures whether women and men have the same rights with regard to access, control, and ownership of land and non-land assets; access to formal financial institutions; and freedom of movement and access to public spaces. The index 'discriminatory property law' is higher when women do not have the same rights as men along these dimensions.

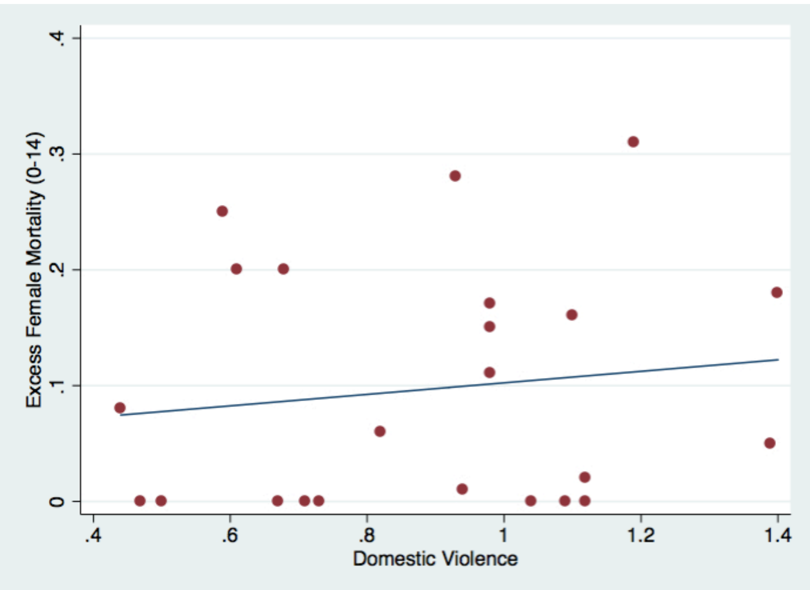
Figure 12: Discriminatory violence law and young excess female mortality



Source: authors' computation using data from GBD (2011) and OECD (2014).

In Figure 12, discriminatory violence law reflects an index that captures whether the legal framework in a given country offers women legal protection from domestic violence, rape, and sexual harassment. This index increases as it becomes less likely for such legislation to be in place, and is positively correlated with young excess female mortality at the country level. From Figure 13, we see that young excess female mortality is also positively correlated with the prevalence of physical or sexual violence from an intimate partner. The variable 'domestic violence' reflects the percentage of women in a given country who have experienced physical and/or sexual violence from an intimate partner at some time in their lives.

Figure 13: Domestic violence and young excess female mortality

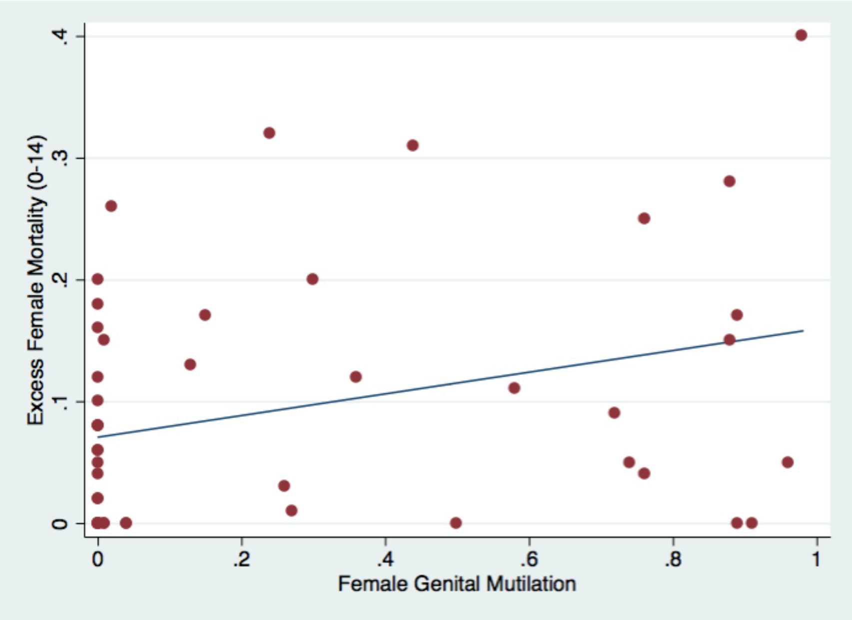


Source: authors' computation using data from GBD (2011) and OECD (2014).

There may also be several cultural factors at play. Among the traditional religions within Africa, the archetypal institution is patrilineage, where at least one surviving son is highly desired, and as a result women can have inferior status (Paulme 1960). Now non-indigenous religions are very predominant across the continent. Islam is a strong presence in several parts of Africa. There is some evidence that in other non-African countries where Islam is the dominant or only religion, child female mortality exceeds that of males (Caldwell and Caldwell 1987; Svedberg 1990). In some Islamic cultural settings in Africa, boys and men traditionally eat first, and girls and women eat the leftovers. When food is short, this can mean females have very little or nothing at all to eat.

Figure 14 demonstrates how one cultural trait, the prevalence of female genital mutilation (at the country level), is positively correlated with young excess female mortality.

Figure 14: Female genital mutilation and young excess female mortality



Source: authors' computation using data from GBD (2011) and OECD (2014).

6 Conclusion

The significant variation in the number of excess female deaths across the regions of Africa, as well as across the countries by region, makes it very difficult to pinpoint a single explanation for such excessively high excess female mortality within the continent. Part of the explanation lies in the prominence of particular diseases. But these patterns then beg the question why the relative female-to-male death rates from these diseases are so high. Is it the case that there is an inherent biological gender bias in these diseases, or is it instead the case that males are more likely to receive medical attention than females in case of illness? The estimated total number of excess female deaths across the continent is alarming, and makes very clear that further research focusing on this issue is crucial.

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