Article

Maternal Mortality in Africa (Part I), Regional Trends (1990-2015)

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Abstract: Background: United Nations Sustainable Development Goals state that by 2030, the Global maternal mortality rate (MMR) should be lower than 70 per 100,000 live births. MMR is still one of Africa's leading causes of death among women. This research aims to study regional trends in maternal mortality in Africa. Methods: We extracted data for Maternal mortality rates per 100,000 births from the World Bank database from 1990-2015. Joinpoint regression was used to study the trends and estimate the annual percent change (APC). Results: Maternal mortality has decreased in Africa over the study period by an average APC of -2.6%. All regions showed significant downward trends, with the sharpest decreases in East Africa. Only the North African region is close to the United Nations' sustainable development goals for Maternal mortality. The remaining sub-Saharan African regions are still far from achieving the goals. Conclusions: maternal mortality has decreased in Africa, especially in East Africa. The only region closed to the United Nations target is North Africa. The remaining sub-Saharan African regions are still far from achieving the goals. These results could be used for the development of Regional Policies.

Keywords: Africa; Maternal mortality rate; Joinpoint regression analysis; mortality; trends

1. Introduction

The WHO ICD Tenth Revision defines maternal death as a death in a woman from any cause related to or aggravated by the pregnancy or its management (excluding acci-

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dental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy [1][2]. United Nations Sustainable Development Goals state that by 2030, the Global maternal mortality rate (MMR) should be lower than 70 per 100,000 live births [3,4]. No country should have an MMR higher than 140 per 100,000 live births. From 2000 to 2017, MMR decreased by 38% in the World[5][6]. In Sub-Saharan Africa, there was a reduction in MMR of nearly 40% in the same period [7].

Nevertheless, MMR is still one of the leading causes of death among African women. Socioeconomic status, parity, and living in rural areas influence maternal mortality[8,9]. Cross-national or civil wars, insurgencies, and political upheavals also significantly influence maternal and infant mortality[10–14]. The same goes for economic crises, famines, epidemics, and subsistence crises. The other influencing factors are the percentage of births occurring in health facilities, the proportion of pregnant women with antenatal visits, and the percentage of births attended by health personnel[15][16]. - In 2012, the World Health Organization launched the Maternal Death Surveillance and Response (MDSR) policy. Many African countries participated[17,18]. There were some difficulties with maternal death surveillance and response implementation in several African countries[19–22] from several causes, including communication problems at district or community levels, recommendations poorly addressed, highly political issues, low accountability, and organizational problems. This study aims to compare the evolution of maternal mortality rates in different regions of Africa.

2. Materials and Methods

MMRs and population data were extracted from all African countries' World Bank mortality databases from 1990 to 2015 [23][24]. The Western Sahara and British and French territories were excluded. Seychelles was also excluded because the last MMR estimation was from 1988. We use the five regions of the African Union (Fig 1): North (Algeria, Egypt, Libya, Morocco, Sudan, Tunisia), East (Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Rwanda, Somalia, South Sudan, Sudan, Tanzania, Uganda), Central (Burundi, Cameroon, Central African Republic, Chad, Congo, DR Congo, Equatorial Guinea, Gabon, São Tomé and Príncipe), South (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Eswatini, South Africa, Zambia, Zimbabwe) and West (Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea-Bissau, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo).

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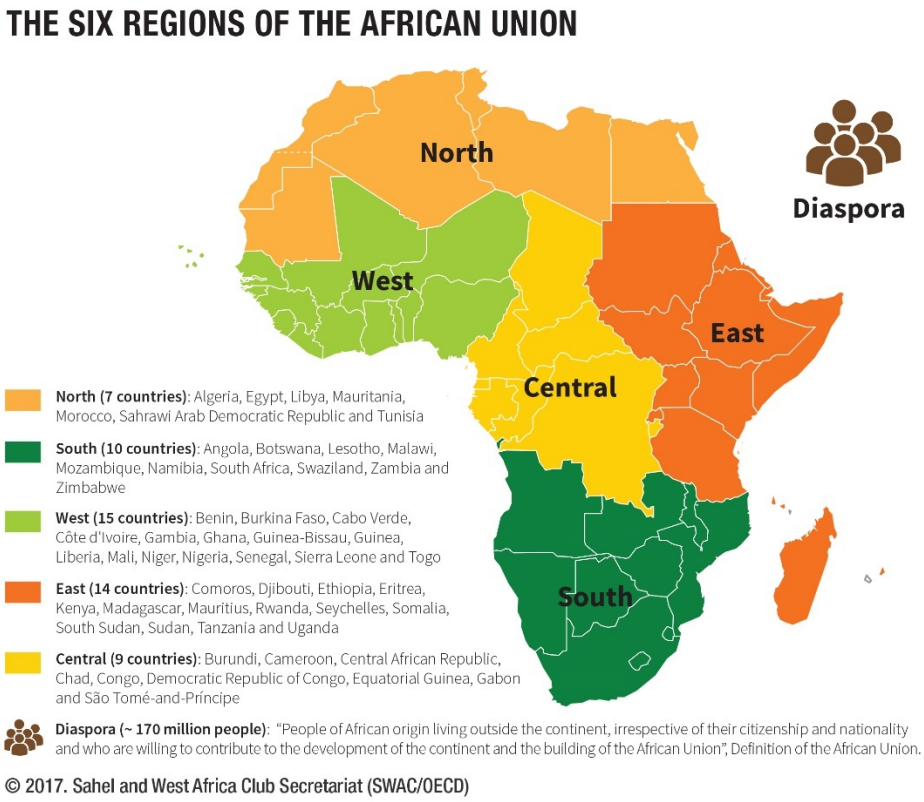

Figure 1. Regions of the African Union, according to the African Union classification.

The annual mortality rates for each region and Africa were estimated by weighting each country's MMR with its population [24]. Joinpoint regression has been widely used in the study of chronic diseases to detect periods of sustained changes in the incidence rates. To detect changes in the trends, a Joinpoint regression was performed. The existence of autocorrelation in the time series was estimated using the Durbin Watson test [25–27].

There was a high positive autocorrelation (Durbin-Watson test = 0.252). The models were first fitted with the uncorrelated errors option. Subsequently, the analysis was repeated, considering the autocorrelation parameter. If there were substantial differences between the two models, the model with autocorrelation was chosen. To describe the magnitude of the change in each trend, we estimated the annual percentage change (APC) and calculated the 95% confidence intervals (95% CI). The MMR was the dependent variable in these models, and the year of death was the independent variable. In all analyses, p values < 0.05 were considered statistically significant. Computations were made with Minitab version 17 [28] and Joinpoint Regression Program, Version 4.9.0.1. February 2022 from the Statistical Research and Applications Branch, National Cancer Institute of the United States[29]. Graphs were drawn with Stata v17[30] and Joinpoint.

3. Results

The MMR experienced in Africa a significant decline, from 849 maternal deaths per 100,000 live births in 1990 to 459 in 2015. (Fig 2) However, 205,670 women still died in Africa in 2015. Most maternal deaths (203,000) occurred in sub-Saharan Africa [23]. Three joint points have been detected, 1996, 2001, and 2007, which define four periods in which there was a substantial change in maternal mortality trend

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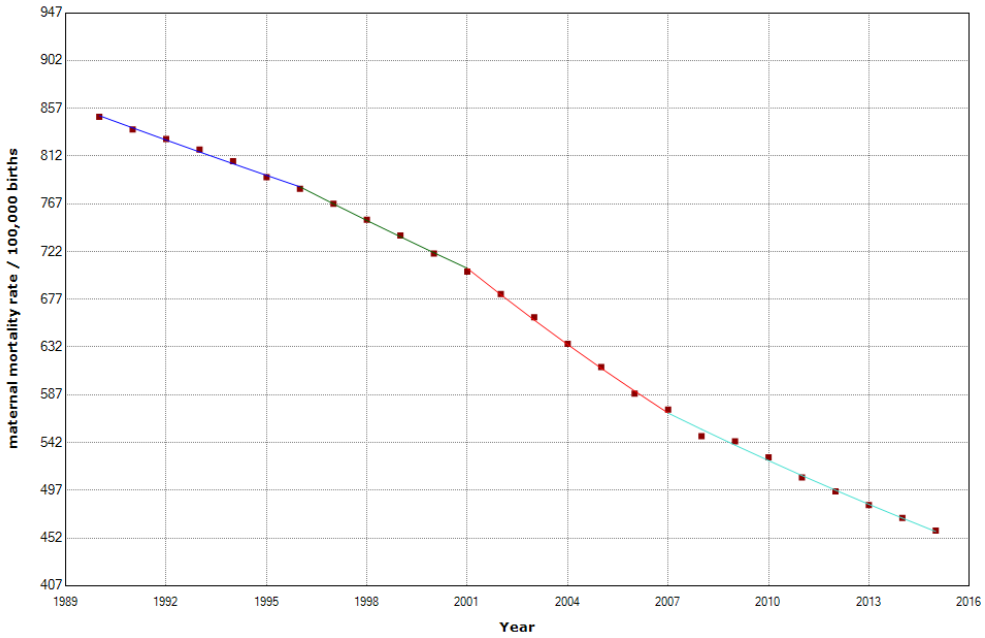

Figure 2. Maternal Mortality trends in Africa (1990-2015), indicating joinpoints at the transitions between different colored lines.

Table 1 shows that there was a significant decline in MMR by a significant APC (−2.6%), ($p < 0.001$). MMR declined from 849 deaths per 100,000 births in 1990 to 459 deaths per 100,000 births in 2015. In the first period, 1990-1996, there was a slight decrease with an APC of -1.4%. A series of stages followed in which the APC reduction of maternal mortality rates was progressively higher and higher. The accelerated trend was interrupted in 2007 when there was a slowdown in the APC. APC changed from -3.5% in the 2001-2007 period to -2.1% in 2007-2015.

Table 1. Joinpoint analysis for maternal mortality rates in Africa, 1990–2017.

Periods	Years	APC (95% CI)	P
Total Period	1990-2015	-2.6 (-2.7; -2.5)	< 0.001
Period 1	1990-1996	-1.4 (-1.6; -1.2)	< 0.001
Period 2	1996-2001	-2.0 (-2.4; -1.7)	< 0.001
Period 3	2001-2007	-3.5 (-3.8; -3.3)	< 0.001
Period 4	2007-2015	-2.7 (-2.8; -2.6)	< 0.001

3.1. Regional Trends

In Figure 3, the evolution of the regional MMR is shown. The difference between the regions with the highest and the lowest MMR decreased from 931 per 100,000 births in 1990 to 589 in 2015. In other words, interregional inequalities decrease with time.

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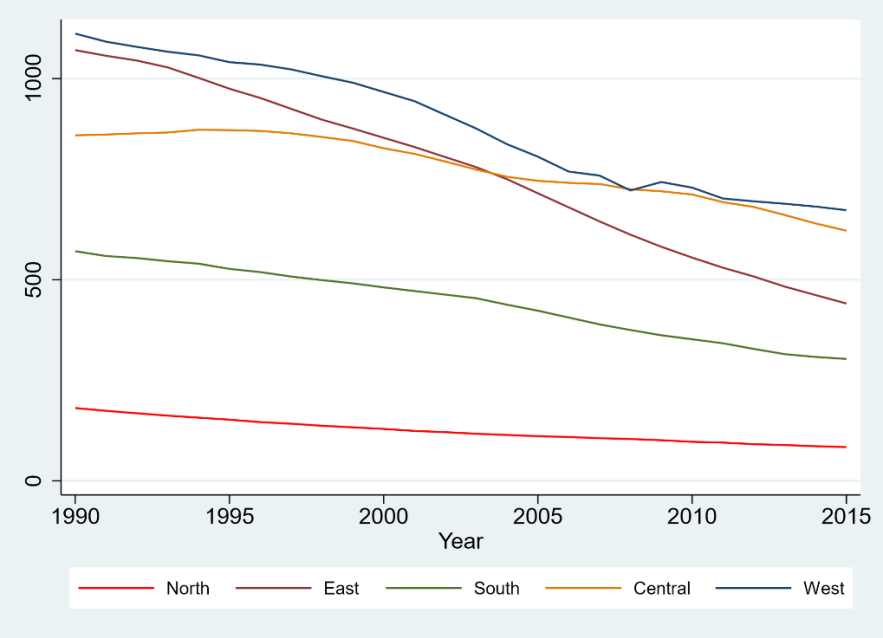

Figure 3. Evolution of regional maternal Mortality rates (1990-2015)

North and South Africa regions consistently remain with lower MMR throughout the period. There has been a convergence between Central and West Africa. Finally, the East African region, which started with very high levels, has experienced a sharp decline. Its rates tend to converge with those of the Southern Africa region. ´

In the North African Region the overall MMR decreased from 113.6 to 59.2 per 100,000 births. We recorded a statistically significant decrease of –1.9% (95% CI -2.0; -1.8) in the MMR, with four joinpoints in 1996, 2003, 2007 and 2010 (Table 2, Fig 4).

Table 2. *Joinpoint analysis for regional maternal mortality rates in Africa, 1990–2017*

Periods	**Years**	**APC (95% CI)**	**P**
North			
Total Period	1990-2015	-1.9 (-2.0; -1.8)	< 0.001
Period 1	1990-1996	-2.0 (-2.1; -1.8)	< 0.001
Period 2	1996-2003	-1.4 (-1.5; -1.3)	< 0.001
Period 3	2003-2007	-2.5 (-2.8; -2.1)	< 0.001
Period 4	2007-2010	-1.7 (-2.6; -0.8)	0.001
Period 5	2010-2015	-3.0 (-3.2; -2.9)	< 0.001
East			
Total Period	1990-2015	-3.6 (-3.8; -3.4)	< 0.001
Period 1	1990-1993	-1.3 (-1.5; -1.1)	< 0.001
Period 2	1993-2001	-2.6 (-2.7; -2.6)	< 0.001
Period 3	2001-2004	-3.2 (-3.7; -2.8)	< 0.001
Period 4	2004-2009	-5.0 (-5.1; -4.9)	< 0.001
Period 5	2009-2015	-4.5 (-4.6; -4.4)	< 0.001
Central			
Total Period	1990-2015	-1.3 (-1.5; -1.1)	< 0.001
Period 1	1990-1995	0.4 (0.1; 0,6)	0.005

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Period 2	1995-1999	-0.8 (-1.3; -0.2)	0.009
Period 3	1999-2004	-2.3 (-2.6; -1.9)	< 0.001
Period 4	2004-2010	-1.0 (-1.2; -0.7)	< 0.001
Period 5	2010-2015	-2.6 (-2.9; -2.4)	< 0.001
South			
Total Period	1990-2015	-2.6 (-2.8; -2.4)	< 0.001
Period 1	1990-1994	-1.4 (-1.8.; -0.9)	< 0.001
Period 2	1994-2003	-1.9 (-2.0; -1.7)	< 0.001
Period 3	2003-2012	-3.6 (-3.7; -3.5)	< 0.001
Period 4	2013-2015	-2.0 (-3.2; -0.8)	0.004
West			
Total Period	1990-2015	-2.3 (-2.4; -2.1)	< 0.001
Period 1	1990-2000	-1.2 (-1.4.; -1.1)	< 0.001
Period 2	2000-2007	-3.8 (-4.1; -3.4)	< 0.001
Period 3	2007-2015	-1.3 (-1.6; -1.1)	< 0.001

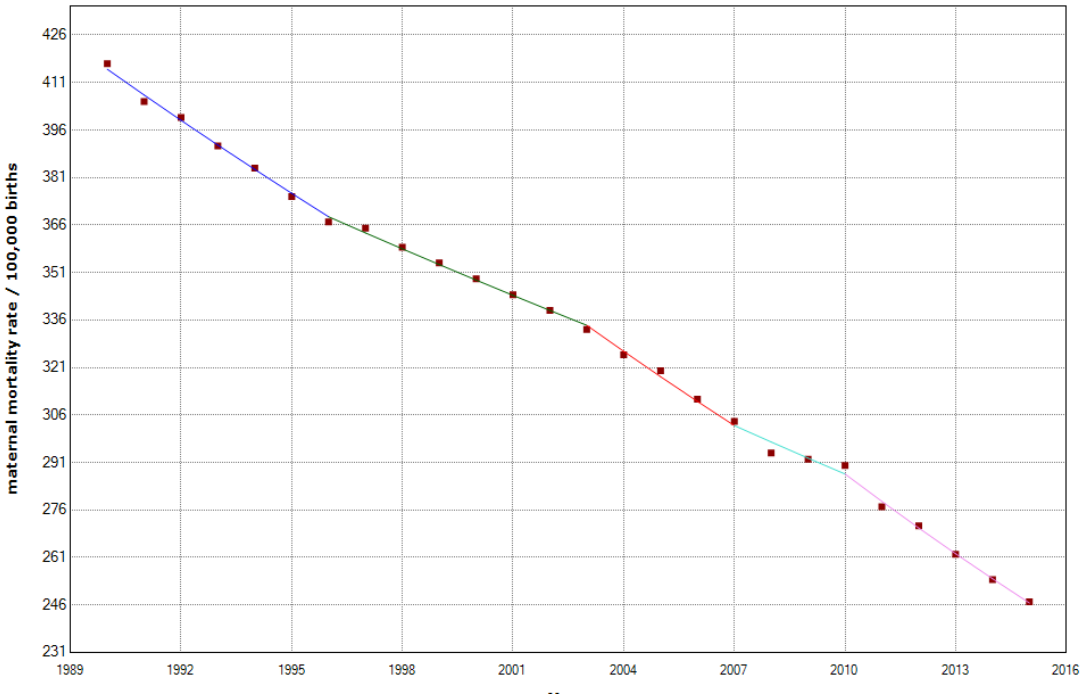

Figure 4. Maternal mortality trends in North Africa (1990-2015), indicating joinpoints at the transitions between different colored lines.

In the East African Region, the overall MMR decreased from 1071 to 441 maternal death per 100,000 births. (Table 2) East Africa was the region with the highest decrease during the study period. MMR was reduced by -58,81%. Maternal mortality in the region decreased annually by 3.6%, with four join points in 1993, 2001, 2004, and 2009. (Fig 5)

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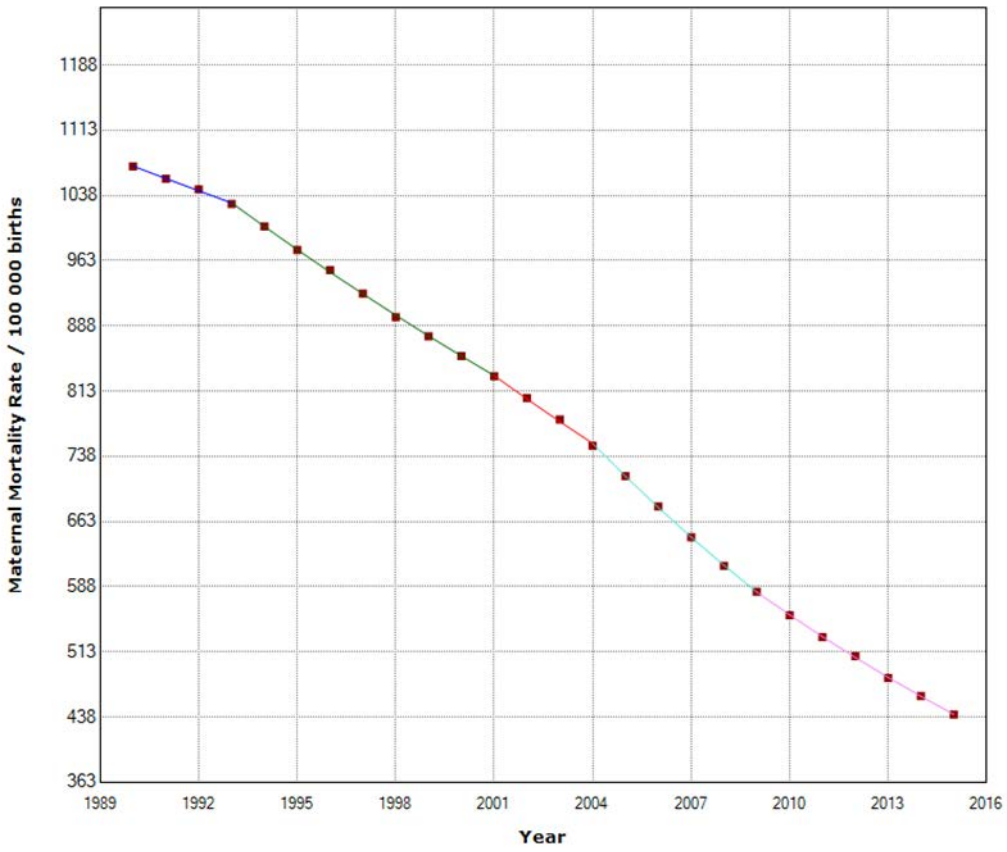

Figure 5. Maternal mortality trends in East Africa (1990-2015), indicating joinpoints at the transitions between different colored lines.

In the Central African Region, during the entire period 1990-1995, maternal mortality increased by 0.4% per year. From 1995-1999, the MMR began to decline with an APC of -0.8%. The decline slowed in 2004-2010 with an APC of -1% and accelerated in 2010-2015 with an APC of -2.6%.(Fig. 6)

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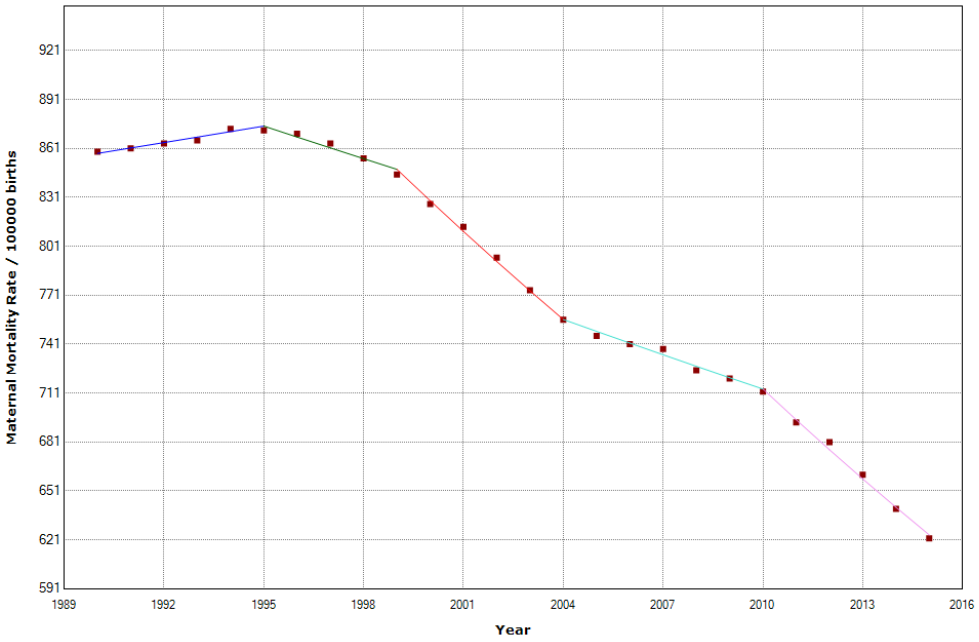

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Figure 6. Maternal mortality trends in Central Africa (1990-2015), indicating joinpoints at the transitions between different colored lines.

In the South African Region, the overall MMR decreased from 442 to 374 per 100,000. We recorded a -statistically significant decrease of –0.6% in the MMR, with four joinpoints in 1993, 2003, 2007, and 2012. (Fig 7) In the first period, MMR decreased with an APC of -2.2%, then in the second period, 1993-2003, MMR increased, with an APC of 4,5%. Finally, in the period 2003-2007, back to a reduction of -4,1%, and the period 2007-2012, with a high APC decrease of -7.9%, this is the highest period regional decrease detected in this study.

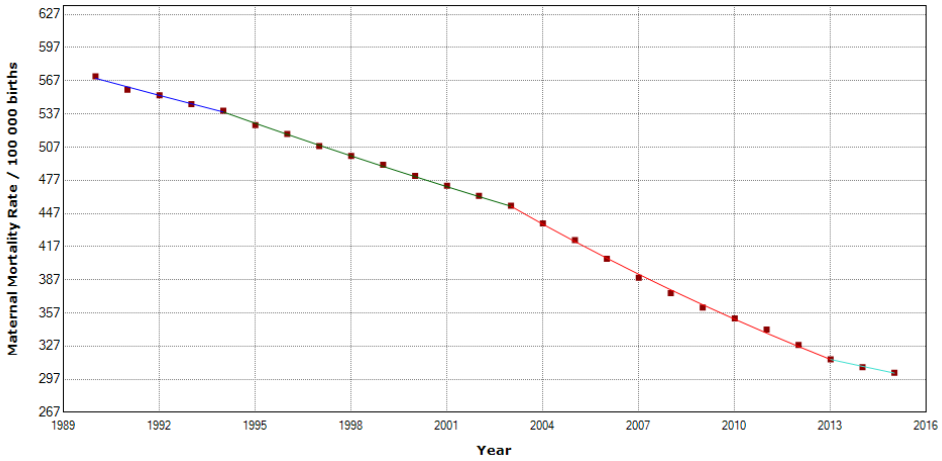

Figure 7. Maternal mortality trends in the South Africa Region (1990-2015), indicating joinpoints at the transitions between different colored lines.

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In the West Africa Region, the overall MMR decreased 39,51% from 1112 to 673 during 1995-2015. We recorded a statistically significant decrease in APC of –2.6% in the MMR, with two join points in 2000 and 2007 (Fig. 8).

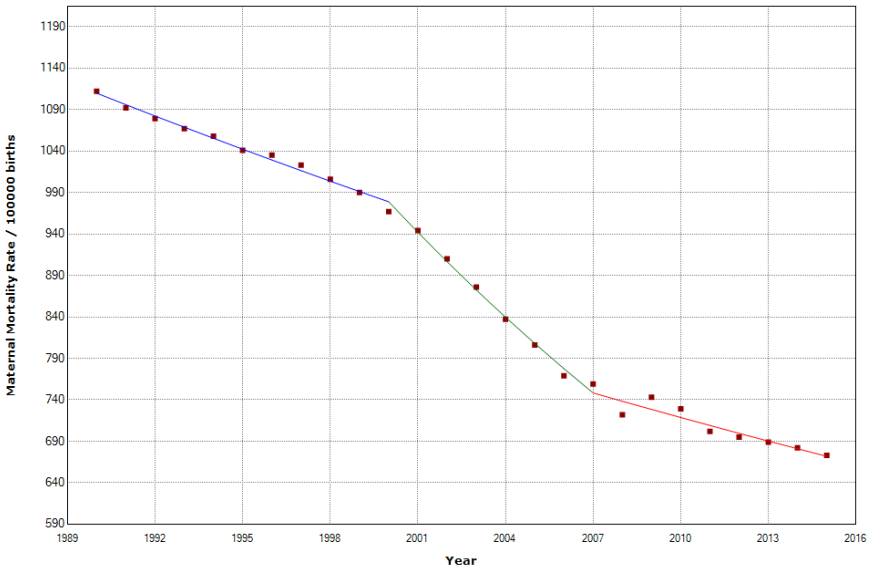

Figure 8. Maternal mortality trends in West Africa Region (1990-2015), indicating join-points at the transitions between different colored lines.

4. Discussion

We have detected a slowdown in maternal mortality reduction in Africa since the economic crisis that began in 2007. The decrease was detected in the North, Central, and West regions. The East region was somewhat affected, while the South region was not affected by the economic crisis.

The United Nations set in 2015, within the Sustainable Development Goals, to reduce MMR to 70 per 100,000 live births by 2030. In 2015 the global rate in Africa was 459 deaths per 100,000 population. Although there has been a considerable reduction from the 1990 figure of 849 deaths per 100,000 population, there is still a long way to go to reach the target. MMR rates would have to fall by an APC of 10.36 to reach the target in 2030. This reduction is a figure that has never been achieved. If we continue with the same APC of the last period (-2.7%), the target will be reached in 2086. In North Africa, the most advanced region, the proposed figure should be reached around 2022.

Although this may seem disheartening, there are signs of hope. A commitment is needed from health authorities to deploy a health policy that allows easy access to health services for all pregnant women. An example would be Ethiopia's case, where the MMR decreased from 871 per 100 000 in 2000 to 412 per 100 000 in 2017. The MMR is still far from the figure of 70, but it represents a reduction of more than 50% [31].

There has been a steady decline in maternal mortality in the South African Region. The decline has been remarkably resilient as it was not affected by the economic crisis that hit the South African region from 2008 onwards. Changes in health policy and legislation may be responsible for these declines despite adverse economic conditions[32]. In the North African Region, maternal mortality has been declining and was not affected by the

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Arab Spring (2010-2011). The decline in maternal mortality accelerated in the Arab Spring period.

A debatable question is which classification to use for the regions of Africa. Many international organizations use the United Nations Region Classification of the M49 Standard, classifying African countries into five regions [33,34] (Fig 10): Northern Africa, Eastern Africa, Middle Africa, and Southern Africa. UN classification includes Sudan in North Africa [35]. Likewise, the Southern region is much larger in the African Union classification because it includes Angola, Zimbabwe, Zambia, and Mozambique.

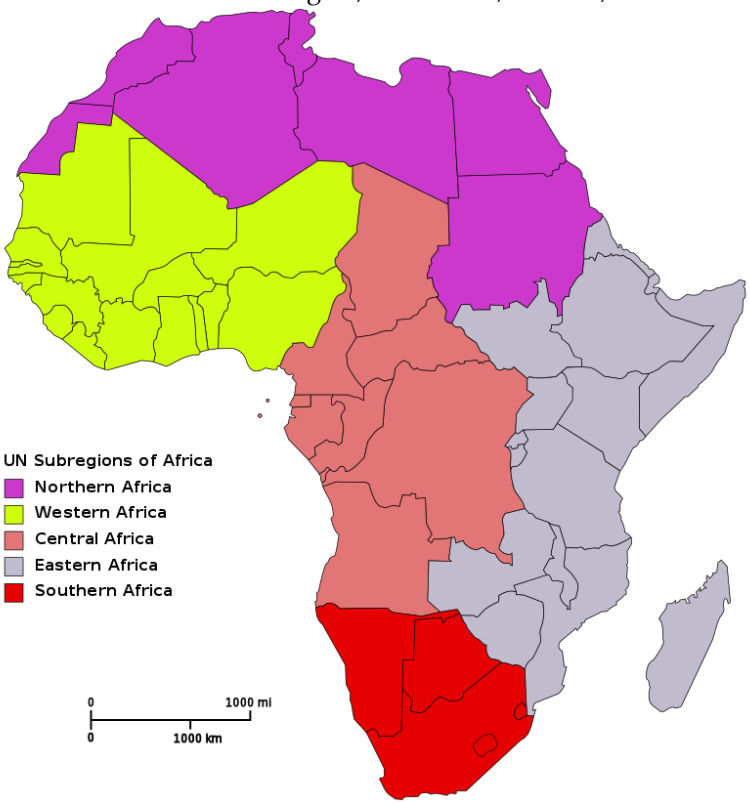

Figure 9 African Regions of the United Nations Region Classification (source: CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=546265)

Choosing one or another classification of regions has implications because it affects regional mortality rates. Table S1 shows the Joinpoint analysis using the United Nations classification. Our study used the African Union classification instead of United Nations Classification. We decided to use the African Union classification instead of the United Nations classification because our data could be more beneficial for elaborating regional policies within the African Union.

In many countries, mortality data collection systems are not very comprehensive, which is a limitation of the study. There are several methods for the estimation of maternal mortality. Estimates from international agencies may differ from official national statistics. Indeed, a study in Ethiopia showed that maternal mortality data provided by international agencies underestimated maternal mortality: 401 versus 412 per 100,000 [36]. - Deaths registration and recording of the cause of death as a part of the Vital statistics system are deficient in many countries of Africa, and in 2015 the regional average completeness rate of death registration was only 34.6% [37]. In addition, some countries have reported low death registration, and few countries achieve international standards[38]. -

Concerning maternal deaths, underreporting has been found in some African countries[39,40].

The demographic, socioeconomic, and geographic diversity of countries in each regional group could be considered in the explication of the results.

Our study indicates that wars and economic crises may have a short-term effect on maternal mortality in Africa. Maternal mortality has decreased in Africa, especially in southern and high-income countries. The most important long-term factors are health policies and the accessibility of health services, which are influenced by the quality of care and road building construction that facilitates transportation to health facilities [41,42].

Our results could serve as a reference for developing health policies in the regions with higher Maternal mortality.

In future research, maternal mortality may be adjusted for potential risk factors, including income and education level, comorbidities, medical assistance, and environmental sanitation, to estimate maternal mortality trends[42–45] accurately.

5. Conclusions

Over the study period, maternal mortality has decreased in Africa by an average APC of -2.6%. All regions showed significant downward trends, with the sharpest decreases in East Africa. Only the North African region is close to the United Nations sustainable development goals for maternal mortality. The remaining sub-Saharan African regions are still far from achieving the goals. These results show the need to develop Regional Policies to further decrease Maternal mortality in Africa.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/T1

Table S1: Joinpoint analysis for Regional maternal mortality rates in Africa (1990–2015) using the United Nations Region Classification

Author Contributions: Conceptualization, LO, FGG, AAP, and IAO; methodology, SGA. WOL, LGA, FGG; software, FGG.; validation, RAB, IAO, AY.; formal analysis, LO, WOL, AY.; investigation, LO, FGG, IAO; Data curation, LO, SGA; RAB, writing—original draft preparation, LO, WOL, SGA, RAB, LGA, AY, MJF, FGG, IAO.; writing—review and editing, LO, WOL, SGA, RAB, LGA, AAP, AY, MJF, FGG, IAO; supervision, FGG, IAO, MJF.; visualization, LO, WOL, SGA, RAB, LGA, AAP, AY, MJF, FGG, IAO supervision, FGG, IAO, MJF.AAP. All authors have read and agreed to the published version of the manuscript.

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