

# Maternal Mortality Rate (MMR), Percentage of Teenage Mothers and Youth Female Literacy Rate

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## Research

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# Abstract

## Background

In the past few years, maternal mortality rate has been a growing area of research interest in Africa. It is also noteworthy that teenage mothers are on the rise. This study is aimed at assessing the relationship between maternal mortality rate (MMR), the percentage of teenage mothers, and literacy rate among female adolescents in different regions of Africa.

## Method

Secondary data on maternal mortality rate, percentage of teenage mothers and youth female literacy rate, originally compiled by United Nations Population Division, was obtained from World Bank data and analyzed using a regression model. The average values were estimated for MMR and youth literacy and the relationship was determined for each region.

## Results

The West African region had the highest average maternal mortality rate while North Africa had the highest mean literacy rate and the highest mean teenage mother rate. A 10% rise in adolescent literacy rate was shown to reduce MMR across all regions, although the extent of reduction differed across each region. A reduction in MMR was observed as well in varying proportions, following a hypothetical 10% increase in youth literacy rate over some years.

## Conclusion

The study shows that low literacy rates were associated with child marriage which increases the risk of maternal mortality. Efforts need to be further intensified in improving the educational level of females in developing countries, especially African nations, in order to reduce maternal mortality in the region.

# Introduction

According to the World Health Organization (WHO), maternal mortality is the death of a woman during pregnancy or six weeks of pregnancy termination regardless of the pregnancy site or duration.[1]

Accidental causes are not included in this definition because the pregnancy does not directly cause it. [1] It has been reported that up to 94% of maternal death cases happen in low and lower-middle-income nations with sub-Saharan Africa accounting for about 86% of the global maternal mortalities in 2017.[2] Even though there was a reduction of 38% in the worldwide maternity mortality rate from the year 2000 to 2017,[2] maternal mortality remains a global health challenge because of the high number of maternal deaths reported.[3] Several nations lag behind in reducing maternal mortality rate, especially those with weak health systems and inadequate health care workers.[4]

The WHO also reported that up to 21 million girls between ages 15 and 19 become pregnant each year and only about 57.1% of them give birth.[5] This percentage was found to be high in marginalized countries due to extreme poverty and lack of education. It has been projected that adolescent pregnancies will increase globally by 2030, with the most significant proportional increases in West and Central Africa and Eastern and Southern Africa.[6] This continuous rise created a global problem due to the fatal complications and socioeconomic effects it has on teenage mothers, their families, and communities. [7]

In a study by Umar, it was discovered that education is associated with antenatal clinic service utilization among Nigerian women.[8] Female education still lacks behind in many developing countries, and girls have been said to drop out in school because it has been given lower priority. Education has been identified as one of the factors affecting maternal mortality.[9] This situation eventually affects their use of reproductive health care services later because they do not have adequate health knowledge.[10] Improving girls' education is likely to reduce preventable maternal deaths significantly. [11]

Different studies have looked at the association between maternal mortality and various socioeconomic factors. Only a few have evaluated these among the different African regions, notably because the different cultures in this region of the world could impact education and marriage. Therefore, there is a need to take necessary actions that will influence health and educational policies. This research to policy action will effectively reduce the high illiteracy, pregnancy, and maternal mortality rates among female youths. This study aimed at assessing the relationship between maternal mortality rate (MMR), the percentage of teenage mothers, and literacy rate among female adolescents in different regions of Africa.

## Materials And Methods

This study utilized secondary data from the World Bank, which was originally compiled by the United Nations Population Division. Data sources include national vital registration, population laboratories, among others. The Maternal Mortality Rate, percentage of teenage mothers, and youth female literacy rate were calculated in the World Bank data. Data is freely available at <https://data.worldbank.org/indicator>.

Data is available from the year 1990 to 2015. Teenage mothers were defined as the percentage of women aged 15-19 who already have children or are currently pregnant. The MMR data were estimated with a regression model using the information on the proportion of maternal deaths among non-AIDS deaths in women aged 15-49, fertility, birth attendants, and GDP measured using purchasing power parities. The actual data on youth literacy rate and maternal mortality rate was modelled for each of the regions across Africa (Eastern, Western, Northern, Southern and Central).

The average values were estimated for both variables (MMR and youth literacy rate) across countries within each region per year (i.e. average MMR values for all countries in Western Africa, for 1990...average values of literacy rate for all countries in Western Africa, also for 1990...and so on).

Furthermore, the relationship between the maternal mortality series and youth literacy series was determined for each region. Region(s) that showed a linear relationship existed between the two variables were modelled and extrapolated for using a simple linear regression; while others that showed a non-linear relationship between the two variables were modelled and extrapolated for using any of the suitable curve estimation technique.

The linear relationship between maternal mortality and youth literacy rate for Northern Africa is presented by the equation:

$$\widehat{MMR} = Constant + Coeff. (Lit. Rate)$$

The Compound model fitted for other regions in Africa is presented by the equation:

$$\widehat{MMR} = Constant \times Coeff. Lit. Rate$$

The linear relationship between maternal mortality and teenage mothers' rate for Central Africa and Southern Africa is presented by the equation:

$$\widehat{MMR} = Constant + Coeff. (Teen. mother)$$

The Compound model fitted for other regions in Africa is presented by the equation:

$$\widehat{MMR} = Constant \times Coeff. Teen. mother$$

## Results

A total of forty-three countries were selected for the study across the five regions in Africa. The mean maternal mortality rate ranges from 17.72 to 2322.8, with a combined mean of  $691.1 \pm 411.1$ . The African regions with the highest average maternal mortality rates are West Africa, Central Africa, and East Africa, with values of 763, 718, and 647 (Figure 1). The trendline shows that the mean maternal mortality rate was reduced progressively from 1990 to 2015 (Figure 1). Among the seven selected countries from Central Africa, Equatorial Guinea had the lowest mean maternal mortality rate (451.9), while Angola had the highest mean maternal mortality rate of 1003.8 (Figure 1). Out of the 15 selected West African countries, Cote d'Ivoire had the lowest mean maternal mortality rate of 173.76, while Sierra Leone had the highest mean maternal mortality rate of 2322.8 (Figure 1). Among the 3 South African countries, Lesotho had the lowest mean maternal mortality rate of 17.7, while South Africa had the highest mean maternal mortality rate of 1261.6 (Figure 2). Among the Eastern African countries, Djibouti had the lowest mean maternal mortality rate of 64.2, and South Sudan had the highest mean maternal mortality rate of 1276.1 (Figure 1). In North Africa, Libya recorded the lowest mean maternal mortality rate of 215.6 while Algeria had the highest rate (867.76)

The mean literacy rate seen in the selected African countries ranged from 22.2 to 98.4, with a combined mean of 64.4 ( $\pm 23.5$ ). The regions with the highest mean literacy rates are North Africa (67.9), West Africa (65.5), and East Africa (62.9) (Figure 2). Among the Central African countries, Gabon had the lowest mean literacy rate of 26.6, and Guinea had the highest literacy rate of 90.8. Botswana had the lowest mean literacy rate of 26.2 among the South African countries, while Lesotho had the highest rate of 97.9. In West Africa, the literacy rate was highest in Guinea (97.5), and the Benin Republic recorded the lowest mean literacy rate (32.9). South Sudan recorded the lowest mean literacy rate of 22.2 in East Africa, while Uganda had the highest rate of 98.4. Among the North African countries, Algeria had the lowest mean literacy rate of 66.9%, and Tunisia recorded the highest rate of 77.51% (Figure 2). The literacy rate shows that the literacy rate in Africa was at its lowest ebb (14.0) in the year 2000 and this was experienced in the Southern region of the continent. On the contrary, the highest literacy rate (92.1) was seen in 1995 in the Central African region.

The mean rate of becoming a teenage mother in the selected African countries ranged from 6.1 to 46.4, with a combined mean of 25.7 ( $\pm 10.2$ ). The regions with the highest mean teenage mother rates are North Africa (25.92), Central Africa (24.25) and East Africa (23.86). In Central Africa, the Democratic Republic of Congo had the lowest mean teenage mother rate (25.5), and Cameroon had the highest rate of 36.1. Only Botswana had data available among the South African countries, and it recorded a teenage mother rate of 21.4. Among the West African countries, Nigeria (6.1) has the lowest teenage mother rate while Mali (46.4) has the highest teenage mother rate. Among the Eastern African nations, Djibouti had the highest teenage mother rate of 9.3 while Madagascar had the highest rate of 39.7. Libya (6.8) has the lowest teenage mother rate in North Africa and Tunisia has the highest rate (33.5). A trend line of teenage mother rate shows that Eastern Africa had the lowest rate across the regions in 1990, and Central Africa had the highest rate in 1995.

In Central Africa, ignoring the effect of teenage mother rate, maternal mortality rate is observed to have a rate of 180 per hundred thousand women; a unit increase in teenage mother rate increases maternal mortality by 15.86 per hundred thousand women. In Southern Africa, a unit increase in the teenage mother rate increased maternal mortality by 31.86 per hundred thousand women (Figure 3).

Given the level of youth literacy rate is set to zero, maternal mortality rate is expected to be about 1189.94 per hundred thousand women in Northern Africa; a unit increase in the youth literacy rate lowers maternal mortality rate by 9.52 per hundred thousand women in Northern Africa (Figure 4).

The non-linear regression results derived from curve estimation for other regions of Africa region whose data were not linear; using the compound model; with a statistically significant result at 1% level for all the regions. The non-linear regression showed that; in Eastern Africa, a 10-unit increase in rate of youth literacy (from 10% to 20%) reduced MMR by 22.18 per hundred thousand women; an increment in youth literacy rate by 30 units (from 40% to 70%) reduced MMR by 59.04 per hundred thousand women.

In Central Africa, an increase in youth literacy rate by 10 units (from 14% to 24%) reduced the MMR by 6.99 per hundred thousand women; an increase by 30 units (44% to 74%) lowered MMR by 20.16 per

hundred thousand women. In Western Africa, a 10-unit rise in the youth literacy rate (27% to 37%) effected a drop in MMR by 48.83 per hundred thousand women; while an increase up to 30-unit (57% to 85%) reduced MMR by 115.29. In Southern Africa, a 10-unit increase in literacy rate (from 14% to 24%) effected an increase on MMR by 2.52 per hundred thousand women; a 30-unit increase in the literacy rate (from 44% to 74%) led to an increase in MMR by 7.68 per hundred thousand women.

Considering a 10% rise in adolescent literacy rate, generally a reduction in MMR is observed across all regions in the Africa continent, although the extent of reduction is different for each of the regions, across the years. A massive reduction in MMR was observed in Eastern Africa, Northern Africa and Western Africa, following a hypothetical 10% increase in youth literacy rate over some years; while in Central Africa, the observed reduction in MMR was little following a hypothetical 10% increase in youth literacy rate (Figure 4).

There are also non-linear regression results derived from curve estimation for the other African regions whose data were not linear (Eastern Africa, Northern Africa, Western Africa); using the compound model; with a statistically significant result at 1% level.

The non-linear regression showed that; in Eastern Africa, a 5-unit decrease in rate of teenage mothers (from 14% to 9%) reduced MMR by 10.2 per hundred thousand women; a decrease in teenage mothers' rate by 15 units (from 39% to 24%) reduced MMR by 28.81 per hundred thousand women.

In Northern Africa, a unit decrease in teenage mothers' rate (from 21 to 20) decreased MMR by 3.12 per hundred thousand women; while a 10-unit decrease (from 36 to 26) reduced MMR by 29.97 per hundred thousand women.

In Western Africa, a deflation in the maternal mortality rate by 3 units resulted into an increase in MMR by 18.48 per hundred thousand women; while a reduction in maternal mortality rate by 15 units led to an increase in MMR by 106.3 per hundred thousand women. Given a 10% reduction in the teenage mother rate across African regions, a significant reduction in the MMR was observed in two regions – Eastern Africa and Central Africa; a reduction in MMR was also observed in the Southern Africa. Conversely, a decrease in teenage mother rate resulted into a rise in MMR in the Western Africa region (Figure 5).

## Discussion

Maternal mortality has steadily become a global health issue and a strain in socioeconomic development as it accounts for thousands of preventable deaths amongst women. The International Classification of Diseases (ICD-9) defines maternal mortality as any death in a woman during pregnancy and up to 42 days post partum, thus including deaths associated with abortion and stillbirth.[12] Maternal mortality could arise from direct causes originating from obstetric complications of pregnancy, or indirect causes as a result of health problems prior to the pregnancy. [13] A powerful predictor of maternal mortality is the women's status which can be as measured by the level of education relative to men, the age at first marriage, and reproductive autonomy. [8]

Literacy, a major contributor to the accessibility of health information is a determinant of a population's level of disease and mortality rate.[14] Studies in many countries even in Africa show that educating girls is widely perceived as being of less value than educating boys, leaving a large number of girls out of school and uninformed.[15] It is noteworthy that countries amongst the five regions of study in Africa that recorded lowest mean literacy rate experienced a high maternal mortality. Therefore, our hypothesis that youth female literacy contributes in declining maternal mortality rate were confirmed in this study. These results accumulated align with prior studies that education, especially in women, is higher in those countries where the maternal mortality rate is lower and yields a general healthy population.[16]

Therefore rates of maternal mortality also tend to be higher in countries where the female literacy rate is lower than the male literacy rate. Programs that focus only on providing medical care to reduce maternal and infant mortality may not be impactful as intended unless carried out alongside adequate women education.[17] Another international survey, explained that women with lower educational levels are more likely to die than women with higher educational levels due to childbirth complications.[18] One of the predominant occurrence associated in regions of low literacy is child marriage which is a major risk factor of maternal mortality as it further encourages early pregnancy thereby increasing the risk of complications during pregnancy and child birth. Compared with women >20 years of age, girls 10–14 years of age are 5–7 times more likely to die from childbirth, and girls 15–19 years of age are twice as likely.[19] Hence, education especially amongst women has a ripple effect in countering harmful norms. It also empowers them with the right knowledge about early warning signs of complications and also improve their communication with health care providers.

A similar study showed that educated women have a higher number of antenatal care visits and institutional delivery compared to uneducated women living in a similar setting and economic status.[20] With this exposure, educated women begin to adopt healthy practices to enhance their health and well-being. They are also more likely to choose to have fewer children, enhancing family planning and reducing the risk of dying at child birth. This can be seen in overwhelmingly documented studies of positive and significant relationships between female education and contraceptive use.[21-23] Generally, it has been discovered that higher levels of education are associated with lower levels of fertility, this led to the question asked by Carr [24] if education is the best contraceptive. Further supporting studies showed that the likelihood of using modern contraception and regular antenatal care visits are 2.01 and 2.89 times, respectively, higher for women with complete primary education than for those less educated which suggested that maternal health service utilization can be accelerated through poverty eradication, universal primary education and women's empowerment.[25]

This healthy practice due to an increase in female literacy level was supported in a study which suggested that nutritional intake reduces pregnancy complications.[26] Investing in girls education will in turn build their financial capacity to be able to effectively demand and pay for good healthcare service therefore female literacy campaigns are the best routes to achieve a long-term reduction in maternal mortality rate with several studies to show that establishing policies that improve female literacy rates is one of the most effective tools in ultimately reducing the burden of maternal mortality.[27, 28]

## Conclusion

Efforts need to be further intensified in improving the educational level of females in developing countries, especially African nations. This act will give them adequate knowledge required by them to take informed decisions about their health. The healthy practices imbibed from the improved female literacy rates will also boost their health during pregnancy. Females in these countries will then be able to confidently utilize available antenatal care facilities during pregnancy. With these, there will be a great reduction in the maternal mortality rate seen in these nations.

## Declarations

### Acknowledgement

Nil

### Funding

No financial support or grant was received for this study

### Ethical Approval and consent to participate

Not applicable

### Consent for publication

Not available

### Availability of data and materials

The datasets generated and/or analysed during the current study are available in the World bank repository, <https://data.worldbank.org/indicator>.

### Competing interests

Authors declare no competing interests

### Authors' contributions

MAA, IIO and RIO conceptualized the study. MAA and IIO wrote the methodology section. MAA and BEO were involved in the statistical analysis for the study. RIO, SA, BEO, PFE and PKI were involved in the literature search. PFE and PKI wrote the introduction section. BEO and SA wrote the results and discussion section. RIO, MAA and IIO wrote the final draft of the manuscript. All authors agreed to the revised and final draft of the manuscript.

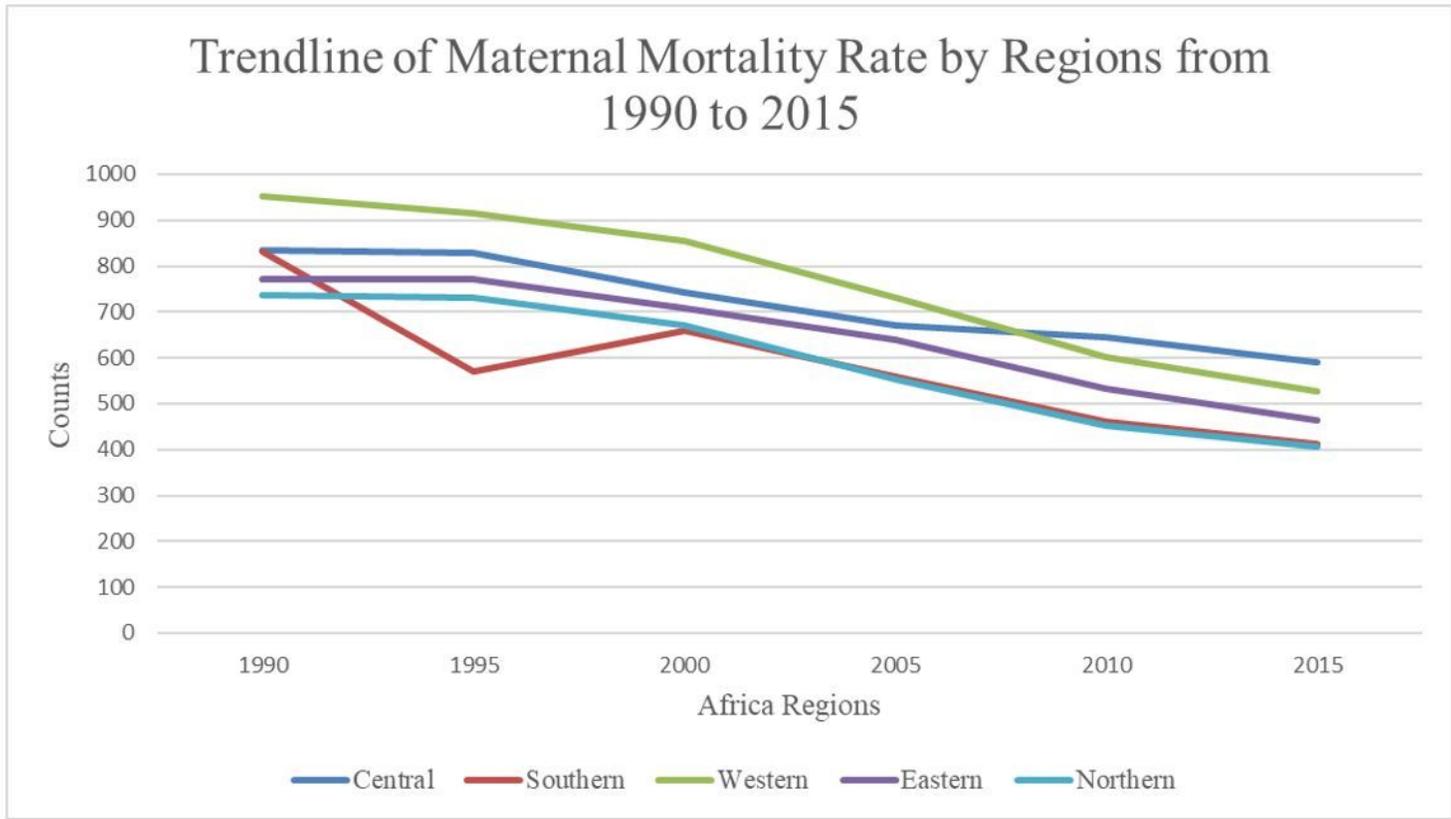
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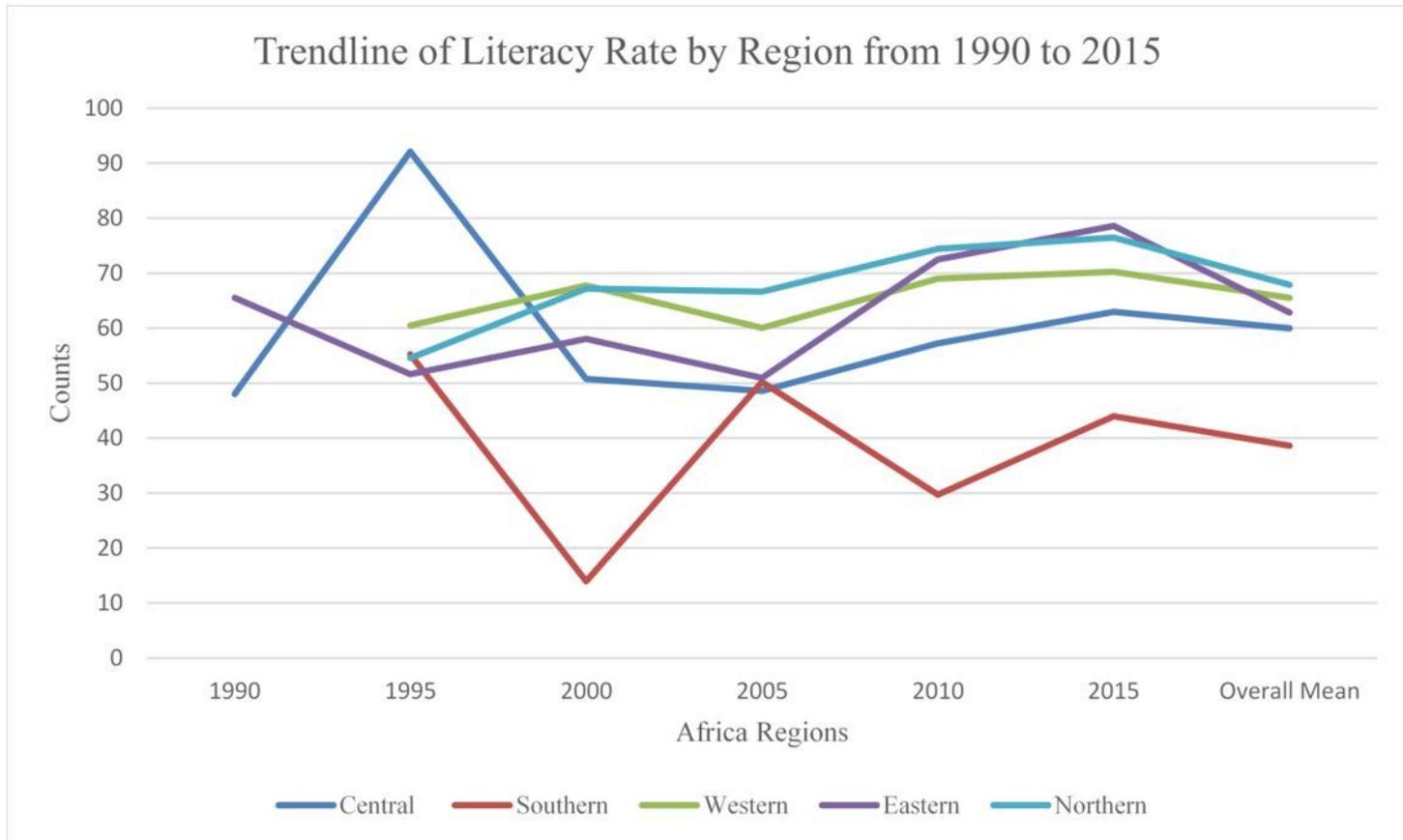
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## Figures



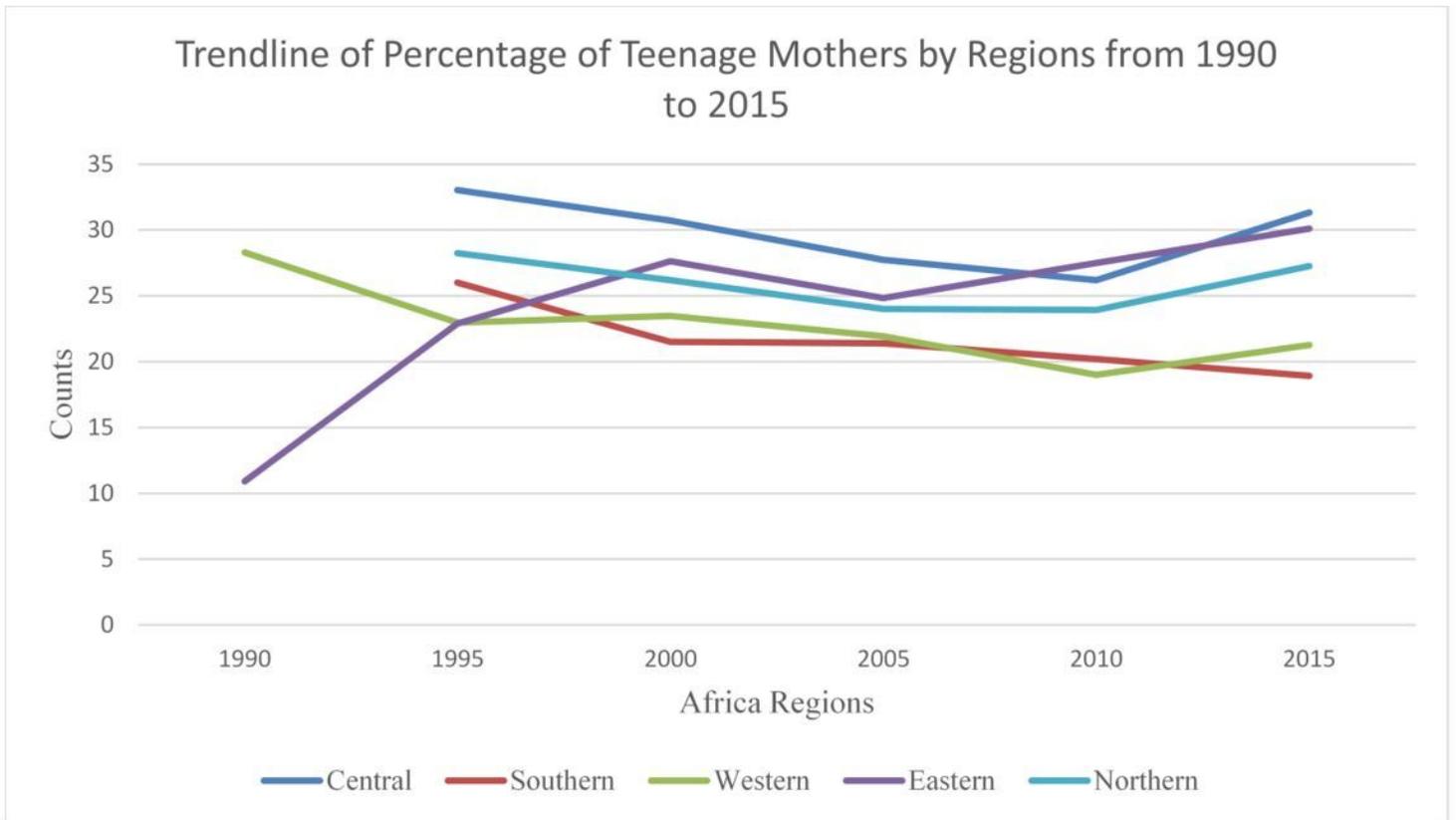
**Figure 1**

Trendline of maternal mortality rate by regions from 1990 to 2015



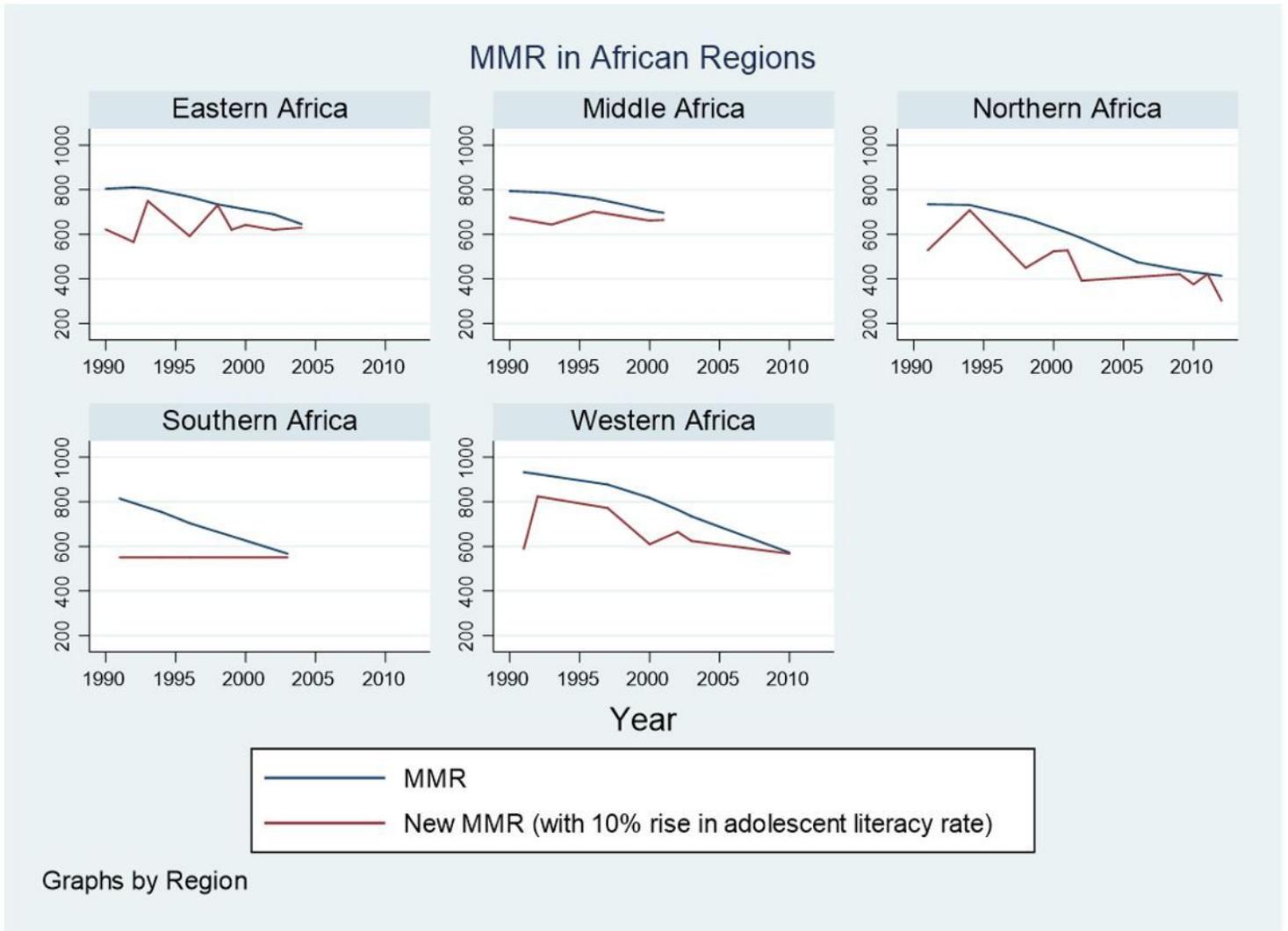
**Figure 2**

Trendline of literacy rate by region from 1990 to 2015.



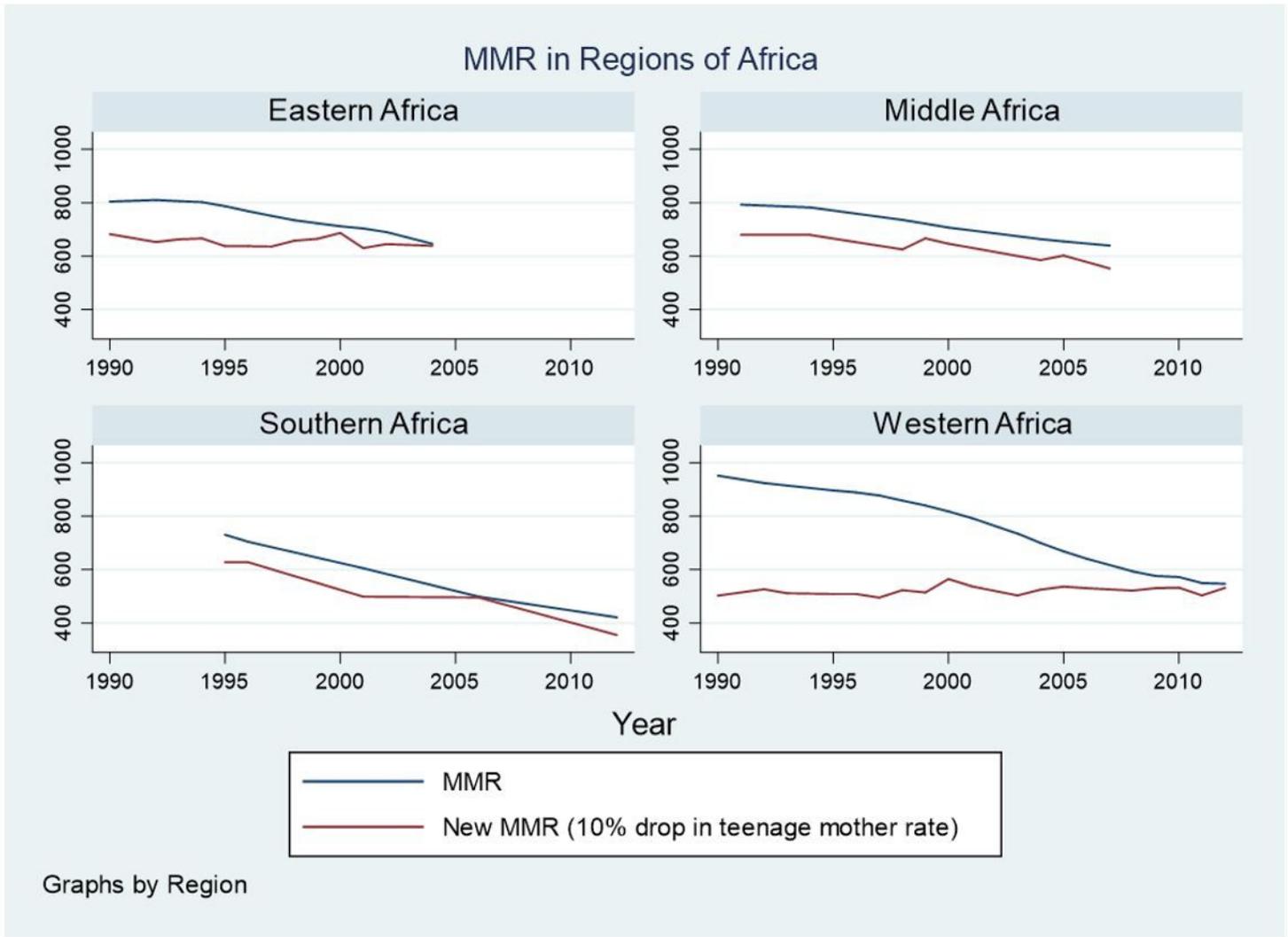
**Figure 3**

Trendline of percentage of teenage mothers by regions from 1990 to 2015



**Figure 4**

MMR in African Regions with 10% rise in adolescent literacy rate



**Figure 5**

MMR in African regions with a 10% drop in teenage mothers rate