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The Impact of Low Farming Yields in Sub-Saharan Africa on Maternal Mortality and Mortality of Children Under the Age of 5

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Abstract

Child and maternal mortality are major causes of morbidity and mortality in sub-Saharan Africa. Further, agriculture is a key part of the sub-Saharan African economy. However, the role of low farming yields in sub-Saharan African health outcomes has not been adequately considered, with only two studies having been conducted as of 2021. In this paper, the experimenter used publicly released data from UNICEF and the World Bank for all sub-Saharan African countries to determine the role that low farming yields had on maternal mortality and mortality of children under the age of 5 (MC5). The experimenter found a negative correlation between low farming yields and maternal mortality as well as low farming yields and MC5; however, the correlation was weak due to data heterogeneity. The two primary outliers, Mauritius and Cabo Verde, have high healthcare scores and high-quality health education respectively, which contributes to their low rates of maternal mortality and MC5. While this study did not find a positive conclusion, it adds to the literature by providing an opportunity for further research to explore the relationship between agriculture and health in sub-Saharan Africa, which has historically been understudied in the region and not studied previously on the scope of this paper.

Keywords: farming yields, child mortality, maternal mortality

Introduction

Sub-Saharan Africa is among the world's poorest regions (Schoch & Lakner, 2020). While the region has improved its health, wealth, and agricultural statistics over the past two decades, agricultural changes have not been as large or impressive as predicted due to a lack of agricultural productivity (Jayne & Sanchez, 2021). Further, many have expressed concern that sub-Saharan Africa may not be able to produce enough food to meet the needs of the millions of people that reside in the region (van Ittersum et al., 2016). Adding to the region's challenges, the Lancet Commission on the Future of Health in Sub-Saharan Africa found that sub-Saharan African nations must implement major reforms by 2030 to improve health in the region (Agyepong et al., 2017). One important and effective approach to reducing disease burden has been information campaigns through commonly consumed media. Studies examining this approach (radio information campaigns) have found positive results for mortality of children under 5 (MC5) and maternal health behaviors in Burkina Faso (Murray et al., 2018; Sarrassat et al., 2018). However, the role of agricultural yields has not been adequately considered in preventing disease, with only two studies conducted on the relationship between low farming yields and MC5 and none conducted on the relationship between low farming yields and maternal mortality. Both MC5 studies were conducted in Burkina Faso,

with no studies examining populations outside of Burkina Faso (Belesova et al., 2017; Belesova et al., 2019). Agriculture is a key sector of sub-Saharan African economies that can be influenced (McCullough, 2017). Thus, the investigator set out to examine the impact of low farming yields on MC5 and maternal mortality in all sub-Saharan African countries generally to determine what role improving farming yields had on reducing MC5 and maternal mortality.

Methods

Dataset & Sample Size

In this paper, the experimenter used existing maternal mortality and MC5 data. in individual sub-Saharan African countries. All countries in sub-Saharan Africa (n=48) were examined in both maternal mortality and MC5 analyses.

Data Sources

MC5 and Maternal Mortality Data: MC5 and maternal mortality data was obtained from two custom data warehouse spreadsheets produced by UNICEF. (UNICEF, n.d.-a; UNICEF, n.d.-b) This dataset consists of data collected by the World Health Organization, UNICEF, the UN Population Fund, the World Bank, and UN Population Database and brought together by UNICEF. The maternal mortality data was available from 2016, 2017, 2018, and 2019. (UNICEF, n.d.-a) The MC5 datasheet contained data for the years 2016 and 2017. (UNICEF, n.d.-b) All data was used under a CC-BY 3.0 license.

Crop Yield Data: Crop yield information was obtained from a World Bank dataset. (World Bank, n.d.) Crop yield data was provided from 1990 to 2018, in the years 1990, 2000, 2011, 2012, 2013, 2014, 2015, 2016, 2017, and 2018 All data was used under a CC-BY license.

Definitions

Maternal mortality refers to deaths of females during pregnancy, childbirth, or post-natal for every 100,000 births. MC5 refers to deaths of children under the age of 5 per 100,000. Farming yields refer to, in this paper, cereal crop yields in sub-Saharan Africa as defined by the World Bank (kilograms per hectare). Sub-Saharan Africa is a region containing the countries of Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, the Central African Republic, Chad, Comoros, the Democratic Republic of the Congo, the Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Principé, Senegal, the Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. (World Bank, n.d.)

Data Analysis

Data analysis was conducted in Microsoft Excel. Raw data from UNICEF and the World Bank was sorted into several spreadsheets in Microsoft Excel. A grand total of 8 different spreadsheets were used: 3 spreadsheets stored raw maternal and child mortality data, while the remaining 5 spreadsheets were used to sort and examine the data. Of these 5 spreadsheets, 3 contained data for farming yields, MC5, and maternal mortality individually; the remaining 2 contained farming yield and maternal mortality data as well as farming yield and MC5 data. Trendlines and their respective equations in Figures 2A-2C were created using Microsoft Excel's scatterplot features (data was added to the respective area, and x- and y-axes were created such that the x-axis signified crop yields [see Definitions] and the y-axis signified the health indicator [MC5 or maternal mortality]).

Results

Farming yield data was found for all sub-Saharan African countries except Equatorial Guinea and the Seychelles. Under-five and maternal mortality data was found for all sub-Saharan African countries. Data for all sub-Saharan African countries and a comparison with the sub-Saharan African average are shown in Figures 1A-1C. All

original data is found in Table 1. These data were derived from the World Bank and UNICEF as mentioned in the Methods section of this paper.

Country	Farming Yield Data	MC5 Data	MM Data
Angola	754.7	80.62230214	241
Benin	1405.4	95.13307868	397
Botswana	320.7	43.78164158	144
Burkina Faso	1009	93.86290945	320
Burundi	1048	61.34873273	548
Cabo Verde	157	16.83571002	58
Cameroon	1682.8	80.81870055	529
Central African Republic	907	117.4709876	829
Chad	825.2	121.50835	1140
Comoros	1364.9	67.32861972	273
Congo, Dem. Rep.	769.4	90.76392438	473
Congo, Rep.	826.2	50.90423184	378
Côte d'Ivoire	2254.7	85.2824024	617
Equatorial Guinea	N/A	87.67384977	301
Eritrea	644.5	43.28047615	480
Eswatini	1163.1	62.32347248	437
Ethiopia	2512.6	55.83953932	401
Gabon	1599.1	45.10712286	252
Gambia	847.6	55.71169433	597
Ghana	1907	50.02845666	308
Guinea	1158.7	103.2265284	576
Guinea-Bissau	1254.7	84.2230564	667
Kenya	1632.9	46.42323611	342
Lesotho	987.2	88.70980547	544
Liberia	1059.5	87.91427497	661
Madagascar	4302.1	54.12789836	335
Malawi	1903.1	46.86405848	349
Mali	1530	101.0624223	562
Mauritania	1361.2	77.79046189	766
Mauritius	5234.8	14.85838858	61
Mozambique	817.1	79.3896324	289
Namibia	426.3	44.52817149	195
Niger	541.9	86.64145094	509
Nigeria	1408.8	122.798947	917
Rwanda	1283.5	37.47282704	248
Sao Tome and Principe	2042.1	32.02913991	130
Senegal	1275	48.78242725	315
Seychelles	N/A	14.71213713	53
Sierra Leone	1143	118.2221809	1120
Somalia	551.9	124.3934416	829
South Africa	5644	35.59544333	119
South Sudan	734.5	96.22929869	1150
Sudan	584	62.16602409	295
Tanzania	1547.9	71.31723539	524
Togo	1139.2	50.24859619	396
Uganda	2047.2	53.75319205	375
Zambia	2479.4	64.33790066	213
Zimbabwe	622	58.23492444	458

TABLE 1: Original Data for Farming Yields, MC5, and Maternal Mortality.

Sub-Saharan African averages are mentioned in the Results text. Abbreviations and non-Anglicised names: MM = maternal mortality; Congo, Dem. Rep. = Democratic Republic of the Congo; Congo, Rep. = Republic of the Congo; Côte d'Ivoire = Ivory Coast

Farming Yield Data Comparisons

Of the countries in sub-Saharan Africa with farming yield data (n=46), 15 countries had higher farming yields, measured in kilograms per hectare, than the sub-Saharan African overall crop yield of 1457.6 kg/hectare in 2017. (Figure 1A) South Africa, Mauritius, and Madagascar had the 3 highest farming yields in the region. The 3 countries with the lowest farming yields (excluding the Seychelles and Equatorial Guinea, which did not have farming yield data) were Namibia, Botswana, and Cabo Verde. (Figure 1A)

MC5 Data Comparisons

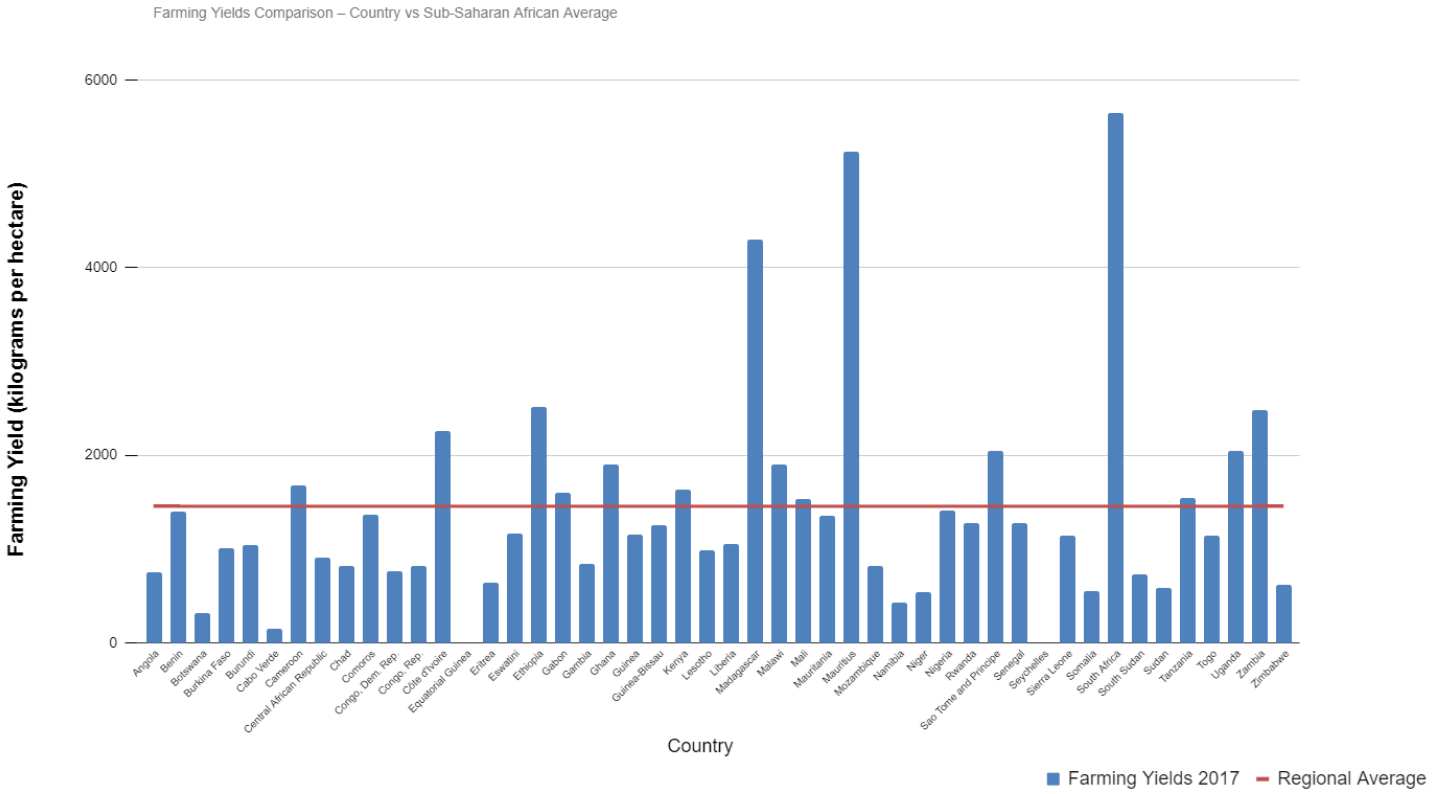
All countries in sub-Saharan Africa were included in this comparison (n=48). The 3 countries with the lowest MC5 were the Seychelles, Mauritius, and Cabo Verde; the 3 countries with the highest MC5 were Somalia, Nigeria, and Chad. (Figure

1B) Angola had the MC5 closest to the sub-Saharan African average of roughly 80.6 MC5 per 100,000, with roughly 80.7 MC5 per 100,000. (Figure 1B)

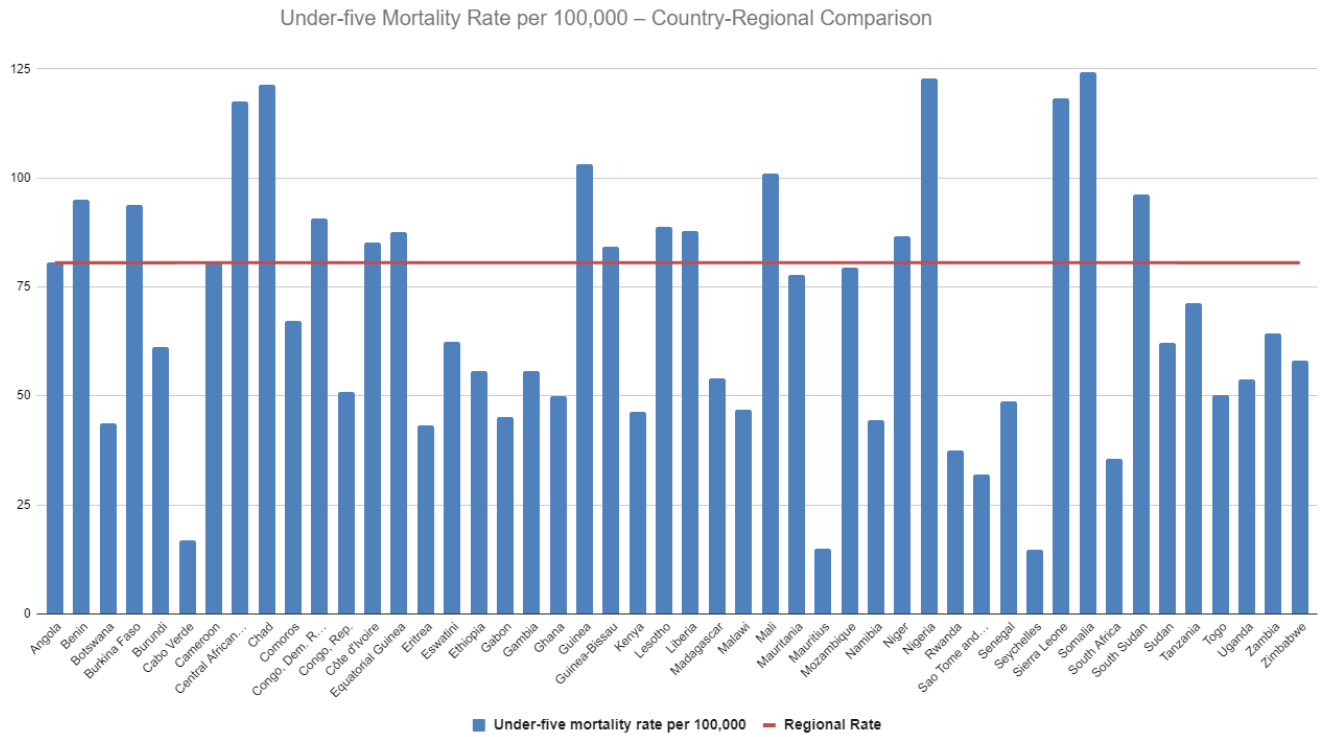
Maternal Mortality Data Comparisons

All countries in sub-Saharan Africa were included in this comparison (n=48). The 3 countries with the lowest maternal mortality were Mauritius, Cabo Verde, and the Seychelles. (Figure 1C) The 3 countries with the highest maternal mortality were Sierra Leone, Chad, and South Sudan. (Figure 1C) The sub-Saharan African overall maternal mortality rate is 533 per 100,000, and 15 countries had higher maternal mortality rates than sub-Saharan Africa as a whole.

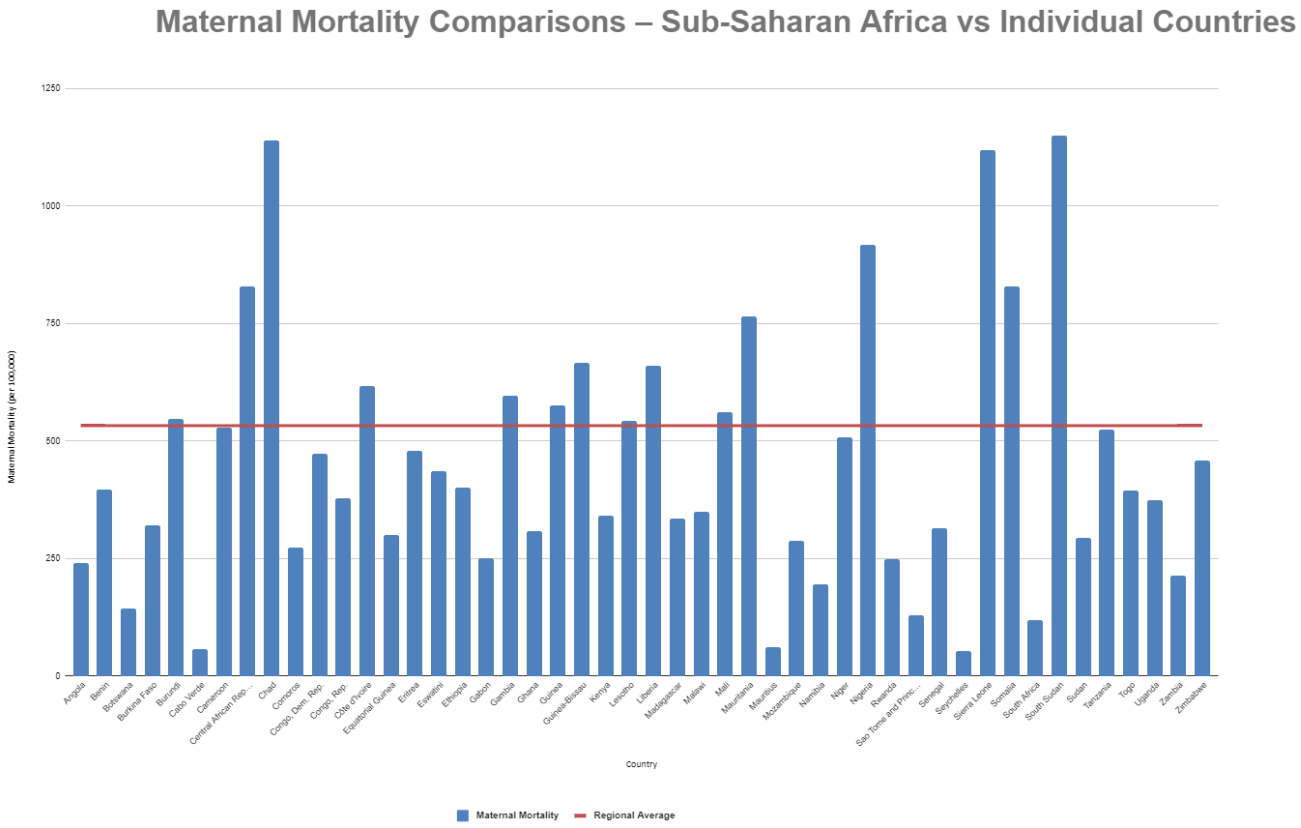
FIGURE 1: Country comparison with regional data



(A) Farming yields (cereal yields in kg/hectare)



(B) MC5 per 100,000



(C) Maternal mortality per 100,000 births

Low Farming Yields and Maternal Mortality

In order to examine the existence of an association between low farming yields and maternal mortality, I used Microsoft ExcelTM to create a scatter plot with all data from countries with farming yield and maternal mortality data (n=46). I found a negative correlation between an increase in farming yields and a decrease in maternal mortality. (Figure 2) However, the statistical coefficient of determination is 0.095169864, indicating that this correlation is a weak fit.

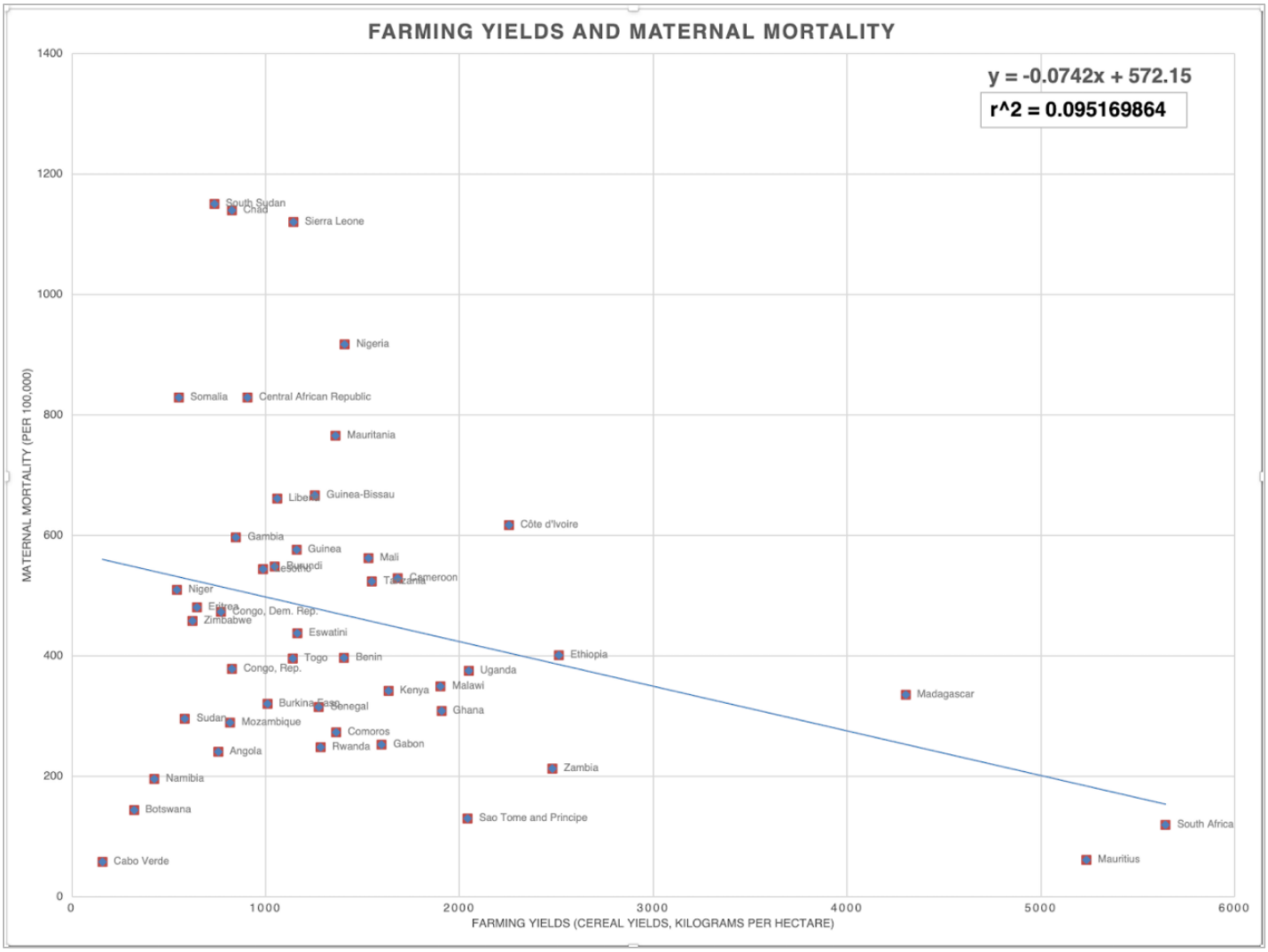


FIGURE 2: Scatterplot of Farming Yields and Maternal Mortality excludes sub-Saharan Africa average, Equatorial Guinea, and the Seychelles

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Low Farming Yields and MC5

In order to examine the existence of an association between low farming yields and MC5, I used Microsoft ExcelTM to create a scatter plot with all data from countries with farming yield and MC5 data (n=46). I found a negative correlation between an increase in farming yields and a decrease in MC5. (Figure 3) However, the statistical coefficient of determination is 0.117151635, indicating that the correlation is a weak fit.

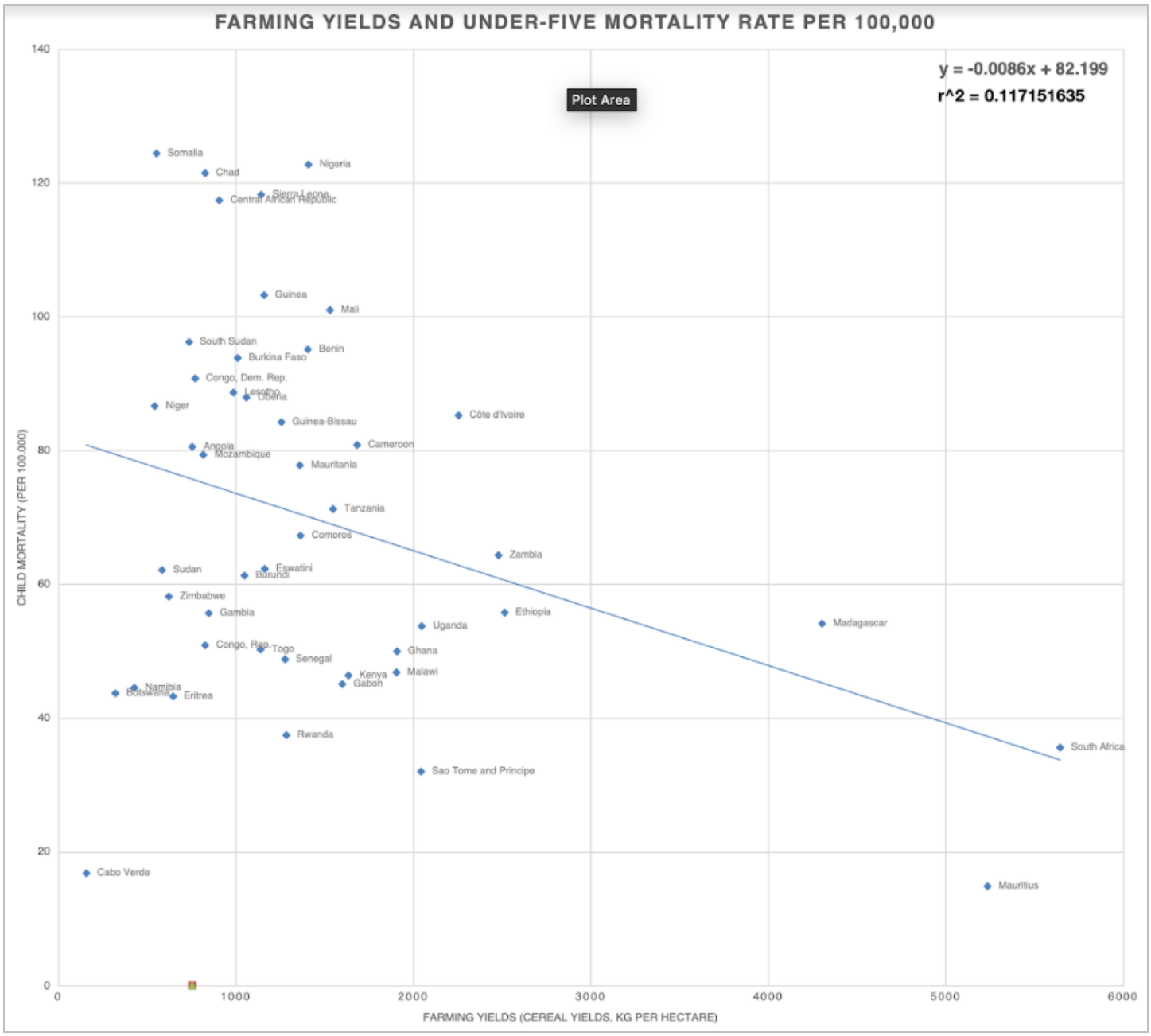

FIGURE 3: Scatterplot of Farming Yields and MC5 excludes sub-Saharan Africa average, Equatorial Guinea, and the Seychelles

Discussions

In this paper, I examined data from UNICEF and the World Bank to determine the relationship between low farming yields and maternal and MC5. I found negative but weak correlations, indicating that low farming yields, across sub-Saharan Africa, do not affect MC5 and maternal mortality much. However, as with many analyses with large sample sizes (n=48), there were several outliers. Notably, Cabo Verde has low farming yields (157 kg/hectare) as well as low maternal and MC5. In cross-country comparisons, Cabo Verde was among the three nations with the lowest maternal and MC5. Mauritius fits a correlation between high farming yields and low maternal and MC5, with among the highest farming yields and among the lowest maternal and MC5. This suggests that Mauritius and Cabo Verde have completely different results than other sub-Saharan African nations due to other factors.

Measures that Result in Lower Maternal and MC5

In 2015, Bauserman et al. examined individuals in the Global Network for Women's and Children's Health Research Maternal and Neonatal Health Registry, obtaining data for more than 270,000 pregnancies and 400 deaths across 6 different countries in South America, Africa, and Asia (Bauserman et al., 2015). Bauserman et al. found that hemorrhage and hypertensive disorders in pregnant females, which are treatable and manageable, should be managed to save lives. Further, Fenta and Fenta used regression modelling to determine the role of preventive measures for the prevention of general child mortality. Fenta and Fenta found that education, contraceptive use, higher age of mother at time of birth, birth at a public or private institution, and living in an urban area reduced the risk of MC5. This means that healthcare access can play a role in reducing both maternal and MC5 (Fenta & Fenta, 2020). Mauritius, one of the key outliers, has a high-quality healthcare system, suggesting that healthcare access and quality are causal factors.

Healthcare as a Causal Factor

This is more likely in functioning healthcare systems with capacity and functionality. The 2021 World Health Statistics, published by the World Health Organization, show that Mauritius has had above-average healthcare functionality from 2015 to 2020, and ranks as the best in functionality and second-best in coverage in the WHO African Region (World Health Organization, 2021). This is corroborated by Mauritius having a Healthcare Access and Quality Index score of 69 in an analysis by the Global Burden of Disease 2016 Healthcare Access and Quality Collaborators (Fullman et al., 2018). Thus, it is plausible that Mauritius has low rates of maternal and MC5 due to a high quality of healthcare. However, this cannot be applied broadly. The opposite is true for Cabo Verde, which has a healthcare score of 55, lower than Mauritius. Thus, Cabo Verde is another outlier, similar to Mauritius, except in a different manner, as the country also ranked highly in MC5 and maternal mortality rankings (among the lowest maternal and MC5 in sub-Saharan Africa).

Education as a Causal Factor

While Cabo Verde still lacks in its healthcare infrastructure, as is evident by its healthcare score, WHO Africa reports that the country has made significant improvements in health, increasing life expectancy especially (WHO Regional Office for Africa). Further, while Cabo Verde lacks hospitals, the country has a high literacy rate, which has eased the burden of spreading health-related information and has contributed to better results for Cabo Verde (WHO Regional Office for Africa). Thus, the low rates of maternal and MC5 can plausibly be attributed to high literacy and education rates as well as a relatively high degree of healthcare quality in the country. However, due to a low score on the HAQ Index, healthcare is not the primary causal factor; rather, education is.

Strengths and Limitations

The strengths of this study are the large sample size and scope as well as its novelty. This study

contributes to the field by providing a detailed analysis of a correlation between farming yields and maternal mortality and farming yields and MC5. As a result, it represents an area that can be further examined to draft policies that can better reduce the burden of maternal mortality and MC5.

Nevertheless, this study has its limitations. For example, no data was available for the Seychelles and Equatorial Guinea. This prevented a thorough analysis for all sub-Saharan African countries, as both were excluded to test the hypothesis most accurately. Second, the data did not account for underreporting, which is a significant issue in sub-Saharan Africa in particular. Third, the farming yield and MC5 data were available until 2019, but the maternal mortality data were only available until 2017. For consistency reasons, the experimenter chose to use 2017 data. However, this limited the applicability of the data to 2021 due to no fault of the experimenter.

Conclusion

In conclusion, the experimenter found a negative correlation between low farming yields and MC5 and maternal mortality in sub-Saharan Africa. However, both correlations were too weak to produce any meaningful result across the region of sub-Saharan Africa. Nevertheless, this study provides a novel result for further research to examine individual countries in more detail and with more accurate statistical approaches. Further, this study provides an opportunity for future research to explore the relationship between low farming yields and health outcomes in sub-Saharan Africa, as well as the relationship between causes of low farming yields and health outcomes in sub-Saharan Africa.

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