What is the burden of bacterial infections causing neonatal sepsis in people between the ages of infants under 90 days old living in Eastern-Sub-Saharan Africa and the changes in the sea levels of the Indian Ocean from 2000-2018?

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Abstract

This research is a literature review regarding the burden of bacteria infections causing neonatal sepsis in people between the ages of newborn to 90 days-old living in Eastern-Sub-Saharan Africa and the changes in the sea levels of the Indian Ocean. Through a literature review, correlation between the two will be found and explained. External factors that may be influencing the burden of neonatal sepsis in people between the ages of newborn to 90 days-old living in Eastern-Sub-Saharan African will also be considered to ensure that the correlation between the burden of neonatal sepsis in the labeled demographic and rising sea levels in the Indian Ocean is real. Further steps to decrease the rates of neonatal sepsis in people between the ages of newborn to 90 days-old living in Eastern-Sub-Saharan African will also be explained. These methods will be related to the decrease of climate change and specific to the region being discussed. Figures and models are included to better explain the correlation and the best way to prevent the incidence rates of neonatal sepsis from increasing.

What is the burden of bacterial infections causing neonatal sepsis in people between the ages of infants under 90 days old living in Eastern-Sub-Saharan Africa and the changes in the sea levels of the Indian Ocean from 2000-2018?

Sepsis (*septicemia*) is a cynical syndrome in which your body reacts in one of the most extreme ways possible. It often results in fevers, high/low pulse, shortness of breath, and extreme pain or disorientation as primary symptoms (Srzić et. al, 2022). Due to the blood pressure dropping, it forces the body to react in an attempt to stabilize, but this may result in blood poisoning ("Sepsis", n.d.). The blood poisoning reflects unstable pH and starts the process of organ failure, where the organs will not receive the blood flow and will function poorly, eventually causing system failures ("Septicemia", n.d.). It is most commonly traced to the infections that complicate in the gastrointestinal tract, lung, skin, or urinary tract ("About Sepsis", 2024). The main stages of sepsis are: infection (no major complications), bacteremia (bacteria located in the bloodstream; blood poisoning), sepsis, and finally septic shock.

The global burden of sepsis is 48.9 million cases world wide with 11 million sepsis related deaths. This represents 20 percent of all global deaths ("Sepsis", 2024), and is a growing issue since 1 out of 3 who die in a hospital have this condition ("About Sepsis", 2024). Furthermore, for every 1000 hospitalized patients, 15 develop this infection as a complication of their treatments (CN). Bacterial infections are one of the major causes of sepsis ("Sepsis", 2024). Bacterial infections that cause Sepsis are those with polysaccharide capsules on their surfaces (ex. Streptococcus pneumoniae, Haemophilus influenzae, Neisseria meningitidis, Klebsiella pneumoniae, etc.). Due to these polysaccharide capsules, it is harder for antibiotics to penetrate through the outer layers of the bacterial cell and damage it. Therefore, intensive care is needed (Yerevan, 2019).

Higher access to health care and awareness of this condition has the potential to decrease the rates of sepsis. Statistically, more than 4.5 billion people in recent years have not had access to proper healthcare ("Billions left behind on the path to universal health coverage", 2023). However, it is important to note that since 1 in every 3 people that die in a hospital have this condition ("About Sepsis", 2024), a closer look into hospital hygiene and treatment plans should be taken. People admitted into a hospital are those with weakened immune systems and who have underlying diseases. Due to their weakened immune systems, they are more prone to contracting sepsis from poor hygienic conditions. The primary source of sepsis in a hospital setting are the central venous catheters (Monegro et. al, 2023). These central venous catheters are flexible tubes that are inserted into a vein to distribute chemotherapy, intravenous fluids, blood transfusions, etc. Since these catheters are placed directly inside the bloodstream, it has a higher chance of causing an infection like sepsis. Most other reasons for patients developing sepsis in a hospital setting is failure to address wounds that may contain infection and failure to address internal infection such as pneumonia (Monegro et. al, 2023). Treatment plans that can decrease the rates of sepsis should aim to identify and address the infections on wounds and internal organs quickly. In order to do this, there would have to be careful examinations of the patient daily after extended use of a catheter. This would entail looking at patient stool and abdomen samples (Monegro et. al, 2023). Additionally, more research would be required to develop more advanced treatments for sepsis. The current treatments for sepsis are IV fluids, several medications such as corticosteroids, and antibiotics ("Treatment", 2021). IV fluids are used to improve the blood pressure and increase oxygen delivery. Next, common medication include corticosteroids, which help decrease body inflammation (a common side effect). Additionally, vasopressors are used in extreme cases where the blood pressure drops so low

that medication is needed to tighten the blood vessels to increase blood pressure. Oxygen is another major treatment and is provided when the blood is not as efficient in delivering oxygen to the body ("Treatment", 2021). Although these other treatments are beneficial in slowing the progression of sepsis in the body, antibiotics are the way to treat the blood infection. Antibiotics are typically broad-spectrum, meaning they help kill a wide range of bacteria. This is an area of sepsis treatments that must go through rapid advancement since the antibiotic resistance related to sepsis is increasing with the rise of climate change (Polat et. al, 2017).

As climate change is ever increasing, it may have an indirect impact on the rates of sepsis. Climate change has already increased the rates of many diseases, a prime example being the case of cholera. Cholera is a disease that affects around 1.3 million to 4 million cases annually ("Cholera", 2024). According to Asadgol et. al, Cholera cases typically rise during the summer months due to the higher temperatures and lower precipitation (Asadgol et. al, 2019). With the overall temperatures increasing yearly due to climate change, there is a positive correlation between temperatures rising and Cholera cases rising and a negative correlation between precipitation rising and cholera cases rising (Asadgol et. al, 2019). Climate change induced natural disasters cause sewage water to enter water bodies ("Cholera Upsurge (2021-present)", 2024). Once entering these water bodies, with the difference in temperature and composure of the water, there is a direct increase in *Vibrio cholerae*, which is the bacteria from which Cholera is derived from. These conditions also make the bacteria more antibiotic resistant (San Lio et. al, 2023), and therefore demand a need for antibiotic research to enhance the effectiveness of the drugs. Much like this, infections that have the potential to result in sepsis have increased due to the optimal breeding ground for bacteria increasing in bodies of water and soil. As the multitude of bacteria that result in sepsis require new and enhanced antibiotics to treat them the rates of antibiotic resistance will also continue to rise. A specific kind of sepsis has been focused on for this research study. Neonatal sepsis, which occurs in infants under the age of 90 days. It is important to use this as the target cases since infants in this age range are among the most vulnerable to sepsis as a general (Cruz-Urbano, 2024).

Climate change is a progressively growing issue as sea level continues to rise. Amongst the oceans, the sea levels have significantly risen in the Indian Ocean. In fact, it was found that the sea levels in the Indian Ocean have been increasing by around 4.05 ± 0.56 cm/decade, faster than the global average (Huang et. al, 2023). This rise in sea levels is caused by the warming of the waters, which allows for the volume of oceans to expand. The expansion of oceans forces water bodies inland to over flow as well, therefore, resulting in floods. Floods result in destruction of infrastructure, and can release toxic substances back into water bodies. This creates a dangerous breeding ground for bacteria of all sorts (as was explained with the *Vibrio cholerae*) and therefore forms new strains of bacteria (Lynch et. al, 2023). This bacteria may be more resilient to conventional treatments and antibiotics making them more difficult and costly to treat. Moreover, floods would cause the demographics that the bacteria effects to change. Since flooding will make new water habitats as well as making older waterbodies more toxic, it will bring bacteria to new environments. This means that the people near these newer sources of water (and bacteria) would be susceptible to having a bacterial infection. As this new susceptible population contracts these bacterial diseases, it would result in complications of sepsis more often than previously due to the patient's body not having built in resistance to these bacterial strains. This is why it is imperative that action be taken to reduce climate change and decrease rates of sepsis.

An area under study for this disease is Eastern Sub-Saharan Africa as this region has one of the highest rates of sepsis globally (Kiya et al, 2024). This area is located near the equator, which is an area that would be greatly impacted by climate change as there are new highs in temperature since the equator typically has the highest temperatures on Earth ("NASA Study Reveals Compounding Climate Risks at Two Degrees of Warming", 2023). Additionally, this area is close to the Indian Ocean, which in recent years has risen and forced natural disasters. Moreover, this area of Africa has the worst healthcare in the continent (Deaton et. al, 2017), and therefore, will be impacted with more mortality for sepsis than other regions. By understanding how sepsis cases increase in Eastern Sub-Saharan Africa, targeted treatment and exposure to the public can be given to prevent this disease from taking more lives. This is important, since we don't know enough about the relationship between sepsis and the growing issue of climate change. By answering this question, we will be able to understand and develop methods to help those in the eastern Sub-Saharan region work to protect the lives of the natives.

Methods:

For this research paper, the main databases used were PubMed, World Health Organization, Centers of Disease Control and Prevention, John Hopkins Medical Journal, and National Aeronautics and Space Administration. Keywords entered were, climate change, cholera, sepsis, sub-saharan africa, hospital, indian ocean, rising sea-levels, antibiotic, equator. Filters include associated data and publication date within 10 years. An overall search on the google database was used to find reputable sources that were used to understand what certain terms or processes referred to.

Results:

First, I looked into the current indicators of neonatal sepsis severity as a world wide account, and found it to be 1.3 million cases of neonatal sepsis reported worldwide 203,000 deaths per year as of 2023 (Hussein Mahmoud et. al, 2023). Then, the search was further

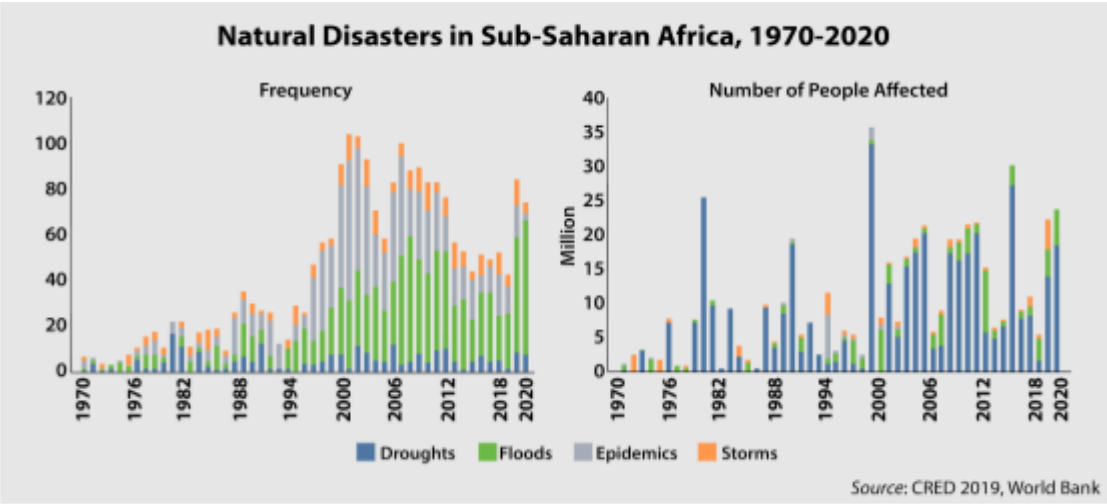

Figure 1: Describes the common natural disasters with their frequency and number of people affected every six years since 1970-2020. Shows that storms were the most frequent but floods affected the most people (in millions) in recent years. Sourced from "How Global Warming Threatens Human Security in Africa" published in 2021

narrowed down to Africa, which showed 5.29 -- 8.73 million disability-adjusted life years lost annually in sub saharan africa due to neonatal sepsis (Ranjeva et. al, 2023).

Next, I was interested in understanding the factors that influenced the current burden of neonatal sepsis which includes healthcare fulfillment (the percent of people satisfied with their healthcare service) , natural disaster rates, and poverty rates. The health care fulfillment, which is the amount of people satisfied with their healthcare service, in eastern sub-Saharan Africa averaged an improvement of 0.6 in Somalia, less than 0.1 for Uganda, and 0.3 for Republic of Congo from 2007-2012 (Deaton et. al, 2017). Life expectancy averaged around 61.2 years in 2016, rising slightly to 63.9 years in 2017 (Wamai, 2023). Then, the natural disaster rates in eastern sub saharan africa were observed, it can be seen that the flood rates have grown (Fig1) the most compared to droughts, epidemics and storms ("How Global Warming Threatens Human Security in Africa", 2021). In Figure 1, it shows flood rates and storms becoming higher in recent years compared to epidemics and droughts. Moreover, flood rates are the natural disaster type that have impacted the most people in 2020 and from 2012-2018. Next, I looked into the poverty rates in eastern sub-saharan africa. For specific recent years, 2016 had 86.5% with earring less than 5.5 US dollars daily, 2017 had 87.4%, 2018 had 87.3%, and 2018 had 87.3% (all in the region of eastern sub-saharan africa) ("Sub-Saharan Africa Poverty Rate 1990-2024", 2023). There has been a significant decrease over the past 20 years (Figure 2).

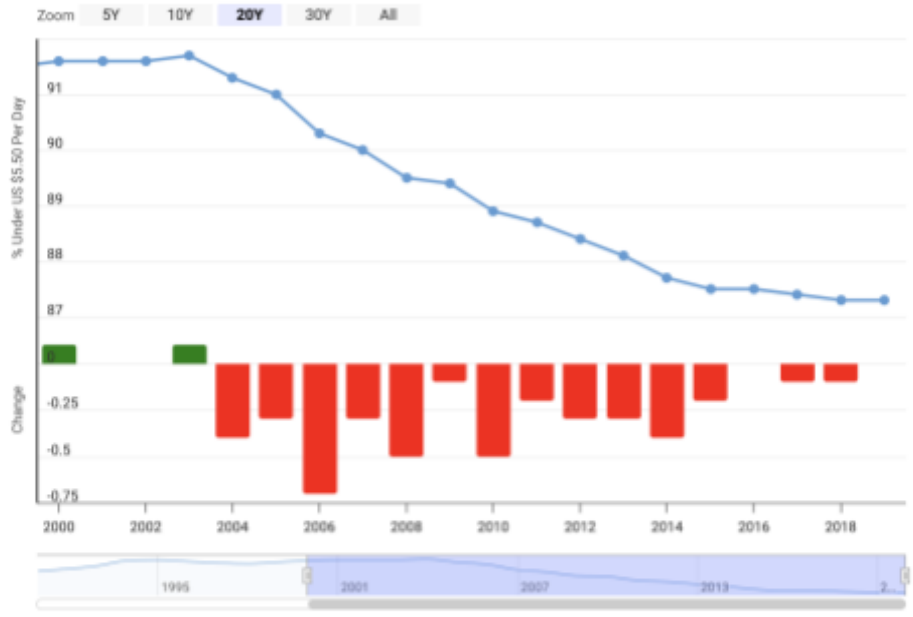

Figure 2: Represents the change from 2000-2018 of the daily amount of money earned on average by a person in Sub-Saharan Africa and the the percent of people that earn less that $5.50 USD daily. Trends show a drastic drop from the early 2000's to near present. The red bars indicate negative change from previous year, the green bars represent positive change from previous year, and the blue line displays overall trend of the percentage of people making less that $5.50 (USD) per day. Sourced from "Sub-Saharan Africa Poverty Rate 1990-2024".

Then, I looked into the specific rates of neonatal sepsis incidence of all ages in specific countries of eastern sub saharan africa by year. The findings have been indicated by the

following graphs. I looked for the incidence rates of the neonatal sepsis in Ethiopia, Somalia, and Uganda from 2000-2019. They all showed a progressive incline of cases. To ensure the results are valid, I included the upper quartile range and the lower quartile range to account for the cases that may have been overlooked (Figures 3-5). I then looked at the results of the specific rates of neonatal sepsis deaths of all ages in specific countries of eastern sub saharan africa by year. The trend showed a relative decline in overall death rates from 2000-2019. Furthermore, I looked for the death rates of the neonatal sepsis in Ethiopia, Somalia, and Uganda from 2000-2019. They all showed varied rates of incline and stability in the trends. To ensure the results are valid, I included the upper quartile range and the lower quartile range to account for the cases that may have been overlooked (Figures 6-8). The trend showed a relative decline in overall death rates from 2000-2019.

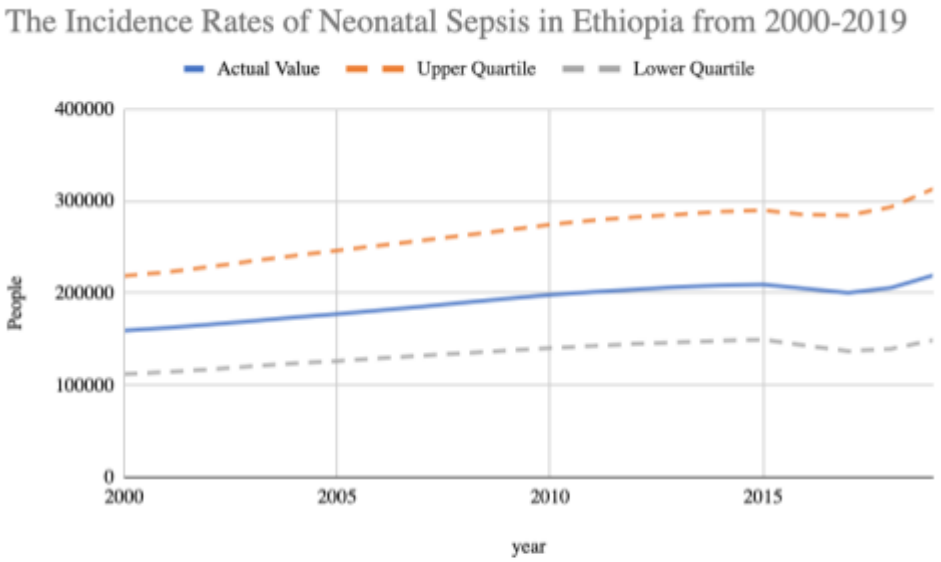

Figure 3: Represents the rates of neonatal sepsis in Ethiopia from 2000-2019 and includes the upper quartile and lower quartile to account for cases that may have not been accounted for. Shows a steady rise over years. Blue line represents the actual amount of cases witnessed, the orange dotted line represents to highest possible number of cases, and the grey dotted line identifies the lowest possible number of cases (both the orange and grey lines are meant to help account for any discrepancies in data). Sourced from "Global, regional, and national incidence and mortality of neonatal sepsis and other neonatal infections, 1990–2019" by Li et. al.

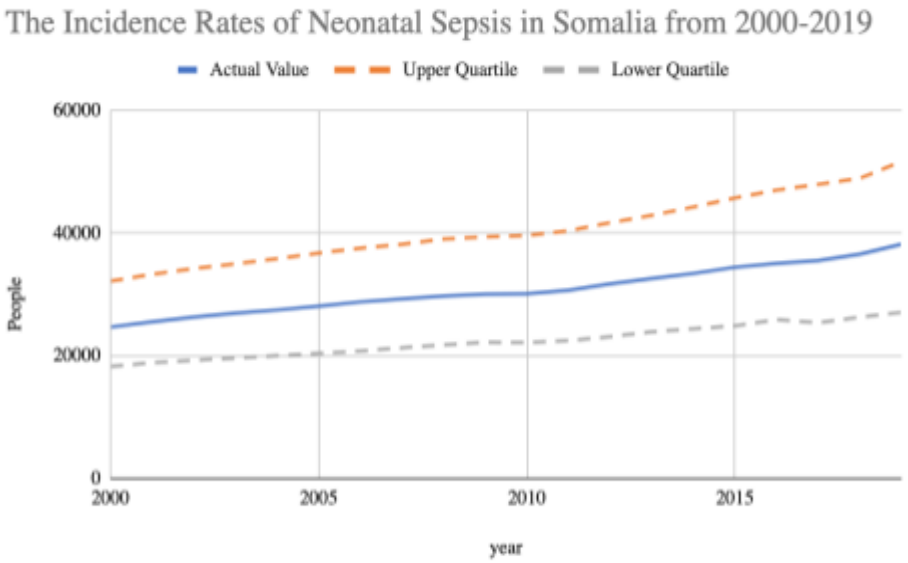

Figure 4: Represents the rates of neonatal sepsis in Somalia from 2000-2019 and includes the upper quartile and lower quartile to account for cases that may have not been accounted for. Shows a steady rise over years. Blue line represents the actual amount of cases witnessed, the orange dotted line represents to highest possible number of cases, and the grey dotted line identifies the lowest possible number of cases (both the orange and grey lines are meant to help account for any discrepancies in data). Sourced from "Global, regional, and national incidence and mortality of neonatal sepsis and other neonatal infections, 1990–2019" by Li et. al.

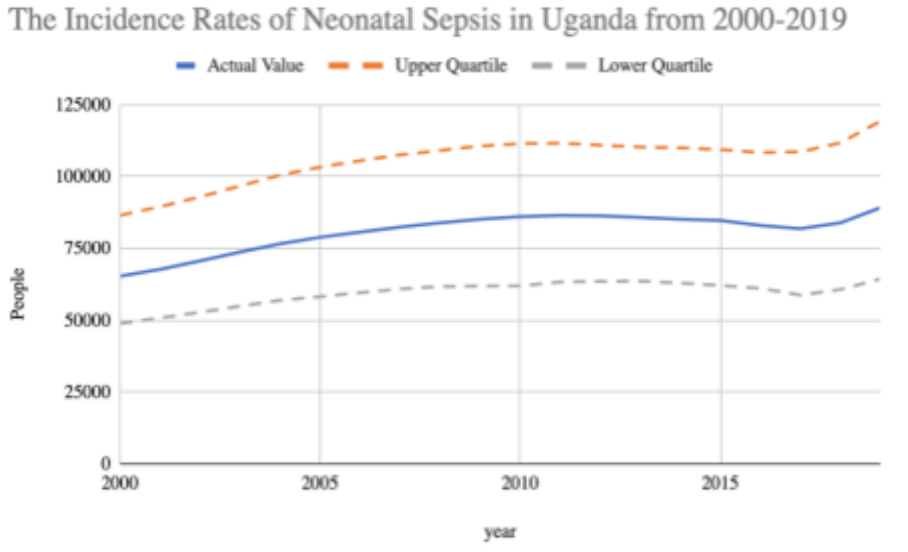

Figure 5: Represents the rates of neonatal sepsis in Uganda from 2000-2019 and includes the upper quartile and lower quartile to account for cases that may have not been accounted for. Shows a steady rise over years. Blue line represents the actual amount of cases witnessed, the orange dotted line represents to highest possible number of cases, and the grey dotted line identifies the lowest possible number of cases (both the orange and grey lines are meant to help account for any discrepancies in data). Sourced from "Global, regional, and national incidence and mortality of neonatal sepsis and other neonatal infections, 1990–2019" by Li et. al.

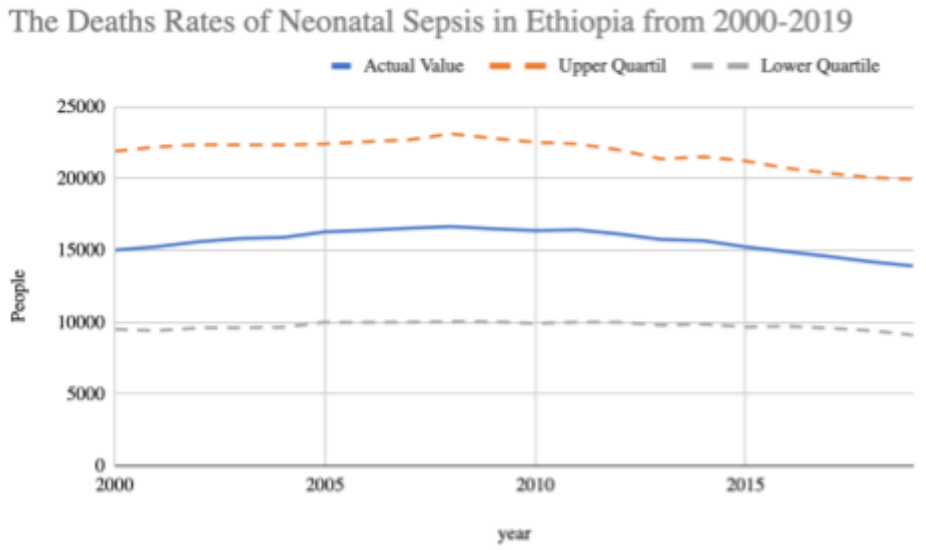

Figure 6: Represents the rates of neonatal sepsis in Ethiopia from 2000-2019 and includes the upper quartile and lower quartile to account for cases that may have not been accounted for. Shows a relative decline over the years. Blue line represents the actual amount of cases witnessed, the orange dotted line represents to highest possible number of cases, and the grey dotted line identifies the lowest possible number of cases (both the orange and grey lines are meant to help account for any discrepancies in data). Sourced from "Global, regional, and national incidence and mortality of neonatal sepsis and other neonatal infections, 1990–2019" by Li et. al.

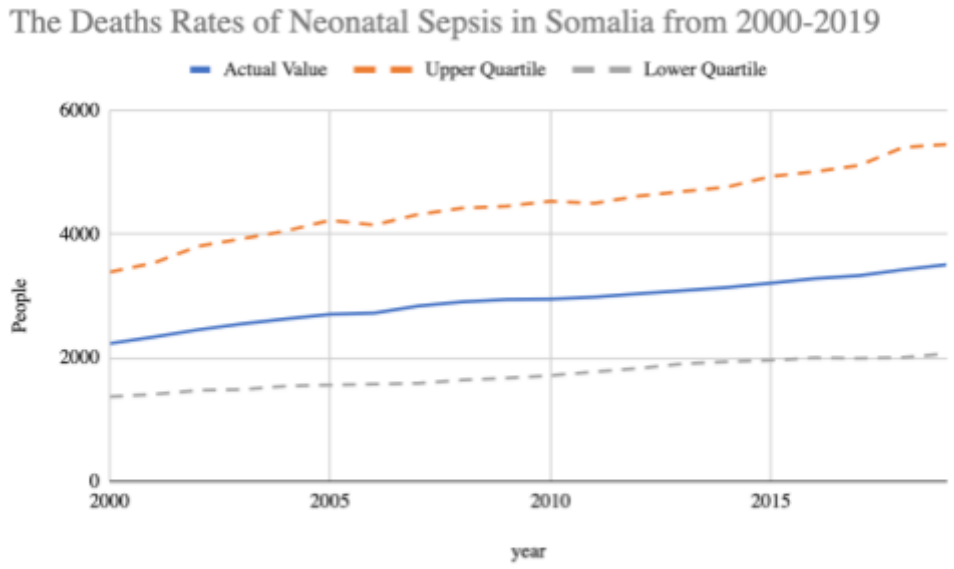

Figure 7: Represents the rates of neonatal sepsis in Somalia from 2000-2019 and includes the upper quartile and lower quartile to account for cases that may have not been accounted for. Shows a steady incline over years. Blue line represents the actual amount of cases witnessed, the orange dotted line represents to highest possible number of cases, and the grey dotted line identifies the lowest possible number of cases (both the orange and grey lines are meant to help account for any discrepancies in data). Sourced from "Global, regional, and national incidence and mortality of neonatal sepsis and other neonatal infections, 1990–2019" by Li et. al.

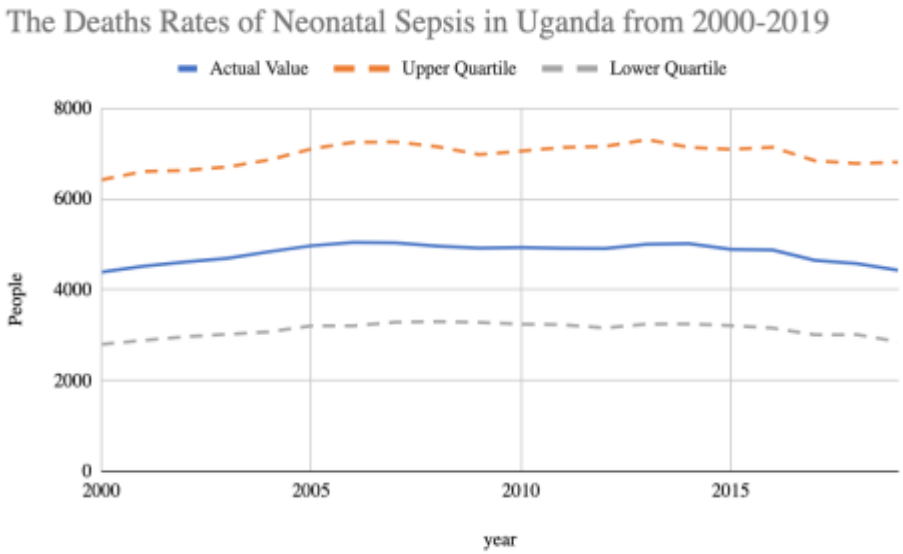

Figure 8: Represents the rates of neonatal sepsis in Uganda from 2000-2019 and includes the upper quartile and lower quartile to account for cases that may have not been accounted for. Shows a relatively steady constant over years. Blue line represents the actual amount of cases witnessed, the orange dotted line represents to highest possible number of cases, and the grey dotted line identifies the lowest possible number of cases (both the orange and grey lines are meant to help account for any discrepancies in data). Sourced from "Global, regional, and national incidence and mortality of neonatal sepsis and other neonatal infections, 1990–2019" by Li et. al.

For the next section, I looked at the overall climate change of eastern sub-saharan africa in terms of weather first. It was found that from 0.7C to 1C increase ("Climate Risk Profile for Eastern Africa", 2023). It was also noted that there was heavier precipitation. The average temperature is projected to rise from 1.7 C to 3.9C by 2080 (Figure 9). I then looked into the

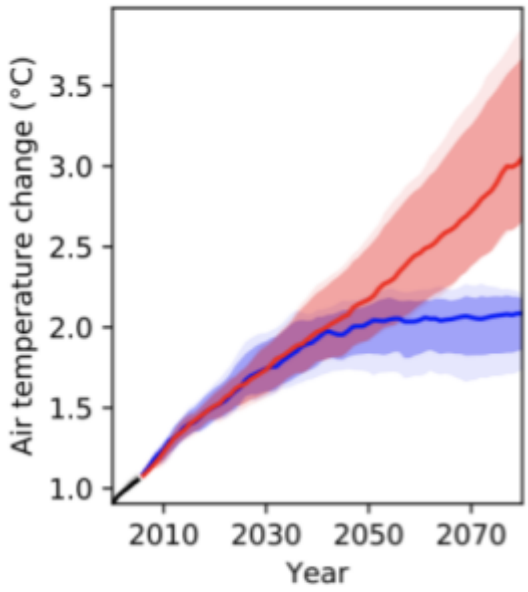

Figure 9: This is a graphical representation of the air temperature changing in Eastern Sub-Saharan Africa in recent year. There is also a projected scale if trends continue. Nearly a 1.5 degree Celsius difference. The red line shows the highest air temperature projected while the blue projects the least air temperature projected over the next decades. Sourced from "Climate Risk Profile for Eastern Africa".

flood rates of the region over the years. Floods accounted for 64% of the natural disasters in Eastern SubSaharan Africa over 2000-2019 (Figure 10). It was also indicated that these natural disasters have been becoming more dangerous compared to the world averages. Lastly, I looked directly at the changes in sea level measurements of the Indian Ocean and found the following result graph (Figure 11). The graph measures the steric sea level (ssl), thermosteric sea level projections (tsl), and halosteric sea level (hsl). Steric sea level refers to the change in ocean volume as a result of water density (influenced by difference in temperature and salinity), thermosteric sea level refers to how the temperature (heat) directly impacts the ocean water (e.g. spreading water molecules further and increasing volume), and halosteric sea level stands focus on how the salinity impacts the ocean water (e.g. if there is a higher salt concentration, the water becomes denser as it is smaller in volume).

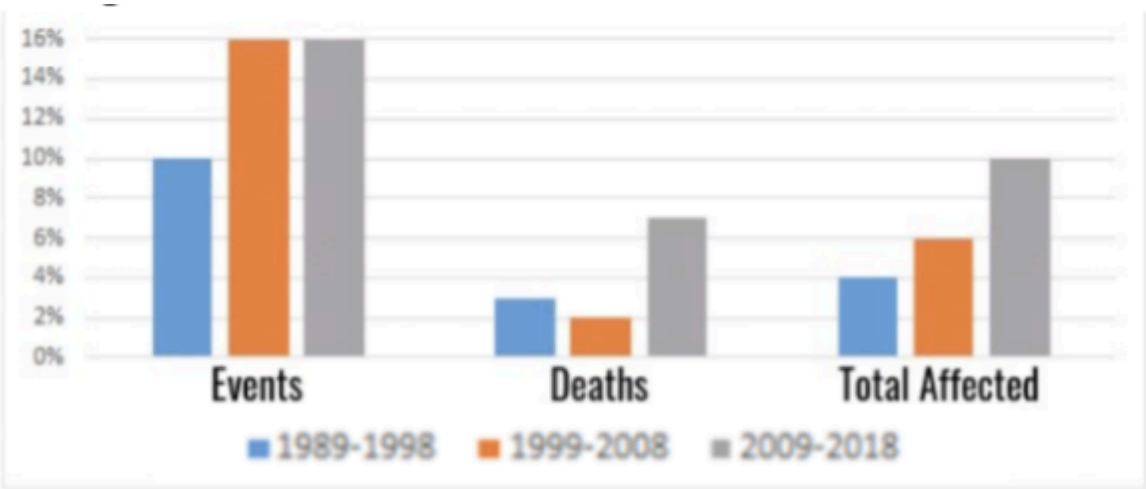

Figure 10: The graph helps depict the events, deaths, and total affected percentages caused by natural disasters in Africa as an impact to the global total. Shows the years 1989-1998 in blue, 1999-2008 in orange, and 2009-2018 in grey to help showcase the differences in various factors of natural disaster effects (ex. severity, total impact, etc.). Sourced from "Disasters in Africa: 20 Year Review (200-2019*)".

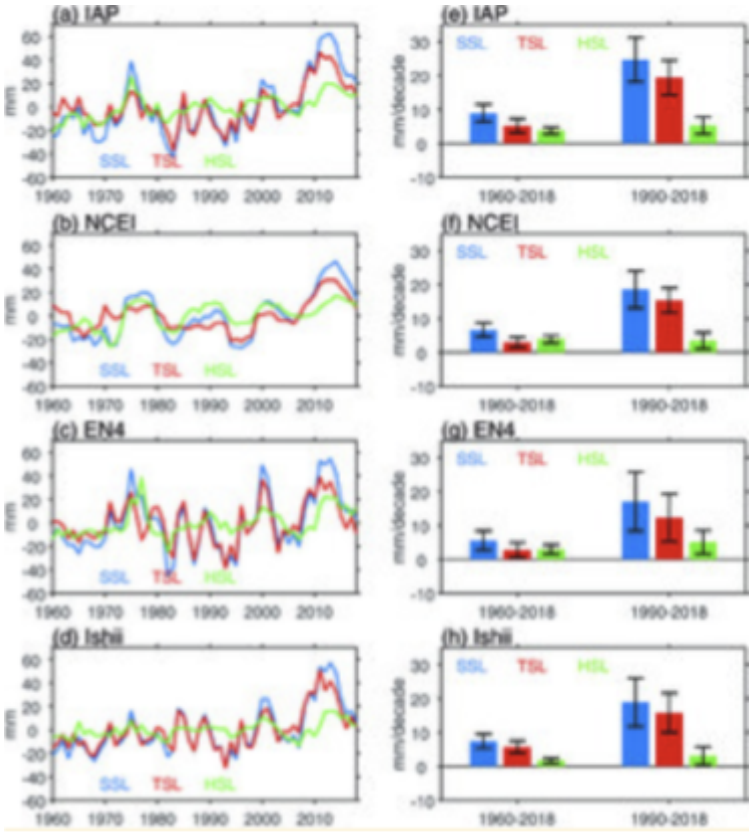

Figure 11: This figure details the exact change in sea level of the Indian Ocean from 1960-2018. By measuring SSL, TSl, and HSL, it should the significant rise in the levels of the Indian Ocean. The key labeled as is on the graph. Each graph shows a different sector. Sourced from Lu et. al.

Discussion:

The rise of the sea levels and related measurements in the Indian Ocean have been drastic. If we compare the rise of the sea level on a general basis from 1960-2018, we can see that it is only 7.4 ± 2.4 mm per decade on average. However, comparing the rate since 1990 (20.3 ± 7.0 mm per decade), we can see that there has been a more drastic change in recent years. As the sea levels have risen more, we can see that this has resulted in higher floods. In fact, it was concluded that places like Tanzania have 8% of the land in a low elevation coastal zone that is more than 10m below sea level (Erman et. al, 2019). This, combined with the rising sea levels, makes places like Tanzania have an increased amount of flooding. It can also be seen by Figure 11 that the sea levels of the Indian Ocean are also rising heavily. There is a high rise in the SSL and TSL, meaning that the temperatures have changed drastically to result in both of these measurements becoming elevated. It accounts for the HSL becoming lowered, and shows the larger volume of the ocean expanding and therefore, causing more floods in the Easter sub-Saharan region.

With more floods occurring, a prime breeding ground for bacteria occurs. When floods occur, it provides a new environment with high humidity levels. This is the ideal setting for bacteria to thrive. This causes the pre-existing bacteria (healthy or dangerous) to have to go through a period of evolution or death (natural selection), as the new bacteria strains attempt to take over their niche. This results in one of two scenarios: the first being the death of a previously inhabiting bacteria; the second being the previously inhabiting bacteria having to evolve. In the first case, the disadvantage would be that a healthy bacteria could have the potential to be out-competed, harming the environment. The effects of this would include less soil productivity, a change in several organisms' diets, etc. However, in the second case, if the preexisting inhabitant bacteria is able to adapt, it has the potential to become more harmful to surrounding organisms. For example, a bacteria which previously utilized free iron in the soil may develop scavenging mechanisms to extract iron from surrounding organisms such as humans. This means that for humans who live near areas with high flooding, like Tanzania, they would be more susceptible to a bacteria that is more pathogenic.

This relates to the trends seen by higher neonatal sepsis rates. We see from the data (figures 3-8) that the incidence of sepsis has grown for all three of the observed countries: Somalia, Ethiopia, and Uganda. It has increased by a near steady slope, indicating that there has been a rise in neonatal sepsis cases. Comparing this with the death rates from the same three countries, we see that only Somalia has seen a significant rise. Both Uganda and Ethiopia seem to have been at a near constant rate and occasionally have seen a decline. Combining both of these ideas, it can be understood that the rate of neonatal sepsis has risen, but due to the healthcare improving in certain areas, there has not been a significant increase in the death rate of both Uganda and Ethiopia. This can be attributed to the fact that Uganda is a considerably “more developed” country than Somalia (“Somalia/Uganda”, n.d.), meaning that there is a higher access to healthcare (as a general statement). This informs us the reason for why the incidence rates have risen in Uganda and Ethiopia while the death rates have remained near constant.

Looking at the increase in incidence rates specifically, we can see that the order of highest increase (or steepest slope on the graph) is Somalia, then Ethiopia and then Uganda (from highest to smallest increase). Comparing this to their geographic location, we can see a direct trend. Somalia is located on the coast of Eastern Africa, right next to the Indian Ocean. Similarly, a portion of Ethiopia is also near the Indian Ocean (a smaller portion than Somalia’s coast). Finally, Uganda does not connect with the Indian Ocean and is farther away from the coastline than both Ethiopia and Somalia. By understanding the geographic location, we can postulate how being near the rising sea levels has impacted the incidence of neonatal sepsis in the region.

However, there are confounding variables on this aspect. To start, social awareness is a large issue that may have impacted this. Social awareness is the amount of social exposure an issue has in a community. People in this region live near areas with 3G or 4G networks, but only 22% of the general population were using a mobile device at the end of 2021 (Delaporte, 2023). Without the majority of the people using a mobile device, it can be assumed that the social awareness of this issue is low. Moreover, 40% of the people in this region fall 40% below that line of extreme poverty (Delaporte, 2023), meaning that they would lack the proper resources to stay informed about an issue like this. In a lack of social awareness due to poverty and therefore a lack of necessary resources to stay informed, it is typical for people to get more infected and have higher death rates in a region due to neonatal sepsis (as social media often plays a

significant role in increasing social awareness). Therefore, this may prove as a confounding variable to the rise of neonatal sepsis in the eastern sub saharan africa region.

Another potential confounding variable is the rates of poverty in relation to healthcare. Although healthcare fulfillment has risen over the past 20 years in eastern sub saharan africa, poverty rates have not. In fact they are at an all time high. This means that even with the higher access to health care, the people cannot afford it due to their financial issues. Although this trend is true, it may or may not be considered a confounding variable. It may not be a confounding variable because the death rates have remained constant while incidence rates have increased, signifying that people have been seeking medical attention. Therefore, poverty is unlikely to be a confounding variable. Alternatively, it can be considered a confounding variable if the disease itself has not been as severe. Although climate change typically causes infections and diseases to be more severe, it may not be the case for neonatal sepsis if the death rates have remained constant while the incidence rates have increased. In this case, poverty would be considered a confounding variable. More research will be needed in this area to understand how neonatal sepsis infections have transformed genetically over the years in order to make a correct conclusion on this point.

Lastly, another major confounding variable may be that the incidence and death rate data was not reported correctly by researchers and the countries. This is because the researchers may have only been able to find the fraction of the cases in the region. Results could be varied for this reason, and therefore, extended research must be done to understand the full gravity of this issue. If the results, on an average, are higher than expected, it will prove a higher need for human intervention. However, if they are lower, the relation to climate change by neonatal sepsis may not be what this paper had concluded.

Conclusion

Overall, neonatal sepsis has been a rising issue in all several areas of the world and in particular, eastern Sub-Saharan Africa. Data and graphs have been created to assess different factors of the disease including prevalence and mortality rates, which have indicated a trend. Based on the location of the three countries analyzed (Ethiopia, Somalia, and Uganda), we can see that the closer a country is to the Indian Ocean, the higher mortality rate (the prevalence of the disease for all of these countries has been relatively the same). By this, I connected the data to the rising sea level of the Indian Ocean and external measurements of the sea level. This realization aided in concluding that neonatal sepsis has increased in severity and prevalence with a correlation and causation of climate change (causing the data observed in the Indian Ocean). Confounding variables were also analyzed to ensure data is valid.

Further research is necessary since the research conducted in this research study has a few confounding variables. Research on the impact of social awareness and disease as a causation is required. Moreover, research is required on the healthcare of the region. This further research needs to regard the care given by healthcare providers and how it is significant. Lastly, research regarding the prevalence rates and mortality rates of the neonatal sepsis in the region is necessary to ensure the evidence gathered can be confirmed. More research in these areas can prompt the understanding of how neonatal sepsis continues to grow and can help analyze the projected growth of the disease. It can further the research into understanding the disease's morphology and genealogy. Finally, research can be furthered in the treatment for neonatal sepsis with a new analysis of the morphology and genealogy to help save more lives.

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