HIGH SCHOOL EDITION
Journal of Student Research
Volume 13 Issue 3 (2024)

Interventions for Acute Malnutrition in Conflict-Ridden and Climate Disaster-Prone South Sudan

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ABSTRACT

After enduring decades of civil wars and political turmoil, South Sudan achieved independence in 2011, which kindled hope for the new nation. However, this optimism was short-lived, as the country plunged back into renewed conflict, forming a crisis that has plagued the nation – acute malnutrition. Malnutrition is a result of factors such as inconsistent climate, ongoing conflict, inadequate healthcare, and lack of resources, which have affected the entirety of the population, particularly young children and pregnant women (UNICEF 2021). This paper examines various interventions aimed at addressing malnutrition through innovative and creative solutions. From exploring the potential of insect farming, producing crops through biotechnology, improving the gut through microbiome-directed diets, and fostering engagement with various communities, these changes have helped improve the nutrition levels among individuals. However, financial constraints, cultural barriers, and political instability stand as significant challenges towards successful implementation. Ultimately, this study highlights the importance of a collaborative approach between local communities and international organizations. By fostering unity and support, individuals can build a brighter and more prosperous future for their home country.

Introduction

In South Sudan, the world's youngest nation spanning 248,777 square miles, approximately 11 million individuals undergo ongoing conflict and political instability. Located in East-Central Africa, it faces many issues aggravated by its history, climate, and geography. Its location on the White Nile valley allows for urbanization of rural settlements, due to its fertile soil. Most of the population, around 71%, reside in rural areas, facing hardships due to climatic factors, such as heavy rainfall and droughts that harm agriculture (Climate Change Knowledge Portal). These challenges, along with limited healthcare access, insufficient sanitation facilities, and conflict are contributors to hunger and malnutrition. Despite some progress in addressing this situation, much work remains to improve the nutrition of food.

Context of Malnutrition in South Sudan

Between July 2023 and June 2024, South Sudan is expected to face a severe malnutrition crisis, affecting approximately 1.65 million children aged 6 to 59 months and 870,000 pregnant women (IPC 2023). With around 33 million acres of arable land, only 4% of the land is currently cultivated, leaving the population vulnerable to food shortages (USAID). Additionally, between April and July 2024, the food security and malnutrition situation will deteriorate. Approximately 7.1 million people, more than 50% of the population, will be severely food insecure, facing IPC Phase 3 or higher. 2.34 million people are likely to face IPC Phase 4 and 79,000 people are likely to be in IPC Phase 5 (IPC 2023).

Examining Figure 1, we can see that the majority of the South Sudanese provinces are suffering a severe malnutrition crisis and are classified in IPC Phase 4. It is projected that around 72% of the acute malnutrition crisis is concentrated in the five states of Jonglei, Northern Bahr el Ghazal, Upper Nile, Unity, and Warrap. IPC also states that 46 counties are classified in IPC AMN Phase 4 (critical phase), 15 counties in Phase 3 (serious), 10 counties in IPC Phase 2 (Alert) and 9 counties in IPC Phase 1 (Acceptable).

Historical Context

The roots of South Sudan's struggles can be traced back to its path to independence. Decades of conflict, beginning with the first and second Sudanese civil wars, devastated South Sudan's infrastructure., agriculture, and led to the displacement of millions. The Comprehensive Peace Agreement of 2005 ended these civil wars and paved the way for independence in 2011. However, the [euphoria] of independence was short-lived as conflict plunged the nation back into turmoil. This ongoing political instability continues to disrupt healthcare and food production, leaving the population highly vulnerable to food insecurity and malnutrition.

Families in South Sudan

The average family in South Sudan faces many challenges, including limited access to education, water, electricity, and healthcare. Family life typically revolves around a large family, with several generations living together in grass-thatched mud huts called tukuls, accounting for 90% of the houses in South Sudan (University at Buffalo). Family roles are versatile, with children typically receiving basic education until age thirteen before they start to perform work to support their family. Job opportunities include agriculture, which is the main employment, fishing, and herding. Women are encouraged to perform domestic roles, primarily housekeepers, while men engage in agricultural activities. South Sudan was renowned for their education, but conflict and political instability have weakened the education system. Only 4% of students have access to education, and there is only 1 university throughout the country (ReliefWebs). This has led to a decline in skilled individuals seeking foreign opportunities.

Climate

South Sudan's tropical climate is characterized by extreme variability, with a wet season from May to October and a dry season from November to April. This rainfall pattern often results in either excessive floods or long periods of droughts, especially due to the effects of climate change. The country experiences frequent flooding due to increases in precipitation, particularly in the White Nile valley, which disrupts farming and leads to water-borne diseases. Conversely, droughts are caused by higher temperatures, which leads to crop failures and water shortages. These fluctuations can result in inconsistent rainfall patterns that reduce harvests and crop production.

The data depicted in Figure 2 reveals the impact of climate change on temperature in South Sudan over the past century. Beginning from the early 1900s, the country experienced relatively stable and lower temperatures. However, as the years progressed, there was an increase in temperatures, which emphasizes the effects of global warming on the region. This trend shows that efforts are required to address the repercussions of climate change, particularly in sectors such as agriculture and livestock. [In response to this challenge, the United Nations High Commissioner for Refugees (UNHCR) has initiated the distribution of drought-resistant seeds and the improvement of irrigation systems, which has helped with agriculture growth while tackling climate change.]

The Healthcare System

South Sudan's healthcare system is one of the least developed globally. With a shortage of healthcare professionals, rural populations lack formal access to medical services. The lack of infrastructure and limited utilization of healthcare services results in frequent virus pandemics and poor health across the population. According to the World Health Organization, South Sudan reports high maternal, infant, and child mortality rates, contributing to a low life expectancy of 56.5 years (WHO).

Out of the entire population, children and pregnant women are affected the most by malnutrition. Around 70% of the children die between ages 0-5 because of diseases such as malaria/fever, diarrhea, and respiratory illnesses, which are all mainly caused by malnutrition. On average, 103 children per month were admitted to health facilities for moderate or severe malnutrition (UNHCR 2023). Children are most affected because of poor childcare practices and lack of healthcare facilities. Only a small number of children receive an adequate diet, meaning that the majority don't get an adequate or nutritious diet, leading to many deaths. Pregnant and lactating women breastfeed for six months, which is not healthy, so malnourished women end up dying right after childbirth. IPC estimates that 870,000 pregnant or breastfeeding women are expected to suffer acute malnutrition in 2024 (IPC).

South Sudan faces significant challenges regarding its nutrition status, presenting a huge concern for the well-being of its population. According to the latest Global Nutrition Report, the country continues to grapple with alarming rates of anaemia among women of reproductive age, with approximately 35% affected. Moreover, while efforts have been made in addressing stunting among children under 5, with progress being currently made, 31% of children still suffer from this condition. Conversely, the lack of sufficient data to assess key targets such as low birth weight, childhood wasting, and exclusive breastfeeding presents a gap in understanding malnutrition in the nation. Such problems not only hurt the health and well-being of individuals but also affect the socio-economic development of the nation. The lack of data collection to improve these healthcare conditions suggests the critical need to improve the overall nutrition and health of these individuals.

The data presented in Figure 3 reveals concerns revolving around sanitation infrastructure in South Sudan from 2012 to 2020. At the beginning, the prevalence of open defecation was significantly high, with over 60% of the population using it in 2012. While there was a slight decrease in open defecation by 2020, it remained prevalently high. Moreover, the low prevalence of basic sanitation in 2012 emphasizes the limited access of essential facilities. Although there was a slight increase in basic sanitation by 2020, this unfortunately is still lower than 20%. The limited and unimproved sanitation remained constant over the years, which reflects the ongoing challenges preventing the delivery of sanitation solutions to the population. These findings emphasize the urgency to enhance sanitation infrastructure in South Sudan, as inadequate sanitation gives rise to significant health risks and disrupts overall well-being.

Water, sanitation, and hygiene (WASH) interventions play a major role in combating malnutrition by addressing environmental factors that contribute to poor health outcomes. South Sudan lacks access to clean water and adequate sanitation facilities, which increases the risk of diseases and malnutrition. Hygienic practices, including proper handwashing and sanitation facilities, can mitigate the spread of diarrheal diseases, a major contributor to malnutrition-related illnesses and mortality. Investing in WASH infrastructure and promoting hygienic behaviors is therefore crucial for improving nutrition and health outcomes in South Sudan, particularly in conflict-affected and resource-constrained areas.

Figure 4 illustrates the prevalence of various sources of drinking water in South Sudan from 2012 to 2020, highlighting critical trends that impact malnutrition. In 2012, at least basic water sources were available to 40% of the population, while limited water sources were used by 25%, unimproved water sources by 15%, and surface water by 21%. Over the years, the availability of at least basic and unimproved water sources remained relatively constant. However, there was an increase in limited water sources and a decline in the use of surface water. Limited and unimproved water sources, as well as surface water, are often contaminated with

bacteria and create a high risk of waterborne diseases, resulting from unsafe drinking water, which hinder nutrient absorption. The dependence on limited water sources indicates increasing challenges in accessing safe water, which potentially worsens malnutrition rates. While the reduction in surface water use suggests some progress, the overall stability in the prevalence of unsafe water sources highlights the needs for substantial improvements in water, sanitation, and hygiene (WASH) infrastructure to effectively combat malnutrition.

Driving Factors of Malnutrition

The situation of malnutrition throughout South Sudan is influenced by various factors. The most significant contributor, the primary driver is the ongoing conflict and lack of resolution or the stress and structural causes that disrupt productivity. The secondary drivers, systemic impacts, and endogenous shocks, which include the inaccessibility of health, water, and sanitation lead to direct impacts, including food insecurity and malnutrition, which both lead to famine (UNDP). There are external shocks, such as climate shocks, which result in crop failures because of droughts and floods (which is a common occurrence in recent years). Farmers rely on rainfed crop production, meaning that delayed rains can result in poor or no harvests, while heavy rains and flooding can waterlog fields and destroy crops (FAO). These challenges stacked with a lack of medical care, limited accessibility to health care services and the poor childcare practice in South Sudan further impact the children. Only 5 out of 100 children are getting the recommended quality of food required for optimal growth, leading to severe malnutrition among children (IPC).

Political instability and economic obstacles are among the most common causes of malnutrition in South Sudan. The country's prolonged civil conflict has led to widespread displacement, disrupting agricultural activities and food production. The instability hinders the establishment of a proper healthcare infrastructure, with many regions lacking access to essential medical services. Economic challenges, including hyperinflation and limited employment opportunities, further challenge families' ability to afford nutritious food. Additionally, the destruction of infrastructure and the difficulty in securing investments for agricultural development weaken efforts to enhance food security. Addressing malnutrition in South Sudan requires long-term strategies to stabilize the political environment and strengthen the economy, enabling sustainable development and improved health conditions for the population.

Figure 5 provides an overview of the GDP per capita trends in South Sudan from 2012 to 2022. Prior to 2012, the GDP per capita stood slightly above $2000, reflecting a somewhat relatively stable economic landscape. However, in 2012, the GDP per capita sharply declined to just below $1000. Despite irregular fluctuations, the overall course of the graph remained on a downward slope, with the GDP per capita frequently below $1000. By 2020, there was a minor recovery, although it was insufficient to reverse the decline, resulting in a GDP per capita around $500 by 2022. These fluctuations stress the economic challenges faced in South Sudan, which are mainly caused by political instability and conflict. The relationship between political turmoil and economic hardship is clear, as periods of continuous instability result in significant declines of GDP per capita. This economic situation leads to problems such as lack of infrastructure to maintain well-developed healthcare systems, water sources, nutrition, and sanitation sources.

Solutions and Interventions

Insect Farming

Malnutrition continues to thrive in South Sudan, affecting most of the population, and nothing has been implemented to resolve this problem. The easiest solution would be for the government to put an end to the conflict, but it is unlikely, and conflict is only one of the contributors. One possible solution would be to implement

insect farming in agriculture. Insect Farming has the means of offering sustainable means of food production and doesn't require much equipment, money, or skill. Edible insects, such as crickets and termites, contain high amounts of protein, vitamins, and amino acids, which could provide a nutritious alternative to traditional food sources. Veterinarians Without Borders has implemented a 10-month research project to examine the impact of insect farming on agriculture. Insect farming in a controlled environment can address challenges in insect collection practices, which could reduce gender-based violence and harassment (VWB). Insect farming also requires less water, which is helpful during times of drought and requires less land, which makes it well-suited for regions with variable climates. Additionally, controlled indoor experiments for insect farming can allow for consistent production throughout the year, unaffected by weather fluctuations. However, environmental factors, such as heavy rainfall, could lead to insect deaths, which would then result in crop failures.

Biotechnology of Crops

Biotechnology is another part of the solution to malnutrition in many parts of Africa and could be implemented in South Sudan. The problem is that as weather patterns become more erratic and important crops such as maize are unable to resist fall armyworm infestation, there will not be enough food (IPS). Maize is an important crop in South Sudan and the inability of local maize to withstand the threats from the armyworms could destroy an entire crop in a matter of weeks (IPS). A genetically modified version of maize, Bt (Bacillus thuringiensis), has shown significant resistance to the attacks of the armyworm. It has been genetically modified to produce Bt protein, which is an insecticide that kills pests (ICP).

WEMA is a public crop breeding initiative and is currently engaging in Bt. maize trials, in which concluded trials in parts of Africa have shown this as a solution to the armyworm. The African Agricultural Technology Foundation confirms that the damage from the armyworm was three for the Bt genetically modified variety and six for the local varieties of maize, which is a significant difference. Only four African countries have implemented biotechnology in agriculture, and South Sudan has still not. Implementing the Bt maize will help reduce the amount of crop failures, which is essential for maintaining agricultural productivity. By breeding crops (through cross-pollination) that can thrive under the climatic conditions of South Sudan, plants would thrive.

Microbiome-Directed Diets

Another major solution is the connection between malnutrition and the microbiome gut. The collaboration between researchers in Dhaka, Bangladesh, and experts at Washington University in St. Louis, Missouri, resulted in the development of a new substance for the treatment of malnutrition that helps improve gut health. Dr. Gordon's research in Malawi found that the gut microbiomes of healthy children and those with malnutrition differed systematically. When the gut bacteria from the malnourished twins were transplanted into germ-free mice, the mice developed symptoms similar to kwashiorkor, suggesting a link between microbiome and malnutrition (The Economist). Studies conducted by Dr. Ahmed and Dr. Gordon in Bangladesh showed that conventional dietary interventions, such as increasing calorie and protein intake, didn't significantly alter the gut microbiomes of malnourished children (The Economist). The two researchers and their teams created 14 distinct experimental diets that they thought might promote the growth of gut bacteria during an experiment. The results from the experiment led them to create three "microbiota-directed complementary food" diets, which are called MDCF -1, -2, and -3. Through another experiment, they found that MDCF-2, which was made from bananas, chickpeas, peanuts, and soya, seemed to be the most effective in promoting the growth of gut bacteria to improve the health of malnourished children. Children who continued to eat MDCF-2 saw significant improvement: their microbiomes were more developed and their levels of 70 blood-plasma proteins improved nutritional status.

MDCF-2 has helped malnourished children, through the experiment conducted, experience significant growth. Implementing this in South Sudan, where malnutrition is prevalent, especially among children, the research conducted by Dr. Ahmed and Dr. Gordon shows the potential of microbiome-directed diets. The implementation of experimental diets, such as MDCF-2, could help children recover from malnutrition, decreasing the rates. However, the problem is that it might be challenging to bring this to other countries. Each country's team has to find the exact equipment used in Bangladesh and source ingredients locally too. Additionally, diets and tastes also vary. Apparently, according to Ishita Mostafa, MDCF-2 tastes like "halwa", which is popular in areas like India and Bangladesh. Babies like this a lot, but this may not be the same in other countries. Dr. Ahmed and his colleagues have started testing other ingredients (for example, sweet potato instead of banana), to see if the impact of the microbiome on malnutrition remains the same. Using this in South Sudan could improve the childcare system and could overall decrease the rates of malnutrition through the increase of gut bacteria.

Community Gardening

Community gardening initiatives have emerged as an effective strategy to address malnutrition in South Sudan. By empowering local communities to cultivate their crops, these initiatives not only improve access to produce but also encourage individuals to share knowledge and resources. Furthermore, community gardens provide an opportunity for women to plant and care for their plots, which can later be sold and feed their families. The incorporation of traditional crops and farming practices allows others to respect local cultures and traditions while promoting sustainable agriculture. With support and investment from organizations, community gardening has the potential to improve agriculture productivity in South Sudan.

Educational Programs

Additionally, educational programs can help spread awareness of the local crisis. These programs should provide education on healthy nutrition, focusing on healthy dietary practices and the importance of micronutrients in the development of a child. By investing in education, South Sudan can empower younger generations to make proper choices about their nutrition and livelihoods, ultimately finding innovative solutions to reduce the spread of malnutrition. These programs can be founded through the collaboration between local communities and non-profit organizations.

Incorporation of Traditions

It is also crucial to incorporate traditional knowledge into these initiatives, which hold immense potential for addressing malnutrition. Indigenous communities possess knowledge about local food sources, traditional farming practices, and dietary habits that they have used throughout their lives. By recognizing their traditions, we can utilize local resources effectively and promote solutions that benefit the local community and culture. Moreover, through these practices, we can contribute to preserving biodiversity, protecting ecosystems, and promoting sustainable food production that benefits the ecosystem. Collaborative efforts that incorporate traditions and cultures offer a collaborative approach to promoting food security.

Conclusion

South Sudan stands as a nation rich in potential and natural beauty, however, conflict and violence affect the lives of many people, causing them to move out and get displaced. With the many problems and challenges the

South Sudanese people face, malnutrition continues to deteriorate counties and states all over the nation. The causes of malnutrition are indeed vast, with climatic elements and conflict being the main contributors. But we should remember that even with various techniques to stop crop failures and promote healthier foods, finding solutions to reducing global warming could help balance the climate factors. Transferring from fossil fuels to renewable energies and reducing energy consumption and carbon emissions could help crops thrive. However, the most important solution to stop the challenges that South Sudan faces is to find a resolution to end the conflict, but this will take a matter of years. Until the conflict is resolved, this nation can implement biotechnology and insect farming to get a better source of food. These solutions could lead to a brighter outlook for future generations.

Limitations and Challenges

While these interventions show promise, several limitations must be acknowledged. First, the implementation of these solutions requires significant funding and resources, which may be challenging to secure. Additionally, cultural acceptance of new dietary practices, such as insect farming, may pose challenges. Insects may be used for consumption and other important traditions and cultural practices of indigenous peoples. The ongoing conflict and political instability in South Sudan also hinder the effective deployment and sustainability of these interventions. Finally, the variability in climatic conditions can affect the success of agricultural initiatives, necessitating adaptive strategies.

Implementing these projects requires various forms of support including donor funding, which can be sourced through a combination of international aid and partnerships with local organizations. There are multiple United Nations agencies and NGOs to bolster early food security and recovery in South Sudan, and these initiatives are supported by USAID. USAID implementation partners provide emergency food assistance—including cash for transferring food, regionally and internationally, to food-insecure families across the nation. USAID continues to support via the World Food Program (WFP Accelerator) to sustain emergency food assistance as demand for food increases in regions across South Sudan. NGO partners also provide agricultural inputs, fishing kits, and training to support at-risk populations. With the support of communities, WFP provided nearly 12,000 tons of food and more than USD 2.5 million in cash assistance to around 1.3 million people in South Sudan. It is also important to collaborate with local institutions, including the South Sudan Ministry of Agriculture and Food Security, which will be essential to help leverage local resources and engage the community. Additionally, efforts by organizations such as UNICEF and WFP address malnutrition through nutrition programs that focus on providing therapeutic foods such as Plumpy'Nut for malnourished children. These measures are critical for food security and reducing malnutrition among children. By creating partnerships both internationally and locally, South Sudan can secure the necessary funding to implement sustainable solutions suggested to address malnutrition.

Acknowledgments

I would like to thank my advisor for the valuable insight provided to me on this topic.

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