

Social Factors Contributing to Childhood Malnutrition in Sub-Saharan Africa

Master's Degree in International Health Scholarly Project

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March 2023

Introduction

In Sub-Saharan Africa (SSA) the rates of childhood malnutrition are increasing (Economist Impact, 2023). In Africa, the number of stunted children increased from 54.4 million in 2000 to 61.4 million in 2020 and is estimated to reach 61 million in 2025 (Economist Impact, 2023). Child stunting refers to a child who is too short for his or her age because of chronic or recurrent malnutrition (WHO). Malnutrition comprises undernutrition - which includes wasting, stunting, underweight and micronutrient deficiencies - and overweight, obesity and diet-related non-communicable diseases (WHO). Malnutrition is estimated to contribute to more than one third of all child deaths and contributes to more than half of deaths of children worldwide (Bain et al., 2013). The World Health Organization has one of its Sustainable Developmental Goals set to end all forms of malnutrition by 2025 which include targeting stunting and wasting in children under 5 years of age. Unfortunately, this goal is not being met and particularly children in Sub-Saharan Africa are facing the burden of malnutrition (Yaya et al., 2022). Malnutrition leads to stunting in children and has been shown to be a contributing factor that impairs human development (Yaya et al., 2022).

While malnutrition can affect people of all ages, the burden on children leads to a downstream effect of influencing the advancement of human, economic and social development (Yaya et al., 2022). This correlation between childhood malnutrition and the development and progress of society is imperative to understand, as we seek ways to make progress in lower socioeconomic countries. Malnutrition is a manifestation of multifactorial causes. Some of those causes include maternal factors, childhood infections, poverty, poor feeding practices, and environmental factors. The purpose of this literature review is to explore the multiple factors that contribute to childhood malnutrition in Sub-Saharan Africa.

Maternal factors

Maternal health, nutrition, and prenatal care is vital to the outcome and development of a child. The state of being pregnant puts a stress on the body that leads to increased energy requirements as well as requires proper rest in between pregnancies for healing and repleting maternal nutrients. In Sub-Saharan Africa about 40% of women aged 20-24 years marry early at <18 years of age (UNICEF). This makes the childbearing age much younger, and mothers tend to have frequent pregnancies at short intervals, which prevents the mother from replenishing nutrient stores between pregnancies. A short birth interval is defined as a period of less than 24 months between birth and the next pregnancy, or a period of less than 33 months in between

births (De Jonge et al., 2014). These short interval pregnancies have been shown to be associated with common factors such as less educated women, poor, younger age, complications and undesired outcome of previous pregnancy, and preference for son's leading into rushed pregnancies (Pimentel et al., 2020). One study identified the prevalence of short birth intervals to be 58.74% in Sub-Saharan Africa, which is consistent with other studies that have been done across the continent (Belachew et al., 2023). This same study found that women living in rural areas have 2.17 times higher risk of short birth intervals than those living in urban areas (Belachew et al., 2023). When a mother's body is lacking the nutrients to properly sustain a fetus, then that leads to adverse outcomes in the health of the newborn and increases their risk for stunting. A meta-analysis published in 2006 reported that short intervals (<18 months) between pregnancies were associated with preterm birth, low birth weight, and being small for gestational age (Conde-Agudelo et al., 2006). Compromising the nutritional needs of the growing fetus and increasing the risk for low birth weight leads to a higher risk of a child being stunted (Quamme et al., 2022). As is noted there are multiple contributing factors for short interval pregnancies.

Less family planning, less autonomy of the mother, and lower household wealth are other risk factors for childhood stunting (Quamme et al., 2022). Lack of family planning leads to shorter interval pregnancies, which can result in families having multiple children under 5 years of age in the same household. This poses an economic challenge for families which leads to poverty and not having the ability to feed many children putting them at risk for childhood malnutrition and stunting. Family planning is crucial to ensuring maternal recuperation between pregnancies and safe pregnancies. Family planning will also contribute to decreasing childhood malnutrition and stunting as there will be more resources available to give to children. This should be sought out through education on birth control.

Lack of maternal empowerment and education are other factors contributing to childhood malnutrition. It's been shown that women are more likely to spend their income in the household, which means that if women's economic situation improves then it would decrease poverty levels and malnutrition rates (Drammeh et al., 2019). It's evident that there should be a high priority on advocating and increasing the access to education for girls and maternal empowerment, as childhood malnutrition and maternal socioeconomic status are shown to be related (Drammeh et al., 2019). Girls who receive an education have improved health literacy and greater awareness and access to family planning resources. In addition, education allows women to be economically empowered, which allows them to contribute to the household

income. Evidence shows that empowered women are more likely to follow appropriate breast-feeding practices, give complementary foods at appropriate age, increase the number of meals, and provide nutritious food (Drammeh et al., 2019).

Most children's attention is given by the mother. Mothers are the ones making decisions on what and how much the child eats. Childhood malnutrition will continue to persist and not decrease if mothers are not educated on adequate nutritious needs of the child. Increasing education access to girls would allow for those mothers to be educated on the needs of a child and proper development. It's been noted that the relationship between education and poverty are interrelated (Bain et al., 2013). In fact, education would help reduce the large family sizes in Sub-Saharan Africa by making poor communities realize that having smaller families will help meet the limited resources and offer adequate and quality nutrition to the family (Bain et al., 2013).

Childhood Infections

Subclinical infections in childhood can contribute to childhood malnutrition. Poor hygiene and contaminated environments lead to diarrheal illnesses that affect nutrient absorption and limited ability of the gut to act as a barrier against disease-causing organisms (Yaya et al., 2022). Poor access to safe drinking water along with unhygienic preparations of foods can expose children to infections and diarrheal diseases that can predispose them to chronic malnutrition (Yaya et al., 2022). Intestinal parasitic infections have been shown to cause undernutrition in children. While there are programs available for deworming children, there are some children that are only treated if symptomatic. A current review found that Ascariasis, hookworm infections, tricuriasis, and giardiasis are four of the most common reported infections in children under 5 (Fauziah et al., 2022). Ascariasis followed by giardiasis have been found to be the leading intestinal infections associated with stunting and wasting in children (Fauziah et al., 2022). In addition, not only are diarrheal illness associated with childhood malnutrition, but many children can suffer from environmental enteric dysfunction (EED). EED is due to chronic exposure to faecally contaminated environments that lead to asymptomatic syndrome of poor absorption, local intestinal inflammation, and increased translocation of bacterial products across the gut surface (Walson and Berkley, 2018). Sanitation and hygiene are risk factors that are highly prevalent in Sub-Saharan Africa making it easy for children to be predisposed to these conditions, and thus be at an increased risk for stunting and malnourishment.

HIV/AIDS are also contributing factors that increase children's risk of malnutrition. Studies have shown that those who are infected with HIV are more likely to suffer from malnutrition (Nalwoga et al, 2010). This same study observed children living in rural Uganda and found that those living with HIV had a higher prevalence of undernutrition and stunting. This study observed worsening children's nutritional status when infected with HIV. One study looked at children hospitalized in Uganda and found that children with HIV were at higher risk for infections and most commonly thrush and persistent diarrhea (Bachou et al., 2006). The suppressed immune system caused by HIV/AIDS puts children at risk for candidiasis and persistent diarrhea, which can lead to malabsorption and thus malnourishment and stunting. HIV/AIDS and malnourishment predispose to a nutritionally acquired immune dysfunction syndrome that further increases susceptibility to infections that can exacerbate the nutritional status of a child (Nigussie et al., 2022). Opportunistic infections lead to children having reduced appetites that further can exacerbated their malnutrition status. HIV itself increases the risk of undernutrition through active pro-inflammatory cytokines that cause growth impairment (Johann-Liang et al.,2000). A meta-analysis looking at undernutrition in HIV infected children not on antiretroviral therapy (ART) found that the prevalence of stunting was 46.7% among HIV infected children in Sub-Saharan Africa (Nigussie et al., 2022). Factors contributing to this prevalence included advanced WHO HIV/AIDS clinical staging, household food insecurity, anemia and diarrhea within the last month, economic status, and frequency of feeds (Nigussie et al., 2022). Comparatively when looking at children who are on ART the prevalence of malnutrition is lower. Three different studies looked at malnutrition in ART treated children in Ghana, Tanzania, and Nigeria. In Ghana, stunting, underweight, and wasting were 28%, 13%, and 16% respectively (Intiful et al., 2021). In Tanzania, stunting, underweight, and wasting were reported to be 36.6%, 22.1%, and 13.6% respectively while in Nigeria the results reported were 23.7% and 20.2% for underweight and stunted respectively (Intiful et al., 2021). ART therapy improves the immune system and helps control the increased metabolic rate, which is caused by infection with the HIV virus (Intiful et al., 2021). Poverty also exacerbates malnourishment when combined with HIV, as the additional cost of medical treatment needs to be considered. This can exacerbate expenses for the family, making it more difficult to provide nutrient dense food for the child.

Poverty

Poverty is nonetheless one of biggest contributors to food insecurity leading to childhood malnutrition. In 2019, 227.5 million people were severely food insecure in Sub-Saharan Africa

and the cost of a healthy diet lied at 1.7 and 3.2 times above the poverty line in Sub-Saharan Africa (Quamme et al., 2022). Part of unresolved childhood malnutrition lies in the economy of the country and the ability for families to have access to nutritious foods. Poverty also leads to mothers prolonging breastfeeding due to not being able to provide transitioning foods and thus increase the risk of stunting in children (Nshimyiryo et al., 2015). When comparing households in Sub-Saharan Africa, those of higher income can afford fruit, vegetables, milk, and meats in comparison to low-income households. Studies conducted in Nigeria and Ghana demonstrated monthly household income increased food security by 1.65 times (Drammeh et al., 2019). Studies have also demonstrated that household income impacted food security (Drammeh et al., 2019). If household income increased then that would lessen food insecurity, making it easier for caregivers to provide nutritious foods to children. When looking at other poverty related factors that contribute to food insecurity it's important to mention that households with multiple families or extended family members increase food insecurity due to having to provide for more members.

The covid-19 pandemic and the war in Ukraine are recent events that have slowed down the progress of decreasing childhood malnutrition, as there have been economic consequences from these events. The covid-19 pandemic led to mass disruptions to global supply chains and the war in Ukraine led to a surge in food prices globally (Economist Impact, 2023). The pandemic led to diversion of essential resources taking away the attention from addressing and meeting malnutrition goals (Economist Impact, 2023). The disruption caused by three years of the pandemic has led to interruption and impairment in public health programs aimed at targeting childhood malnutrition. Conflict and worldwide health emergencies contribute to disrupting prior set agendas. This disruption leads to deviation of resources and funds towards the current events, which halts the progress being made in childhood malnutrition.

Poverty is one of the factors that is multifaceted. Poverty results from political and socioeconomic problems. These problems can lead to food shortages or inflation of prices which further contributes to the discrepancies in Sub-Saharan Africa. Food discrepancies are a major driving factor perpetuating lack of food in most areas of Sub-Saharan Africa (Bain et al., 2013). These food discrepancies lead children to eating staple food crops that don't provide appropriate nutrients for proper growth. For example, in a rural community in Uganda you will find staple foods to include matoke, cassava, porridge, maize flour etc. A breakfast will consist of tea or porridge. These are staple foods that don't provide enough protein and nutrients needed for growth and thus leads to childhood stunting. It also leads to impairment in

intellectual development, which contributes to the poverty cycle as these children grow up lacking proper intellectual development to contribute to society (Bain et al., 2013).

Environmental Factors

Environmental factors also contribute to childhood malnutrition. Global warming and climate change affect agriculture, disease prevalence, and increased pricing of foods. This contributes to poverty and lack of access to nutrient dense foods. Africa has been identified to be one of the most vulnerable countries to climate change because of multifactorial causes that lead to endemic poverty, weak institutions, as well as recurrent droughts and associated complex emergencies and conflicts (Bain et al., 2013). Increased temperatures lead to droughts which affect agricultural lands and destruction of crops. Unfortunately, Sub-Saharan Africa is facing the consequences of increased temperature as precipitation becomes more variable (Bain et al., 2013). Variability in precipitation further hinders the ability to secure crops and food items for children and families, exacerbating the cycle of childhood malnutrition. Climate change will impact childhood malnutrition through changes in yield and area growth, higher food prices, and reduced calorie availability (Ringler et al., 2010). Climate change leads to droughts and water scarcity that impacts agricultural growth as well as hygiene.

The direct effect of climate change and high temperatures leads to childhood illnesses that can exacerbate childhood malnutrition and its complication. Such effects include thermal stress induced dehydration and heat exhaustion, exposure to changes in disease environment including increased prevalence of vector borne and diarrheal illnesses (Baker and Hughes, 2020). These secondary effects can exacerbate childhood malnutrition through chronic diarrheal illnesses that can lead to malabsorption of nutrients. Furthermore, the scale of exposure to heat has been shown to have different levels of implications for children. Those who have shorter intervals of exposure to high temperatures, such as days to weeks, can directly affect the child's ability to retain nutrients through thermal stress induced appetite, increased dehydration, increased diarrhea. Greater periods of exposure to high temperatures leads to decreased agriculture production and decreased nutritional yields (Baker and Hughes, 2020). Climate change and high temperatures affect children's nutritional status through secondary effects. Variations in the climate in the coming years can have different impacts on agricultural production, disease prevalence, and children's nutritional status.

Discussion

As presented in this literature review, there are multifactorial causes that contribute to childhood malnutrition. Each factor alone is multifactorial and produces secondary outcomes that ultimately have an impact on a child's health. Motherhood and maternal factors are a result from societal norms and governmental policies that prevent mothers from being able to overcome the multiple barriers that exist in Sub-Saharan Africa. Among those factors that were discussed include lack of education/empowerment/family planning, poor maternal health, and prenatal care. These maternal factors cause adverse outcomes in children. Poverty which is intertwined with multiple factors also plays a major role. The economic development of countries in Sub-Saharan Africa is impacted by civil wars and political conflict. The downstream effects of these political and economic disruptions are the country's population facing the consequences of hunger, poverty, and poor health. Poverty creates disruptions in multiple facets of people's ability to live a healthy life. Poverty is also a big contributor to childhood infections. Poor sanitation and hygiene which are due to lack of proper investment in the country's infrastructure leads to unsafe drinking water and puts children at risk of developing acute infections. These infections if not treated on time can progress to chronic infections that can limit a child's ability to absorb nutrients from meals. Lack of investment or ability to direct funds towards HIV care and education leads to spreading of infection and inability to properly manage it early on. Our environment is another contributor to childhood malnutrition as it exacerbates poverty through decreased agricultural production and increasing susceptibility of children to infections. The various factors discussed in this review provides an overview of some of the major factors that are contributing to childhood malnutrition. All these factors are interrelated to one another. Though the probability of fixing every factor is low there are interventions that can be sought out to reduce the burden that many of these factors have on childhood malnutrition. There are various factors being studied. Interventions aimed at reducing childhood malnutrition starts with finding ways to reduce the multiple factors involved.

Addressing Maternal Factors

Maternal factors including education and female empowerment should be addressed by increasing access to education for females. By increasing access to education more females would become knowledgeable on the birthing process, the importance of prenatal care and maternal recuperation in between pregnancies. In addition, women would be able to contribute to the household income and provide more nutrient dense food that children need to grow.

Staple food items that lack nutritious value would be able to be supplemented by other food items. An education would lend women to getting jobs that are less demanding on the body and would allow for greater attention to maternal care and nutrition. In addition, knowledge on the benefits of breastfeeding and when to transition to solid food would ensure proper nutrition of a child and prevent stunting (Quamme et al., 2022). Interventions aimed at encouraging and increasing female education and empowerment would not also benefit women and children but would also help to contribute to the growth of the economy and would benefit society. When women can receive higher education, they are able to contribute to the economy and be more knowledgeable about their own health and the health of their children. When children are provided for at a young age with the appropriate nutrients then they can grow and develop appropriately and be able to contribute to the future of the economy. It's imperative that interventions be aimed at encouraging women to receive an education as it will bring many benefits to society and the future of society.

In many countries of Sub-Saharan Africa, you will find women to be farmers. Compared to male farmers women farmers own a smaller percentage of agricultural lands and often work lands without getting paid, despite women providing 50% or higher of agricultural labor (Madzorera and Fawzi, 2020). Interventions aimed at increasing access to resources and getting paid for their work would provide women with increased income, work, and ability to provide diverse and nutritious diets for themselves and their children. This would allow women to have easier access to prenatal care, medical care, and be able to provide for the needs of their children.

Interventions aimed at eliminating gender inequalities would allow women to have autonomy and maximize their potential. Such interventions include eliminating societal norms. Given that societal norm includes male dominance, then it's men who can also help shift societal norms and increase gender equality. Part of increasing women empowerment and access to education is making sure that men start the conversation and help shift this existing dichotomy.

Addressing Childhood Infections and Poverty

Childhood infections are also secondary to multifactorial causes. Interventions aimed at reducing childhood infections should include addressing the factors that predispose children to these infections. Poverty, maternal factors, women's education, elimination of societal

prejudices and knowledge of HIV, and increased awareness of climate change are all factors that need to be addressed. The elimination of childhood infections starts with elimination of poverty. Poverty creates a state of limited resources, limited quality resources, limited educational resources, limited access to nutrient dense food and so much more. Stated by the United Nations, the elimination of poverty in Sub-Saharan Africa by 2030 will be particularly difficult. The UN's first two sustainable goals include eliminating poverty followed by eliminating hunger worldwide. There are six target goals sought out by the UN to help eliminate poverty. Part of these strategies include mobilizing resources, creating policy frameworks at the national, regional, and international levels, based on pro-poor and gender sensitive developmental strategies (*THE 17 GOALS | Sustainable Development*, n.d.). Part of eliminating poverty includes having access to clean water and proper hygienic practices for individuals. Having access to safe housing with flooring/roofing, plumbing, safe water, drainage, electricity, all can help prevent susceptibility to infection. Diarrheal illness and intestinal parasitic and hookworm infections can be diminished through access to clean water and improvements in infrastructure. Increasing deworming programs and increasing screening of parasitic infections would also help decrease the prevalence of these infections. In the same manner, EDD can also be eliminated if there are purification systems in place for accessing clean water. Clean water leads to better hygiene and prevents diarrheal illness and fecally contaminated water from entering a child's body and preventing impairment of absorption of nutrients. Improvements in housing has also been shown to reduce childhood infections as well as poor growth outcomes (Tusting et al., 2020). A study looked at housing conditions and found that there was a 12-18% reduction in odds of malaria, 8% reduction in diarrheal illnesses, 17% reduction in stunting, 10% reduction in wasting, and 15% reduction in being underweight (Tusting et al., 2020). These results were due to improvements in water, sanitation, sufficient living area, and use of finished materials, such as parquet, vinyl, tile, cement, and carpet floor. Specifically, this research found that improved water and sanitation led to improved child growth and stunting (Tusting et al., 2020). This same study suggests that there needs to be more research done on the impact of housing on child growth as well as concurrent reductions in malaria and diarrheal illnesses (Tusting et al., 2020). Poverty encompasses many things that need to be addressed. Among addressing poverty includes targeting essentials of living including shelter, food, and water.

Women's empowerment and addressing women's health throughout maternity is important in reducing childhood illnesses as well. When mothers have access to prenatal care, have greater interpregnancy intervals, and have nutritious meals then infants are less prone to

low birth weights, preterm births, and anemia. These factors help reduce childhood infections given that these factors predispose to a less well-developed immune system thus creating a susceptible host for infections.

Diminishing the prevalence of HIV, having increased access to HIV ART therapy, and having access to counseling would decrease the prevalence of HIV. This would decrease the number of opportunistic infections that impairs the ability of children to absorb nutrients. Infants are infected by HIV due to mothers not receiving ART, stopping ART, or becoming infected while breastfeeding (*Elimination of Mother-To-Child Transmission - UNICEF DATA*, n.d.). Interventions aimed at eliminating new infections of HIV among children and keeping mothers alive include increasing testing and knowledge of HIV status, early initiation and retention on antiretroviral treatment, and attainment of viral suppression (*Elimination of Mother-To-Child Transmission - UNICEF DATA*, n.d.). In addition, early nutritional interventions, and close monitoring of nutritional status in HIV infected children is crucial to monitoring the impacts of nutrition counseling.

Addressing Environmental Factors

Climate change is ever evolving and year by year society has seen the impact of rising temperatures and increased natural disasters. The UN's 13th sustainable developmental goal includes combating climate change and its impacts. By the year 2030, the UN predicts that droughts are estimated to displace 700 million people and medium to large scale disasters will increase above 40% (*THE 17 GOALS | Sustainable Development*, n.d.). Droughts and natural disasters affect Sub-Sahara Africa's agricultural production. These droughts predispose to higher temperatures which allows for increased prevalence of vector born infections and diarrhea illnesses. Mitigating the effects of climate change involves implementing climate change plannings, policies, and strategies at the regional, national, and global level. Increasing investment and education on the impacts of climate change and the state would lead to improved efforts from nations and communities.

Personal Application

This review provided me with a foundation of knowledge on the factors that contribute to childhood malnutrition in Sub-Saharan Africa. Using this information to continue to advocate and study individual factors will add to the existing evidence on childhood malnutrition. While there are factors that are not possible to be changed by medications or any medical intervention there

are factors that can be advocated for. This information provides me with the knowledge on which a platform can be created to advocate for childhood malnutrition. I can also use this knowledge to partner with organizations to help combat childhood malnutrition in Sub-Saharan Africa. As I return to the Africa in a few years, I hope that I will have the space to speak on the matter to my colleagues as well as discuss the importance of raising awareness. While I am just starting my pediatric residency training, I hope to be able to use this literature review to further explore individual factors and find strategies to help combat childhood malnutrition in Sub-Saharan Africa.

Bibliography

1. Simwanza NR, Kalungwe M, Karonga T, Mtambo CMM, Ekpenyong MS, Nyashanu M. Exploring the risk factors of child malnutrition in Sub-Sahara Africa: A scoping review. *Nutrition and Health*. 2023;29(1):61-69. doi:10.1177/02601060221090699
2. Lartey, A. (2008). Maternal and child nutrition in Sub-Saharan Africa: Challenges and interventions. *Proceedings of the Nutrition Society*, 67(1), 105-108. doi:10.1017/S0029665108006083
3. Bain, L. E., Awah, P. K., Geraldine, N., Kindong, N. P., Sigal, Y., Bernard, N., & Tanjeko, A. T. (2013). Malnutrition in Sub-Saharan Africa: burden, causes and prospects. *The Pan African medical journal*, 15, 120. <https://doi.org/10.11604/pamj.2013.15.120.2535>
4. Pimentel, J., Ansari, U., Omer, K. *et al.* Factors associated with short birth interval in low- and middle-income countries: a systematic review. *BMC Pregnancy Childbirth* 20, 156 (2020). <https://doi.org/10.1186/s12884-020-2852-z>
5. Sanni Yaya, Olanrewaju Oladimeji, Emmanuel Kolawole Odusina, Ghose Bishwajit, Household structure, maternal characteristics and children's stunting in sub-Saharan Africa: evidence from 35 countries, *International Health*, Volume 14, Issue 4, July 2022, Pages 381–389, <https://doi.org/10.1093/inthealth/ihz105>
6. Quamme SH, Iversen PO. Prevalence of child stunting in Sub-Saharan Africa and its risk factors. *Clin Nutr Open Sci*. 2022;42:49-61. doi:<https://doi.org/10.1016/j.nutos.2022.01.009>
7. Conde-Agudelo A, Rosas-Bermúdez A, Kafury-Goeta AC. Birth Spacing and Risk of Adverse Perinatal Outcomes: A Meta-analysis. *JAMA*. 2006;295(15):1809–1823. doi:10.1001/jama.295.15.1809
8. Drammeh W, Hamid N. A, Rohana A. J. Determinants of Household Food Insecurity and Its Association with Child Malnutrition in Sub-Saharan Africa: A Review of the Literature. *Curr Res Nutr Food Sci* 2019; 7(3). doi : <http://dx.doi.org/10.12944/CRNFSJ.7.3.02>
9. Walson, J. L., & Berkley, J. A. (2018). The impact of malnutrition on childhood infections. *Current opinion in infectious diseases*, 31(3), 231–236. <https://doi.org/10.1097/QCO.0000000000000448>
10. Bachou, H., Tylleskär, T., Downing, R., & Tumwine, J. K. (2006). Severe malnutrition with and without HIV-1 infection in hospitalised children in Kampala, Uganda: differences in clinical features, haematological findings and CD4+ cell counts. *Nutrition journal*, 5, 27. <https://doi.org/10.1186/1475-2891-5-27>

11. Nigussie, J., Girma, B., Molla, A., Mareg, M., & Mihretu, E. (2022). Under-nutrition and associated factors among children infected with human immunodeficiency virus in sub-Saharan Africa: a systematic review and meta-analysis. *Archives of public health = Archives belges de sante publique*, 80(1), 19. <https://doi.org/10.1186/s13690-021-00785-z>
12. Johann-Liang, R., O'Neill, L., Cervia, J., Haller, I., Giunta, Y., Licholai, T., & Noel, G. J. (2000). Energy balance, viral burden, insulin-like growth factor-1, interleukin-6 and growth impairment in children infected with human immunodeficiency virus. *AIDS (London, England)*, 14(6), 683–690. <https://doi.org/10.1097/00002030-200004140-00007>
13. Nshimiyiryo, A., Hedt-Gauthier, B., Mutaganzwa, C. *et al.* Risk factors for stunting among children under five years: a cross-sectional population-based study in Rwanda using the 2015 Demographic and Health Survey. *BMC Public Health* 19, 175 (2019). <https://doi.org/10.1186/s12889-019-6504-z>
14. WHO. Malnutrition 2020. Available from: <https://www.who.int/news-room/questions-and-answers/item/malnutrition#:~:text=Malnutrition%20refers%20to%20deficiencies%2C%20excesses,220broad%20groups%20of%20conditions.&text=The%20other%20is%20overweight%2C%20obesity,%2C%20diabetes%2C%20and%20cancer>
15. Ringler C, Zhu T, Cai X, Koo J. Climate Change Impacts on Food Security in Sub Saharan Africa: International Food Policy Research Institute, IFPRI Discussion Paper 01042, December 2010. Available at <http://www.ifpri.org/sites/default/files/publications/ifpridp01042.pdf>. Accessed 13 January 2013.
16. Baker, R. E., & Anttila-Hughes, J. (2020). Characterizing the contribution of high temperatures to child undernourishment in Sub-Saharan Africa. *Scientific reports*, 10(1), 18796. <https://doi.org/10.1038/s41598-020-74942-9>
17. Madzorera, I., & Fawzi, W. (2020). Women empowerment is central to addressing the double burden of malnutrition. *EClinicalMedicine*, 20, 100286. <https://doi.org/10.1016/j.eclinm.2020.100286>
18. Tusting, L. S., Gething, P. W., Gibson, H. S., Greenwood, B., Knudsen, J., Lindsay, S. W., & Bhatt, S. (2020). Housing and child health in sub-Saharan Africa: A cross-sectional analysis. *PLoS medicine*, 17(3), e1003055. <https://doi.org/10.1371/journal.pmed.1003055>

19. *Elimination of mother-to-child transmission - UNICEF DATA*. (n.d.). UNICEF Data. Retrieved May 18, 2023, from <https://data.unicef.org/topic/hivaids/emtct/#status>
20. *THE 17 GOALS | Sustainable Development*. (n.d.). Sustainable Development Goals. Retrieved May 18, 2023, from <https://sdgs.un.org/goals>
21. *Breaking the cycle of chronic child malnutrition in Sub-Saharan Africa*. (2023, February 9). Economist Impact. Retrieved May 19, 2023, from https://impact.economist.com/perspectives/sites/default/files/economist_impact_breaking_the_cycle_of_chronic_malnutrition_in_ssa_feb_23.pdf
22. De Jonge HC, Azad K, Seward N, Kuddus A, Shaha S, Beard J, et al. Determinants and consequences of short birth interval in rural Bangladesh: a cross-sectional study. *BMC Pregnancy Childbirth*. 2014;14(1):1–7.
23. Belachew, T.B., Asmamaw, D.B. & Negash, W.D. Short birth interval and its predictors among reproductive age women in high fertility countries in sub-Saharan Africa: a multilevel analysis of recent Demographic and Health Surveys. *BMC Pregnancy Childbirth* 23, 81 (2023). <https://doi.org/10.1186/s12884-023-05403-0>
24. Fauziah, N., Aviani, J. K., Agrianfanny, Y. N., & Fatimah, S. N. (2022). Intestinal Parasitic Infection and Nutritional Status in Children under Five Years Old: A Systematic Review. *Tropical medicine and infectious disease*, 7(11), 371. <https://doi.org/10.3390/tropicalmed7110371>
25. Intiful, F. D., Abdulai, H., Nyarko, R., Tette, E., & Asante, M. (2021). Malnutrition in HIV infected children on antiretroviral drugs in a cohort of Ghanaian children. *Heliyon*, 7(12), e08636. <https://doi.org/10.1016/j.heliyon.2021.e08636>