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THE DETERMINANTS AFFECTING SEVERE ACUTE MALNUTRIITION IN SENEGAL

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ABSTRACT

Severe Acute Malnutrition (SAM) is a major cause of mortality in children under the age of five worldwide. One in three preschool aged children is undernourished in some way (World Food Program, n.d.). According to the World Food Program (WFP), 47.6% of the 13.7 million living in Senegal live in poverty (World Food Program, n.d.). In 2014, UNICEF projected 340,000 children with acute malnutrition under the age of 5 living in Senegal; 79,000 of these children have SAM (UNICEF, 2014). UNICEF's report states that overall 480,000 people, children in particular, need immediate attention due to major health implications such as kidney failure, brain deterioration, reduced ability to fight infection, growth deficiencies, and mortality that may result (UNICEF, 2014). Nine of the 45 departments in Senegal have SAM prevalence over the critical threshold of >2% of the population, and 5 have a level of SAM over the alert threshold set by worldwide measures at <3% (UNICEF, 2014). This thesis explores the determinants surrounding SAM in the children of Senegal through the six levels of Bronfenbrenner's Ecological Systems Theory. These levels of analysis speak to the complexity of SAM. Literature was sourced through online databases, journals, government publications, educational websites, and printed sources and analyzed to speak to these levels of complexity. This literature review includes the main social and physical determinants of SAM in Senegal today by discussing the most recent publications on the subject.

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Personal Connection to the Topic

Pursuing education in global health and attempting to further understand the problem at hand, I traveled to Senegal in the summer of 2014. I was pursuing my Global Health Minor, completing six weeks' field work. Immersing myself in the culture allowed the literature to come to life. Not many studies have been conducted thus far compiling all of the data on the subject in an attempt to see holes in our knowledge. The only major study that is easily accessible about the determinants of malnutrition in Senegal is titled, Determinants of Child Malnutrition in Senegal: Individual, Household, Community Variables, and their Interaction (Linnemayr, Alderman &

Ka, 2008). Therefore, I decided to further analyze the situation through published literature seeing if any conclusions could speak to why this problem persists. With a better understanding of the culture and lifestyle of the Senegalese, I am able to examine the literature more critically and speak to the true childhood nutritional situation as it can be seen through hundreds of publications. This literature review is a necessary task and an essential read if we hope to understand the current situation in Senegal and eradicate malnutrition in the near future.

Chapter 1: Malnutrition in Senegal

Section 1: Research question

Study Rationale

This study focuses on Senegal because it is a region of concern for global health in regards to increasing levels of SAM in children in West Africa. It is important to understand how culture and other social determinants, sometimes overlooked in acute medical situations, affects nutritional states (World Health Organization, 2000), and how it can be combated in the next decade. Besides Senegal, other African countries also suffer from SAM at higher levels including Nigeria, Mali, and Niger (Gordts, 2012). Asia is the continent with the highest number of hungry people with about two thirds of the total hungry population worldwide (UNICEF, 2014). Nevertheless, sheer number does not indicate the overall prevalence rate, meaning Asia may have a larger number of people suffering SAM, but Africa as a continent has the larger percentage of their population suffering SAM (World Food Program, n.d.). Sub-Saharan Africa is the region with the highest prevalence of hunger, with one in every four people being undernourished (World Food Program, n.d.). Prevalence shows the percentage of a total population that is affected by a disease. The higher the prevalence of a disease, the greater the problem is in that specific area. The prevalence of malnutrition in Sub-Saharan Africa is 25% of the total population in that area. Understanding the importance of prevalence, this study will focus on Sub-Saharan Africa in the hopes of focusing attention on the prevalence of SAM in this region

Research (World Food Program, n.d.) shows that nearly half of deaths in children under five can be attributed to malnutrition, which is about 3.1 million children yearly. This study focuses on children for that specific reason. The first five years of a child's life is the most critical and a test for whether they will be able to survive. This is when a child is developing major cognitive and physical functions that will help him/her throughout life. Since so much is developing and forming during this time, a child's health becomes extremely important. Any health issues incurred during this time can have lasting developmental effects on the child. In these years, the child also becomes more susceptible to illness as they are building their immune systems to withstand the environment around them (Malnutrition, n.d.). If childhood malnutrition can be combatted, millions of lives may be saved per year. Once a person passes their fifth birthday having survived being malnourished, their chance of continued survival increases drastically. Nevertheless, they are much more likely to suffer morbidities like diminished cognitive functioning, and physical growth issues. Even though they survive, the quality of life may still be affected due to these health issues. The child may continue to have long term health effects and development delays (Malnutrition, n.d.). SAM can cause mental retardation or even permanent brain damage if left untreated in a child (Malnutrition, n.d.). Once the issue becomes chronic, it will affect many systems of the child's body. Malnutrition can cause gastroenteritis, diarrheal disease, lead to poor management of chronic diseases like HIV, and increase the risk of tuberculosis.

Section 2: Introduction to Malnutrition

Types of Malnutrition and Development Needs

SAM is defined by measuring weight-for-height z-score. This is a way to compare children suffering to those of a healthy weight and height to get a standard deviation as to where they fall on the scale. If the patient is 70% or less below the median of weight-to-height, have a mid-upper arm circumference of less than 110mm, presence of nutritional edema, or are three standard deviations or more away from the National Centre for Health Statistics reference values, the child has SAM (Collins, Dent, Binns, Bahwere, Sadler, & Hallam, 2006).

There are several types of malnutrition caused by poor quality or insufficient quantity of nutrient intake or absorption. The types of malnutrition depend upon which nutrients are missing from the diet, for how long they have been absent, and at what age the patient is diagnosed (London, 2009). The three main categories of malnutrition are acute malnutrition or wasting, chronic malnutrition or stunting, and acute and/or chronic malnutrition called underweight.

Acute Malnutrition (AM) is categorized as wasting (thinness) or nutritional edema (UNICEF, n.d.). This growth failure has three clinical diagnoses: marasmus, kwashiorkor, and marasmic-kwashiorkor. Marasmus is categorized by severe weight loss or wasting which can be seen at <http://healthdrip.com/wp-content/uploads/2012/05/Kwashiorkor-and-Marasmus.jpg>. This is the most common form of acute malnutrition in nutritional emergencies, and can quickly lead to death if not treated.

Marasmus can be categorized as moderate or severe. These determinations are based on body measurements. The two main body measurements are the waist-for-height Z-score (WHZ) and the mid-upper-arm-circumference (MUAC).

- Moderate Acute Malnutrition: defined as having WHZ <-2 or >-3
- Severe Acute Malnutrition: defined as MUAC < 11.5 cm; WHZ <-3 ; bilateral pitting edema, marasmic-kwashiorkor (both wasting and bi-lateral edema)
- Global Acute Malnutrition: is the combination of the prevalence of MAM and SAM at a population level worldwide.

Kwashiorkor is categorized by a bloated appearance due to water retention which is bi-lateral edema, which can be seen in the child at <http://healthdrip.com/wp-content/uploads/2012/05/Kwashiorkor-and-Marasmus.jpg>. This is caused by excessive fluid retention when someone is severely nutritionally deficient. All cases of Kwashiorkor are categorized as SAM (London, 2009). Clinical signs of Kwashiorkor include appetite loss, irritability and apathy, yellowing or orangening of the hair, and dermatosis (UNICEF, n.d.). Dermatitis is when the skin has patches of abnormally light or dark, and is shedding, has weeping lesions or ulcerations (UNICEF, n.d.). Marasmic-kwashiorkor is diagnosed by the appearance of wasting and bi-lateral edema. It is considered SAM and needs immediate attention.

Chronic Malnutrition is another form of growth failure seen globally (London, 2009). A chronically malnourished child looks proportional but is actually small for their age (UNICEF, n.d.). This process often begins before birth and can be caused by poor maternal nutrition, poor feeding practices, poor food quality, and frequent infections (UNICEF, n.d.). According to UNICEF (2015), 195 million children under 5 years of age experience chronic malnutrition and 85% of these children live within only 20 countries (UNICEF, 2015). To combat this problem, interventions need to address pregnant women and nutrition between the ages of 0 and 18 months.

At <http://conflict.lshtm.ac.uk/images/pic055.gif> the difference between acute malnutrition (wasting) versus chronic malnutrition (stunting) versus acute and chronic malnutrition in comparison to normal height and weight can be seen.

Acute and chronic malnutrition is the presence of both wasting and stunting, which can be addressed at both the public health perspective and a clinical setting. The child needs aid for their acute problem immediately, and they need to develop an understanding of nutritional needs to address the chronic issue on an individualized basis. Chronic malnutrition requires maintenance from many layers of societal influence. This means that interventions addressing chronic diseases must address the various determinants of the disease.

Measuring Health Effects of SAM

Taking measurements is generally not difficult for a healthcare provider or trained personnel, but getting the child to the clinic for the diagnosis is a problem. Some people take children to clinics when they have an acute problem that can be helped by medication, and not when they are severely hungry. Going to the clinic is inconvenient and more importantly expensive, so it is viewed as an extra unnecessary expense by the Senegalese (Department, 2008). Malnutrition can cause fever related to systemic infection, respiratory distress, heart failure, electrolyte derangements, marked anorexia, anemia, profuse diarrhea, and shock (Manary and Sandige, 2008). Therefore, SAM measurements are usually done as a result of people coming to the clinic for other symptoms caused by SAM but not directly related to a person's state of hunger.

In a study conducted by the International Food Policy Research Institute (2006), it was projected that by 2020 the prevalence of SAM will increase in Sub-Saharan Africa from 19% to 35% , and due to the regions recent natural disasters in the Sahel region, this estimate may be low (Collins et al., 2006). This increase was described as being due to decreasing resources, and increasing ignored prevalence. With these rising numbers, something must be done to address this public health concern.

Access to food is a human right according to the United Nations Human Rights, Office of Commissioner on Human Rights (United Nations, 2010). This right is unfortunately unmet by millions worldwide. Nutrition is essential for life, yet it is not as simple as driving down to the grocery store and purchasing a week's worth of food for everyone across the globe. Due to this fact, a variety of regions must be considered before understanding a country's situation.

Malnutrition in Senegal

Overall 18% of the Senegal population under the age of 5 is underweight. This statistic places Senegal 35th on the list of countries worldwide suffering with high underweight populations under the age of 5 (UNICEF, 2015). Countries such as India, Bangladesh, Niger, and Madagascar suffer from underweight percentages between 36% and 43%, higher than Senegal (6). Timor-Leste suffers the highest percentage of underweight children worldwide with 45% of it's under age 5 population suffering (UNICEF, 2015).The United States has an underweight percentage of only 1% (UNICEF, 2015). Asia and Africa appear to be the two continents that suffer most from this public health concern. This review focuses on Africa because, according to UNICEF (2014), the problem is believed to worsen if something is not done to intervene here,

because the numbers have been steadily increasing (UNICEF, 2014). Senegal is mostly affected by acute malnutrition, both moderate and severe (World Food Programme, n.d.). Marasmus and/or Kwashiorkor are the most common type of malnutrition in the country. This means that chronic malnutrition, while it still exists, is not the problem seen most often. Addressing a chronic issue requires more of a structural change than an immediate medical intervention. Chronic diseases are, in a very general sense, caused by a multitude of determinants and needs to be addressed through a lifestyle change. An acute problem is generally caused from one direct stimulus, such as lack of food, and needs immediate medical attention (Collins, 2006).

Senegalese children are very tall according to WHO's records of worldwide average heights of children (World health Organization, n.d.). The rate of chronic malnutrition may be higher than reported because the average height of a child in Senegal is taller than the average height of a child in America (Ujiri, 2012). The difference in height should be accounted for in the age height-to-weight measurement but each African country does not have their own standard national height records. This may be because the data recorded isn't always reliable and depends on self-reporting or from information from an overburdened clinic. Children tend to only go to the clinic when they are ill and therefore may be a group that is shorter than the general population who are more susceptible to getting sick (Linnemayr et al., 2008). Nevertheless, acute malnutrition poses eminent threat to the patient's life. SAM can be treated immediately with nutritional packs and the patient may see faster results compared to a chronically malnourished child.

Malnutrition can be seen in both adults and children. Collins et al. (2006) focuses on children with SAM, because SAM is one of the largest causes of childhood mortality in the world (Collins et al., 2006). There are many more children suffering SAM than adults because if

a child is diagnosed with SAM, it is not very likely they will make it to adulthood. Once a patient reaches adulthood and continues to be malnourished, they are most likely chronically malnourished and will need a different treatment. Furthermore, a child needs to continue growing and developing an immune system. If a patient becomes severely malnourished before the age of 5, they will most likely have a life of developmental issues and health-related problems, and if they are not treated they may die (Collins et al., 2006).

Chapter 2: Research Methods and History

Section 1: Research Method

Research Question and Methods

The main question addressed by this literature review is as follows: What are the determinants of malnutrition in Senegal? This study utilizes the literature on malnutrition to assess the many determinants of SAM, focusing on cultural norms and overlooked social practices. By examining the history, literature, and published statistics of SAM within the country, this thesis will compile a comprehensive understanding of the nutritional situation for children in Senegal.

This thesis primarily utilized government documents from Senegal, the PubMed database, the Demographic and Health Survey, UNICEF and WHO humanitarian reports, and other relevant articles and scientific journals for the topic at hand. The study searched these documents and databases before outlining how to discuss the determinants discussed most frequently in the literature. Once the literature was compiled into relevant sections, the

determinants were organized using Bronfenbrenner's ecological theory, creating both a comprehensive understanding of the various levels of analysis as well as the complexity in social factors surrounding the childhood disease. Each article was utilized if it had relevant information to the topic. All sources, except for two books *Your Pocket is What Cures You* and *So Long a Letter*, were found online through educational tools like the PSU Library. This study is a compilation of already published material, producing a document where most relevant social determinants surrounding SAM can be found in one place.

Section 2: Theoretical Framework

Bronfenbrenner's Ecological Theory

To understand the situation better, it is important to analyze the layers of a society. This study uses Bronfenbrenner's Ecological Systems Theory for analysis. This theory was chosen for many reasons. First of all, this theory emphasizes the importance of different environmental systems affecting human development. Childhood malnutrition affects human development and needs to be assessed from all ecological levels to truly understand the health issue. This model helps explain the interconnection of various levels of the child's environment. The task at hand in this scenario is SAM. The microsystem level of analysis takes into account the individual's perception and things that address that person directly. The mesosystem level attempts to introduce the environments that directly affect the person being affected by an intervention. This would include the person's society, religion, or school. The exosystem is the larger social system that the child does not contact directly but that affects the child's mesosystem and microsystem.

This may include the parent's work schedule or the community resources. The macrosystem is the outermost layer of the child's environment including cultural norms and laws. The last level is the chronosystem which includes the dimensions of time as it relates to the child's environment (Paquette & Ryan, 2001). At <http://faculty.weber.edu/tlday/1500/systems.jpg> a graphic of Bronfenbrenner's Ecological System Theory displaying each of the levels relating to one another can be seen.

According to Bronfenbrenner the larger levels of environmental influence are just as important to analyze as the smaller levels. The next section gives an example of how Bronfenbrenner's Ecological Systems can be used.

Example of Bronfenbrenner's Ecological Systems Theory

Let's consider a small child suffering SAM in M'Bour Senegal named Fatou (pseudonym). The first level of analysis would be the micro level. This system would include Fatou's home and family life. It would include her interactions with her parents and siblings. Her school interactions and medical interactions are also a part of her micro system, meaning peer interaction, doctor interaction, and teacher interaction. The people Fatou interact with affect her and reciprocally she affects those people as well. The meso level of analysis would include the relationship between Fatou and her parents, teachers and doctors. These relationships may directly or indirectly affect Fatou, but they definitely have an impact on her schooling and medical care. This also includes her parent's interactions with each other and Fatou's siblings. These relationships will have an effect on Fatou's perception of life as well as her perception of malnutrition.

The next system of the theory is the exosystem. Fatou's father's job is an example of the exosystem. Her father may work as a businessman in the city of Dakar which requires him to be gone for months at a time, only sending money when he gets enough to distribute. This absence would affect Fatou and the rest of her family emotionally and financially. She may even let her sadness or her mother's sadness affect mealtime and other interactions. This may also affect how her family is viewed in society.

In the macrosystem, Fatou is affected by the fact she is raised with an absent father. The community she identifies with has general concerns and sufferings due to a dominant male presence being absent. This environment she identifies with will affect her psychology and further her understanding of social and physical health. She may rely more on her mother or her community for financial or emotional support that she is not receiving from her father, who is off at work.

The last system of analysis is the chronosystem. In this system Fatou is affected by time and how it relates to her environments. The amount of time her father is gone affects her functioning as well as the amount of time her mother waits to take her to the clinic if she needs medical care. Time is a significant factor in the functioning of a person's life. Time connects all aspects of Fatou's life and is the identifying determinant keeping her life in order. Time tells her when to eat, when to go to school, when to go to sleep, and so much more. Overall, the interaction among Fatou's different ecological levels is important to understand so each level of her life can be addressed in some way.

Section 3: Short History of Senegal

Sahel Region: Recent Famine and SAM

Senegal is in the Sahel region of West Africa. This region was affected in 2012 with failed crops and famine. The drought led to high food prices and malnutrition in the northern regions of Senegal (IRIN Africa, n.d.). The Sahel region of Africa, seen at http://www.acegeography.com/uploads/1/8/6/4/18647856/6372964_orig.jpg spans from the east to the west across several countries.

The Sahel region is a 1000 km belt between the Sahara and Sudanian Savannas (Gordts, 2012). Gordts (2012) claims that the SAM problem could worsen with almost 1.4 million children suffering SAM if the problem is ignored. Past crises due to weather in 2005, 2008, and 2010 have also put many families in nutritional deficiencies that they have yet to recover from. With these unforeseeable natural disasters, the area was forced to address a nutritional deficiency caused by a lack of viable crops. The crops were destroyed by the drought. The weather barriers easily explain why this problem erupted, but the reasons why it persists are a little greyer. Deeper analysis of the weather conditions of the country are necessary in understanding why this struggle has continued and how it can be overcome. This situation combined with high food prices, chronic poverty, and displacement could, and has, caused a full scale nutritional crisis that needs global attention (Gordts, 2012).

Historical Context

Senegal is located in the western-most part of Africa, with Mali to the east, Mauritania to the north, Guinea to the south, and the Atlantic Ocean to the west. The country was originally under French colonial power until it gained its independence as the Republic of Senegal in 1960. The country's first president was Léopold Sédar Senghor, a Roman Catholic and a fervent advocate of African unity (Countries and Their Cultures, n.d.). Due to his leadership, the country has always been regarded as very compassionate and understanding. The Senegalese peoples' hospitality is understood throughout Africa. Most of the population practices the Muslim religion and about 44% of the population identifies with the Wolof ethnic group. About 23% of the country identifies as Fulani, 15% as Serer, and the rest as mainly Jola, Mandinka, or Soninke (CIA, n.d.).

The country relies heavily on agriculture. Senegal's main crops are peanuts, millet, and sorghum (CIA, n.d.). Most of the economy is based on the success of their crop, and agriculture as a whole. The main food dishes of the country rely on rice, vegetables, fish and meat. Chep-bu-jen is the national dish of Senegal and it contains rice and fish. The rice is mostly imported because the landscape does not easily adhere to the harvest of rice. Senegal is located in the Sahelian region that has constantly been affected by drought, causing major problems to the agricultural success of the nation. The Sahelian region of Africa also relies on a livestock sector, but drought causes drastic decreases in the survival of that livestock (CIA, n.d.). The weather conditions make it difficult to have a successful harvest and healthy livestock, leading to overall nutritional deficiencies throughout the country's history.

Diourbel is one of the regions of Senegal that is still suffering the worst from the famine and can be seen at http://upload.wikimedia.org/wikipedia/commons/b/b8/Senegal_Diourbel.png.

This region has one of the highest rates of SAM and has continually been an area of food insecurity.

Chapter 3: The Determinants of Malnutrition

The determinants outlined in this chapter were chosen because they have shown up in multiple sources in association with SAM or other types of malnutrition and pediatric health. Each of the factors has a profound connection to SAM either directly or indirectly and ultimately may have a profound effect on a child's nutritional status.

Section 1: Microsystem

1. Age/SES/Gender/Ethnicity

Age, SES, gender, and ethnicity can explain a person's likelihood of becoming malnourished. The younger the patient, the more likely they are to suffer SAM because they are more susceptible to nutritional deficiencies as their body is developing and needs these nutrients to grow and survive (London, 2009). The reason younger children generally suffer SAM is because the disease is so deteriorating that the child is not likely to live into older age. If they can make it past five, when many key developments are underway, then the child has a better chance of physically handling malnutrition. This increases the likelihood of a young SAM demographic. Furthermore, the first 5 years of life require adequate nourishment for development, they will not be able to develop in accordance with child growth standards. These guidelines are also influenced by an individual's SES.

Lower socioeconomic status (SES) is a risk factor for SAM. According to researchers from the London School of Hygiene and Tropical Medicine (2009), if you do not have the

money to pay for food or live in a region that is considered impoverished, your children are more likely to have a SAM diagnosis before the age of five (London, 2009). In Senegal, the lower SES groups live in the rural regions to the East away from the coast (World Food Programme, n.d.). Many places on the coast are urban or suburban, as the coast remains one of the main trading posts and access points into Africa (Senegal, n.d.). The regions furthest from the coast have a dry climate and suffer the brunt of most drought seasons, impacting agriculture and food access significantly.

The focus of many studies on Senegal has been on SES and not gender. This is because there has not been a strong association between SAM and one gender over the other. According to the 2013 Demographic Health Survey conducted in Senegal (Republic of Senegal, 2013), the prevalence of female and male SAM is almost exactly equal with males being slightly higher at 10% versus 8% females (Republic of Senegal, 2013). Each ethnic group of Senegal, outlined in Section 3 of Chapter 2, has their own practices which may or may not affect the rate of malnutrition. Nevertheless, since vast research has not been done on this matter, what is understood lies in increased malnutrition in rural regions. Rural areas lack the proximity to healthcare facilities and food markets that urban and semi-urban areas have (Countries and their Cultures, 2015). The ethnicities residing in the east and south of Senegal are mainly Diola, Pular and Mandé groups that are most affected by SAM in the country (Kwintessential, n.d.). Their distance from Dakar and the coast may cause some nutritional problems. The ethnic groups of Senegal can be seen at <https://michelledakar.files.wordpress.com/2011/01/ethnic-groups-in-senegal2.gif>.

2. Genetics

Genetics have a role in diseases. The most common diseases associated with family history are cancers, cardiovascular disease, diabetes, autoimmune disorders and psychiatric illnesses (Hernandez, 2006). Yet, these are not the only things that are affected by one's genes. To understand how genetics affects SAM patients, it is essential to first comprehend how genetics influence health overall. The Centers for Disease Control (CDC) outlines main diseases that have been found to correlate with specific sequences in the human genome (CDC 2015). These sequences increase the likelihood of acquiring certain diseases and also show a map to how each person battles illnesses (CDC, 2015). Genetic information contains endless information about a person's family history, immune system, and physicality. If you can read a person's genes, or just understand a person's family history of diseases, you can predict the likelihood that a patient may be diagnosed with a particular illness at some point in their life (CDC, 2015). Individual genes also affect weight and height (Hernandez, 2006).

In the case of SAM, there has not been a discovery of a mutated gene nor specific genetic sequence associated with malnutrition. There has, however, been identification of family ties to height and weight, as well as immune system capabilities. These three factors play a critical role in the diagnosis and treatment of SAM. If your family is generally underweight, the testing standard weight for SAM is not changed on an individual basis, so it may increase your likelihood of diagnosis. If your genetic weight and height are lower than national averages, then the WHO standard charts would skew your diagnosis, as you would be more likely to be diagnosed as malnourished. If a patient inherits tall genes, the standard Mid-Upper Arm, Circumference (MUAC) measurements may be incorrectly interpreted. Family history also shows that if a mother is underweight, her children are likely to also be underweight (Simmons,

2008). Whether or not those children suffer malnutrition is influenced by environment. There have been genetic connections to metabolism and immune function (Alberts, Johnson, Lewis, et al., 2002). In a very broad sense, if a child is not receiving adequate nutrition and they have a poor immune system due to genetics, they are more likely to suffer major consequences of SAM such as diarrheal disease, respiratory infections, and heart failure. These diseases are correlated with untreated SAM.

According to Harvard Health Publications 2015, proper immune function of T-cells was associated with well-balanced nutrition (Harvard Health Publications, 2015). SAM patients are already at risk for improper immune function, but genetics can also complicate the ability to overcome SAM side-effects. However, if a child has a very strong immune system and they have poor nutrition, the child may be able to overcome some diseases because their genetics continue to produce T-cells with a poor diet (Harvard Health Publications, 2015). If untreated SAM can affect organ functionings, and viral or bacterial infections while malnourished could be deadly (Hernandez, 2006).

Malnutrition is not diagnosed through genetic testing, and can be overcome through dietary changes and medication (Elia & Bistran, 2009). Individual genes affect one's ability to deal with SAM, but it does not affect a child's risk of becoming severely malnourished. A child's genes can help them deal with the side effects of being malnourished, but no matter what genes a child possesses, they must eat a well-balanced diet in order to stay well nourished (Elia & Bistran, 2009).

Permanent effects on health caused by having SAM can be handed down from generation to generation through epigenetics, which is the mutation of genes based on environmental factors through behavior of an individual or an individual's ancestors (Hughes, 2014). In other words,

the actions of one generation can affect the genes of the subsequent generations. For instance, recent research found that if a father did not have adequate food available during a critical period of development before puberty, his sons were less likely to die from cardio vascular disease (CVD; Kaati et al., 2002). Conversely, if food were plentiful during this critical period for paternal grandfathers, his grandsons were more likely to suffer diabetes (Simmons, 2009). This effect on genes based on environment is something that should be examined more in relation to malnutrition.

3. Doctor's Influence

A doctor influences a child in a very direct way. A physician must recognize, diagnose, and treat the disease when it is presented to them. The physician must be qualified to see past the ailments described into the underlying nutritional problem, if there is one. They can take measurements to solidify the diagnosis and categorize the severity of the problem. The doctor should measure the child's weight and height, then compare the results to a standardized chart to make an official determination. However, these standardized charts are not country specific and may be unreliable. Further testing and analysis of the child's dietary intake must be conducted in order to fully understand the nutritional situation.

A study conducted by Patricia Becker and colleague (2015) found that food/nutrient intake, assessment of energy and protein needs, growth parameters, weight gain velocity, mid-upper arm circumference, handgrip strength, proxy measures as substitutes for traditional anthropometric measure, and documentation of Tanner stage are essential indicators of nutritional status and must be utilized by healthcare providers (Becker, 2015). Becker's research

outlines indicators recommended for identification and documentation of pediatric malnutrition (Becker, 2015). To classify malnutrition as a healthcare worker, you must understand an array of indicators. The indicators outlined in this study were chosen because they “are evidence informed and consensus derived, are universally available and validated, can be applied inexpensively in multiple settings, can be properly used with minimal training, can reproducibly identify under nutrition, can quantify the severity of under nutrition, can be used to monitor changes in nutritional status” (Becker, 2015, p. 149). These requirements are essential because they outline the reasons that healthcare providers should utilize all these indicators of under nutrition when diagnosing and treating the situation.

The Tanner stage, a measurement of a teenager’s nutritional status, cannot measure the nutritional status of prepubescent patients, but it is a good measurement of preteens and teenagers. This measurement was not made for children before puberty; rather, it takes into account developmental changes that only occur after puberty has taken place. This thesis does not focus on that age-group, and therefore has not analyzed the Tanner stage measurement further. Nevertheless, this study helped show the vast array of indicators that much be analyzed by a healthcare provider when dealing with a patient suspected to be malnourished. In Senegal, doctors diagnose SAM through weight-height ratio, visual identification of wasting, and swelling of the feet through water retention (Jones & Berkley, 2014).

From the point of acknowledgement and diagnosis, the doctor must treat the patient. This means the doctor or healthcare provider has an essential influence on how the child is treated. Since there are several different treatments available, all generally dealing with therapeutic foods and behavior change, the doctor may be influenced to choose one course of action over another. According to the World Food Program (2015), there are several therapeutic foods you can give

to severely malnourished children that may help their situation such as ready-to-use therapeutic foods (RUFs). Besides having different types, there are also different brands and countries make their own versions of therapeutic foods. Fortified blended foods are not recommended in SAM cases, but prevent and address nutritional deficiencies to mothers and children in a state of malnutrition. Ready to use Foods are suggested for patients diagnosed with malnutrition in severely food insecure areas. They are generally peanut-based pastes that help overcome nutrition issues in children on a short term basis. High Energy Biscuits (HEBs) are a short-term and immediate solution to increase nutrition at the start of a longer term solution. Compressed food bars cannot be used for children under 6 months or in the first two weeks of SAM treatment, but can be used on a longer-term basis if the physician is able to follow up with the patient. (World Food Programme, 2015).

The recommendation today according to World Food Program is that high-energy food like RUFs and antibiotics to treat infections be used to treat SAM (World Food Programme, 2015). The differences lie in manufacturers and funding. According to a study conducted by Give Well (2012), manufacturers such as Edesia, MANA, and Valid Nutrition say that the main issue preventing the success of the ready-to-use foods is directly tied to funding (Give Well, 2012). Recently, Bachmann (2010) found that community-based treatment programs could cost anywhere between US\$46-US\$453 per child being treated for SAM. This disparity can differ based on length of treatment and resources available. Doctor follow-up is essential for patients. According to Elizabeth (2014), in-patient management of SAM drastically increases the case survival rate. This is because the family feel autonomy over their healthcare, which empowers them to adhere to recommendations. Furthermore, follow-up care by a physician results in a lower overall fatality rate (Elizabeth, 2014). Nevertheless, doctors are extremely busy. Tracking

down one SAM patient is very difficult, as people travel hours to get to the clinic, houses in Senegal lack official addresses, and transportation is not as simple as driving down the road using GPS. Therefore, According to the WHO (2013), the doctor must come-up with a way of explaining future maintenance of nutrition to keep the child healthy at the time of diagnosis. They may also have to prescribe a treatment plan for longer than a few weeks. This may include regular diet recommendations. This recommended diet must be implemented through the child's parents (WHO, 2013).

It has been studied how a doctor-patient or in this case a doctor-parent interaction affects the patient's health. There are often problems with adherence to recommendations or misunderstanding in communication. In a study analyzing doctor-patient interaction (Heszen-Klemens & Lapińska, 1984), doctors' directedness, doctors' emotional attitude towards the patient, patients' activity, and patients' partnership status had an effect on the patients' health behavior, with low directedness, poor emotional attitude, low patient activity, and single patient partnership related to negative effects on the patient's health behavior (Heszen-Klemens & Lapińska, 1984). This understanding shows the importance of doctor's communication to a patient. In the case of childhood SAM, the parents must be able to communicate and interpret the doctor's words.

If the parent does not understand the doctor or does not adhere to the doctor's recommendations, the chances that the child's health situation improving are diminished. In a study conducted by Jackson et al. (2015), an ethnic barrier between doctor and patient was shown to drastically decrease the patient satisfaction with their experience (Jackson et al., 2015). These patients also saw a decrease in their health due to misinterpreting their treatment plans. Medical competency is of utmost importance if a patient is hoping to get better. Nevertheless,

competency is a difficult thing to achieve if you don't communicate effectively with the healthcare worker. The belief in Senegal is that a white person in a hospital must be a doctor and can help (Foley, 2010). The Senegalese also believe the doctor must have money to be in Senegal and therefore they can help patients (Foley, 2010). Doctors see hundreds of patients a day and sometimes the patients do not see immediate results. This creates a lack of trust in the system as a whole. Positive medical results sometimes take time and it is hard for patients to understand this.

A doctor's opinion about a patient's family may have a large impact on the treatment and follow-up care provided by that doctor. It has been shown that doctors who do not identify with their patients, tend to spend less time with their patients and do not make them feel comfortable in the patient-doctor interaction (Plan, 2010). If a patient does not feel comfortable, they are less likely to adhere to recommendations, and their overall health is negatively affected.

Section 3: Mesosystem

1. Religion

Senegal is comprised of approximately 92% Muslim citizens (Countries and their Culture, n.d.). Of the remaining, 8% most are Christian at 4.2% (Countries and their Cultures, n.d.). With almost everyone in the country practicing the Muslim religion, it is essential to examine its influence on health.

Three practices that stand out in the Muslim religion that may be related to nutrition. These are Salat, which is prayer; Zakat, which is giving; and Sawm, which is fasting during Ramadan and other holy days (What is Islam, 2015). Practicing Muslims pray 5 times a day at

specific times. These praying times may dictate when they can and cannot eat a meal. Zakat refers to Muslims giving money to their religious houses and leaders in the name of Allah. Everyone is expected to give a certain percentage of their money once a year. This money is then not used for food or healthcare. If a child's family must give to their religion in the name of Allah, yet they have very little to survive on, they may prioritize their religious zakat over their meals. Religion is very important, and some people believe it is the most important thing in life, but if you do not have food to feed the family, their lives may be in danger. The third practice is called sawm, which is fasting. This is when people practicing Islam do not eat from sun-up to sun-down for about a month a year, called Ramadan. Depending on the strictness of a family's religious practice, children may suffer nutritional deficiencies even more in this time period. Many practicing Muslims believe in keeping the nutritional health a priority for children and pregnant women, but portions and food options are much smaller than outside this time period for this group. If a family allows it, these religious practices can most certainly affect children in the home setting.

2. Polygamy

In the Muslim religion, polygamy is accepted. Under this set of beliefs, a man is able to take on more than one wife to fulfill the household duties and his overall needs. According to the Quran, "If ye fear that ye shall not be able to deal justly with the orphans, Marry women of your choice, Two or three or four" (Islam, n.d.). In Wolof households, which comprise approximately 43% of Senegalese households, the wives are not able to pool their resources in an attempt to alleviate each other's daily housework burden (Foley, 2010). One woman's chores or cooking

burdens cannot be done by another wife. If a woman needs help with her duties, she will use her daughters. If she has no daughters, or there is still no resources for them to utilize, the family will continue to not eat. If children do not have access to food, and their mother is not able to get necessary help to cook the food they do have, a child will not be fed. This process will eventually lead to malnutrition.

If a woman is needed to help cooking a meal and she has a co-wife, that wife must cook her part of the meal separately. Therefore, if a meal is not completed by one wife, that woman and her children may suffer, but the husband can be fed by his other wife. If the woman is pregnant, this lack of nutrition will affect her lactation and the fetus's nutritional health. During pregnancy, a woman must have protein to promote the baby's growth as well as folate and folic acid to prevent birth defects in their child (Ricardo, Tyson & Zahidi, 2012). If they do not receive these nutrients their child could potentially not survive, and may be malnourished at birth. A wife's duty is to keep her husband full and satisfied according to Islamic practice, yet a man does not necessarily have to reciprocate. Islamic men are not always oppressive, but if they adhere closely to the teachings in the Quran, they are more likely to put their own health before their wife's.

Even though there are many detrimental health effects of polygamy, there are also positive effects of a polygamist family on child and maternal health. George (1981), describes how the Ashanti, a West-African tribe, develops polygamist units in order to increase maternal and child nutrition, mental health, and quality of life. George (2006) analyzed relevant material on maternal and child health in relation to the polygamist lifestyle of the tribe, while outlining a few cases of pediatric Kwashiorkor. His statistics show that, out of 12 families studied (6 were monogamous, while 6 were polygamous), children in monogamous families had SAM

prevalence of 35.9%, whereas polygamous families had no children with SAM. The children in families practicing polygamy had increased social skills, were able to pool their resources with their peers, and had a greater sense of identity within the community. These positive effects on psychology linked closely with SAM prevalence, as the children in polygamist families supported one another if anyone became ill. The large family became a community. In this study, monogamy became a risk factor of SAM.

The study also explained the introduction of the polygamist practice as a way to increase child health. At the tribe's inception, monogamous family units suffered childhood deaths more often than their polygamist counterparts. Once families united and helped one another in times of need, pregnant women and children became a priority. Children survival rates increased and SAM prevalence decreased. If monogamy was introduced into a society that lived so successfully with polygamy, the study explained that it could result in an overall decrease in family health. Drastically changing a family's dynamic will have negative psychological effects on children. In this case, the detrimental effects do not outweigh the positive effects of introducing the polygamist lifestyle. This example shows that families practicing polygamy today should continue the practice as it will hinder their children's health if they tear apart the family structure. (George, 1981)

Even though the study by George (1981) outlined the positive physical health benefits of being in a polygamist family, Al-Krenawi (2013) outlined the negative effects of polygamist marriage on the wives and their children in Syria. These negative effects were mostly seen to be psychological. However, it was explained that psychological harm can lead to physical harm in both children and wives. The women that suffered the most were the first wives, complaining of more family problems, more anxiety, less money, and more child illness. (Al-Krenawi, 2013).

Even though SAM is a physical ailment, psychological harm can effect nutritional status, in that depression, anxiety disorders and low self-worth can all lead to changes in dietary intake.

According to the Demographic Health Survey (Republic of Senegal, 2013), 55% of women in Senegal are not educated and therefore unable to attain employment, and women are making drastically less money than men across the country. This is true across the globe; the Global Gender Gap Report (2012) gives Senegal with a score of 0.666 out of 1 (1 being equal and 0 being unequal). Importantly, every country measured has men making more money than women (Ricardo, Tyson & Zahidi, 2012). In Senegal, women make about 58% of what men make if they are actually working, and annual salaries average \$1,455 for females and \$2,525 for males (Ricardo, Tyson & Zahidi, 2012). Gender income disparities has been connected been the increasing underweight prevalence in females as the gender gap has increased slightly since 2010 and the underweight prevalence has also increased (Republic of Senegal, 2013). This disparity must be overcome in order to positively influence childhood SAM.

3. Women's Empowerment

Women must be empowered to stimulate a change in overall health in Senegal. Jaacks and colleagues (2014) state that in rural areas of Senegal, the prevalence of underweight females decreased 0.23% annually between 1992 and 2005, then increased 1.60% annually between 2005 and 2010 (Jaacks et al., 2014). The data suggests that women and their children have been progressively becoming malnourished since 2010. The increase was introduced when government policies introduced gender equality into the constitution; therefore, in theory, women have been afforded equality at least in theory, yet their rates of malnutrition are

increasing. Jaacks (2014) lists Senegal as the number one country needing aid immediately due to its continually increasing rate of underweight women and children compared to the other 28 low and middle income countries surveyed throughout South and East Asia as well as Sub-Saharan Africa (Jaacks et al., 2014). These alarming statistics further show the food crisis that rural Senegal is currently in.

Jennings (2014) assessed DHS data from sub-Saharan Africa to see how women's empowerment can reduce their morbidity and mortality (Jennings, 2014). If morbidity and mortality in women decreases, morbidity and mortality in children also decreases. This is because children's morbidity is closely linked with mother's morbidity. Therefore, this study showed that empowering women may lead to reduction of morbidity and of SAM diagnoses in children. This can be accomplished by increasing opportunity, control, and inclusion in both family and community for women who do not perceive themselves as having these things (64). These topics empower women to take ownership of their own life, as well as enable them to make informed decisions for themselves, boosting both confidence in their abilities and overall self-worth.

Heckert (2013) suggests that women empowerment in Senegal and other West-African countries needs to be included in a few more surveys in the DHS report to get baseline reading on these problem areas: economic empowerment, knowledge of legal rights and recourse, participation in decision making, attitudes and social norms, and adolescent girls (Heckert, 2013). The study shows how these areas could spark an empowerment movement in Senegal, and if actual statistics on certain ideas within the subjects were collected, interventions could be developed to address the most serious and consequential problems. The areas to address in the DHS survey can also be explained by a perceived level of equality in men and women. If women

believe they are treated the same as men, their health will increase and children will also benefit. Equality leads to confidence and control over one's life, which in turn will benefit a women's health. She will be able to eat when and how much she wants to eat, make money to pay for the food, and choose her path in education. This autonomy will give the women more resources in taking care of her children. Therefore with women's empowerment, child health increases.

Article 7 of the Senegalese constitution states that men and women are equal (Social Institutions and Gender Index, n.d.). Nevertheless, women are still facing very real threats to unequal treatment in ways outside of career, and also within their careers. For instance, Senegalese parliament has just doubled the number of female parliament positions, surpassing the US in female congress representatives (Gayles & Withers, 2014). Sixty-four women have been sworn into parliament's 150 seats, making the female presence almost half (Faye, 2012). United, gender inequality can begin to disappear. Women know the problems children face because they take care of the children in Senegal. If they gain political power, they can have the voice to address pediatric health issues like SAM that is burdening most of rural Senegal without political notice (Faye, 2012). Problems have arisen with the gender parity law as the women have been rumored to be chosen on purpose and not on merit. Women thought they were beginning to come closer to equality when, in reality, it appears politics are still ruled by patriarchal decision (Senegal makes, 2012). This means that women still have little say in trade policy, nutritional funding regulations, and allocation of government funds. With little control, women's comments and perspectives are not necessarily heard and respected and they cannot make the political choices that they believe will better children's health. Women see different issues than men, and many times they also see the same issue with different perspectives (Kassé, 2003).

Section 4: Exosystem

1. Mother's Education

A mother must learn how to feed her child before and after birth. This means learning what to consume during a pregnancy, and how to properly breastfeed after birth. This education will entail cooperation from trained health workers as well as materials for demonstration of breastfeeding, nutritional meal preparation, and proper care practices with a newborn. It requires the time of an educator and the willingness to learn from a mother. If they do not learn the proper feeding techniques and do not give the child proper medical care, the risk of malnutrition increases drastically (IDRC, n.d.). Specifically the risk of SAM increases due to eminent wasting and the child's life is put in danger (IDRC, n.d.).

A mother's education level is an important determinant in the nutritional status of their children. If a mother has completed primary school and has access to a sanitary facility in her household, her children's nutritional status are positively affected (Linnemayr & Alderman, 2008). This sanitary facility includes access to clean water in the home, and a way of disposing of human urine and feces appropriately.

Education is an essential factor in relation to nutrition and the ability to achieve a healthy nutritional status. This education entails both maternal and child lessons; WHO explains the importance of breastfeeding in avoiding malnutrition. The WHO recommendation is 6 months of exclusive breastfeeding, and up to two years of supplementary breastfeeding (Vesel, Bahl, Martines, Penny, Bhandari, & Kirkwood, 2010). Kramer and Kakuma (2002), combined the results of two studies conducted in Honduras and found that exclusively breastfed infants had a lower prevalence of stunting, wasting and underweight (Kramer and Kakuma, 2002). Children

continuing breastfeeding were receiving the proper nutrients from the milk, and mothers were getting the positive benefits of the bonding activity as well. Their study contributed to the WHO recommendations. *Scaling-Up Nutrition, a Framework for Action* indicated that breastfeeding is one of the 13 highly cost-effective nutrition interventions (UNICEF, 2008).

Since Senegalese women traditionally stay at home with the children and are in charge of the house, many of them stop education very early. This age varies based on location. In rural areas of Senegal, females tend to stop education after primary school around age 11, and in urban areas this age increases to after secondary school at around 16 (Heckert, 2013). If school costs money that a family does not have, or there is a lot of work to be done in the household, girls stay home and help. In 2010, UNICEF published an article explaining the reasons girls in Dakar were required to leave school (Shryock, 2010). Some were involuntarily persuaded to leave to help at home, some to make money for their household, and others because their family couldn't afford it (Shryock, 2010). These barriers are a threat to a girl's education.

Lack of education leads to decreased socio-economic standing. Senegalese households with high numbers of illiterates have shown to be the poorest and most vulnerable populations with the lowest social ranking (UNESCO Global, 2012). Women and female children have the highest rates of illiteracy at 62% compared to men at 38% (UNESCO Global, 2012). This stark difference affects a family's social standing in society and can have an impact on their children. Being illiterate does not allow you to attain the highest paying jobs. Illiteracy is linked with SES and low SES is tied with overall low control in a community (UNESCO Global, 2012). If a family is viewed as being uneducated, children in that family are more likely to fall in this cycle of poverty and illiteracy. This negative impact can affect the onset of malnutrition and further the

treatment if a child does not have the support of its community as well as the educational background to stay nourished and treat malnutrition as it develops.

On the other hand, an educated mother is more likely to know how to feed her children appropriately for them to stay healthy. Counterpart International (2014) outlines an intervention based in Matam, Senegal that increases child nutrition education through school lunches and more cooking and education facilities, and also increases mother education through the Parent Teacher associations (Counterpart International, 2014). The intervention, which is called McGovern-Dole International Food for Education and Child Nutrition program, has helped increase mother nutrition education and helped to begin to decrease child malnutrition in the area. The McGovern-Dole funding allocation from 2014 suggests that Senegal, through Counterpart International, has received about \$11,159,000 and affected about 97,980 people (United States Department of Agriculture, 2014). This education program reaches 270 primary schools and preschools in the St. Louis Region of Senegal, influencing nutrition by increasing school attendance, encouraging the establishment of good health and nutrition practices, improvement of school infrastructure through the construction of classrooms, latrines and water station systems, provision of school cafeterias and energy-saving stoves for cooking to feed student's breakfast and lunch (Counterpart International, 2014). These changes are working towards improving rates of SAM in rural Senegal through education. Mothers and children are benefitting from these lessons.

An educated mother is more likely to have financial gains and be in a more affluent part of the community. An educated mother is more likely to live in a higher SES, and attain a job with a relatively stable salary. In a study conducted on the relationship between childhood malnutrition and parental education as well as mothers' nutrition (Gupta, Mehrotra, Arora, &

Saran, 1991), it was found that mother's education level was directly correlated to the child's nutrition status. However, the father's education level had no correlation to the child's nutrition status.

During the testing in Gupta et al.'s study (Gupta et al., 1991), the content areas of knowledge, attitudes and practices were significantly associated with nutritional status pertaining to nutritional requirements of children, nutritional value of foods, immunization, hygiene, oral rehydration and diarrhea (Gupta, Mehrotra, Arora, & Saran, 1991). This means that the knowledge, attitudes and practice of the mothers surrounding the subject can influence whether or not the child is malnourished. Knowledge and attitudes have an immense impact on SAM as a whole. If a family knows the appropriate nutritional practices and believes in their effect on the body, it is more likely that their children will be nourished from a young age.

Bread for the World (2011) explained that one of the most popular reasons for abandoning exclusive breastfeeding in the first 6 months of life in rural areas of Africa is mothers returning to farming work (Bread for the World, 2011). However, the SUN framework for action explains that mothers should be able to work and breastfeed without difficulty if they plan ahead of time (UNICEF, 2008). This requires a lot of planning and sacrifice, but working and breastfeeding is possible if the mother prioritizes it and has appropriate supports. If a mother is educated on how to breastfeed and for what duration, SAM rates in children under 5 would decrease (Kramer & Kakuma, 2002).

Knowing a mother's education level can help determine the risk for a child's SAM diagnosis. OyeKale (2009) studied malnutrition determinants for Gambia and Niger using the 2000 End-Decade Multiple Indicator Cluster Survey by the United Nations International Children Emergency Funds (UNICEF) for Gambia and Niger (Oyekale, 2009). It was found that

a child's rate of malnutrition drastically decreased when a mother was alive and stayed at home to take care of them for the first 5 years of life (Oyekale, 2009). Gambia and Niger are in the Sahel region of Africa, with many cultural and geographic similarities to Senegal. Therefore the results in the study should be examined within Senegal as it is possible the determinants are present within Senegal as well. The same correlation with SAM was found with mother's education level by Fuchs et al. In this case it leaves the question, is it important for a mother to be educated instead of being home, or is there a critical period of the child's development that a mother must be at home to avoid malnutrition in her children?

Dereje (2014) studied the determinants of SAM in children in Ethiopia (Dereje, 2014). The research conducted anthropometric measurements and face to face interviews with 108 children diagnosed with SAM and 108 children not diagnosed with SAM. The study linked SAM in Ethiopia to sub-optimal frequency of complimentary breast-feeding and maternal illiteracy. The study recommends that to reduce childhood malnutrition due emphasis should be given in empowering women and improving the knowledge and practice appropriate infant and young child caring practices (Dereje, 2014).

You can look at the education systems in close proximity to children as a risk factor for SAM. Primary secular education is free in Senegal up until the age of 16 (Foreign Credits, 2014). Yet, at the end of 6 years, students must take a common examination to see if they can continue being educated. If they fail, they must find another school, which costs money (Foreign Credits, 2014). This education system and success rate of schools reflects the economic situation of that area. According to the Education Database through Foreign Credits (2014), if a school has a low drop-out rate, they are most likely in an economically sound area. If the school has a high rate of drop-out, especially at young ages, it is located in a lower socioeconomic area, suggesting that

the children may be at high risk for SAM. Children in these areas may have to drop out to help the family make money or to help around the house. Secondary education is a time of haves and have-nots, and even though the largest target population for SAM is younger than secondary school (ages 12-16), this system can show a lot about the surrounding area. After two years of secondary education, children may be asked to leave by the school if they are not making competitive grades or do not have appropriate funds to pay. Only a select few in the top of their class are asked to move on and educated for free. Many girls never make it this far and this further contributes to the gender inequality. If a child lives in an area with education ending at a young age, they are more likely to be in an unhealthy area. (Foreign Credits, 2014).

2. Access to healthcare/ Geographic Location

Lack of access to healthcare negatively affects the number of children receiving treatment for SAM. Many of the government health services available in Senegal lack the appropriate resources for treating nutritional needs (Marek, Diallo, Ndiaye & Rakotosalama, 1999). These resources include healthcare workers, therapeutic foods, antibiotics, scales, tape measures, blood pressure cuffs, needles, and other things to operate a medical facility on a regular basis (World Food Program, n.d.). If a facility lacks the resources it needs to treat a patient, then SAM diagnosis and treatment is negatively affected.

Most doctors in Senegal get trained in the capital, Dakar (Heyen-Perschon & USAID, n.d.). Yet, the rural regions of Senegal, specifically the eastern and southern regions are the ones needing immediate nutritional attention as their rates of SAM are the highest in the country. The regions also in conflict such as in Casamance (Kolda, Sedhiou and Ziguinchor regions), as well

as in the Kedougou and Matam regions are in dire need of assistance (World Food Program, n.d.). All specialties of doctors are lacking across the country.

There are three levels to the national healthcare system in Senegal. This includes regional hospitals, district health centers, and health posts (Heyen-Perschon & USAID, n.d.). In addition to that, there are two university health clinics and a small number of private health clinics (Heyen-Perschon & USAID, n.d.). About 12% of the national budget is spent on healthcare, and the system is decentralized (Our Africa, n.d.). World Bank (2014) explains the stages of the decentralization of health management in Senegal. The first stage was the creation of municipalities and regional development committees including municipal and rural councils. The second aimed at increasing the local government's responsibilities in the management of local affairs beginning in 1990. The third and most recent phase, beginning in 1996, was the adoption of legislative reforms and the modification of the Code of Local Governments, including the creation of the FDD (Fund for the Endowment of the Decentralization) to ensure the transfer of financial resources to support the transfer of competencies (The World Bank Group, 2014).

Decentralization has allowed the country to empower the local governing entities, transfer responsibility for the local health system to the locally elected authorities, transfer management of the district health budget to the mayors, and transfer responsibilities and management of health posts to the rural community's councils (Diallo & Sorgho, 2001). It also has positive effects increased decision-making power and autonomy and creating enthusiasm and improved communication (Diallo & Sorgho, 2001). The process has been looked upon positively by the World Bank, and the decentralization has given the communities in Senegal perceived control over their own situations.

Generally, individual districts are responsible for organizing the services in healthcare with funds coming from the government, and a generous portion of funds from international agencies. More than 50 donor countries and agencies are active in Senegal, with most bilateral and multilateral development agencies having an active presence in Senegal. The World Bank, the European Union, France, and the United States are the largest contributors (World Bank, 2010). The unfortunate truth is that this aid is not lacking in the healthcare realm, as 1 in every 11 children die in Senegal in today's time from childhood diseases including SAM (The World Bank Group, 2014). As outside aid is not a direct correlate to the healthcare system as a whole, changes must be made at various levels of the system in order to change this high child mortality rate.

Across the globe, in both developed and developing areas, it is difficult to get gynecologists and obstetricians to stray from their family ties in the city and move out to the rural areas. Yet if women in these areas do not receive this care, pre-natal and post-natal care is negatively affected; their children's lives may result in health complications. Addisse (2003) expresses concern for mothers who do not seek the counsel of trained professionals in Ethiopia, because the risk of child morbidity and mortality increases with less doctor interaction (Addisse, 2003). This must be examined in Senegal where mid-wives handle the majority of births. WHO (2011) reports the importance of midwives in saving the lives of newborns and mothers in low income countries (WHO, 2011).

To meet the demand for rural healthcare facilities there have been several health huts built to treat people in remote regions of Senegal (Mane, 2012). Statistics show that there is one hospital for 545, 800 people in Senegal and the World Health Organization wants about one hospital for every 150,000 people maximum (Heyen-Perschon & USAID, n.d.). The rates are

slightly better since 2002, but there has not been drastic development to improve these ratios. There is about one health center for 175,000 people, where WHO recommends one per every 5000 people, and there is one health post per every 11,500 citizens, even though the WHO recommendation is one per every 1000 people (Heyen-Perschon & USAID, n.d.). With these drastic differences in the ratio of citizen per facility, the Senegalese lack needed healthcare buildings and doctors. Statistics from 2008 suggest that there are 0.6 physicians for every 1000 people in Senegal (Index Mundi, n.d.). This number must change to improve the quality of care including SAM management and treatment.

This lack of infrastructure and resources fosters a disbelief in the effectiveness of the health care system within members of the community. If the citizens do not believe in the system, waiting hours upon hours to even see a physician, they will only go to the clinic in dire need (Heyen-Perschon & USAID, n.d.). In January 2014, Senegalese health insurance was analyzed. Enrollment in programs was minimal, and people reported a lack of trust in the insurance plan (Mladovskya, Soors, Ndiaye & Criel, 2014). Analysis of certain regions in the country showed that people ignored the program due to distrust in the system, and expressed interest in the insurance plan only if they received other benefits (Mladovskya, Soors, Ndiaye & Criel, 2014). Citizens know that the clinic is needed but the system in place at this moment needs drastic improvements.

According to the CDC (2014), your geographic location is one of the strongest determinants of disease prevalence. Many of the main clinics and healthcare facilities are located in Dakar, where the doctors and health worker training is located (Mane, 2012). Therefore, living closer to cities increases a child's chance at surviving malnutrition and decreases their chance of ever getting in that situation in the first place.

A child's SAM diagnosis and treatment may be affected by the location of a family's house in relation to health and educational facilities. For example, if a home is close to a clinic and food market, then the child will have access to healthcare and nutrition without needing transportation. If the house is close to a school, the children are more likely to be educated. Heckert (2013) explains with a higher education level comes a lower SAM prevalence (Heckert, 2013). If the house is close to a source of water, fish may be abundant and a very cheap source of nutrients; furthermore, the child will have access to a source of water, even though it may not be sanitary. According to Water and Sanitation Program (2015), access to sanitary water decreases the likelihood of SAM. In this context, a child may be less likely to suffer SAM if their home has access to clean water, food, and schooling. If the house is closer to the desert in the north, the community may be isolated and the children may be far from any source of food or healthcare. Rural areas must rely on only a few food sources and clinics, as most of the larger market places and healthcare centers are located in the cities like Dakar (The World Bank Group, n.d.).

One, an organization dedicated to eradicating hunger in Sub-Saharan Africa, outlines that farming is one of the ways to address SAM; however, in areas where farming is failing, SAM is prevalent and needs to be addressed in another way (World Bank, 2010). The location of a home may give important information about the health status of the children residing in that home. Living conditions affect health through environmental factors on physical health and emotional health. Weather and climate can affect a person's physical well-being while the culture of an area can affect a person's psychological health. This means that a child's home will affect his/her health. Living alone and being isolated put people at risk for malnutrition (NHS Choices, 2015). In the case of Senegal, this is not a huge problem. Families, even extended families, tend to live under one roof. Nevertheless, children can feel isolated due to social situations. If a child feels

like they are abandoned or alone, they are more at risk for becoming malnourished (NHS Choices, 2015).

One subset of children that becomes apparent when dealing with isolation or abandonment issues are orphans and foster children. About 100,000 estimated children in Senegal are given up by their parents and forced to roam the streets begging for food (NHS Choices, 2015). About 35% of children in the country between 7-17 years of age are working, yet there are thousands more children living in orphanages. Approximately 520,000 children in Senegal are orphaned by both parents (SOS Children's Villages International, n.d.). Many times this happens because the parents cannot afford to feed or educate the child. Birth control and contraceptives are not readily available in Senegal and are not commonly used. Both religion and cultural norms teach that contraceptives are against the norm, many times resulting in large families. Many times parents do not have the means to take care of so many children, so boys are sent to these orphanages to be taken care of. In some situations, children return to their parents when they get a little older and their family is able to gain more income. Additionally, about 50,000 boys in Senegal are enrolled in Quaranic schools by their parents. These schools send these boys out begging on the streets; these boys are known as "talibes" (SOS Children's Villages International, n.d.). Children in these situations are very likely to become malnourished, and in many cases they may not survive past 5. In summary, housing and family situations are extremely influential when it comes to children's health and development.

Section 5: Macrosystem

1. Economics

Economic growth is associated with the reduction of malnutrition, yet nutrition is one of the main factors in human capital (Linnemayr & Alderman, 2008). When an economy is stimulated, the poverty rate decreases, and the rate of SAM decreases. When people have money to spend, food becomes a priority. Poverty and SAM diagnosis are directly related. In this section, the economy surrounding a child's community and family are addressed as determinants for SAM. But to understand the smaller economy fully, an overview of the national and global economy is needed first. Elia (2009) discusses how international studies estimate that that prevalence of malnutrition is associated with increased hospital bills, hospital stays, and frequency of hospital admissions. If the economy can be stimulated as a whole, and a need for SAM-related funds is addressed, then SAM rates will decrease.

The World Bank reports the GDP and GDP growth of every country in the world. In 2013, Senegal was reported as having a GDP of about \$14.7 billion and a growth rate of 2.8% (The World Bank, 2015). The GDP growth should remain between 2-4% for a country to be successful, meaning from 2012-2013 Senegal's increase was in fact a healthy economic growth, but not quite where it should be compared to other African nations (Barnes, 2003). According to data since 2006, the growth rate has averaged about 3.3% for Senegal and 6% for other Sub-Saharan African nations. The slow rate of growth can be attributed to poor harvests and a lack of production in mining and industry. For the purpose of comparison, in 2013 the US had a GDP of about \$16.7 trillion and a growth rate of 2.2%. This drastic difference in GDP from the US to Senegal shows that Senegal's overall economic health is poorer than that of the United States.

Of all the Sub-Saharan countries, Senegal ranks lower on the GDP scale, with the average GDP growth around 4.4% (The World Bank, 2015). To address health issues, the country must become more economically stable. The predictions for 2014 by the World Bank hope that economic performance will improve with a growth rate of 4.5% due to a boost in the secondary sector of the economy and an improved business climate. However the low rainfall this past year as well as the Ebola crisis in surrounding countries could reduce predicted gains and growths in the near future (The World Bank, 2015).

The 2015 Index of Economic Freedom (2015) ranked Senegal's economy to that of other Sub-Saharan Africa nations. Senegal's economic freedom is ranked 16th of the 46 countries in Sub-Saharan Africa, meaning that it has a slightly more authoritative economy than other nations in the same geographic region. However, only seven Sub-Saharan African nations have economic freedom scores above or equal to the world average. Even though this number is not ideal, Senegal has increased its economic freedom score since last year as improvements in freedom from corruption, business freedom and fiscal freedom outweigh declines in labor freedoms and management of government spending. The poor regulatory environment and weak law in Senegal prevent economic freedom. If SAM is to be addressed, the economy needs freedom to choose how to spend its funds and what interventions to focus on financially. The country must see the importance in this health issue and allocate funds to improve health. ("2015 Index of Economic Freedom," 2015).

The Cost of Hunger in Africa (2014) outlines the economic and social implications of ignoring childhood nutrition issues. The research has discovered that undernourishment of children generates healthcare costs between 1-11% of total government health budget allocation. These costs are directly associated with the severity of the illness that affect underweight

children, as well as any procedures they may need to undergo as a result of their diagnosis. Unfortunately, the study found that 69-81% of children who are undernourished do not seek appropriate treatment in healthcare facilities, which puts them at risk for further complications. Eliminating the inequalities in access to healthcare is an essential step at addressing SAM, which also means addressing the rural/urban gap in healthcare coverage. If these inequalities are prioritized economically, undernourished children may be able to seek the medical attention they need and the prevalence rate may decrease. (CARMMA, 2014).

According to the World Bank (2006), the returns to investing in malnutrition are high. Community-based programs focused on children under the age of two are seen as economically and physically successful in preventing under nutrition (The World Bank, 2006). The Copenhagen Consensus rates potential development investments and lists which ones show the greatest economic returns. On this list, malnutrition ranks among the top three important investments in affecting micronutrient deficiencies, but among the top 11 in improving child and infant malnutrition (The World Bank, 2006). Both of these statistics show that the economy would benefit by giving more funds and attention to childhood malnutrition.

Not addressing SAM through economics is affecting the Millennium Development Goals, displayed at <https://hopesforwomen.files.wordpress.com/2012/11/millennium-development-goals.gif?w=525>, for eliminating hunger, as well as other goals that could be overcome if hunger was addressed (The World Bank, 2006).

If a child is malnourished, they are less likely to succeed in school, the second MDG. Addressing malnutrition will also empower women, as they tend to have less access to food and be the caretakers of their severely malnourished children. This will help address the third MDG of promoting gender equality. Malnutrition is related to childhood death and if eliminated will

reduce child mortality, thereby achieving the fourth MDG. With addressing the first MDG of eliminating hunger, the globe can also address almost all of the other MDGs. It is impossible to ignore the vast benefits for overall quality of life by economically addressing malnutrition on a global scale (UN, 2015). Senegal is struggling to be on track to meet each of these MDGs by 2015 as planned.

If SAM was addressed on an economic basis, other types of malnutrition may be able to benefit such as moderate acute malnutrition and chronic and acute malnutrition. The treatment for SAM and other types of malnutrition is similar in that raising money for SAM interventions will help address moderate malnutrition and maybe even some types of stunting. According to research conducted by the African Economic Outlook (2015), Senegal's GDP is increasing slightly since 2012. In 2013, the GDP increased from 3.4% growth in 2012 to 4% growth in 2013 (Gassama, Houeninvo & Traoré, 2014).

Unite for Sight (2015) explains the social determinants associated with malnutrition with a main focus on economics. Low socioeconomic status is associated with nutritional deficiencies, but handing money to the people of Senegal would not solve the problem for the long term. The issue must be addressed on a local and familial level as well. This means that families who struggle to pay for their medications, get to the doctor, or put food on the table need a voice in the development of the intervention. Those individual families and communities need to feel like they can manage and allocate the resources in an appropriate and financially logical arena. (Unite for Sight, 2015).

Section 6: Chronosystem

1. Time

The last level of analysis in Bronfenbrenner's Ecological Systems Theory's is the chronosystem, in which time influences all previous levels discussed. The age of the child affected by SAM, the length and extent of the disease, the average life span of children affected by SAM, and the meaning of time for that family all fall under the chronosystem. Time influences SAM at many levels and is a factor that needs to be understood to address malnutrition.

If a child is younger than 5, their disease prevalence differs from a child older than five. The younger you are, the more likely you are to suffer SAM. If an infant under 6 months is affected by SAM and can be breastfed for all their nutrients, WHO (2013) recommends that child is breastfed (WHO, 2013). A child aged 6 to 59 months is nine times as likely to die as a healthy child if diagnosed with SAM through low weight to height ratio, a visible identification of severe wasting, or acknowledgment of swollen feet from tissue retention of water (Mana, 2013). The age of the child can determine the severity of their nutritional condition and also their treatment.

The amount of time a child is malnourished determines the effect on their overall health in the long term. The longer a child is malnourished the more likely they are to be affected by infections (Jones & Berkley, 2014). Jones and Berkley (2014) discussed antimicrobials, antipyretics, tuberculosis, HIV, malaria, pneumonia, diarrhea, sepsis, measles, urinary tract infection, nosocomial Infections, soil transmitted helminths, skin infections and pharmacology in the context of SAM. This study explained that the longer a child is severely malnourished, the more likely it is that they contract an infection and must be treated for more than just severe

hunger and wasting. A child is more likely to die if they contract an infection while being malnourished. These infections are why many children do not survive past 5 years old when they also suffer SAM.

Chapter 4: Current Interventions, Discussion and Conclusions

Current intervention protocols: How SAM is being addressed

Malnutrition in Senegal is a major health problem the country faces on a daily basis, and organizations both internal and external are addressing the problem. One of the major agencies helping to combat malnutrition is UNICEF. UNICEF is the sole provider of RUTF and therapeutic milk to the Senegalese health system. RUTF is a therapeutic food supplement pack of peanut paste that contains all the essential nutrients a child needs to be healthy. UNICEF also provides training, anthropometric tools, and nutritional medicines to all fourteen regions of Senegal for the functionality of nutritional units (Senegal, 2013). UNICEF works closely with other agencies to collaborate on interventions and fund their many efforts.

The Red Cross has also helped the effort by covering the cost of transportation and food for the time that SAM children are in the hospital receiving treatment. UNICEF's main goal originally was to help those in need by addressing the health situation first. However, this only yielded results in the short term. They have begun to focus on a longer-term solution, but they have only focused on health care access, availability and political adjustments. While making a large impact on the problem, they have failed to decrease the prevalence of SAM in Senegal. Interventions at this time are mostly focused on short-term solutions as SAM patients need nutritional food packs and antibiotics to survive. Sustainable interventions need to address the social and structural factors surrounding SAM in order to assist future generations at risk of developing SAM.

The European Commission Health Organization (ECHO) has funded provisions of food assistance and supplies for nutrition care including easy-to-use therapeutic foods. They have focused their funding efforts towards specific regions of Senegal needing immediate attention- (Diourbel, Tambacounda, and close to the Mauritanian border in Matam), due to continually having the highest rates of SAM in the country. The ECHO has been much less hands on compared to UNICEF, but continues to give a lot of money to the country in support of interventions for malnutrition. They have given in-kind donations and cash transfers to vulnerable families in high-risk area. As described in the literature, ECHO funds a program aimed at adopting a Household Economy Approach to better understand vulnerability to food insecurity, and also to inform the humanitarian response in Senegal. ECHO has taken a household based approach in which the money is allocated to individual families in need. This approach fails to address the problem at a community level, and instead focuses on the individuals in the poorest segments of the populations who fail to feed themselves (European Commission, n.d.)

Other than UNICEF, the Ministry of Health and the ECHO, the United Nations (UN) and United States have gotten involved in addressing malnutrition in Senegal. The UN through the office of agriculture and food, as well as through the children's fund, has assessed the issue and continues to monitor the problem looking for financial support from westernized countries. The US is one of the countries that continually gives aid to Senegal, whether they control how that money is spent or not, even though many times the USAID has a lot of control over how the money is spent. The United States has only given 32% of the requested \$52 million to combat the nutritional crisis. From the money received, 70% has gone towards nutrition and refugee issues due to the Mali conflict, and only 12% has gone towards agriculture (United, 2013).

Going back in history, other interventions have been successful in addressing SAM in Senegal. Understanding what worked in these interventions will help future efforts attain success. In 1996, the Community Nutrition Project (CNP) was launched in the poor, peri-urban areas of Senegal. This focused only on urban areas building community nutrition centers in rented buildings all over the country. These centers provide monthly growth monitoring for children, weekly nutrition and health education sessions, referral to health services for unvaccinated or severely malnourished children, home visits to follow up, and food supplements to malnourished children. In places where the centers were located, malnutrition rates have decreased. The major problem with this was that it only addressed urban areas and rural populations were still suffering and it is very expensive. About 4% of the cost was contributed from the community, 5% from the government, and the remaining relied on donors. This dependence on outside funds brings to question the sustainability of the intervention (Marek, Diallo, Ndiaye & Rakotosalama, 1999).

Since the solution cannot become fully operational without outside donations, when those donations stop so does the solution. Nevertheless, the community nutrition centers (CNC) have increased from 23 in 3 cities to 176 in 14 cities. The project received results in providing preventative nutrition services through the private sector and without the need for healthcare professionals, but it was not as successful in helping cure those already suffering from SAM. This intervention was able to show that people can be positively and significantly impacted without healthcare professionals (Marek, Diallo, Ndiaye & Rakotosalama, 1999).

Another intervention that showed some success was the 1994 Projet de Nutrition Communautaire (PNC). Through the PNC \$28 million was donated from the World Bank, World Food Programme, and German Kreditanstalt fur Wiederaufbau. There was also \$1.6 million

donated from the United States. PNC was managed by Public Works and Employment Agency (AGETIP), an autonomous semi-private agency attached to the Senegalese government (Pickstock, n.d.). The program was able to show some improvements in rates of malnutrition. It directed a lot of money at easy-to-use therapeutic foods and health needs, positively affecting the acute problem but without producing a sustainable solution. Overall, most of the interventions in place over the years have addressed those suffering malnutrition in the present as well as attempting to address those in danger, yet a sustainable and successful solution has yet to be discovered.

Even though other interventions have been put in place, both the World Health Organization and UNICEF remain the dominant forces attempting to combat SAM in children worldwide. The WHO is the coordinating authority for health within the United Nations system. The organization is based in Geneva, but they have offices in most countries. They provide leadership on critical health matters around the globe, partner up with other organizations when necessary, organize the research agenda with collaboration of leaders, set standards and monitor implementation, and they monitor and assess the health situation in areas worldwide while developing trends in disease (World Health Organization, n.d.).

UNICEF works closely with WHO on effort's for worldwide child health. UNICEF's mission is to protect children's rights and help them meet their basic needs. The United Nations General Assembly mandates that UNICEF help children reach their full potential through advocating on their behalf. (UNICEF, n.d.). They have their headquarters in New York City, but they work on projects worldwide to help attain human development goals (UNICEF, n.d.). Both WHO and UNICEF have protocols that they have collaborated on together and others that they

push individually. They both focus on immediate treatment for suffering patients and how to maintain nutritional health on a lifelong basis.

Conclusions

SAM continues to cause fatalities in children in Senegal and across the world. A disease traditionally dealt with in purely physical treatment has an array of determinants associated with it. This thesis has compiled and explored the most dominant determinants across each level of Bronfenbrenner's analysis. Understanding the impact these factors have on pediatric SAM will lead future interventions in Senegal. The interconnectivity of the determinants discussed in this analysis speaks to the biopsychosocial model of health in today's world. Knowing that all aspects of an individual's life affects overall health and quality of life is a concept essential to the development of sustainable solutions.

Chapter 3 discusses the microsystem of Bronfenbrenner's ecological model; focusing on how direct factors to the child interact with one another. A child's SES, gender, and ethnicity speak to their genetic make-up as well as their risk of developing SAM. Furthermore, these individual identifications can affect daily activity. A doctor's opinion, funding opportunities, skill-set, and availability deeply affect a patient's diagnosis and treatment as discussed in detail in the microsystem. Nutrition packs and antibiotic treatments recommended for SAM patients are essential to their survival with the disease. However, knowing how other individual factors influence the social determinant is quintessential to their sustainable health.

In the mesosystem analysis, a patient's broader context was determined extremely influential on long-term treatment and nutritional habits. The Muslim religion has specific

practices differentiating it from other practiced religions around the world. These unique characteristics of the belief system will affect a person's daily activities and reactions. The practice of polygamy accepted by the Muslim religion also affects mother's and children's health. This partially indirect relationship shows how SAM prevalence and incidence may be slightly affected by a family's religious and cultural practices. Changing the culture may not be necessary, but understanding how the practices impact pediatric health is important to consider when developing an intervention for eradication of malnutrition. Furthermore, women's inequality in Senegal both directly and indirectly affects SAM in children through social and political mechanisms. On a familial and community basis, women's empowerment can begin to lessen the SAM burden. Nevertheless, political change must continue to empower women towards equality in order to make a drastic impact on annual SAM prevalence.

The exosystem level of analysis takes a step further back discussing education and access to healthcare within the community and country as a whole. Nutritional education of both children and mothers is important to consider when dealing with a nutritional disease. Education access is also a factor affecting disease prevalence, and reflects the SES of the area. Rural regions of Senegal still have trouble accessing healthcare when they need it, and therefore have higher prevalence of SAM. Creating easier access to healthcare facilities is something that needs to be addressed in hope of treating all SAM patients in the country.

Taking another step back, the macrosystem level of analysis speaks to the country-wide issues surrounding economics. Even though most would like to believe money is not absolutely necessary for health, the unfortunate truth is that money is needed for treatment and prevention of nutritional issues. Someone has to front the bill for consultations, medications, doctor bills, facilities, necessary equipment, and nutrition packs. Whether this funding comes from within or

outside is dependent upon the intervention, but the economic situation of a country and of a specific community has an immense impact on rates of mortality, prevalence of SAM and treatment of the disease. Since Senegal's economy is struggling, and the average income is quite low, it affects all aspects of a child's life. It affects what they eat, how often they eat, where and if they go to school, their healthcare, and furthermore their quality of life.

The chronosystem of Bronfenbrenner's analysis uses time as the final determinant. Time is essential when considering the course of a disease. SAM patients need to know the average lifespan, when to get meds, how long the treatment takes, and so much more. Time is the factor overarching all determinants. Once factors are determined, time gives a scope of understanding. It ties all the factors together, prioritizing short-term over long-term. Knowing that a person needs antibiotics to survive in the short-term will help address the health issue now in order to focus on broader, sustainable solutions later. The famine of 2012 affecting the northern part of Senegal, combined with the Mali conflict, negatively affected Senegal. Since 2012, malnutrition has become a larger problem within the rural areas of the country. Developments within Senegal still need to be made in hopes of creating a sustainable solution. Malnutrition is not only caused by physical symptoms, but also by social barriers. The interventions that have attempted to address the problem have focused on those children currently affected and have failed to create a lasting solution. These interventions have also failed to address all of the determinants of nutritional deficiencies. Malnutrition can only be eradicated when all of the determinants of the problem have been addressed. This analysis takes into account cultural perspective and recent literature; however, it does not have extensive information on Senegal specifically. To strengthen the analysis, a full scientific research study must be conducted. This would include collecting both quantitative and qualitative research in the field. Once the information is collected, the

interventions in place today must be analyzed as well. To come up with the most successful intervention, the interventions in place must be improved upon taking into consideration the social determinants surrounding the medical situation. This thesis begins to uncover the SAM problem in Senegal today, but follow-up on-site analysis is needed in order to understand the determinants more fully.

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- World Health Organization. (2011). Updates on Management of Severe Acute Malnutrition in infants and children. World Health Organization Protocols.

ACADEMIC VITA

Katherine W. Dempster

EDUCATION

Pennsylvania State University, University Park, Pa. Expected 5/2015
Schreyer Honors College –College of Health and Human Development
B.S. in Biobehavioral Health/ Minor: Global Health
Thesis Topic: Malnutrition in Senegal, Africa to be presented May 2015
Global Health Fieldwork M’Bour, Senegal Summer 2014
Led by *Dr. Rhonda BeLue, Ph.D.*, Associate Professor Penn State University
Pantheon Institute, summer program in Rome, Italy 2012
Central Bucks High School East: Summa cum Laude 2011

WORK EXPERIENCE

Pennsylvania State University, University Park, Pa.
Head Lifeguard 9/2012-Present
Manage and oversee the lifeguard team as well as correspond with administration. Guarding an average of 15 hours per week during school year and 30 hours per week in the summer of 2013. Trained in CPR, AED, First-Aid, and Oxygen; all certifications are up to date.
Research Assistant in Biobehavioral Health
Senegal Project with *Dr. Rhonda BeLue, Ph.D.* 7/2014-Present
Filed IRB certification, created curriculum for students and website for non-profit, and helped organize community health outreach programs focused on diabetes

Family and Child Health Project with *Dr. Lori Francis Ph.D.* 11/2012-10/2013
Substantial qualitative research experience, led project dealing with nutritional education in after school programs.
WISER Research Assistant in Bio/Industrial Engineering with Dr. Andris Frievalds, Ph.D. 1/2012- 12/2012
Funded by NASA, substantial quantitative research experience, actively contribute and gather data for several research projects, focusing on studies revolving around obesity, and redesigning tools for impaired women gardeners.
Holy Redeemer Health System, Meadowbrook, Pa. Summer Internships
Intern
2010/2013/2014

- Observed *Dr. Beth Dupree M.D./F.A.C.S.* and was exposed to various health fields: integrative medicine, breast cancer center, and Healing Consciousness Foundation
- Assisted in the NICU, observed and aided Neonatologists and Nurses.
- Shadowed various doctors for over 40 hrs including pediatricians, emergency room doctors, and a breast surgeon. Observed procedures and patient interaction for H.S. Senior project.

Fanny Chapman Memorial Swimming Pools, Doylestown, PA
Manager/Assistant Director/Lifeguard/ Swim Instructor 6/2007 – 7/2012

- Progressive promotions culminating in being named Manager of over 60 lifeguards and Assistant Director of swim program handling over 400 children. Organized and introduced a pre-team swim program which allowed 40 additional swim team members to participate.

COMMUNITY LEADERSHIP

Pennsylvania State University, University Park, Pa.

Penn State Dance Marathon-THON

Captain Special Events: Family Carnival Coordinator: 9/2014-Present

- Organized Family Carnival for over 200 children and families affected by pediatric cancer.

Captain Family Relations: General and Special Interest Organization Liaison: 9/2013-Present

- Facilitated communications and timeline between organizations involved in THON and THON captains. Liaison for 15 families affected directly by pediatric cancer.

Fundraising Chair Morale Committee 9/2012-9/2013

Mid-County Literacy Counsel 9/2013-12/2013

Tutor English as a Second Language

- Taught a class of 30 students seeking to hone their pronunciation and conversation skills using English in their daily lives. Class met for 6 hours a week.

LifeLink PSU 9/2013-12/2013

Tutor

- Student aid/tutor for a special needs student assisting with homework and life skills for about 6 hours weekly.

Ronald McDonald House Charities August 2013/ 2014

Counselor

- Camp Counselor at Timber Tops in the Poconos one week every August volunteering as a sleep-away camp counselor/coordinator for young children diagnosed and affected by pediatric cancer.

Global Medical Brigades Winter 2012

Medical Aid Volunteer

- Traveled to Ghana, Africa over winter break to aid the Efracful community, setting up medical tents, diagnosing the patients, and distributing the appropriate medicines.

COMMUNITY AFFILIATIONS

Pennsylvania State University, University Park, Pa.

Active Club Participant September 2011 - Present

- Biobehavioral Health Society Member/ Atlas THON Organization Member/ Global Medical Brigades Brigadier/ Morale THON committee Fundraising Chair (2012-2013)

Central Bucks East High School

Varsity Swim Team Member 10/ 2008 – 4/2011

- Four year Varsity Letter winner, *Captain* Senior year, *MVP* Freshman and Junior year, District Qualifier all four years, Coaches Award Senior year for most contribution and dedication to the team.

Certifications

- Completed online training of Nutrition Environment Measures Survey, NEMS, Jan 2013.
- Certified in health research with human subjects, CITI training, Feb 2012.