UNDERSTANDING THE RELATIONSHIP BETWEEN KEY CLINICAL VARIABLES OF CHILDHOOD MALNUTRITION AND TIME-TO-RECOVERY IN GUATEMALA

by

Morgan E. Braxton

May 2022

Director of Dissertation: Dr. Kim Larson, RN, PhD, MPH, FNAP

Major Department: Nursing Science

ABSTRACT

Guatemala has the highest rates of malnutrition in Latin America, and with the onset of the COVID-19 pandemic, the number of Guatemalans experiencing food insecurity doubled. The purpose of the study was to understand malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic. A retrospective record review of children admitted to the center was conducted, examining cases pre-and post- onset of COVID-19 and guided by the Social Ecological Model. There were few significant differences between pre- and post- COVID cohorts and no difference in time-to-recovery. Mean time-to-recovery was 39.57 days among recovered cases (n=149). Weight gain was significantly higher in the post-COVID cohort. Amoxicillin was the only significant predictor variable; with those receiving it being more likely to not recovery in ≤6 weeks. The lack of differences between COVID cohorts was possibly attributed to low admission rates post-COVID. It would be beneficial for the NRC to conduct a family needs assessment, to identify sociocultural factors that may serve as potential barriers to families as they navigate and maintain nutritional recovery. Further research is needed to more fully understand the complexities COVID-19 has had on childhood SAM outcomes.

UNDERSTANDING THE RELATIONSHIP BETWEEN KEY CLINICAL VARIABLES OF CHILDHOOD MALNUTRITION AND TIME-TO-RECOVERY IN GUATEMALA

A Dissertation

Presented to the Faculty of the Department of Nursing

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Doctor of Philosophy in Nursing

by

Morgan E. Braxton

May 2022

UNDERSTANDING THE RELATIONSHIP BETWEEN KEY CLINICAL VARIABLES OF CHILDHOOD MALNUTRITION AND TIME-TO-RECOVERY IN GUATEMALA

By

Morgan E. Braxton

APPROVED BY:

Director of Dissertation _____
Kim L. Larson RN, PhD, MPH, FNAP

Committee Member _____
Nancy Dias, PhD, RN, CNE

Committee Member _____
Carlos R. Melendez, PhD, MPH, MS

Committee Member _____
Lauren R. Sastre, PhD, RDN, LDN

Chair of the Department of Nursing Science _____
Pamela Reis, PhD, CNM, NNP-BC, FACNM

Dean of the Graduate School _____
Paul J. Gemperline, PhD

DEDICATION

I would like to dedicate this work to my husband, Nic Braxton. I am so thankful for all his love and support through every peak and valley of this process. He kept me laughing, encouraged me to have balance, and always reminded me of what is most important in life. He is truly my best friend; I could not have asked for a better person to go through life with. I will look back on the years I was in school as some of my best, and that is because he made every day sweeter and more fun.

ACKNOWLEDGEMENTS

I would like to sincerely thank my parents, Ted and Debi, for supporting me in my career to become a nurse, encouraging my love of travel and service to others, and most importantly for demonstrating what it looks like to serve the Lord in your daily life.

I also want to acknowledge my sister, Megan, who has always cheered me on and believed in me. It is a gift to have her as a lifelong friend and role model.

I would like to thank my in-laws, Kristen and Dallas, they have been such a kind support to me over the years and treated me like their own daughter. Being a part of their family is such a blessing to me.

I want to acknowledge all of my dissertation committee members: Drs. Nancy Dias, Carlos Melendez, and Lauren Sastre. Their time and feedback to help me grow as a scientist is so valued.

A special thanks to my chair and mentor, Dr. Kim Larson. Over the last eight years, she has helped me to grow into the nurse and scientist I am today; her love of students, service, and science is truly remarkable.

This work is a testament to God's goodness to me; I am undeserving of such grace.

Whatever you do, work at it with all your heart, as working for the Lord, not for human masters, since you know that you will receive an inheritance from the Lord as a reward. It is the Lord Christ you are serving. Col. 3: 23-24

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

Introduction

Severe Acute Malnutrition (SAM) is a preventable disease that affects 16 million children worldwide (UNICEF, 2021), and as a result of childhood malnutrition, 149 million children experience growth stunting (WHO, 2021a). This preventable disease can negatively impact both physical and cognitive development, and for many infants can be fatal. It is estimated that 400,000 deaths per year are attributed to SAM (WHO, 2019); with a disproportionate number of children affected from low- and middle-income countries (LMIC) (UNICEF, 2021). Guatemala, a low-income country, has the highest rate of childhood malnutrition in Latin America, and fifth highest worldwide (USAID, 2021); timely investigation of this phenomenon is critical.

In Spring 2020, the World Health Organization (WHO) announced a global pandemic of the novel SARS-CoV2 virus (WHO, 2020). The pandemic disproportionately impacted LMICs, as lockdowns and food shortages left vulnerable families unable to afford necessities; additionally, in low-income areas maintaining social distance was often impossible and adequate personal protective equipment was unavailable (Kabir et al., 2020; Zar et al., 2020). Since the onset of the pandemic, the number of Guatemalans experiencing food insecurity has doubled, and an estimated 1.2 million Guatemalans were in need of emergency food-aid (Action Against Hunger, 2020). The United Nations Children's Fund (UNICEF) predicts that childhood malnutrition will rise, as the COVID-19 pandemic has negatively affected families of low socioeconomic status (UNICEF, 2021). Many Guatemalans have faced loss of jobs and food insecurity from the closure of public transportation systems and open food markets (People for Guatemala, 2020). With limited access to vaccinations, Guatemalans continue to be negatively impacted by the COVID-19 pandemic (Welsh, 2021). As of February 2022, Guatemala had the

lowest percentage of fully vaccinated citizens in Central America at 32%, compared to 61% in the Mexico and 65% in El Salvador (Johns Hopkins University, 2022). In a recent study, investigators found that the pandemic negatively impacted income, food security, and diet patterns among Guatemalan families (Ceballos et al., 2021). Young children from LMICs are most at risk for life-long complications from malnutrition in the midst of the COVID-19 pandemic; there is an urgent need for provision of services and policy development among national stakeholders to improve child health during this pivotal time (Akseer et el., 2020; Fore et al., 2021; Ntambara & Chu, 2021; Saha & Chouhan, 2021). Overall, the onset of the pandemic threatens longstanding consequences to undernourished children, particularly those who are marginalized, and has the potential to undo previous widespread efforts to improve global nutrition (Saccone, 2021; Victora et al., 2021).

Even before the onset of the pandemic, Guatemalans experienced many barriers in regard to the Social Determinants of Health (SDOH), or the conditions in which people are born, grow, live, work and age (WHO, 2021c). Guatemala is the most populous country in Central America, with the majority of citizens being from minority Mayan descent, and there are ongoing health disparities among these indigenous groups (Minority Rights, 2018). In addition, access to a potable water source and essential medications is not reliable for many (Gentry & Metz, 2017). Further, Guatemala has 0.36 physicians per 1000 people, which is below the recommended number to meet community needs (2.3 per 1000) (Central Intelligence Agency, 2018). The World Bank (2020) began the *Crecer Sano* Nutrition and Health Initiative in Guatemala to improve practices, services, and behaviors surrounding malnutrition. This initiative is further evidence of the need to prioritize research on the elimination of SAM in Guatemala. Guatemala's high rates of SAM (USAID, 2021) and rising rates of food insecurity due to the COVID-19

pandemic (Action Against Hunger, 2020) make this a critical setting to understand malnutrition.

Children under age 2 are developmentally at a critical age for nutritional intervention (Olney et al., 2018) and early identification of SAM among children is a priority of the World Health Organization (WHO, 2019). Ready-to-Use Therapeutic Food (RUTF) has been the primary treatment strategy (WHO, 2013); yet, for long-term health outcomes, must be paired with on-going educational strategies (Grossman et al., 2015; Kassier et al., 2019). Various medications and vitamin supplements are currently recommended for SAM management, with inconsistent results (Lanou et al., 2019; Schauer et al., 2017; WHO, 2013; 2016). Multiple types of treatment programs for SAM, both residential and community-based, have been implemented with varying effectiveness. These programs have concerns for accessibility, competency-based staff training, as well as long-term sustainability and effectiveness (Bhutta et al., 2017; Trehan & Manary, 2015).

Residential programs are known as Nutrition Rehabilitation Centers (NRCs), in which children stay on-site are monitored by a team of experts in childhood nutrition, and parents/guardians are educated on healthy feeding practices (Rastogi et al., 2018). Most NRCs are based in India. Rates of weight gain in these programs ranged from 3.8 - 9.92 g/kg/day (Chaturvedi et al., 2018; Golandaj et al., 2017; Rastogi et al., 2018; Taneja et al., 2012); secondary diagnoses were a major deterrent to recovery (Sanghvi et al., 2014). In several studies the majority of children admitted to NRC programs were under age 2 (Joshi et al., 2020; Rastogi et al., 2018). There are few current studies on NRCs, so the knowledge of barriers of these programs is limited.

Community-based programs are known as Outpatient Treatment Programs (OTPs), in which children are brought to a clinical site, assessed by providers, offered appropriate

treatments, and provided food and medications. They return home and are expected to return to the program base for on-going evaluation and treatment (Liben et al., 2019). These programs provide a means of local access for SAM management and early intervention to reduce fatalities and complications (Kassaw, 2020). Most OTPs are based in African countries. Time-to-recovery ranged from 38.5 days to 73 days (Akparibo et al., 2017; Atnafe et al., 2019; Doocy et al., 2018; Gebremedhin et al., 2020; Kabalo & Seifu, 2017; Mamo et al., 2019; Tadesse et al., 2018; Teshome et al., 2019) and reported rates of weight gain ranged from 4.2 -10.5 g/kg/day (Kabalo & Seifu, 2017; Kassaw, 2020; Teshome et al., 2019).

Community Health Workers (CHWs) have been integrated with OTPs (Alvarez Morán et al., 2018; López-Ejeda et al., 2019). Trained CHWs are uniquely positioned to identify and manage uncomplicated cases of SAM within their communities and refer them for treatment when needed (Alvarez Morán et al., 2018; López-Ejeda et al., 2019). While OTPs provide increased accessibility for more children to receive treatment, there are concerns about sustainability (Liben et al., 2019). Heavy burden is placed on families for travel, and children in these programs have not consistently achieved international standards for weight gain over time (Liben et al., 2019).

Previous studies indicate that children of low socioeconomic status are at the highest risk for SAM (Blaney et al., 2019), and the science on best practices of prevention and treatment is not fully developed. The state of the science surrounding childhood SAM within the context of Guatemala includes knowledge, practices and beliefs, food assistance and supplementation, gender equity, double burden of malnutrition, long-term effects, as well as social policies and health disparities. However, the current literature on the state of the SDOH in Guatemala is limited. In addition, there are few studies investigating clinical outcomes of children with SAM

in this country. There is still a need to understand the relationship between ongoing nutritional problems in the context of the social and environmental structures of communities. The goal of this study was to better understand SAM within the sociocultural and economic context that exists in Guatemala today, providing a previously unexplored perspective from an NRC.

East Carolina University's College of Nursing was the first nursing program to provide volunteer service with one Guatemalan NRC. Since 2008, ECU nursing faculty and students spend part of a three-week cultural immersion program assisting staff with the care of children. This study built on the established community-university partnership between ECU and the NRC leadership. This project provided a unique opportunity to engage with this Guatemalan community and better understand the relationships between clinical variables of SAM in the context of COVID-19.

A retrospective record review was conducted to investigate the relationship of clinical variables among children with SAM, looking at cases both pre-and post-COVID-19, to gain an understanding of health outcomes, specifically time-to-recovery, and the impact of the pandemic. This research is intended to inform further investigation and intervention development. Findings from this research were shared and discussed with NRC leadership to support on-going program development and quality improvement efforts. Insight from this study will lend a better understanding of SAM on clinical variables amid the COVID-19 pandemic.

Theoretical Framework

The Social Ecological Model (Bronfenbrenner, 1979) was adapted to evaluate malnutrition among Guatemalan children. The Social Ecological Model is an exploratory model that provides a way to understand the multifactorial influences on behavior and contributes to development of successful interventions. The model was applied to understanding the SDOH

that affect children with SAM. The five levels of the model are formatted in a circular fashion, where levels are individual, interpersonal, organizational, community, and public policy (See Figure 1) (Bronfenbrenner, 1979; Healthy People, 2020). The model considers how health outcomes are shaped through the social context. Health outcomes are achieved from the interactions within and between the five levels, which continuously interact with one another (Bronfenbrenner, 1979). This framework is a holistic representation of how the SDOH contribute to health outcomes. Adaptations to this model in the context of malnutrition in Guatemala are depicted in the subheadings of the five levels. Data collected in this study were analyzed within the framework of the model to collectively inform the researcher's holistic understanding of the influence of external factors on individual health outcomes.

Figure 1

Social Ecological Model as applied to understanding children with SAM

Purpose

The purpose of the study was to understand malnutrition recovery at a Guatemalan NRC in the context of a pandemic. The aims were to (a) describe the characteristics of a sample of infants and children (0-5 years) treated for malnutrition at a residential NRC in Antigua, Guatemala; (b) examine the relationships between individual clinical variables and time-to-recovery; and (c) assess the impact of COVID-19 on child outcomes at the NRC.

Hypotheses

The hypotheses of each aim respectively were that (a) there would be a greater number of young children, more males, and a correlation between living in a rural region and experiencing more severe malnutrition; (b) older children without secondary diagnoses and with less severe malnutrition would have quicker time-to-recovery; and (c) children in the post-COVID sample would have longer time-to-recovery than those in the pre-COVID sample.

Significance and Innovation

This study intended to provide novel insights to understand SAM among Guatemalan children, applying a holistic, theoretical framework in a previously unexplored setting. A retrospective record review utilized quantitative data as a means to better understand children during their treatment for SAM, and what impact the COVID-19 pandemic has had on time-to-recovery from SAM. There was no current research available on residential nutrition rehabilitation programs within Guatemala, despite the high rates of malnutrition in this country. Thus, this study offers more context to management and outcomes of children with SAM in this setting. The Future of Nursing 2020-2030 calls for nurses to address health equity among vulnerable populations, ultimately eliminating health disparities (National Academies, 2020). This study attempted to fulfill that call by understanding the cultural and social factors that

impact the health and wellness of Guatemalan children and suggest innovative solutions to eliminate health disparities.

Conceptual and Operational Definitions

Multiple variables were investigated in this research. Below are the variables and their corresponding conceptual and operational definitions (See Table 1).

Table 1

Conceptual and operational definitions.

Concept	Conceptual Definition	Operational Definition
Time-to-Recovery	The total number of days a child is admitted to the NRC receiving treatment for malnutrition	Total number of days from admission to NRC to successful completion of treatment, as determined by the NRC nutritionist and demonstrated by height and weight; international standard is <6 weeks
Time-to-discharge	Total number of days a child is present at the NRC	Total number of days from admission to discharge; international standard is <6 weeks
COVID cohort	A case admitted prior to or after the onset of the COVID-19 pandemic	Pre-COVID cohort: Jan. 1, 2019 to February 28, 2020; Post-COVID cohort: March 1, 2020 to Dec. 2020
Age	How many months and/or years a child has been alive	The number of years/months a child has been alive (measured in months)
Gender	A child's identity as either male or female	The assigned identity of a child as either male or female as indicated in the NRC records
Severity of Malnutrition	Physician's diagnosis of level of malnutrition upon admission	Mild, moderate, severe
Type of SAM	Physician's diagnoses of specific symptoms in severe malnutrition	Marasmus, Kwashiorkor

Concept	Conceptual Definition	Operational Definition
Secondary diagnoses	Any condition a child has upon admission or that they develop during their time at the NRC	Type of diagnosis (i.e. respiratory illness, anemia, diarrhea)
Height	The measurement of how long a child is	The length a child is, to the nearest half centimeter, collected on admission and discharge
Weight	The measurement of how heavy a child is	Amount a child weighs, to the nearest tenth of a kilogram, collected on admission and discharge
Medications	Any drug given to a child to manage their health, whether in treatment or prophylaxis	Examples: Amoxicillin, Nebulizer and/or Bronchodilator
Supplements	A substance given to children to help them meet their nutritional/health needs	Examples: Multivitamin, Zinc
Discharge disposition	The location a child went to after completing treatment at the NRC	Home, hospital, or unknown
Referral	The directing of a child to the NRC for treatment	The reported means by which a child was admitted for management of SAM (i.e. Walk-in, hospital, health clinic/department, social services)
Region	One of the 12 departments in the country child/family resides, and the corresponding region of the country	The listed region from which the child came for treatment, divided into regions (i.e. North, Central, Southern)
Sociocultural characteristics	Relevant sociocultural details available in child's file	Details included in record of child's social situation (i.e. number of children living in the home or parent's marital status)

Of note, time-to-recovery is the total number of days from admission until a child is deemed by the nutritionist to have completed treatment, while time-to-discharge is the total number of days from admission to a program until discharge. Time-to-discharge is utilized in cases where recovery is not confirmed, or a child remains in a treatment program, even after being deemed recovered. In addition, secondary diagnoses were the only variable that investigators anticipated being able to collect that was not available in either the pilot or larger study data.

Assumptions

In this study, it was assumed that information entered into children's medical records was factual and accurate. It was also assumed that children did not require repeat treatment and maintained a healthy weight after their discharge; there was no feasible way for the researcher to follow up with participants. At the macro-level, researchers assumed that external factors, such as culture, society, and community influence the health of individuals. Additionally, nurses are able to utilize their skills to advocate for vulnerable populations and collaborate with international partners in order to improve health.

Summary

A retrospective design was used to understand malnutrition recovery at a Guatemalan NRC in the context of a current pandemic. Variables collected in this research included severity of malnutrition on admission, gender, age, referral location, height, weight, diet, medications, supplements, and discharge disposition. This work was guided by the Social Ecological Model, and investigators considered the impact of the SDOH on clinical outcomes. This research informs our understanding of SAM and the factors that influence SAM in vulnerable households and communities by providing timely data needed to combat rising food insecurity and health

needs amid COVID-19. Better understanding of SAM in Guatemala allows for future development of sustainable interventions to improve health and wellness from the individual level to the policy level.

CHAPTER TWO

Literature Synthesis

This literature synthesis will situate malnutrition as a global problem, and delineate the context of childhood nutrition in Guatemala, and the state of the science in global malnutrition management strategies. Gaps in the literature will be examined, followed by application of the Social Ecological Model (Bronfenbrenner, 1979) to evaluate childhood malnutrition in the context of Guatemala. This literature synthesis has been an iterative process; the Principal Investigator (PI) has maintained an interest in child health in Guatemala over the last five years; and conducted prior research in the country (Braxton & Larson, 2019); relevant literature has been continuously collected, refined and synthesized over time.

Malnutrition as an Ongoing Problem

Among children under age 5, nearly half of all deaths are related to malnutrition (UNICEF, 2021). Children who are undernourished are more susceptible to infection, and their fragile state results in slowed recovery and increased risk of complications (UNICEF, 2021). Long term, SAM negatively impacts child growth and development (WHO, 2021b). To be diagnosed with SAM, a child must have a very low weight-for-height, -3z scores from the median growth standards by the WHO (2021b). Children with SAM will also have severe wasting, or nutritional edema (WHO, 2021b). There are several terms of malnutrition commonly used and understanding how these are defined is key to comprehending the current literature on SAM (See Table 2).

The United Nations 2030 Sustainable Development Goals identified 17 goals as a call to action to end poverty and improve the environment (United Nations, 2020a). Goal 2, Zero Hunger, addresses malnutrition. This goal includes ensuring access to food for all, ending

childhood malnutrition and creating sustainable food production (United Nations, 2020b). The rates of malnutrition and growth stunting are continuing to rise in LMICs, and action is needed to achieve this 2030 goal to end childhood malnutrition in all forms (United Nations, 2020b). The normalization of malnutrition by Guatemalans and risk of recurrence creates challenges; early intervention using RUTF is a necessary management strategy (Chary et al., 2013; Bhutta et al., 2017). New interventions for prevention and treatment are still needed, and community partnerships are key to sustainable intervention development (Bhutta et al., 2017; Suarez-Balcazar, 2020).

Table 2

Malnutrition-related term definitions

Term	Definition
Malnutrition	Imbalanced intake of nutrients that is either excessive or deficient [c]
Micronutrient deficiencies	Diet with insufficient intake of vitamins and minerals needed for bodily functions and appropriate development [c]
Wasting	Low weight-for-height; indicates that a person does not have adequate access to food. Wasting requires treatment and is a high risk for death if unmanaged [c]
Growth Stunting	Low height-for-age; indicates chronic undernutrition and is associated with low socioeconomic status and poor feeding practices. Stunting negatively impacts a child both cognitively and physically [c]
Underweight	Low weight-for-age; a child who is underweight may be stunted and/or wasted [c]
Marasmus	Severe, chronic undernutrition caused by inadequate caloric intake [b]
Kwashiorkor	Severe form of malnutrition; a lack of protein in the diet, resulting in excess fluid under the skin and swelling [a]

(NHS, 2019; [a] Merriam-Webster., n.d.; [b] WHO, 2021a [c])

The Context of Childhood Nutrition in Guatemala

This section describes childhood malnutrition in Guatemala, with respect to knowledge, practices and beliefs, food assistance and supplementation, gender equity, double burden of disease, long-term effects, as well as social policies and health disparities.

Knowledge, Practices, and Beliefs

Various studies have evaluated knowledge, practices, and beliefs related to nutrition in Guatemala. Nutrition is the outcome of a complex collection of factors: cultural and personal preferences, accessibility, employment, gender, and social views (Kadetz, 2014). In Guatemala adequate nutrition is complicated by multiple indigenous groups, numerous dialects, and people living in remote conditions. In a study set in Guatemala, heads of households explained health as access to food, in particular herbs, and access to clean water (Braxton & Larson, 2019). Among indigenous mothers living in Guatemala, growth stunting and malnutrition has been normalized and not viewed as a problem unless the child was actively symptomatic (Chary et al., 2013). Brown et al. (2016) found Guatemalan mothers acknowledged malnutrition as a concern but underestimated the severity of the problem. Fortified foods, such as RUTF, were perceived as expensive; the cost of fortified foods was prioritized only during acute bouts of malnutrition, evidenced by diarrhea and a lack of appetite (Brown et al., 2016). In an ethnographic study, researchers reported concerns of gendered feeding practices among indigenous Guatemalan families, in which female infants had healthier growth in their first year of life, while males were perceived by their mothers to require more complementary feeding practices, such as RUTF (Tumilowicz et al., 2015). Complementary feeding practices lack cultural acceptance within many indigenous communities (Tumilowicz et al., 2015).

Factors related to family and home environment contribute largely to child health and illness. In a study of 852 Guatemalan children, the most significant predictors of malnutrition included: having other children under five in the household, vomiting or diarrhea within the previous week, and previous poor nutritional status (Nagata et al., 2016). In another study, researchers looked specifically at environmental factors and found that access to potable water and sanitation were the most vital to child development (Voth-Gaeddert & Oerther, 2019). Interestingly, mothers associated the variable 'child play' negatively with child health; playing outdoors put children at risk for disease (Voth-Gaeddert & Oerther, 2019). In a qualitative study, 17 Ch-orti Maya women considered multiple ways their environment negatively impacted the health of the community; yet, physical symptoms their children experienced, such as diarrhea and respiratory infections, were rarely recognized (Gentry & Metz, 2017). Investigators in a pilot study evaluated the prevalence and risk factors of growth stunting in Guatemala; the overall inadequate resources to meet nutritional needs, lack of variety in the diet, and high rates of secondary diagnoses were factors associated with stunting (Kragel et al., 2020). It is important to consider the family and home environment when evaluating SAM and to create sustainable interventions that support safe drinking water, sanitation, and hygiene needs. Researchers are working to develop a scale to measure infant feeding behaviors, validated in several countries, including Guatemala, to better identify eating habits among children at risk for SAM, to inform causes and treatment of malnutrition (Wright et al., 2021).

Within the school environment, there are also factors that impact child health. Among 223 school-age children, their experience of food insecurity exaggerated their negative perceptions towards thin body sizes (Maupin & Brewis, 2014). Children were shown pictures of various body sizes and asked to describe them, and the most negative terms were consistently

given towards thin sizes (Maupin & Brewis, 2014). Other investigators examined the food environment at a low-income elementary school in Guatemala (Pehlke et al., 2016). They found that principals and food vendors, who have primary control over daily nutrition for students, had strong concerns specifically about undernutrition among students. The primary food options for children included calorie-dense snacks and sugary beverages, and there was a lack of concern for providing healthy food choices and establishing overall healthy behaviors (Pehlke et al., 2016).

Food Assistance and Supplementation

Previous investigation of SAM in Guatemala was also related to food assistance and supplementation. Chary et al. (2011) found that socioeconomic barriers including poverty, unemployment, alcoholism, domestic violence, lack of autonomy, and unfair wages forced mothers to delay the introduction of solid foods. As a result of the financial barriers and gender inequality, community nutrition programs offered a solution to childhood malnutrition (Chary et al., 2011). Other investigators found that when families were provided staple items, such as rice and beans, and education on healthy food preparation, they reported using their own money to buy additional healthy foods (Jensen at al., 2016). Families did this because they had financial access, as well as improved understanding of the benefit of healthy foods (Jensen et al., 2016). A quality improvement initiative was conducted in a community-based food supplementation program to provide feedback support to staff (Juarez et al., 2021). The audit tool that was developed improved the effectiveness of the food supplementation program, both in growth monitoring by staff and distribution of supplements (Juarez et al., 2021). Food supplementation programs can be an effective way to increase accessibility to nutritious foods; however, there are concerns about sustainability of these types of programs.

Several studies related to food assistance included agricultural interventions. Guzman-Abril et al. (2021) discovered that home gardens were a feasible strategy to provide health benefits to children and could improve growth and development. Luna-Gonzalez and Sorensen (2018) also found higher agrobiodiversity was a way to increase dietary variety among children. However, these agricultural interventions require complementary strategies in sanitation, education, and women's empowerment to be successful (Guzman-Abril et al., 2021; Luna-Gonzalez & Sorensen, 2018).

Several studies focused specifically on supplementation for children under age five, highlighting the need for targeted, early intervention to promote child wellness. Krebs et al. (2012) evaluated the impact of meat intake versus fortified cereal in a longitudinal, multisite study, which followed over 1000 Guatemalan children from ages 6 to18 months. Growth patterns did not vary between the two groups, and the high rates of stunting pre-intervention indicated the need for earlier intervention to promote optimal child health (Krebs et al., 2012). In a longitudinal RCT that provided food assistance to children ages one to 24 months, scientists found that these targeted programs reduced growth stunting, demonstrating the value of early intervention (Olney et al., 2018). In another study, when researchers provided zinc supplementation to Mayan children, there was a significant increase in adherence to the zinc regimen and lower rates of diarrheal illness (Grossman et al., 2015). Mothers who received education from lay health advisors had the highest rates of adherence (Grossman et al., 2015), supporting the integration of community health workers in community-based nutrition efforts. In an investigation of zinc supplementation among children <5 years in Guatemala, most children had not met their daily requirement and benefited from supplementation (Monroy-Valle, et al., 2017). A Guatemalan-operated day care program provided breakfast, lunch, and two snacks daily

to children in their care (Vossenaar et al., 2015). The provided meals met 90% of daily energy requirements and all nutritional requirements, except Vitamin D and calcium (Vossenaar et al., 2015). This supplementation provided vital nutrition for children during a critical growth period but was limited to children in the area.

Gender Equity

It is important to consider the impact of women's employment on childhood health outcomes. Women's experiences with poverty, low-autonomy, and lack of social support can negatively impact child health (Chomat, 2021). In a multilevel analysis of malnutrition within 49 LMICs, including Guatemala, investigators demonstrated that when gender equity in relation to education and employment was high, child malnutrition was low (Ekbrand & Hallerod, 2018). Further, those countries with greater female empowerment had lower levels of health deprivation (Ekbrand & Hallerod, 2018). Burroway (2017) found that more women participating in the workforce could allow for the purchase of healthier foods; however, there was concern that maternal employment increased risk of malnutrition (Burroway, 2017). Women's employment opportunities, family structure and the impact on childhood nutrition is not clearly understood (Burroway, 2017). In another study, mothers reported not having autonomy to make decisions about food for their families as well as lacking access to reliable food supplies (Deeney & Harris-Fry, 2020). Researchers investigated the effects of female employment on Guatemalan families through in-depth interviews with 14 working and six unemployed women (Oddo et al., 2018). Employed women purchased larger quantities of food and had improved financial stability but reported less time to prepare meals. Meanwhile, unemployed women believed working would be harmful to their child's health and bad for their own mental health. Both employed and unemployed women expressed concern that work would cause them to neglect

their households (Oddo et al., 2018). The impact of women entering the workforce has benefits to child health, such as financial independence and access to healthier foods; however, this cultural shift also comes with uncertainty including management of household responsibilities, child care supervision, and maternal mental health.

Double Burden of Malnutrition

The double burden of malnutrition refers to a situation where undernourishment and obesity exist within a single household or community and is a growing trend in LMICs (Muros et al., 2016; Ramirez-Zea et al., 2014). The double burden link was investigated in a sample of 2,388 mother-child dyads in Guatemala, and this phenomenon was found to affect indigenous populations more often than non-indigenous (Lee et al., 2017). Investigators found that living in an urban area increased the likelihood of a family experiencing double burden. Researchers inferred this combination of indigenous populations in urban areas was associated with lack of access to healthy foods (Lee et al., 2017). Mothers experienced a lack of agency to purchase items of their choosing, causing a poor diet for families and resulting in adverse outcomes: child growth stunting and maternal obesity (Lee et al., 2017). In another study with 446 mother-infant dyads in the Western Highlands of Guatemala, investigators noted high rates of growth stunting (38%) and maternal obesity (45%) (Doak et al., 2016). Yet only 17% were considered a double burden (e.g. in the same household). There was no correlation between the socio-demographic factors of the stunted children and maternal obesity. Two recent systematic reviews were conducted on the topic of double burden; Cordon et al. (2019) reviewed stunting research in Guatemala and Pries et al. (2019) reviewed the literature on snack food and beverage consumption among children in LMICs. Many investigators find a need for future research and

policy development to address the combined burden of malnutrition and obesity (Cordon et al., 2019; Pries et al., 2019).

Long-Term Effects

There are few studies investigating the long-term impacts of nutrition intervention programs. Ford et al. (2018) found that protein-energy nutrition supplementation in the first two years of life reduced the likelihood of adult diabetes between ages 37-54 years but increased the risk of obesity. There is some association between nutritional intervention in the first 1000-day period of life and improved cardiac function (Kroker-Lobos, 2020). Other researchers found that early-life nutrition interventions have long lasting positive impacts on cognitive and psychological status (Ramírez-Luzuriaga, 2021a; 2021b; 2021c). Researchers conducted a prospective study of nearly 1500 Guatemalan adults who had participated in a food supplementation program as children (Ramírez-Luzuriaga et al., 2021a; 2021b). Those with the highest growth trajectories were of higher income and had taller mothers; participants' level of education was positively correlated with growth patterns and cognitive function. In another prospective study, Ramírez-Luzuriaga et al. (2021c) examined the association between childhood growth and subsequent international emigration as an adult and found that adults who had higher height-for-age scores at 24 months were more likely to emigrate. National nutrition guidelines will need to be reevaluated over time to match recommendations as practices of nutritional supplementation are better understood (Villatoro Santos, 2020; Ng, 2019).

Social Policies and Health Disparities

Two articles investigated social policy in Latin America, with implications for needed nutrition improvement in Guatemala. Flores-Quispe et al. (2019) conducted a cross-sectional analysis of health from nine Latin American and Caribbean countries to assess childhood growth

stunting from 1996-2016. There was a natural reduction over time in socioeconomic inequality in all countries except Guatemala and Bolivia (Flores-Quispe et al., 2019). Guatemala had the highest prevalence for stunting and the highest proportion of households in rural areas out of the nine countries in the study. Researchers called for improved health equity, specifically in Guatemala, where health inequalities remained unchanged (Flores-Quispe et al., 2019). Health policies addressed undernutrition in 18 Latin American countries; still, there was a need for stakeholder collaboration for these policies to be effective and sustainable (Tirado et al., 2016).

Socio-economic and ethnic disparities of SAM within Guatemala are ongoing; stunting is more prevalent among indigenous groups and those with low income and low literacy across all age groups (Batis et al., 2020; Mazariegos et al., 2020). Gatica-Domínguez et al. (2019) found that children who identified as indigenous Maya and living in rural areas were at greatest risk for being stunted. The prevalence of growth stunting among Mayan children in this study was similar or worse, when compared to the health of non-indigenous children 20 years prior, regardless of income category (Gatica- Domínguez et al., 2019). Gaensbauer et al. (2019) analyzed the correlation between enteric pathogens that cause diarrheal illness and socioeconomic variables among 316 Guatemalan children. Rural participants had significantly higher malnutrition rates, exposure to animals, and lower sanitation. Public health strategies are needed to implement effective interventions (Gaensbauer et al., 2019). Rohloff (2021) cautioned against short-term interventions and highlighted the need for large-scale social justice interventions to empower indigenous Guatemalans and reduce ongoing health disparities, while prioritizing the needs of individual families and recognizing the social context of their daily experience. Further, contextual factors impact the likelihood of SAM (Fagbamigbe et al., 2020). Children who are male, of low birthweight, or from poorer, rural areas with high rates of

unemployment and illiteracy are significantly more likely to have SAM (Fagbamigbe et al., 2020). Davis and Brazil (2016) found that even a father's choice to migrate out of country for work is correlated with worsened growth patterns among their young children.

Global Malnutrition Management Strategies

The Sphere Project was founded in Geneva in 1997 by various non-governmental organizations, including the Red Cross, to determine standards of care for humanitarian action among global communities through inter-agency collaboration (Sphere Project 2011). According to the Sphere Project, the standard for SAM treatment programs is that at least 75% of children recover successfully, with less than a 10% death rate (Sphere Project, 2011; Hassen et al., 2019) and recovery within six weeks (Kabalo & Seifu, 2017; Sphere Project, 2011). Another standard is that children gain at least 8g/kg/day during treatment (Sphere Project, 2011).

Medications and Supplements

For children with SAM Ready-to-Use Therapeutic Food (RUTF) has been the primary treatment strategy (WHO, 2013); yet for long-term health outcomes, RUTF must be paired with educational strategies (Grossman et al., 2015; Kassier et al., 2019). The Institute of Nutrition of Central America and Panama developed *incaparina* as a low-cost, culturally accepted beverage, with the nutritional equivalence to milk (Scrimshaw, 1980). Incaparina is typically made of vegetable protein, and is suitable for weaning infants and children, particularly in low-income countries with limited resources, such as Guatemala (Scrimshaw, 1980).

In addition to formulas, various medications and supplements such as Amoxicillin, zinc, and multivitamins, are currently recommended for SAM management; however, much of the research is low-level evidence and warrants further investigation (Lanou et al., 2019; Schauer et al., 2017; WHO 2013; 2016). The most common recommendation is to treat children with

uncomplicated SAM with oral Amoxicillin (Williams & Berkley, 2018; WHO, 2016); yet research in this field has been contradictory. Some found minimal or no difference in recovery when comparing Amoxicillin administration in SAM treatment, and investigators warned against routine antibiotic use, given worldwide antibiotic resistance (Isanaka et al., 2016; 2020; Lelijveld et al., 2021; Maataoui et al., 2020; Nel, 2018; Warring & Fischer, 2016). However, other researchers found Amoxicillin was positively associated with reduced mortality, improved time-to-recovery, and decreased risk of hospitalization, and therefore, recommended continued prescription of Amoxicillin for uncomplicated SAM (Abate et al., 2020; Bitew et al., 2020; Kabalo & Seifu, 2017; Million et al., 2017; WHO, 2016; Williams & Berkley, 2018). Overall the evidence for this recommendation is weak, and in settings with limited resources, this practice is often not prioritized (WHO, 2016).

Adequate provision of vitamins and minerals is another priority during SAM treatment (WHO, 2019), and adequate supplementation can positively impact cognitive functioning (Olsen et al., 2020). According to WHO (2019), vitamins can be provided through fortified formulas, or individual ready-made vitamin mixes. A recent study found that many Guatemalan children had deficiencies in folate and B12 and recommended additional fortification methods to ensure daily needs are met (Wong et al., 2022). Zinc has been recommended as a standard therapy for children experiencing diarrhea, to reduce duration and severity of illness (WHO, 2013). In a recent study of Guatemalan children, investigators found that zinc deficiencies in children under two were associated with anemia, and recommended micronutrition supplementation in this population (Palacios et al., 2020). Also, zinc supplementation programs have improved health outcomes among Guatemala children; and should target the critical needs of children under age 2

(Grossman et al., 2015; Monroy-Valle, et al., 2017). Evidence-based practices surrounding administration of medications and supplements to positively impact SAM recovery are lacking.

Outpatient Strategies

A common treatment strategy for SAM is Outpatient Treatment Programs (OTPs). In OTPs, children are brought to a clinical site, assessed by providers, offered appropriate treatments, provided food and medications, then sent home with the expectation of regular assessment for on-going evaluation and treatment (Liben et al., 2019). Most OTPs are based in African countries and are evaluated using the outcome indicator, time-to-recovery. Time-to-recovery in published studies ranged from 38.5 days-73 days (Akparibo et al., 2017; Atnafe et al., 2019; Doocy et al., 2018; Gebremedhin et al., 2020; Kabalo & Seifu, 2017; Mamo et al., 2019; Teshome et al., 2019). Reported rates of weight gain ranged from 4.2 -10.5 g/kg/day (Kabalo & Seifu, 2017; Kassaw, 2020; Teshome et al., 2019) and recovery rates ranged from 42%-79.8% (Al Amad et al., 2017; Cuneo et al., 2017; Doocy et al., 2018; Gebremedhin et al., 2020; Kabalo & Seifu, 2017; Kassaw, 2020; Mamo et al., 2019; Mengesha et al., 2016; Teshome et al., 2019). Predictors of recovery included: use of antibiotics (Mamo et al., 2019; Teshome et al., 2019), Vitamin A, decreased travel time to the OTP site (Teshome et al., 2019), up-to-date vaccinations (Al Amad et al., 2017), lack of secondary diagnoses (Doocy et al., 2018; Dorion et al., 2012; Kassaw, 2020), admission weight greater than 7 kg (Gebremedhin et al., 2020), and mid-upper-arm circumference >11.5 cm (Kassaw, 2020). Those with Marasmus were either less likely to recover or recovered significantly slower than those with Kwashiorkor (Atnafe et al., 2019; Kabalo & Seifu, 2017; Mengesha et al.,2016). Investigators found that edematous children recovered quicker, potentially related to caregivers' perception of the child's health and prioritization of RUTF (Kabalo & Yohannes, 2018). In one study, children ≤ 24 months old had

significantly longer time-to-recovery than those older than 24 months (Doocy et al., 2018). In another study, children greater than age 3 recovered slower (John et al., 2018). Mortality was highest among those who were severely stunted on admission and those aged 6-11 months (John et al., 2018).

One component of outpatient treatment to assist in preventing and managing SAM worldwide is the use of Community Health Workers (CHWs). A CHW is a non-medical person trained to provide selective health services to their community. Typically, trained CHWs collaborate with outpatient treatment programs; identifying uncomplicated cases of SAM within their communities and referring them for treatment as needed (Alvarez Morán et al., 2018; López-Ejeda et al., 2019). In mild cases, CHWs can assist families to manage malnutrition at the household level (Boyd, 2022). The unique position of the CHW within the community allows for early intervention and improved access (Alvarez Morán et al., 2018). However, when OTPs were compared to CHW care, there was no significant difference between the two intervention strategies in child outcomes or cost-benefit (Hussain et al., 2021; Rogers et al., 2019). In some studies, CHWs lacked the needed knowledge and resources to appropriately support SAM recovery, and there was a need for further infrastructure development and training (Mambulu-Chikankheni et al., 2018, Miller et al., 2019). Appropriate incentives and training, as well as provision of needed treatment measures, are essential to the success of CHWs in the management of SAM (Ireen et al., 2018; López-Ejeda et al., 2019; Mambulu-Chikankheni et al., 2018).

The benefits of OTPs are the increased accessibility for children to receive treatment and the trust established among providers in the community (van Immerzeel et al., 2019); however, there are concerns for sustainability (Liben et al., 2019). There is heavy burden on families for

travel, and children in these programs have not consistently achieved international standards for weight gain over time (Liben et al., 2019). Inadequate use of antibiotics and RUTF, as well as early discharge from the program were barriers to the effectiveness of OTPs (Tadesse et al., 2016). Training and education for parents and healthcare workers on anthropomorphic measurements and appropriate dosing of RUTF is key to program success (Daures et al., 2020; Tadesse et al., 2016), along with consideration of access to clean water and sanitation (Altmann et al., 2018; Doocy et al., 2018). Staff training and increased accessibility are needed to combat high default rates in OTPs (Al Amad et al., 2017). Investigators argue that OTPs alone are insufficient to address malnutrition worldwide; health promotion and food access interventions should be targeted towards high risk groups, such as indigenous mothers of young children and those of low socioeconomic status (Adegoke et al., 2021; Ghimire et al., 2020).

Nutrition Rehabilitation Centers

Another intervention for SAM management is through residential care, specifically Nutrition Rehabilitation Centers (NRCs). Limited information is available on this strategy; various districts within India provide much of the available data. In NRCs, children stay on site and recover in a community setting; they are monitored by staff, and parents/guardians are provided education on healthy feeding practices (Rastogi et al., 2018). In some programs, children stay until they are recovered, and in others they stay a maximum of 14 days and then are discharged with resources for parents to continue to manage care at home (Rastogi et al., 2018). Days in treatment have ranged from 14 days to 21.8 (Asres et al., 2018; Golandaj et al., 2017; Josh et al., 2020). Many residential programs are designed as 14-day programs, so discharge is not necessarily indicative of recovery. Rates of weight gain ranged from 3.8 - 9.92 g/kg/day (Chaturvedi et al., 2018; Golandaj et al., 2017; Rastogi et al., 2018; Taneja et al., 2012);

secondary diagnoses were the major deterrent to recovery (Asres et al., 2018; Sanghvi et al., 2014).

In the only study in a Latin American country, children older than 24 months on admission to the Brazilian NRC had a lower probability of nutritional recovery, compared to those under age 1, and those with developmental delays recovered better than children without delays (Fernandes et al., 2012). In NRCs in India, children under age 2 made up the largest percentage of the study (Joshi et al., 2020; Rastogi et al., 2018). In the study by Rastogi et al. (2018), there were more females; Dhawan et al. (2019) found that older children and females were more likely to be treated for SAM.

In one NRC, low occupancy rates demonstrated how underutilized this program was in the region it served (Golandaj et al., 2017). There were also concerns that children lost weight after discharge from NRC programs (Bhujade et al., 2021; Pandey et al., 2018). In multiple studies, challenges included the inability to follow up with patients after discharge, mother's lack of knowledge on feeding practices, and environmental factors that negatively impact health (Golandaj et al., 2017; Sanghvi et al., 2014; Taneja et al., 2012). Another need in these programs is a stronger integration of structured play therapy to maximize child development (Kumar et al., 2021).

Gaps in the Literature

Despite Guatemala's high rates of malnutrition (USAID, 2021), there are few studies investigating clinical outcomes of children with SAM in this country. In addition, there is a community-based Nutrition Rehabilitation Center (NRC) in Guatemala, where children live on site to receive management for SAM. There are few current studies on NRCs, and none are based in Guatemala. This is a unique setting in a country that could contribute to the science on assessment and evaluation of malnutrition, making it an ideal setting to advance the science.

Best practice of prevention and treatment of SAM is not fully developed. The recommendations for medication use for SAM management are based on low-level evidence and require further evaluation (WHO, 2016). Despite its effectiveness, RUTF requires complementary strategies to be successful, and these are underdeveloped. Multiple studies suggest the relationship between the SDOH and SAM, but studies on the impact of the SDOH on clinical variables and health outcomes of children with SAM are limited. There is still a need to understand the relationship between ongoing nutritional problems in the context of changes in the social and environmental structures of communities. Guatemalans have been negatively impacted by the onset of COVID-19 (Action Against Hunger, 2020); however, there is no current literature on how the pandemic has impacted childhood SAM recovery. In addition, treatment methods of SAM within Guatemala have limited representation in the literature. Past studies have been atheoretical and are missing an interdisciplinary perspective, particularly from nursing. The goal of this study was to better understand SAM within the sociocultural and economic context that exists in rural Guatemala today, providing a previously unexplored perspective from a residential NRC. This project provided a unique opportunity to better understand relationships between clinical variables of SAM within the context of COVID-19.

Social Ecological Model

This study was guided by the Social Ecological Model (Bronfenbrenner, 1979), which delineates the multifactorial influences on behavior and contributes to development of successful interventions. An exploratory model was applied to understanding the SDOH that effect children with SAM. The SDOH are defined as the conditions in which people are born, grow, live, work and age (WHO, 2021). For example, if a child lives in a remote area without access to transportation or a potable water source, it would be extremely challenging for them to maintain

nutrition recommendations. Several departments within Guatemala have been targeted by the United States Agency for International Development for child nutrition intervention (USAID, 2021). It is important that the SDOH be considered when striving to understand SAM in Guatemala.

Levels of influence in the model include individual, interpersonal, organizational, community, and, public policy (See Figure 1) (Bronfenbrenner, 1979). These levels are formatted in a circular fashion, where levels fit within one another. The primary concept of this model is that human behavior is shaped by the sociocultural environment and suggests that creating an environment that is conducive to change facilitates adoption of healthy behaviors (Bronfenbrenner, 1979). The model considers how health outcomes are shaped through the social context. Health outcomes emerge from the interactions within and between all five levels in this model, which are always interacting with one another (Bronfenbrenner, 1979). As Bronfenbrenner (1979) wrote, "...such interconnections [between levels] can be as decisive for development as events taking place within a given setting" (p. 3). This multilevel model allows for the researcher to observe the impact of wide-ranging influences as they are perceived by the individual (Bronfenbrenner, 1979). The interactions between factors at all levels are equally as important as the factors influencing a single level. This is a holistic framework that depicts the interactions of the SDOH at all levels. By utilizing the Social Ecological Model to guide analysis of variables collected from children's paper records at the NRC, researchers were able to see the complications of a problem at all levels and are able to utilize a multi-faceted approach to inform creation of solutions that are feasible and sustainable (Bronfenbrenner, 1979).

Social Ecological Model Applied to Research Study

Individual

The central agent in this model is the individual child and their experience of the phenomenon (Bronfenbrenner, 1979). At the individual level is the investigation of children's clinical variables and outcomes. Key process clinical variables, including nutrition status on admission, gender, age, referral location, height/weight, diet, medications, supplements, were identified as contributing to the outcome variables, time-to-recovery and discharge disposition.

Interpersonal

The interpersonal level includes relationships with family and caregivers, or their social support. Relationships were represented by parents and caregivers who were present in the household.

Organizational

The organizational level includes the healthcare facilities where the child is, as well as the workplaces of their caregiver. This level was informed by the social and cultural factors, as well as referral and discharge disposition variables. Occupation of members of the household were included in data collected at this level.

Community

The community level includes an assessment of the neighborhoods, villages, and departments within Guatemala. Children come to the NRC from various departments of the country and by referral from various entities; knowing the different regions, including assets and challenges facing families, contributes to a holistic understanding of malnutrition.

Public policy

The public policy level consists of the governing bodies and established policies and agencies committed to prevention of nutrition-related problems (Bronfenbrenner, 1979). This includes health and social services programs. The researcher looked at the health policies set

forth by organizations such as the World Health Organization and the Sphere Project, as well as the NRC's specific policies to better understand the facilitators and barriers to malnutrition programs.

Using the Social Ecological Model provided a holistic view and a deeper understanding of the multifactorial influence of the SDOH impacting key clinical variables of SAM. Relationships between the five levels in the Social Ecological Model are concurrent; the model is not inferring causation in its process (Bronfenbrenner, 1979). The factors that exist within the five levels of the model impact health outcomes, but there is not a definite, measurable relationship. For example, if a child lives in poverty and parents have low levels of education, that may tend to coexist with the realities of SAM, but there is no defined, causal relationship. This model simplifies complex topics, provides the researcher a lens to understand the context of SAM in Guatemala, and may be generalizable to other contexts and similar low-resource areas.

Summary

Previous studies have added to our understanding of knowledge, practices and beliefs, food assistance and supplementation, gender equity, double burden, long-term effects, as well as social policies and health disparities. Yet, further development of effective, nutrition-specific interventions and implementation science within Guatemala is warranted (Cordon et al., 2019). Existing policies need to be revitalized, taking into account the United Nations 2030 Sustainable Development Goals to prevent SAM in LMICs (United Nations, 2020a). There is an urgent need to address the prevalent inequalities of SAM within Guatemala. As Siu (2020, p.87) stated, "Food and nutrition is a human right, not a confusing statistic. Our greatest efforts must recognize the nutritional needs of people, while valuing, respecting, and protecting foods' flavors and the knowledge of the food and nutritional culture of the region."

A major concern across all SAM management strategies is appropriate follow-up with families to ensure sustained growth patterns; which is a challenge in LMIC with limited resources (Bhujade et al., 2021; Pandey et al., 2018; John et al., 2018). Management of secondary diagnoses should be prioritized when managing SAM (Mamo et al., 2019). Routine evaluation of water supply is necessary for program success and continued improvement of child health (Dorion et al., 2017). Overall, outpatient strategies provide a means of local access for SAM management and early intervention to reduce fatalities and complications (Kassaw, 2020). However, these programs are not meeting international standards for weight gain (Sphere Project, 2011) and barriers for their use exist. Researchers have emphasized the need for improved training of workers, education for families on appropriate feeding techniques and use of RUTF, appropriate use of antibiotics and supplementations, and consideration of the SDOH (Bitew et al., 2020, Dorion et al., 2012). There were fewer studies on NRCs, and no studies were found that took place in Guatemala. There was a need to understand the relationship between ongoing nutritional problems among children in this setting and the context of changes in the social and environment structures of communities. The Social Ecological Model was utilized to better understand the SDOH in rural Guatemala today and their impact on clinical variables of SAM, within the context of COVID-19.

CHAPTER THREE

Methods

The purpose of the study was to understand malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic. The aims were to (a) describe the characteristics of a sample of infants and children (0-5 years) treated for malnutrition at a residential Nutrition Rehabilitation Center (NRC) in Antigua, Guatemala; (b) examine the relationships between individual clinical variables and time-to-recovery; (c) assess the impact of COVID-19 on child health outcomes in an NRC.

Design

A retrospective record review was conducting, utilizing medical records of children admitted and discharged from the NRC in 2019 and 2020. The rationale for this study design was to assess data that would contribute to a better understanding of the processes and outcomes of children during treatment for SAM, and the impact the onset of COVID-19 had on time-to-recovery. The Social Ecological Model was adapted for this study to describe the multifaceted problem of malnutrition from individual, interpersonal, community, organizational, and societal perspectives. The research team consisted of a PhD nursing student (Principal Investigator), biostatistician, and nursing professor with research expertise in global and Latino population health. The NRC leadership were consultants throughout the study period as needed to provide the contextual, historical, and cultural understanding of the center. In particular, the NRC nutritionist and director brought insight to the social and cultural nuances of daily nutrition management. The PI had previously spent three weeks in Guatemala volunteering at the NRC as part of a cultural immersion study abroad program and published a qualitative descriptive study on Guatemalan health beliefs (Braxton & Larson, 2019). In addition, the PI had previously

participated in international service internships in Cameroon and Cambodia. This international lens informed this study, and bias was managed through reflexivity and discussions with dissertation committee members.

The research project was informed by a pilot study conducted in 2021. The purpose of the pilot study was to determine the feasibility of examining clinical variables of SAM among a subset of children at a Guatemalan NRC. A total of 42 cases were reviewed and the major findings were (a) an inability to verify time-to-recovery and (b) lack of access to height and weight variables at discharge. Time-to-recovery is the total number of days from admission until a child is deemed by the nutritionist to have completed treatment, while time-to-discharge is the total number of days from admission to a program until discharge. Since recovery was not confirmed in this sample, only time-to-discharge was reported. The median time-to-discharge among children in this sample was 48 days. Mean age of children was 23 months (SD = 12.9). All children were discharged home. Kaplan-Meier analyses indicated children $\leq$ 2 years had slower time-to-discharge (51 days) compared to those older than age 2 (32 days). The difference in time-to-discharge was not statistically significant. Findings can inform NRC leadership about improved process and outcome indicators for children at the NRC. The potential for children to stay at the NRC after they have recovered due to adverse social conditions and the inability to determine time-to-recovery in this study highlights the importance of considering the SDOH when investigating SAM recovery in future investigations. The on-going international community-university partnership was key to this study and vital to future work in this region.

Protection of Human Participants

Approval for this study was received from East Carolina University and Medical Center

Institutional Review Board (UMCIRB # 21-001884) through an expedited review. The NRC leadership wrote a letter of support for this study and agreed to share all records from 2019 and 2020 with the PI for study purposes. Due to the retrospective design and absence of direct contact with participants, expedited review was provided. While there was no way for researchers to obtain consent directly from participants due to the nature of the study of design, permission to use the records for the purpose of research was given by the NRC leadership. All records were deidentified by the PI; no identifying information was included in data entry in Excel. Therefore, no identifying information was removed from the study site, and participants' privacy was protected.

Setting

The follow-up study took place at an NRC in Antigua, Guatemala. The NRC, founded in 2006, is a part of a large non-profit organization, *Nuestros Ahijados* (Our Godparents). *Nuestros Ahijados* has a large campus facility with a health center, school, dental clinic, mothers' group, food bank, and homeless shelter. The NRC is one of the programs provided by the organization; it is housed in a three-story building on the campus in Antigua. Children are referred to the NRC by hospitals, community health centers, or health departments. The NRC is a residential center that treats an estimated 135-170 children annually with shelter, food, medicine, and health assessments from a Guatemalan healthcare team. A pediatrician, nutritionist, and nursing assistants staff the center 24/7 and manage the care of 15-20 children daily. The average length of stay is one month, but severe cases have remained as long as six months. One parent is encouraged to stay with their child, but there is limited space for adult sleeping (one room with three bunk beds) thus, not all parents stay overnight. Around 70% of children have a parent who stays with them (personal communication, August 24, 2021, NRC Center Coordinator).

This NRC has three floors and a basement used as a central supply area. The first floor is dedicated to admissions with a large waiting room, an administrative office and an exam room. There is a playroom for children in residence and a separate isolation room with 6-8 cribs where acutely ill or infectious children are initially placed on admission. On this floor there are also three bathrooms: one for the public, one for parent/guardians residing with their children, and one for staff. The second floor has three child bedrooms, with 5-10 cribs per room. On this floor, there is a kitchen, laundry room, linen closet for children's clothes, nurses' station, bathroom with one toilet and sink for child use, and a separate bathing area with three tubs. The third floor is an open-air rooftop patio with an area for play and drying laundry. Nurse aides are responsible for completing all assessments and medical orders (i.e., medication administration, nebulizer treatments), assistance with three meals/day and bottle-feeding, and laundry. There is one staff member preparing meals. Paper medical records are maintained for all children served by the NRC. Research team members had a long-standing partnership with the NRC staff. The leadership at the NRC were interested in a long-term, mutually beneficial collaboration to better understand SAM management within this global context.

Sampling Strategy

With the assistance of NRC staff, records of children admitted to the NRC between January 1, 2019-December 31, 2020 were identified using inclusion criteria. Inclusion criteria for eligible children were: ages 0-5 years old, a diagnosis of SAM, and those that had been discharged from the NRC. Exclusion criteria were children older than 5 years of age, those whose parents refused to complete treatment, or that were not discharged from the NRC by the end of the year 2020. The PI evaluated available records to determine if they met eligibility

criteria. Data were clarified with the NRC leadership as needed and records that did not meet criteria were removed.

Sample size for the retrospective record review was calculated based on the two-population proportion formula using the Stat Calc application of Epi-Info (Version 7.2.4.0). To achieve the 80% power, the assumptions were: 95% confidence interval for a two-sided test, using severity of malnutrition as an indicator of sampling variation, in line with similar studies (Fikrie et al., 2019; Gebremedhin et al., 2019). Accordingly, the calculated sample size was 282 records. After consideration of possible missing data, 10% was added, making the total sample size 312 records. Available records were organized by year (2019 or 2020). The PI numbered all records with a year and number in ascending order (i.e. the first record listed on the dataset was 1901, followed by 1902, etc.). Every record that met study criteria was included. In the case that power was not met, researchers considered the implications of the smaller sample size throughout analyses.

Instrument

A structured audit tool, based on the pilot study, was developed for data entry using an Excel spreadsheet. The PI designed the instrument to contain a multiple-choice format for common responses for categorical variables (i.e. nutritional status). Continuous variables (i.e. age, height, and weight) required a numerical format for entering data. There were sections for admission and discharge dates (in mm/dd/yyyy format), as well as a free-text section for any other relevant social and environmental notes from records.

Data Collection

Data collection was completed in November 2021. The PI traveled to Guatemala and worked on site at the NRC to enter data into an Excel spreadsheet. Each medical record that was

included in the study was explored for the relevant variables. Each case was given an ID number, and data points were collected on admission and discharge, where applicable. Missing data were recorded as 'unknown.' No paper records were removed or photographed; only deidentified data was collected. Cases were also classified as either pre-COVID-19 (prior to March 1, 2020) or post-COVID-19 (after March 1, 2020). Upon completion of data entry, the dataset was uploaded to SPSS v. 28, where it was coded, organized, and analyzed by the PI with regular consultation from dissertation committee members.

Data Analyses

The primary outcome measure was time-to-recovery from SAM. Primary predictor variables were pre- and post-COVID cohort, age, gender, severity of malnutrition, and admission weight. Secondary predictors variables were use of Amoxicillin, multivitamins, nebulizer/bronchodilator, and zinc. Secondary diagnoses were not available in the records. Data was analyzed using SPSS v. 28 and SAS v. 9.4. Descriptive statistics, Chi-square tests, Student's *t*-tests, and multiple logistic regression were conducted to fulfill the aims of this study.

Aim 1: Describe the characteristics of a sample of infants and children (0-5 years) treated for malnutrition at a residential NRC in Antigua, Guatemala. The hypothesis of this aim was that there would be a greater number of young children, more males, and a correlation between being from a rural region and being more severely malnourished. Cultural and social factors were examined in relation to the Social Ecological Model.

Descriptive statistics were conducted to identify characteristics and patterns or trends to describe and better understand childhood malnutrition.

Aim 2: Examine the relationships between individual clinical variables and time-to-recovery. The hypothesis of this aim was that older children, without secondary diagnoses, and with less severe malnutrition would have quicker time-to-recovery.

Multiple logistic regression was utilized to investigate the effects of predictor variables (pre- and post-COVID cohort, age, gender, severity of malnutrition, admission weight, use of Amoxicillin, multivitamins, nebulizer/bronchodilator, and zinc) on outcome (time-to-recovery from SAM) in one model.

Aim 3: Assess the impact of COVID-19 on child outcomes at the NRC. The hypothesis of this aim is that children in the post-COVID sample would have longer time-to-recovery than those in the pre-COVID sample.

Descriptive statistics, Chi-Square tests, and Student's t-tests were conducted to explore characteristics and significant relationships in data when comparing children pre-and post-COVID-19.

Limitations

There were several limitations of this retrospective record review. This study drew on a convenience sample of available records, which limits generalizability. The sample size was smaller than anticipated due to low admission rates; power analysis was not met. Due to the retrospective design, there was no way to control for missing data. Also, this study was looking specifically at one NRC in Guatemala, which limits generalizability of findings.

Summary

This study explored variables that describe the course and outcomes of childhood malnutrition. The primary outcome variable was time-to-recovery, the total number of days from admission to the NRC to a child's successful completion of treatment. The data in this study was

used to describe the population admitted to the NRC, identifying trends among variables, and evaluating the impact of individual variables (i.e. nutritional status or gender) on the primary outcome, time-to-recovery. Data was collected via a retrospective record review of paper medical records for children admitted and discharged from 2019-2020. The PI collected and analyzed all data for this research study. In order to fulfill the three aims of this study, descriptive statistics, Chi-square tests, Student's t-tests, and multiple logistic regression were conducted.

CHAPTER FOUR

A Feasibility Study to Examine Clinical Variables of Childhood Malnutrition in Guatemala

Abstract

Guatemala is a country with the highest rate of malnutrition in Latin America and fifth highest worldwide. The purpose of this pilot study was to determine the feasibility of examining clinical variables of Severe Acute Malnutrition (SAM) among a subset of children at a Guatemalan Nutrition Rehabilitation Center (NRC). The study was conducted using a secondary dataset of children who were admitted and discharged at the NRC in 2018 using Research Electronic Data Capture (REDCap). The 12 key clinical variables selected for extraction from the dataset were age, gender, height, weight, nutrition status, referral, diet, secondary diagnoses, medications, supplements, discharge disposition and time-to-discharge. A total of 42 cases were reviewed for the key clinical variables. The two major findings were (a) the lack of access to height and weight at discharge and (b) the inability to verify time-to-recovery. Mean age of participants was 23 months (SD = 12.9). The median time-to-discharge among children in this sample was 48 days. All children were discharged home. The Kaplan-Meier analyses indicated that children less than 2 years of age had slower time-to-discharge (51 days), compared to those older than age 2 (32 days); though not statistically significant. Findings from this study provide valuable data to inform ways NRC leadership can better assess and improve child health outcomes. Inclusion of height, weight, secondary diagnoses, diet, medications and supplements in future reports would provide a comprehensive assessment of children recovering at the NRC. The inability to determine time-to-recovery in this study highlights the importance of considering the social context when investigating SAM recovery in future studies. International community-academic partnership could contribute to understanding malnutrition and time-to-recovery.

Introduction

An estimated 16 million children suffer from Severe Acute Malnutrition (SAM) worldwide (UNICEF, 2015; 2021) and as a result of childhood malnutrition, 149 million children experience growth stunting (WHO, 2021). Childhood malnutrition, a preventable disease, can negatively impact both physical and cognitive development, and for many infants can be fatal. A disproportionate number of children in low- and middle-income countries (LMIC) are affected by SAM (UNICEF, 2021). Guatemala has the highest rate of malnutrition in Latin America, and fifth highest worldwide (USAID, 2021).

Numerous studies have addressed malnutrition in Guatemala. Adequate nutrition is the outcome of a complex collection of factors: cultural and personal preferences, food security, employment, gender, and social views (Kadetz, 2014). In Guatemala adequate nutrition is compounded by multiple indigenous groups, numerous dialects, and people living in remote conditions (Kadetz, 2014; Cuj et al., 2020). Among indigenous mothers living in Guatemala, growth stunting and malnutrition were often characterized as normal unless the child had overt physical symptoms (Chary et al., 2013). Brown et al. (2016) found Guatemalan mothers acknowledged malnutrition but underestimated its severity. Fortified foods were perceived as expensive and prioritized only during periods of acute malnutrition (Brown et al., 2016). In an ethnographic study, researchers found gendered feeding practices among indigenous Guatemalan families, which resulted in females having healthier growth in their first year of life, while males required more complementary feeding strategies (Tumilowicz et al., 2015). Complementary feeding strategies require mothers to supplement breast milk to meet nutritional needs (Tumilowicz et al., 2015). Researchers in another study found that there are many obstacles to effective use of complementary feeding practices such as Ready-to-use Therapeutic Food

(RUTF) in Guatemala; these practices lack cultural acceptance within many indigenous communities (Davis et al., 2014). In a pilot study, inadequate resources to meet nutritional needs, lack of variety in the diet, and high rates of secondary illness were factors associated with growth stunting in Guatemala (Kragel et al., 2020). Other investigators reported that Ch-orti Maya women explained how the environment impacted the health of the community; yet, children's physical symptoms (diarrhea and respiratory infections) were rarely acknowledged (Gentry & Metz, 2017). Researchers conducted multivariable Bayesian logistic multilevel regression models of 51 recent demographic and health surveys and found that children who are male, of low birthweight, or from poorer, rural areas with high rates of unemployment and illiteracy are significantly more likely to have SAM (Fagbamigbe et al., 2020). In one study, researchers found that when fathers migrated out of the country for employment their child's growth patterns worsened (Davis & Brazil, 2016). Factors, such as the family and home environment, are essential to consider when investigating SAM (Voth-Gaeddert & Oerther, 2019).

Nutritional intervention studies have also been conducted among Guatemalan children. In one intervention study, the high rates of stunting pre-intervention indicated the need for earlier involvement to promote optimal child health (Krebs et al., 2012). A longitudinal randomized controlled trial provided food assistance over time to children 1-24 months and found that these targeted programs reduced growth stunting among children under age 2, the critical period for nutritional intervention (Olney et al., 2018). However, the prevalence of stunting was still at least 50% at 24 months in all six study groups (Olney et al., 2018). Researchers investigating a food assistance program found that these programs can be an effective way to increase accessibility (Jensen et al., 2016), but there are concerns for the long-term sustainability of these programs.

In addition, researchers conducted a recent cross-sectional study of nine Latin American and Caribbean countries and found a natural improvement in socioeconomic inequality in all countries except Guatemala and Bolivia (Flores-Quispe et al., 2019). Guatemala had the highest prevalence for stunting and the highest proportion of households in rural areas out of the nine countries (Flores-Quispe et al., 2019). In 2019, Gaensbauer et al. (2019) analyzed the correlation between enteric pathogens that cause diarrheal illness and socioeconomic variables among 316 Guatemalan children. Rural participants had significantly higher malnutrition rates, exposure to animals, and poorer sanitation (Gaensbauer et al., 2019).

Socio-economic and ethnic disparities of SAM within Guatemala are ongoing; poverty and growth stunting is more prevalent among indigenous groups (Batis et al., 2020). Researchers called for improved health equity, specifically in Guatemala, where health inequalities remained unchanged (Flores-Quispe et al., 2019). The literature on Nutrition Rehabilitation Centers (NRCs) is limited, and no studies have been found on Guatemalan NRCs. Thus, the purpose of this pilot study was to determine the feasibility of examining clinical variables of SAM among a subset of children at a Guatemalan NRC.

Current Management Strategies for SAM

The Sphere Project (2011) was designed by various non-governmental organizations to determine standards of care for health problems among global communities; and has become the standard of reference for non-profit work. According to the Sphere Project, the international standards for recovery from malnutrition or SAM are a recovery rate of at least 75%, with less than a 10% death rate; and recovery within six weeks (Sphere Project, 2011). The recommendation is weight gain of at least 8g/kg/day during treatment (Sphere Project, 2011). The primary treatment strategy for SAM is RUTF (WHO, 2013). Vitamins, minerals and anti-

parasitic or antibiotic agents are also often part of SAM treatment (WHO, 2013;2016). The management of SAM can require hospitalization but most often is managed in Nutrition Rehabilitation Centers (NRCs) or Outpatient Treatment Programs (OTPs).

In NRCs, children are managed in a community residential treatment center; they are monitored by staff, and parents/guardians are provided education on healthy feeding practices (Rastogi et al., 2018). In some programs, children stay until they recover, and in others they stay for a maximum of 14 days of treatment and then are discharged with resources for parents to continue to manage care at home (Rastogi et al., 2018). Days in treatment have ranged from 14 to 21.8 days (Asres et al., 2018; Golandaj et al., 2017; Joshi et al., 2020); however, many programs are designed as 14-day programs, so discharge is not necessarily indicative of recovery. Rates of weight gain ranged from 3.8 - 9.92 g/kg/day (Chaturvedi et al., 2018; Golandaj et al., 2017; Rastogi et al., 2018; Taneja et al., 2012); secondary diagnoses have been the major deterrent to recovery (Sanghvi et al., 2014). In several studies the majority of children admitted to the programs were under age 2 (Rastogi et al., 2018; Joshi et al., 2020). In multiple studies primarily set in India, challenges were the inability to follow up with patients after discharge, mothers' lack of knowledge on feeding practices, and environmental factors that negatively impact health (Golandaj et al., 2017; Sanghvi et al., 2014; Taneja et al., 2012).

In OTPs, parents or guardians bring children to a designated clinical site, where they are assessed by providers and offered appropriate treatments, including supplemental food and medications. Parents manage their children at home with these resources and then return on a regular basis to the program site for further evaluation (Liben et al., 2019). Most studies of OTPs are based in African countries. Time-to-recovery in published studies ranged from 38.5 days to73 days (Akparibo et al., 2017; Atnafe et al., 2019; Doocy et al., 2018; Gebremedhin et al.,

2020; Kabalo et al., 2017; Mamo et al., 2019; Teshome et al., 2019). Reported rates of weight gain ranged from 4.2 -10.5 g/kg/day (Kabalo & Seifu, 2017; Kassaw, 2020; Teshome et al., 2019) and recovery rates ranged from 42%-79.8% (Akparibo et al., 2017; Al Amad et al., 2016; Atnafe et al., 2019; Doocy et al., 2018; John et al., 2018; Kassaw, 2020; Mamo et al., 2019;). Predictors of recovery included: use of antibiotics, Vitamin A (Teshome et al., 2019), vaccinations (Al Amad et al., 2016), lack of secondary diagnoses (Doocy et al., 2018; Kassaw, 2020), admission weight greater than 7 kg (Gebremedhin et al., 2020), mid-upper-arm circumference >11.5 cm (Kassaw, 2020), and decreased travel time to the OTP site (Teshome et al., 2019). Children less than 24 months old had significantly longer time-to-recovery than those older than 24 months (Doocy et al., 2018). In another study, children greater than age 3 recovered slower (Al Amad et al., 2016). Mortality was highest among those who were severely stunted on admission and those aged 6-11 months (John et al., 2018). Those with Marasmus were either less likely to recover or recovered significantly slower than those with Kwashiorkor (Atnafe et al., 2019; Kabalo & Seifu, 2017l Mengesha et al., 2016). While OTPs provide increased accessibility for more children to receive treatment, there are concerns for sustainability (Liben et al., 2019). There are heavy burdens on families for travel, and children in these programs have not consistently achieved international standards for weight gain over time (Liben et al., 2019).

Methods

A feasibility study was conducted using a 2018 secondary dataset of children who had been admitted to and discharged from the largest NRC in Guatemala. The rationale for conducting a feasibility study was that investigators could evaluate the practicality of using a secondary dataset, better identify the challenges in international research, and establish

preliminary findings to build upon in future work. A long-standing community-university partnership led to sharing of this dataset; originally compiled by administrative staff for their annual reports to public health officials and financial donors. The research team for this pilot study consisted of a PhD nursing student (Principal Investigator), an undergraduate honors student, biostatistician, and nursing professor with research expertise in global and Latino population health. The NRC leadership served as consultants.

The research team originally sought to assess a total of 12 clinical variables (See Figure 2). Process variables were age, gender, height, weight, nutrition status, referral type, diet, secondary diagnoses, medications, supplements, and discharge disposition. The outcome variable was time-to-discharge, or the total number of days from admission date to discharge date, as calculated by the PI. Criteria for feasibility was that the data for at least 50 children were extracted from a secondary dataset, less than 5% of the total data points would be missing, and at least 90% of the children's records would contain all key clinical variables. These criteria were similar to a previous feasibility study (Kamsvåg et al., 2021) and agreed upon by the research team. The university institutional review board approved the study and the NRC leadership provided a letter of support.

Figure 2

Study variables and definitions

Variables Available in Dataset	**Definition/Measurement**
Age	Number of months
Gender	Male or female
Height	In centimeters
Weight	In Kilograms

Nutrition Status	Mild, moderate, or severe
Referral/Region	Parent, outpatient, inpatient, other
Discharge disposition	To home or higher level of care
Time-to-Discharge	Total # of days from admission to discharge
Variables Not Available in Dataset	**Definition/Measurement**
Diet	As prescribed by the nutritionist
Secondary diagnoses	Any other additional medical problem
Medications	Prescription drugs
Supplements	Vitamins and minerals

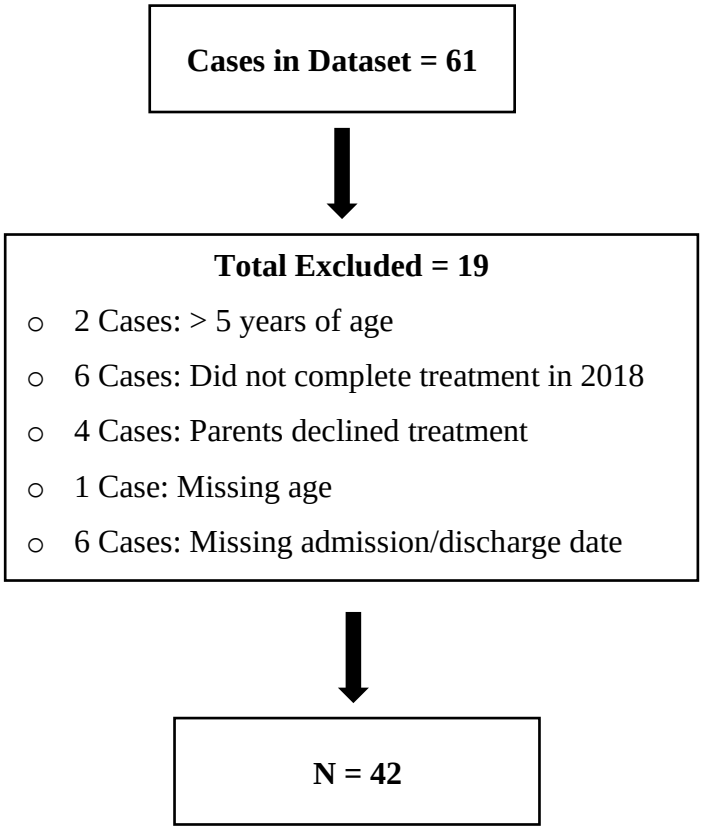
Setting and Sample

The NRC, founded in 2006, is part of a large non-profit organization, located near Antigua, Guatemala. The NRC is a residential treatment center that serves an estimated 135-170 children annually with food, medicine, and health assessments from a Guatemalan healthcare team. Children are admitted to the NRC by parent referral, or by clinic, public health department, hospital, or private doctor referral. A pediatrician, nutritionist, and nursing assistants staff the center full time and manage the care of 15-20 children daily. Around 70% of children have a parent who stays with them, which is encouraged (personal communication, August 24, 2021, NRC Center Coordinator). This NRC has three floors: first floor has a waiting room, exam room, and an isolation room for acutely ill children; second floor has three children's rooms with 5-10 cribs in each, a kitchen, laundry room, linen closet , nurses' station, bathroom, and a bathing area; and t third floor is an open-air rooftop patio with an area for play and drying laundry.

Of the 136 children admitted to the NRC for treatment in 2018, only 45% (n = 61) were included in a deidentified dataset from which this study's sample was derived. Out of the 61, a total of 42 child records met inclusion criteria of 0-5 years old, a diagnosis of SAM, completed treatment and discharged from the NRC in 2018. Exclusion criteria was age over 5 years, parents' refusal to complete treatment, unknown age, unknown admission or discharge date, or treatment not being completed in 2018 (See Figure 3). The NRC was given a $200 donation from the research team as a contribution for needed health care supplies.

Figure 3

Cases excluded from dataset



Data Collection

The PI developed a structured tool for data collection using Research Electronic Data Capture (REDCap) and determined eligibility of children's records. The REDCap tool provided multiple choice and text boxes for the researchers to enter information on each of the 12 clinical variables, as available. Each record was given a unique identifier and saved on a secure university research drive. An undergraduate honors student was trained by the PI in research protocol and data entry using REDCap. The PI entered data for the first 24 records, and the student entered data for the final 18 records. The data was then exported into SPSS v. 28. The PI checked every fourth record completed by the student to establish 90% interrater reliability. In the case of discrepancies, such as a variable entry left blank instead of marking 'unknown,' the PI went back to the original dataset and corrected the data entry within SPSS.

Findings

The mean age of participants was 23 months (SD = 12.9) with a range of 5 to 59 months. In this sample, 29 cases (69%) were under 2 years of age (See Table 3). The Kaplan-Meier analyses indicated that children less than or equal to 2 years of age had slower time-to-discharge (51 days), compared to those older than age 2 (32 days). The difference in time-to-discharge was not statistically significant, per the Fleming-Harrington test, $\chi 2$ (1, N = 42) = 2.77, p = 0.096. More than half of the children were moderately malnourished (n = 27, 64%) while over one third were severely malnourished (n = 15, 36%); no children were acutely malnourished. Among severe cases, Marasmus was reported in 5 cases (12%); there were no cases of Kwashiorkor. The majority of children were females (n = 23, 55%). Twice as many females (n = 10, 67%) were severely malnourished compared to males (n = 5, 33%), and there were more females (n = 6, 75%) under age one in the sample than males (n = 2, 25%). A child was referred to the NRC

most often from the community, such as clinic, health post or department of public health (n = 19, 45%); followed by parent referral (n = 8, 19%) and hospital (n = 8, 19%), or private doctor (n = 1, 2%). There were 6 cases (14%) with unknown referral locations. Most children resided with families from the southern region of the country (n = 25, 60%), followed by the central region (n = 12, 29%), and other regions (n = 5, 11%) of Guatemala.

Table 3

Selection of process variables from the 2018 NRC dataset

Variable	**Category**	**n**	**%**
Age	≤ 24 months	29	69%
	>24 months	13	31%
Gender	Male	19	45%
	Female	23	55%
Nutrition Status	Mild (Acute)	0	0%
	Moderate	27	64%
	Severe	15	36%

Note. N = 42.

The two major findings were (a) the lack of height and weight data at discharge and (b) the inability to verify time-to-recovery in each case. Weight gain over time could not be calculated, so the meeting of international standards of 8g/kg/day (Sphere Project, 2011) could not be assessed. All cases included in the sample were deemed 'recovered' in the dataset, a term created by the non-clinical staff members who extracted the data from medical records. Verification of height and weight upon discharge by the research team was not possible. Since time-to-recovery could not be assessed, the term "time-to-discharge" was used to describe the

number of days a child spent at the NRC; this term is not equivalent to time-to-recovery and, therefore, cannot be compared to other studies using time-to-recovery. The median time-to-discharge among children in this sample was 48 days. There were no fatalities in this sample, and when looking at discharge disposition, no children were referred to a higher level of care. The four key clinical variables not available in this dataset were: diet, secondary diagnoses, medications, and supplements.

Discussion

Through this study, investigators determined the feasibility of examining clinical variables of SAM among a subset of children from the largest NRC in Guatemala. Given the small sample size and less than half of the total number admitted in 2018, caution must be used when interpreting results. Discharge height and weight, key clinical variables for reporting malnutrition outcomes, were not included in this dataset; thus, researchers were unable to verify time-to-recovery, and could only evaluate time-to-discharge, which limited analysis. Inclusion of these variables in future reports would provide more reliable assessment data for the NRC to report process and outcome indicators. No children in this sample were referred to a higher level of care, which suggests better outcomes than international standards. In addition, the fact that children were either moderately or severely malnourished may account for the longer time-to-discharge. This study provides valuable data to inform ways NRC leadership can improve assessment of their program outcomes in the future.

Previous studies' findings were that young age was predictive of slower recovery, requiring longer nutritional support, and that there is a need for intervention among children under age 2 (Olney et al., 2018). This study had similar findings, with children less than or equal to 24 months of age having slower recoveries compared to older children. In the study sample,

more females were severely malnourished, while in another study males were more likely to be malnourished (Tumilowicz et al., 2016). Further research to understand infants' health in their first year of life, parents' perspectives, and whether gendered feeding practices continue to be experienced would add to our knowledge of SAM in Guatemala and how to best develop early interventions.

The outcome variable, time-to-recovery requires special consideration within this sample. At the NRC, children live on site, and are expected to be discharged when they have successfully completed treatment. Per discussions with NRC leadership, children sometimes stay at the center long after recovery due to adverse social conditions. No indication was included in the dataset of cases that required staying at the NRC longer due to social conditions. In further investigations, the outcome of time-to-recovery will need to be more clearly identified, through collaboration with NRC partners, to identify the point of 'nutritional recovery' when it does not coincide with official discharge from the facility. In addition, this highlights the importance of considering the social context when investigating SAM recovery in future investigations. The role of home life, including family structure and resource availability, greatly impact a child's nutritional and overall health status.

Overall, this method of data collection was insufficient to fill gaps in the literature related to childhood malnutrition and time-to-recovery in Guatemala. Researchers anticipated that working with an existing dataset would have advantages and disadvantages. Advantages of an existing dataset included the accessibility to international data, particularly during the COVID-19 pandemic when travel was restricted, and that utilizing an existing dataset decreases the project time and resources. The disadvantage to this method were the missed opportunities to collaborate with the NRC when they were creating the 2018 dataset, so that it could include key variables

important to the assessment of malnutrition. The limitations in this investigation were greater than expected. The lack of available height and weight data at discharge was a particular constraint, as the researchers could not verify recovery. Also, in past studies, researchers found that secondary diagnoses limited time-to-recovery (Kassaw, 2020; Sanghvi et al., 2014), but that variable was also unavailable in this dataset. Diet, medications, and supplements are variables that provide a more complete clinical picture; thus, missing these variables limits interpretation of this dataset. Our experience from 12 years of working at this NRC and collaborating with NRC leadership is that this data is available in paper medical records, however, we do not know how complete these records are. Going forward we can collaborate on data collection of key variables directly from medical records in order to better capture true outcomes of malnutrition.

The ongoing international community-university partnership was key to the success of this study and will be vital in future work to understand malnutrition and time-to-recovery. Findings highlight the need for a follow up study and will provide a foundation for the larger comprehensive retrospective record review that is to follow. Investigators have a greater understanding of data availability and how variables are recorded within records. Also, through collaborative discussions with NRC leaders, researchers are able to more clearly understand the data available in paper records on-site at the NRC and are able to utilize knowledge gained from this pilot study in development of the data collection tool. This partnership is an essential component of success when conducting international research and serves to improve ongoing evaluation of population health.

Additionally, many gaps in understanding could be investigated using qualitative exploratory methods. For example, investigation of the perspectives of parents would add another dimension of understanding to time-to-recovery, such as, decision making related to self-

referrals and refusal to complete treatment. Further inquiry of child outcomes within the critical period (Olney et al., 2018), particularly investigating gendered feeding practices (Tumilowicz et al., 2015) would add to our understanding of SAM recovery. Also, socioecological information on children, in particular, of the southern and central regions of Guatemala would provide a better understanding of SAM and inform development of culturally-tailored interventions.

Conclusion

This pilot study used a 2018 secondary dataset of children who had been admitted to and discharged from the Guatemalan NRC. The international community-university partnership is an essential component of understanding clinical variables of SAM. This pilot study identified variables important to nutritional outcomes, yet feasibility criteria were not met. Findings can improve the assessment of process and outcome indicators in the future and suggest the value of considering the social context when investigating SAM recovery. Future collaborative investigations using both quantitative and qualitative methods could address the limitations in this feasibility study.

CHAPTER FIVE

Understanding the Relationship between Key Clinical Variables of Childhood Malnutrition and Time-to-Recovery in Guatemala

Abstract

Guatemala has the highest rates of Severe Acute Malnutrition (SAM) in Latin America, and with the onset of the COVID-19 pandemic, the number of Guatemalans experiencing food insecurity doubled. The purpose of the study was to understand malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic. A retrospective record review of children admitted to the NRC was conducted, examining cases both pre-and post-onset of COVID-19 and guided by the Social Ecological Model. There were few significant differences between pre- and post- COVID cohorts. There was no difference between cohorts in regard to time-to-recovery. When cohorts were combined, mean time-to-recovery was 39.57 days (SD = 25.62) among recovered cases (n=149). Mean rate of weight gain was significantly higher in the post-COVID cohort (9.1 g/kg/day, SD = 9.5), compared to pre-COVID (6.6 g/kg/day, SD = 6.9). Amoxicillin was the only significant predictor variable; children receiving Amoxicillin were more likely to not meet recovery standards. A more comprehensive evaluation of cases using Amoxicillin is needed. The lack of differences between COVID cohorts was possibly attributed to low admission rates post-COVID. Scant availability of sociocultural data within records limited analysis. It would be beneficial for the NRC to conduct a family needs assessment on admission, to quickly identify sociocultural factors that may serve as potential barriers to families as they navigate and maintain nutritional recovery. Further research is needed to more fully understand the complexities COVID-19 has had on childhood SAM outcomes.

Introduction

It is estimated that 400,000 child deaths per year are attributed to Severe Acute Malnutrition (SAM) (WHO, 2019), disproportionately affecting children in low- and middle-income countries (LMIC) (UNICEF, 2021). Children who are undernourished are more susceptible to infection, and their fragile state results in slowed recovery and increased risk of complications (UNICEF, 2021). Long-term, SAM negatively impacts child growth and development (WHO, 2021b). Guatemala, a low-income country, has the highest rate of childhood malnutrition in Latin America, and fifth highest worldwide (USAID, 2021).

In Spring 2020, the World Health Organization (WHO) announced a global pandemic of the novel SARS-CoV2 virus (WHO, 2020). This pandemic disproportionately impacted LMICs, as lockdowns and food shortages left vulnerable families unable to afford necessities; additionally, in low-income areas social distancing was often impossible and adequate PPE was unavailable (Kabir et al., 2020; Zar et al., 2020). Since the onset of the pandemic, the number of Guatemalans experiencing food insecurity has doubled, and an estimated 1.2 million Guatemalans were in need of emergency food-aid (Action Against Hunger, 2020). The United Nations Children's Fund (UNICEF) predicts that malnutrition will rise among families at high risk for food insecurity as the COVID-19 pandemic continues into the third year of transmission (UNICEF, 2021). Many Guatemalans faced loss of jobs and food insecurity from the closure of public transportation systems and food markets (People for Guatemala, 2020). In a recent study, investigators found that the pandemic negatively impacted income, food security, and diet patterns (Ceballos et al., 2021). Overall, the onset of the pandemic threatens longstanding consequences for undernourished people, particularly marginalized populations, and may undo previous widespread efforts to improve global nutrition (Saccone, 2021; Victora et al., 2021).

Young children from LMICs are most at risk for life-long complications from malnutrition in the midst of the COVID-19 pandemic; there is an urgent need for provision of services and policy development among national stakeholders to improve child health during this pivotal time (Akseer et el., 2020; Fore et al., 2021; Ntambara & Chu, 2021; Saha & Chouhan, 2021). The World Bank (2020) began the *Crecer Sano* Nutrition and Health Initiative in Guatemala to improve practices, services, and behaviors surrounding malnutrition. This initiative provides nutrition services and resources for mothers and children (World Bank, 2020) and provides evidence of the need to prioritize research on the elimination of SAM in Guatemala. Guatemala's high rates of SAM (USAID, 2021) and rising rates of food insecurity due to the COVID-19 pandemic (Action Against Hunger, 2020) make this an important setting to explore the clinical variables of SAM and the SDOH that impact child health. Thus, the purpose of the study was to understand malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic.

Review of Literature

Early identification of SAM among children is a WHO priority that encompasses management and prevention strategies (WHO, 2019). In particular, children under age 2 are at a critical period for nutritional intervention (Olney et al., 2018). A synthesis of the literature captures an understanding of nutritional standards and treatment programs, medications and supplements, the context of Guatemala, and the SDOH.

Nutritional Standards and Treatment Programs

The Sphere Project was founded in Geneva in 1997 by various non-governmental organizations, including the Red Cross, to determine standards of care for humanitarian action among global communities through inter-agency collaboration (Sphere Project 2011). It

promotes quality and accountability and has become the standard of reference for non-profit work (Sphere Project, 2011). The standard for SAM treatment programs is that at least 75% of children recover successfully, with a mortality rate of less than 10% (Sphere Project, 2011; Hassen et al., 2019); and recovery within six weeks (Kabalo & Seifu, 2017). It is also recommended that children gain at least 8 g/kg/day during treatment (Sphere Project, 2011). Multiple types of treatment programs for SAM, both Nutrition Rehabilitation Centers (NRCs) and Outpatient Treatment Programs (OTPs), have been implemented with varying effectiveness; these programs have issues related to accessibility, appropriate staffing, and long-term sustainability (Bhutta et al., 2017; Trehan & Manary, 2015).

In Nutrition Rehabilitation Centers (NRCs) children stay on site and recover in a community setting; they are monitored by staff, and parents/guardians are provided education on healthy feeding practices (Rastogi et al., 2018). Most NRCs in the literature are based in India. Rates of weight gain in these programs ranged from 3.8 – 9.92 g/kg/day (Chaturvedi et al., 2018; Golandaj et al., 2017; Rastogi et al., 2018; Taneja et al., 2012); secondary diagnoses were a major deterrent to recovery (Sanghvi et al., 2014). In several studies the majority of children admitted to the programs were under age 2 (Joshi et al., 2020; Rastogi et al., 2018). There are few current studies on these programs, so the knowledge of barriers of these programs is limited. One recommendation is a stronger integration of structured play therapy to maximize child development (Kumar et al., 2021).

Outpatient Treatment Programs (OTPs) offer a clinical site where children are brought in and assessed by providers, offered appropriate treatments, provided supplemental food and medications, and sent home with ongoing evaluation and treatment (Liben et al., 2019). The OTPs provide a means of local access for SAM management and early intervention to reduce

fatalities and complications (Kassaw, 2020). Most studies that evaluate OTPs are based in African countries. Time-to-recovery in published studies ranged from 38.5 days to 73 days (Akparibo et al., 2017; Atnafe et al., 2019; Doocy et al., 2018; Gebremedhin et al., 2020; Kabalo & Seifu, 2017; Mamo et al., 2019; Tadesse et al., 2018; Teshome et al., 2019) and reported rates of weight gain ranged from 4.2 -10.5 g/kg/day (Kabalo & Seifu, 2017; Kassaw, 2020; Teshome et al., 2019). Predictors of recovery in OTPs included: use of antibiotics (Mamo et al., 2019; Teshome et al., 2019), vitamins, decreased travel time to the OTP site (Teshome et al., 2019), up-to-date vaccinations (Al Amad et al., 2017), lack of secondary diagnoses (Doocy et al., 2018; Dorion et al., 2012; Kassaw, 2020), admission weight greater than 7 kg (Gebremedhin et al., 2020). While OTPs provide increased accessibility for more children to receive treatment, sustainability is a concern (Liben et al., 2019). There is heavy burden on families for travel, and children in these programs have not consistently achieved international standards for weight gain over time (Liben et al., 2019).

Community Health Workers (CHWs) collaborate with outpatient treatment programs (Alvarez Morán et al., 2018; López-Ejeda et al., 2019). Trained CHWs are uniquely positioned in their communities to identify and manage uncomplicated cases of SAM and refer them for treatment, or in mild cases, manage at the household level (Alvarez Morán et al., 2018; Boyd, 2022; López-Ejeda et al., 2019). Appropriate incentives and training, as well as provision of needed treatment measures, are essential to the success of CHWs in the management of SAM (Ireen et al., 2018; López-Ejeda et al., 2019; Mambulu-Chikankheni et al., 2018).

Overall, NRCs and OTPs have had some success in managing SAM. However, a major concern across all SAM treatment methods is appropriate follow-up with families to ensure sustained growth patterns, which is a challenge in LMIC with limited resources (Bhujade et al.,

2021; Pandey et al., 2018; John et al., 2018). Routine evaluation of household water supply is necessary for successful management and continued improvement of child health (Dorion et al., 2017).

Medications and Supplements

For children with SAM Ready-to-Use Therapeutic Food (RUTF) has been the primary treatment strategy (WHO, 2013); yet, for long-term health outcomes, RUTF must be paired with educational strategies (Grossman et al., 2015; Kassier et al., 2019). The Institute of Nutrition of Central America and Panama developed *incaparina* as a low-cost, culturally accepted beverage, with the nutritional equivalence to milk (Scrimshaw, 1980). Incaparina is typically made of vegetable protein, and is suitable for weaning infants and children, particularly in low-income countries with limited resources, such as Guatemala (Scrimshaw, 1980).

In addition to formulas, various medications and supplements, such as Amoxicillin, zinc, and multivitamins, are currently recommended for SAM management; however, much of the research is low-level evidence and further investigation is warranted (Lanou et al., 2019; Schauer et al., 2017; WHO 2013; 2016). The most common recommendation is to treat children with uncomplicated SAM with oral Amoxicillin (Williams & Berkley, 2018; WHO, 2016); yet, research in this field has had conflicting results. Some found minimal or no difference in recovery when comparing Amoxicillin provision in SAM treatment, and investigators warned against routine antibiotic use given worldwide antibiotic resistance (Isanaka et al., 2016; 2020; Lelijveld et al., 2021; Maataoui et al., 2020; Nel, 2018; Warring & Fischer, 2016). However, other researchers found Amoxicillin was positively associated with reduced mortality, improved time-to-recovery, and lower risk of hospitalization; therefore, they recommended continued prescription of Amoxicillin for uncomplicated SAM (Abate et al., 2020; Bitew et al., 2020;

Kabalo & Seifu, 2017; Million et al., 2017; WHO, 2016; Williams & Berkley, 2018). Overall the evidence for this recommendation is weak, and in settings with limited resources, this practice is often not prioritized (WHO, 2016).

Adequate provision of vitamins and minerals is another recommendation during SAM treatment (WHO, 2019), and adequate supplementation can positively impact cognitive functioning (Olsen et al., 2020). According to the WHO (2019), vitamins can be provided through fortified formulas, or individual ready-made vitamin mixes. A recent study found that many Guatemalan children had deficiencies in folate and B12 and recommended additional fortification methods to ensure daily needs are met (Wong et al., 2022). Zinc has been recommended as a standard therapy for children experiencing diarrhea, to reduce duration and severity of illness (WHO, 2013). In a recent study of Guatemalan children, investigators found that zinc deficiencies in children under two were associated with anemia, and recommended micronutrition supplementation in this population (Palacios et al., 2020). Zinc supplementation programs have also improved health outcomes among Guatemalan children; these programs should be targeted to meet the critical needs of children under age 2 (Grossman et al., 2015; Monroy-Valle, et al., 2017). Evidence-based practices surrounding administration of medications and supplements to positively impact SAM recovery are lacking.

Context of Guatemala

The state of the science surrounding childhood SAM within the context of Guatemala includes individual knowledge, health beliefs and practices, food assistance interventions, gender equity, as well as social policies and health disparities.

Knowledge, practices, and beliefs

Various studies have evaluated knowledge, practices, and beliefs related to nutrition in Guatemala. Nutrition is the outcome of a complex collection of factors: cultural and personal preferences, accessibility, employment, gender, and social views (Kadetz, 2014). In previous studies, childhood malnutrition was not recognized among Guatemalan mothers (Chary et al., 2013; Brown et al., 2016; Gentry & Metz, 2017), and often complementary feeding practices lacked cultural acceptance (Tumilowicz et al., 2015). In addition, family and home environment contribute largely to child health and illness. In a study of 852 Guatemalan children, the most significant predictors of malnutrition were: having other children under five in the household, vomiting or diarrhea within the previous week, and prior poor nutritional status (Nagata et al., 2016). In another study, researchers looked specifically at environmental factors and found that access to potable water and sanitation were the most vital to child development (Voth-Gaeddert & Oerther, 2019). Investigators in a pilot study evaluated the prevalence and risk factors of growth stunting in Guatemala; lack of variety in the diet and high rates of secondary diagnoses were factors associated with stunting (Kragel et al., 2020). It is important to consider the family and home environment when evaluating SAM and to create sustainable interventions that support water, sanitation, and hygiene needs. Researchers are working to develop a scale to measure infant feeding behaviors, validated in several countries, including Guatemala, to better identify eating habits among children at risk for SAM, to inform causes and treatment of malnutrition (Wright et al., 2021).

Food assistance interventions

Previous investigation of SAM in Guatemala was also related to food assistance interventions. Chary et al. (2011) found that socioeconomic barriers including poverty, unemployment, alcoholism, domestic violence, lack of autonomy, and unfair wages forced

mothers to delay the introduction of solid foods. As a result of the financial barriers and gender inequality, community nutrition programs offered a solution to childhood malnutrition (Chary et al., 2011). Food assistance programs can be an effective way to increase accessibility to nutritious foods; however, concerns about sustainability of these types of programs remain (Jensen et al., 2016; Juarez et al., 2021; Olney et al., 2018). Agricultural interventions, such as home gardens, have also been successful in previous studies, but require complementary strategies in sanitation, education, and women's empowerment to be successful (Guzman-Abril et al., 2021; Luna-Gonzalez & Sorensen, 2018).

Gender equity

It is important to consider the impact of women's employment on childhood health outcomes. Women's experiences with poverty, low-autonomy, and lack of social support can negatively impact child health (Chomat, 2021). In a multilevel analysis of malnutrition within 49 LMICs, including Guatemala, investigators demonstrated that when gender equity in relation to education and employment was high, child malnutrition was low (Ekbrand & Hallerod, 2018). The impact of women entering the workforce has benefits to child health, such as financial independence and access to healthier foods (Burroway, 2017). However, women still report lacking autonomy to make decisions regarding food access (Deeney & Harris-Fry, 2020), and this cultural shift also comes with uncertainty including how household responsibilities are managed, childcare supervision, and maternal mental health (Burroway, 2017; Oddo et al., 2018). It is also important to consider the type of work women have when discussing the impact of employment on child health (Burroway, 2017).

Social policies and health disparities

Two articles investigated social policy in Latin America, with implications for needed nutrition improvement in Guatemala. Flores-Quispe et al. (2019) conducted a cross-sectional analysis of health from nine Latin American and Caribbean countries to assess childhood growth stunting from 1996-2016. There was a natural reduction over time in socioeconomic inequality in all countries except Guatemala and Bolivia (Flores-Quispe et al., 2019). Guatemala had the highest prevalence for stunting and the highest proportion of households in rural areas out of the nine countries in the study. Researchers called for improved health equity, specifically in Guatemala, where health inequalities remained unchanged (Flores-Quispe et al., 2019). Health policies addressed undernutrition in 18 Latin American countries; still, there was a need for stakeholder collaboration for these policies to be effective and sustainable (Tirado et al., 2016).

Socio-economic and ethnic disparities of SAM within Guatemala are ongoing; stunting is more prevalent among indigenous groups, especially those with low income and low literacy (Batis et al., 2020; Mazariegos et al., 2020). Gatica-Domínguez et al. (2019) found that children who identified as indigenous Maya and living in rural areas were at greatest prevalence for being stunted. The prevalence of growth stunting among Mayan children in this study was greater than their non-indigenous counterparts (Gatica- Domínguez et al., 2019). In another study, Guatemalan children living in rural areas had significantly higher malnutrition rates, greater exposure to animals, and lower sanitation, highlighting the need for public health interventions (Gaensbauer et al., 2019). Rohloff (2021) cautioned against short-term interventions and highlighted the need for large-scale social interventions to empower indigenous Guatemalans and reduce ongoing health disparities, while prioritizing the need of individual families and recognizing the social context of their daily experience. Further, contextual factors impact the likelihood of SAM (Fagbamigbe et al., 2020). Children who were male, of low birthweight, or

from poorer, rural areas with high rates of unemployment and illiteracy were significantly more likely to have SAM (Fagbamigbe et al., 2020). Davis and Brazil (2016) found that even a father's choice to migrate out of country for work is correlated with worsened growth patterns among their young children.

Social Determinants of Health

Investigation of the key clinical variables of malnutrition alongside the Social Determinants of Health (SDOH) that impact this phenomenon is critical. The SDOH are defined as the conditions in which people are born, grow, live, work and age (WHO, 2021c). The SDOH heavily impact child health outcomes and are largely outside the individual's control. For example, if a child lives in a remote area without access to transportation or a potable water source, it would be extremely challenging for them to maintain nutrition recommendations. It is important that the SDOH be considered when striving to understand SAM in Guatemala.

Purpose

Guatemala is a unique setting as a country that could contribute to the science on assessment and evaluation of malnutrition, making it an ideal setting to advance the science. Thus, the purpose of the study was to understand malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic The aims were to (a) describe the characteristics of a sample of infants and children (0-5 years) treated for malnutrition at a residential NRC in Guatemala; (b) examine the relationships between individual clinical variables and time-to-recovery; (c) assess the impact of the COVID-19 pandemic on child health outcomes. The goal of this study was to better understand SAM within the sociocultural and economic context that exists in Guatemala today. This project provided a unique opportunity to

engage with this Guatemalan community and better understand the relationships between clinical variables of SAM alongside the SDOH, within the context of the COVID-19 pandemic.

Methods

A retrospective record review was conducted to understand malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic. The rationale was that this provided data to better understand processes and outcomes of children during treatment for SAM. Additionally, investigators examined cases both pre-and post- onset of the COVID-19 in order to evaluate the impact of the pandemic on time-to-recovery from SAM. This study was guided by the Social Ecological Model, which informed the examination of the multilevel factors influencing childhood malnutrition. The research team for this study consisted of a PhD nursing student (Principal Investigator), biostatistician, and nursing professor with research expertise in global and Latino population health. The Guatemalan-based NRC leadership staff, including the director, nutritionist, and center coordinator, served as consultants throughout the study period to provide the local context and cultural and social nuances of the project. East Carolina University's College of Nursing was the first U.S. nursing program to partner with the NRC. Since 2008, ECU nursing faculty and students have assisted staff with the care of children every summer in a cultural immersion study abroad program. This study builds on this established international community-university partnership and was approved by the East Carolina University and Medical Center Institutional Review Board (UMCIRB # 21-001884).

Setting and Sample

Guatemala is the most populous country in Central America, with the majority of citizens being from minority Mayan descent; there are ongoing health disparities among these indigenous groups (Minority Rights, 2018). Access to a potable water source and essential medications is

not reliable for many Guatemalans (Gentry & Metz, 2017). In addition, Guatemala has 0.36 physicians per 1000 people, below the recommended 2.3 per1000 to meet community needs (Central Intelligence Agency, 2018). With delayed access to vaccinations, Guatemalans continue to be negatively impacted by the COVID-19 pandemic (Welsh, 2021). As of February 2022, 32% of Guatemalans are fully vaccinated, compared to 61% in Mexico and 65% in El Salvador (Johns Hopkins, 2022).

The NRC, founded in 2006, is part of a large non-profit organization, *Nuestros Ahijados* (Our Godparents) that includes medical and dental clinics, a school, and food bank. The NRC is a residential treatment center housed in a three-story building. Admission and isolation rooms are located on the first floor. Three pediatric rooms, kitchen, laundry and nurses' station are located on the second floor. The children share one bathroom and one bathing area on this floor. Children are referred to the NRC by hospitals, health clinics, social services, or health departments. The NRC serves an estimated 135-170 children annually with food, medicine, and health assessments from a Guatemalan healthcare team. The director, center coordinator, pediatrician, nutritionist, and nursing assistants staff the center 24/7 and manage the care of 15-20 children daily. Parents are encouraged to stay with their child. Nurse aides are responsible for completing all health assessments and medical orders (i.e., medication administration, nebulizer treatments), assistance with feeding and laundry.

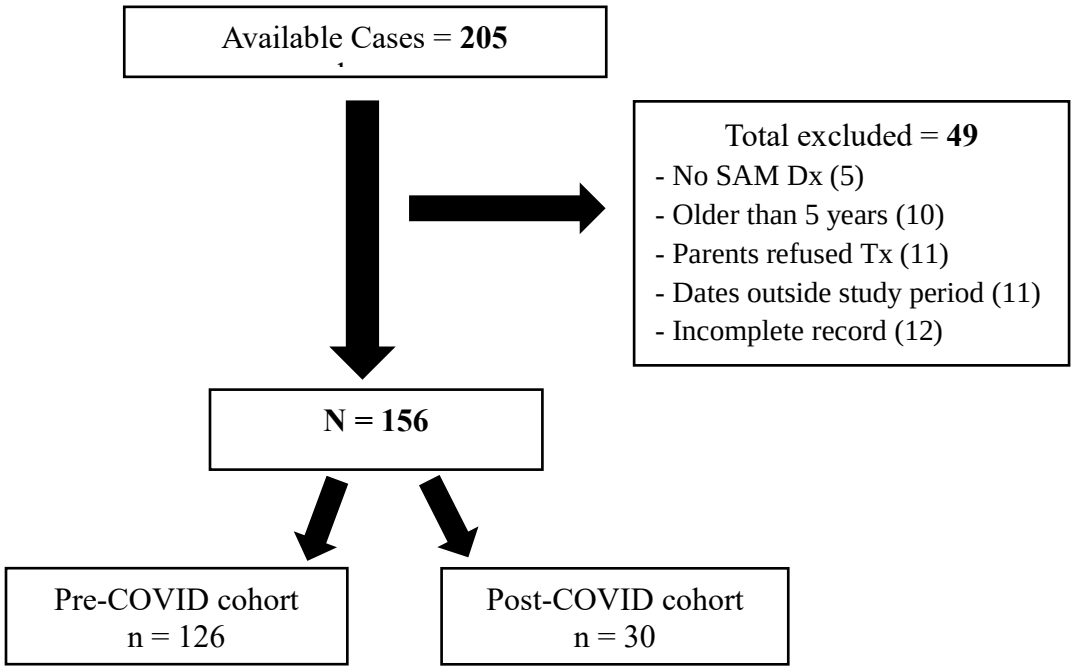
Sample size for the retrospective record review was calculated based on the two-population proportion formula using the Stat Calc application of Epi-Info (Version 7.2.4.0). To achieve the 80% power, the assumptions were: 95% confidence interval for a two-sided test, using severity of malnutrition as indicators of sampling variation, in line with similar studies (Fikrie et al., 2019; Gebremedhin et al., 2019). Accordingly, the calculated sample size was 282

cases. Considering possible missing data, 10% was added, making a calculated sample size of 312 cases.

The paper medical records of eligible children admitted to the NRC between January 1, 2019 through December 31, 2020 were identified using the following inclusion criteria: <5 years of age, a diagnosis of SAM, and those that were discharged from the NRC within the study period. Exclusion criteria are children older than 5 years of age, those whose parents refused to complete treatment, or that were not discharged from the NRC by the end of the year 2020. The PI evaluated available records to determine if they met eligibility criteria. Cases were classified as either pre-COVID-19 (prior to March 1, 2020) or post-COVID-19 (after March 1, 2020). Data was verified with the NRC leadership as needed. There were 205 cases available; 49 were excluded, leaving a total sample of 156 cases (See Figure 4).

Figure 4

NRC cases included and excluded in the study



Data Collection

Data were collected on-site by the PI in November 2021. Data were extracted from medical records of children admitted and discharged from the NRC in 2019 and 2020. A structured audit tool, based on a pilot study (Braxton et al., 2022), was developed for data entry using an Excel spreadsheet. The tool included a section for free-text notes pertaining to sociocultural characteristics, including household, neighborhood, and workplace characteristics. Missing data was recorded as 'unknown.' No records were removed or photographed; all data was deidentified. The primary outcome measure was time-to-recovery, defined as the total number of days from admission to successful completion of treatment. Primary predictor variables were pre- and post-COVID cohort, age, gender, severity of malnutrition, and admission weight. Secondary predictor variables were use of Amoxicillin, multivitamin, nebulizer/bronchodilator, and zinc (See Figure 5). Secondary diagnoses were not available in the records.

Figure 5

Conceptual and operational definitions

Variables	Conceptual Definition	Operational Definition
Dependent Variables		
Time-to-Recovery	The total number of days a child is admitted to the NRC receiving treatment for malnutrition	Total number of days from admission to NRC to successful completion of treatment, as determined by the NRC nutritionist and demonstrated by height and weight; Sphere standard is <6 weeks
Time-to-discharge	Total number of days a child is present at the NRC	Total number of days from admission to discharge; Sphere standard is <6 weeks
Independent Variables		
COVID cohort	A case admitted prior to or after the onset of the COVID-19 pandemic	Pre-COVID cohort: Jan. 1, 2019 to February 28, 2020; Post-COVID cohort: March 1, 2020 to Dec. 2020
Age	How many months and/or years a child has been alive	The number of years/months a child has been alive (measured in months)
Gender	A child's identity as either male or female	The assigned identity of a child as either male or female as indicated in the NRC records
Severity of Malnutrition	Physician's diagnosis of level of malnutrition upon admission	Mild, moderate, and severe
Type of SAM	Physician's diagnoses of specific symptoms in severe malnutrition	Marasmus, Kwashiorkor
Height	The measurement of how long a child is	The length a child is, to the nearest half centimeter, collected on admission and discharge

Variables	Conceptual Definition	Operational Definition
Weight	The measurement of how heavy a child is	Amount a child weighs, to the nearest tenth of a kilogram, collected on admission and discharge
Medications	A drug given to a child to manage their health, whether in treatment or prophylaxis	Amoxicillin, Nebulizer and/or Bronchodilator
Supplements	A substance given to children to help them meet their nutritional/health needs	Multivitamin, Zinc
Discharge disposition	The location a child went to after completing treatment at the NRC	Home, hospital, unknown
Referral	The directing of a child to the NRC for treatment	The reported means by which a child was sent for treatment (i.e. Walk-in, hospital, health clinic/department, social services)
Region	One of the 12 departments in the country child/family resides, and the corresponding region of the country	The listed region from which the child came for treatment, divided into regions (i.e. North, Central, Southern)
Sociocultural characteristics	Relevant sociocultural details available in child's file	Details included in record of child's social situation (i.e. number of children living in the home or parent's marital status) as available in the records

Data Management & Analysis

Records were given an identification number using year (19 or 20) and case (01, 02, 03, etc.) in ascending order; for example, 1901, followed by 1902, etc. Data were uploaded and analyzed using SPSS v. 28 and SAS v. 9.4. Variables were coded, outliers and missing data were

identified, discussed by the research team and managed appropriately. For example, there were three cases where the discharge height or weight value was considerably outside the norm, which was considered an error within the dataset, so these were excluded. Coded variables were validated by two members of the research team to ensure accuracy. Excluding sociocultural factors, there were less than 1% missing data. Descriptive statistics, Chi-Square tests, Student's t-tests, and multiple logistic regression were conducted to address study aims ($\alpha = .05$). Chi-square tests were conducted to analyze relationships between categorical variables. In some cases, Mantel-Haenszel Chi-square test was reported instead of the regular Chi-square when one of the categorical variables was not dichotomous. In cases where minimum expected counts were not met (≥5 in each cell of the table), Fisher's or Mantel-Haenszel exact test was reported.

Findings

Six of the 17 categorical variables evaluating the pre-COVID (n = 126) and post-COVID (n = 30) cohorts were significant: type of SAM ($p < .001$), admission weight <7 kg ($p = .036$), referral type ($p = .025$), multivitamins ($p < .001$), nebulizers/bronchodilators ($p = .004$), mother's occupation ($p = .013$) (See Table 4). Among the pre-COVID cohort, 49% (n = 62) were severely malnourished, and in the post-COVID cohort 67% (n = 20) were severely malnourished. While this was not significant, the post-COVID cohort had a greater proportion of cases with Marasmus and Kwashiorkor. There was also a significant relationship between COVID cohorts and admission weight <7kg, with the pre-COVID cohort having more cases under 7 kg on admission. In the pre-COVID cohort, children were primarily referred by the hospital, followed by walk in (i.e. self-referrals); in the post-COVID cohort, the most common referrals were from health clinics, followed by the hospital. The majority of cases in both the pre-COVID (n = 73) and post-COVID (n = 21) cohorts were admitted from the Southern region of Guatemala. While mother's

occupation was significant; however, caution should be used in interpreting these findings due to the large number of unknown data points (n = 92) (See Table 4).

Multivitamins were administered more often in the post-COVID cohort (n = 22, 73%) than the pre-COVID cohort (n = 28, 22%).The pre-COVID cohort had a greater proportion of cases utilizing nebulizers and/or bronchodilators (n = 70, 55%) compared to post-COVID (n = 8, 27%). There was no significant difference in the gender distribution of the cohorts. Also, there was no significant difference in either age ranges ≤24 months (See Table 4), or mean age in months between the pre-COVID cohort (14.0, SD = 8.4) and post-COVID cohort (16.7, SD = 11.3); t (154) = -1.51, p = .133, two-tailed). The mean difference (-2.77, 95% CI: -6.38, .85) was small (Cohen's d = .307).

The post-COVID cohort had significantly greater discharge weight (p = .018), weight gain (p = .005), and rate of weight gain (i.e. g/kg/day) (p = .042) (See Table 5). There was no significant difference in height upon discharge or total height gained between cohorts. The pre-COVID cohort mean rate of weight gain was 6.6 g/kg/day from admission to recovery date, below the international standard (8 g/kg/day), while the post-COVID mean gain was 9.1 g/kg/day (SD = 9.5), meeting the national standard (Sphere Project, 2011) (See Table 5).

Student's t-tests were conducted to compare mean time-to-recovery and mean time-to-discharge among COVID cohorts. There was no significant difference in time-to-recovery for the pre-COVID (M = 40.46, SD = 26.65) and post-COVID cohorts (M = 35.90, SD = 20.80; t (147) = .860, p = .391, two-tailed). The difference in means (mean difference = 4.56, 95% CI: -5.93-15.05) was small (Cohen's d = .178). Also, there was no significant difference in time-to-discharge for the pre-COVID (M = 44.3, SD = 26.98) and post-COVID cohorts (M = 43.97, SD = 19.85; t (153) = .065, p = .948, two-tailed). The difference in means (mean difference = .337,

95% CI: -9.92-10.59) was very small (Cohen's d = .013). While there were significant differences between COVID cohorts, the differences were not in the primary outcome variable, time-to-recovery; thus, these samples were combined in the regression model investigating predictors of recovery.

Recovery and Discharge

In the total sample (N = 156), there were 92 (59%) cases that recovered within six weeks, 57 (37%) that recovered in greater than six weeks, and 7 (4%) that did not complete recovery. Mean time-to-recovery, or the total number of days from admission to recovery (n = 149), was 39.57 days (SD = 25.62), which meets the international standard of recovery (<6 weeks). Time-to-discharge, or the total number of days from admission to discharge, for the total sample (N = 156) was an average of 43.97 days (SD = 25.59).

Recovered cases were indicated as either normal (n = 143, 92%), or mildly malnourished (n = 6, 4%) upon discharge, as determined by the on-site nutritionist. Of the seven cases (4%) not recovered upon discharge, three were transferred to the hospital and four were discharged home in a moderately malnourished state. Of those that were discharged home with mild or moderate malnutrition, the record indicated the healthcare team deemed the child able to safely recover at home. Hospital referrals were due to onset of seizures (n = 1), an HIV diagnosis (n = 1), and complications of hydrocephalus (n = 1).

There were 36 cases (21%) that recovered nutritionally but experienced a delay in discharge. Among these, the number of additional days at the NRC ranged from 2-50 days, with a mean of 20.1 days (SD = 14.24). Consultation with NRC leadership suggested delays in discharge were due to either treatment of a secondary diagnosis or adverse social conditions. Of note, only three of the 10 cases referred by social services experienced a delay in recovery in this

sample. There was no significant relationship between malnutrition severity on admission and delayed discharge.

Sociocultural Characteristics

Occupation was not available for the majority of mothers (n = 92, 59%) and fathers (n = 60, 38%). Records noted that 46 mothers (30%) were homemakers, 16 (10%) were employed, and 2 (1%) were not contributing (See Table 4). Among mothers that were employed, examples of jobs were laundry, food sales, cleaning, and agriculture. There were 47 fathers (30%) that were employed and financially contributing to their families; 48 (31%) were not contributing (See Table 4). Examples of fathers' occupations included journalism, agriculture, law enforcement, and banking. Among those with available data, mothers' (n = 141) mean age was 26 (SD = 6.59), ranging from 15-41 years; fathers' (n = 99) mean age was 30 (SD = 8.85), ranging from 18-66 years. The only significant relationship among sociocultural variables was between COVID cohorts and mother's occupation; however, investigators are cautions when interpreting all findings related to sociocultural data, due to the large amount of unknown data (See Table 4).

Data was even more limited with regard to other sociocultural characteristics. Some data was available on grandparent involvement and home structure. There were 42 cases that indicated grandparents were involved in their living situation or providing for their daily needs. There were 17 cases with no access to running water. Of the reported housing floor types, 20 cases had dirt floors and 29 cases had either cement or ceramic (Data not shown).

Indicators of Recovery

Among all predictor variables (COVID cohorts, age, gender, severity of malnutrition, admission weight, Amoxicillin, multivitamin, nebulizer/bronchodilator, and zinc), the univariate

analysis indicated a significant association between recovery time and two predictors, treatment by Amoxicillin (p = .014) and nebulizers/bronchodilators (p = .039) (See Table 6). Of note, there was no significant relationship between severity of malnutrition on admission with use of either Amoxicillin χ^2 (1, N = 155) = .210, p = .659, or nebulizers/bronchodilators, χ^2 (1, N = 155) = .619, p = .476 (Data not shown).

Multiple logistic regression analysis was conducted to assess the impact of the nine predictor variables on the outcome (recovery in ≥6 weeks) (See Table 6). Only one predictor variable of the logistic model, Amoxicillin, was significant, Wald χ^2 = 4.14, p = .042. The adjusted odds ratio for Amoxicillin was *aOR* = 2.14 [1.03,4.47], indicating children receiving amoxicillin were 2.14 times more likely to not meet recovery standards (<6 weeks), after controlling for other predictor variables (See Table 6). Cox & Snell R^2 = 0.121, and Nagelkerke R^2 = .163 for the full model; which indicates that the model only explains between 12% to 16% of the variability on the response variable.

Discussion

We found no significant difference in the primary outcome time-to-recovery between COVID cohorts; this may be due to the considerably low admission rates in the post-COVID cohort. This lower admission rate was likely impacted by both fear of the pandemic, and new COVID-19 policies established at the NRC that kept new admissions in isolation for 14 days. Isolation rooms were on the first floor and other children's rooms along with the nurses' station were on the second floor, where more activity occurred. Also, in this study there was a shorter timeframe to evaluate the impact of the pandemic (March 1, 2020-December 31, 2020), which limited our ability to understand malnutrition amid COVID-19. There was also a change in referral trends between the cohorts, and more cases in the post-COVID were referred by an

outside health care facility as opposed to largely self-referral (walk-ins) in the pre-COVID cohort. This would suggest that families were less inclined to seek out treatment, as was done more frequently before the pandemic.

Descriptive data in this study was similar to the pilot study. The majority of children were under age 2 in both this study (n=139, 89%) and the pilot (n=29, 69%), highlighting the priority of intervention development in this age group (Olney et al., 2018). In the pilot, the types of severe malnutrition (marasmus or kwashiorkor), were only present in 5 cases (12%), as opposed to 41 (26%) in the larger study. Time-to-discharge was similar in both studies. The inclusion of admission and discharge weights, as well as type of SAM in this study allows for a more complete understanding of clinical indicators of child recovery than what was possible in the pilot study.

Both cohorts' mean rates of weight gain were within range of similar studies (Chaturvedi et al., 2018; Golandaj et al., 2017; Rastogi et al., 2018; Taneja et al., 2012). However, it was unanticipated that the post-COVID cohort would have a higher rate of weight gain (9.1 g/kg/day) than the pre-COVID cohort (6.6 g/kg/day); this could be explained by the small post-COVID cohort receiving closer attention by NRC staff. Overall, the rate of weight gain, average time-to-recovery, and lack of fatalities in this sample are evidence that the NRC has similar levels of effectiveness to other treatment programs (Chaturvedi et al., 2018; Golandaj et al., 2017; Rastogi et al., 2018; Taneja et al., 2012). One concern is the delay many children faced between time-to-recovery and discharge. Due to the nature of the paper records used to collect the data, there is limited insight as to why children experienced these delays. Likely it is due to treatment of secondary illnesses, such as respiratory or gastrointestinal infections. The other possibility is

adverse social conditions, such as financial resources and human capacity resulting in the lack of a safe discharge plan.

There were five children in this study that were admitted with mild malnutrition. These cases could have been managed within the community demonstrated in previous research (López-Ejeda et al., 2019), and admission to the NRC could have been avoided. With the constraints of admission, from COVID-19 isolation protocols to transportation barriers, community-based management is recommended. Partnerships and training of CHWs have positively impacted SAM treatment in the past and CHWs are well positioned to identify needs and prevent health complications in their own communities (Alvarez Morán et al., 2018; Boyd, 2022; López-Ejeda et al., 2019). Strong development and support of CHWs in Guatemala, particularly in the Southern region, focusing on rural and Mayan populations (Gatica-Domínguez et al., 2019), would benefit child health outcomes, and follow the USAID (2021) current work in supporting rural indigenous populations.

Another unique finding in this study was the use of Amoxicillin as a significant predictor of time-to-recovery. However, its relationship to recovery was the opposite of what was anticipated; in this study children prescribed Amoxicillin were less likely to recover within six weeks. Studies evaluating Amoxicillin treatment of SAM have been ambiguous, with both benefits (Abate et al., 2020; Bitew et al., 2020; Kabalo & Seifu, 2017; Million et al., 2017; WHO, 2016; Williams & Berkley, 2018) and risks (Isanaka et al., 2016; 2020; Lelijveld et al., 2021; Maataoui et al., 2020; Nel, 2018; Warring & Fischer, 2016). Children treated with Amoxicillin in our sample experienced a longer time-to-recovery, even without a relationship between Amoxicillin use and severity of malnutrition on admission, which could have been an explanation for why these cases recovered slower (i.e. if Amoxicillin was being used only in

cases of severe illness). Of note, Amoxicillin was not widely used in this sample (n = 56, 36%); a more comprehensive evaluation of cases using this antibiotic would further validate this finding.

Interestingly, gender, age, vitamin supplementation, and admission weight less than 7 kg had no influence on recovery, unlike other studies (Gebremedhin et al., 2020; Mamo et al., 2019; Teshome et al., 2019). This could be because of the homogeneity of the sample, for example, there was a nearly even distribution between males and females, and most children in the sample were under age 2. An unanticipated finding was the widespread use of either a nebulizer and/or bronchodilator (n = 78, 50%), suggesting common respiratory illnesses. Secondary diagnoses were not available in the paper record, so this cannot be confirmed. Further, treatment with a nebulizer and/or bronchodilator did not significantly impact recovery time. While the use of medications was not the focus of this study, children were commonly prescribed multiple medications such as, acyclovir, Tylenol, folic acid, azithromycin, and reflux prescriptions. Future investigation of these and other medications might provide insight to secondary diagnoses and medication prescription practices for malnourished children.

In this study, the Social Ecological Model (Bronfenbrenner, 1979) informed the factors influencing childhood malnutrition. In this sample, some families relied on grandparents and other relatives for housing, financial needs, and childcare assistance. While exact data on finances could not be obtained, it was apparent that families were living on very low incomes; in some cases, families were in homes with dirt floors and without running water. Additionally, mothers' professions were most often listed as homemakers, but among those that did have employment, these were typically lower paying occupations (i.e. food sales or laundry). Alternatively, many fathers were often not contributing to their families financially, but if they were, they typically had higher paying roles (i.e. law enforcement, banking). The high rates of

fathers not being involved in providing for their children's needs, and yet mothers needing to stop working in order to care for their children, or not working in high-earning occupations is evidence of the ongoing challenges surrounding gender equity (Burroway, 2017; Chomat, 2021; Ekbrand & Hallerod, 2018). Families are encouraged to return for follow-up assessments, but few return due to lack of transportation or bus fare, particularly with increased bus fares after the onset of the pandemic. When evaluating family compliance to healthcare professional recommendations, it is essential to consider the impact of barriers, especially transportation and financial means. Macro-level data was scant; there was no data available with regard to neighborhoods and villages, or religion and education.

Strengths and Limitations

Findings from this investigation provide insight on an underserved population and add to our understanding of the service provided by an NRC program in Guatemala. This study built on a community-university partnership and consultation by the NRC staff included the local perspective. The research team's previous experience collaborating with the NRC gave the needed background to understand practices within the NRC and to anticipate data availability. Importantly, nearly all the key variables were able to be collected. Also, this study provides timely data on a vulnerable population with limited representation in the current literature within the context of a worldwide pandemic.

The target sample size calculated in the power analysis was not reached, due to a lower admission rates than anticipated in 2020. This could have negatively affected the statistical power of the tests used in analysis, but it does provide insight to the impact of COVID-19 on child health services. The post-COVID sample size was only from 10 months of data, as opposed to 14 months in the pre-COVID period. Still, implications of the small sample size of the post-

COVID cohort should be considered in the context of food insecurity that existed for Guatemalans in the year 2020 (UNICEF, 2021). It was anticipated that the effects of the pandemic would have resulted in a rapid need for nutrition services like the NRC; however, the services were less utilized than previous years. This decrease in admissions is similar to the dramatically lower rates of pediatric hospitalizations in the US in 2020 (Pelletier et al., 2021). Due to the retrospective design and use of paper records written in Spanish, there were challenges to data collection. Handwritten notes were often illegible and secondary diagnoses were not readily available. Nonetheless, the benefit of this method was that nearly all desired data was available for the sample and it was a feasible method to evaluate an international setting. Data was only collected from one NRC in Guatemala, so findings have limited generalizability; however, this study does add knowledge on a population with limited representation in the literature.

Implications for Nursing Practice, Policy, and Research

To better understand the sociocultural factors related to malnutrition, one recommendation might be for the NRC staff to conduct a family needs assessment on admission, to quickly identify factors that may serve as potential barriers of family units as they navigate and maintain nutritional recovery. For example, if it was identified on admission that a child was in a home that had a grandparent involved, staff could encourage grandparents to participate in educational activities, to learn nutrition information and feeding recommendations. In cases where finances are constrained, the NRC could ensure the child is discharged on an affordable formula, such as incaparina (Scrimshaw, 1980). A family needs assessment would be a quick way for staff to identify needs of families, and also provide them with a tangible demonstration of their population needs and serve in procurement of additional resources and funding. Also,

transitioning from paper records to an electronic health record system could improve monitoring and tracking of relevant variables surrounding child health outcomes, although this requires significant training and support. Overall, future development of ways to better document nutritional progress of children, as well as sociocultural barriers to discharge could be done through engagement and collaboration with the NRC health team.

Health policy in Guatemala related to malnutrition requires further development. In Guatemala, mild malnutrition is generally not considered a major health concern by the Guatemalan Ministry of Health (personal communication, November 23, 2021, NRC Nutritionist), and community-based care is recommended. This is a concern, and closer monitoring of mildly malnourished children upon discharge is essential to promote positive health outcomes; this could be done through partnerships with CHWs. Increasing access to COVID-19 tests would decrease the need for isolation period for newly admitted children, improving parent's experience and receptiveness toward receiving needed care, as well as promoting staff safety. Also, a clearer understanding of the impact of Amoxicillin use, along with other medications and supplements, is urgently needed to create better policies on best practice treatment methods. Resources and policy development surrounding childcare and safety is needed, to help decrease the number of delays in discharge.

Further research is needed to more fully understand the complexities COVID-19 has had on childhood SAM outcomes, ideally looking into the long-term effects of the pandemic in the years after its onset. Research could also be conducted to understand families' experience of SAM treatment amid COVID-19, including isolation times and testing availability. Investigation of admission trends and detailed medication uses could help understand the additional medical complexities commonly experienced by children during nutritional treatment. Future studies

should investigate the factors impacting rates of weight gain, to potentially improve treatment regimens. In addition, findings indicate that Amoxicillin had a negative relationship to recovery time, so a follow-up phase might be to examine secondary diagnosis with prescription practices. A multi-site RCT evaluating the impact of Amoxicillin on time-to-recovery would allow investigators to further understand its impact on child health outcomes. In addition, further investigation of secondary diagnoses during treatment in the future would benefit our understanding of children's experience of SAM treatment; a prospective cohort study design would allow researchers to collect all relevant variables and decreases likelihood of missing data. A number of features in this dataset warrant a case study for a greater depth of understanding from the perspectives of families and staff. A qualitative study investigating the SDOH, through discussions with caregivers, CHWs, and NRC leadership would provide a deeper understanding of the sociocultural variables.

Conclusion

Findings from this study provide greater understanding of malnutrition recovery at a Guatemalan Nutrition Rehabilitation Center in the context of a pandemic. Recovery rates point to the overall success of this NRC program. The research informs our understanding of SAM by providing timely data on clinical variables in a vulnerable population. The key to this study was the on-going international community-university partnership; such partnerships are necessary for future work. Findings from this study can be utilized in further investigation and intervention development to combat rising food insecurity and health needs amid the ongoing COVID-19 pandemic.

Table 4

Frequencies and Chi-Square Results for Pre-COVID (n=126) and Post-COVID Cohorts (n= 30)

	Pre-COVID		Post-COVID					
Variable	n	%	n	%	Total	χ^{2}‡	*df*	*p*
Age								
≤24 months	115	82.7	24	17.3	139	--	--	.100
>24 months	11	64.7	6	35.3	17			
Gender								
Male	69	83.1	14	16.9	83	.64	1	.425
Female	57	78.1	16	21.9	73			
Severity of SAM								
Mild	5	100.0	0	0.0	5	3.52	1	.061
Moderate	59	85.5	10	14.5	69			
Severe	62	75.6	20	24.4	82			
Type of SAM								
Marasmus	22	66.7	11	33.3	33	11.83	1	<.001*
Kwashiorkor	4	50.0	4	50.0	8			
None	100	87.0	15	13.0	115			
Admit Weight								
<7 kg	92	85.2	16	14.8	108	4.41	1	.036*
≥7 kg	34	70.8	14	29.2	48			
Referral Type								
Walk-in	31	93.9	2	6.1	33	6.62	1	.010*
Hospital	61	84.7	11	15.3	72			
Health Clinic/Dept.	25	61.0	16	39.0	41			
Social Services	9	90.0	1	10.0	10			
Amoxicillin								
Yes	49	87.5	7	12.5	56	2.64	1	.104
No	76	76.8	23	23.2	99			

Variable	Pre-COVID n	%	Post-COVID n	%	Total	χ^{2}‡	*df*	*p*
Multivitamin								
Yes	28	56.0	22	44.0	50	28.72	1	<.001*
No	97	92.4	8	7.6	105			
Nebulizer/ Bronchodilator								
Yes	70	89.7	8	10.3	78	8.33	1	.004*
No	55	71.4	22	28.6	77			
Zinc								
Yes	106	80.9	25	19.1	131	--	--	.785
No	19	79.2	5	20.8	24			
Region								
Northern	3	75.0	1	25.0	4	1.01	1	.356
Central	50	86.2	8	13.8	58			
Southern	73	77.7	21	22.3	94			
Discharge Delay								
Not Delayed	95	84.1	18	15.9	113	1.53	1	.272
Delayed	25	69.4	11	30.6	36			
Did Not Recover	6	85.7	1	14.3	7			
Discharge Plan								
Home	119	81.0	28	19.0	147	.04	1	.851
Hospital	3	100.0	0	0.0	3			
Unknown	4	66.7	2	33.3	6			
Mother's Occupation								
Agriculture	1	50.0	1	50.0	2	6.30	1	.013*
Homemaker	39	84.8	7	15.2	46			
Sales	6	85.7	1	14.3	7			
Service	0	0.0	7	100.0	7			
No Contribution	1	50.0	1	50.0	2			
Unknown	79	85.9	13	14.1	92			

Variable	Pre-COVID n	%	Post-COVID n	%	Total	χ^{2}‡	*df*	*p*
Father's Occupation								
Agriculture	18	78.3	5	21.7	23	.07	1	.807
Construction	4	66.7	2	33.3	6			
Food Service	4	80.0	1	20.0	5			
Homemaker	0	0.0	1	100.0	1			
Security/Govern.	2	66.7	1	33.3	3			
Service/Industry	3	60.0	2	40.0	5			
Technology	5	100.0	0	0.0	5			
No Contribution	37	77.1	11	22.9	48			
Unknown	53	88.3	7	11.7	60			
Mother's Age Range								
≤18	15	93.8	1	6.2	16	.66	1	.416
19-29	66	77.6	19	22.4	85			
30-39	32	86.5	5	13.5	37			
40+	2	66.7	1	33.3	3			
Unknown	11	73.3	4	26.7	15			
Father's Age Range								
≤18	1	100.0	0	0.0	1	1.98	1	.159
19-29	47	83.9	9	16.1	56			
30-39	22	84.6	4	15.4	26			
40+	14	87.5	2	12.5	16			
Unknown	42	73.7	15	26.3	57			

Note. N = 155 for the following variables, Amoxicillin, Nebulizer/bronchodilator, Zinc, and Multivitamin. Asterisks (*) indicate significant results.
‡ Refers to Mantel-Haenszel for all non-binary (nominal or ordinal) variables, and Fisher's Exact (--) when minimum expected counts (≥5) were not met.

Table 5

Mean Growth among Recovered Cases in Pre- and Post- COVID Cohorts

Variables	Pre-COVID (n = 118)		Post-COVID (n = 29)			
	M	*SD*	*M*	*SD*	*z*	*p*
Admission						
Weight	6.1	2.0	6.7	2.3	1.89	.060
Height	66.2	9.5	69.4	11.2	1.77	.076
Discharge						
Weight	7.1	2.0	8.5	3.9	2.36	.018*
Height	67.0	9.2	70.6	10.3	1.95	.051
Weight Gained	1.0	0.5	1.7	2.6	2.79	.005*
Height Gained	0.9	1.2	1.2	1.4	1.29	.196
Grams/KG/Day	6.6	6.9	9.1	9.5	2.03	.043*

Note. Weight reported in kilograms, height in centimeters. Reported growth on recovered cases; the six pre-COVID cases and one post-COVID case did not complete recovery were excluded. Missing data points led to the pre-COVID n = 118, and post-COVID n = 29. Asterisks (*) indicate significant results.

Table 6

Frequencies and Chi-Square Results for Recovery Time (N = 156)

	≥ 6 or no recovery		<6 weeks					Univariate analysis		Multivariable analysis	
Variables	n	%	n	%	Total	χ^{2}	*df*	OR [95% CI]	*p*	aOR [95% CI]	*p*
COVID Cohorts											
Post-COVID	10	33.3	20	66.7	30	.91	1	0.67 [0.29,1.54]	.341		
Pre-COVID	54	42.9	72	57.1	126						
Age											
≤24 months	56	40.3	83	59.7	139	.29	1	0.76 [0.28,2.09]	.592		
>24 months	8	47.1	9	52.9	17						
Gender											
Female	29	39.7	44	60.3	73	.10	1	0.90 [0.48,1.71]	.757		
Male	35	42.2	48	57.8	83						
Severity of Malnutrition											
Mild	1	20.0	4	80.0	5	3.44	1	0.28 [0.03,2.57]	.081		
Moderate	24	34.8	45	65.2	69			0.47 [0.05, 4.43]			
Severe	39	47.6	43	52.4	82			0.59 [0.30, 1.14]			
Admit Weight											
<7 kg	49	45.4	59	54.6	108	2.74	1	1.83 [0.89,3.75]	.098		
≥7 kg	15	31.3	33	68.8	48						

Variables	≥ 6 or no recovery n	%	<6 weeks n	%	Total	$\chi^{2\cdot}$	*df*	Univariate analysis OR [95% CI]	*p*	Multivariable analysis aOR [95% CI]	*p*
Amoxicillin											
Yes	30	53.6	26	46.4	56	6.07	1	2.31 [1.18,4.52]	.014*	2.14 [1.03,4.47]	.042*
No	33	33.3	66	66.7	99						
Multivitamin											
Yes	17	34.0	33	66.0	50	1.35	1	0.66 [0.33,1.33]	.245		
No	46	43.8	59	56.2	105						
Nebulizer/ Bronchodilator											
Yes	38	48.7	40	51.3	78	4.24	1	1.98 [1.03,3.79]	.039*		
No	25	32.5	52	67.5	77						
Zinc											
Yes	57	43.5	74	56.5	131	2.88	1	2.31 [0.86,6.20]	.090		
No	6	25.0	18	75.0	24						

Note. N = 155 for the following variables, Amoxicillin, Nebulizer/bronchodilator, Zinc, and Multivitamin. Mantel-Haenszel was reported for non-binary variables (Severity of Malnutrition). Asterisks (*) indicate significant results.

References

Abate, B. B., Tilahun, B. D., Kassie, A. M., & Kassaw, M. W. (2020). Treatment outcome of Severe Acute Malnutrition and associated factors among under-five children in outpatient therapeutics unit in Gubalafto Wereda, North Wollo Zone, Ethiopia, 2019. *PloS One*, *15*(9), e0238231. https://doi.org/10.1371/journal.pone.0238231

Action Against Hunger. (2020, June). Number of people facing hunger doubled due to COVID-19. https://www.actionagainsthunger.org/story/number-people-facing-hunger-guatemala-doubled-due-covid-19

Adegoke, O., Arif, S., Bahwere, P., Harb, J., Hug, J., Jasper, P., Mudzongo, P., Nanama, S., Olisenekwu, G., & Visram, A. (2021). Incidence of severe acute malnutrition after treatment: A prospective matched cohort study in Sokoto, Nigeria. *Maternal & Child Nutrition*, *17*(1), e13070. https://doi.org/10.1111/mcn.13070

Akseer, N., Kandru, G., Keats, E. C., & Bhutta, Z. A. (2020). COVID-19 pandemic and mitigation strategies: implications for maternal and child health and nutrition. *The American Journal of Clinical Nutrition*, *112*(2), 251–256. https://doi.org/10.1093/ajcn/nqaa171

Akparibo, R., Harris, J., Blank, L., Campbell, M. J., & Holdsworth, M. (2017). Severe acute malnutrition in children aged under 5 years can be successfully managed in a non-emergency routine community healthcare setting in Ghana. *Maternal & Child Nutrition*, *13*(4), e12417. https://doi.org/10.1111/mcn.12417

Al Amad, M., Al-Eryani, L., Al Serouri, A., & Khader, Y. S. (2017). Evaluation of outpatient therapeutic programme (OTP) for treatment of severe acute malnutrition in Yemen: A

focus on treatment default and its risk factors. *Journal of Evaluation in Clinical Practice, 23*(6), 1361-1366. https://doi.org/10.1111/jep.12798

Altmann, M., Altare, C., van der Spek, N., Barbiche, J. C., Dodos, J., Bechir, M., Ait Aissa, M., & Kolsteren, P. (2018). Effectiveness of a household water, sanitation and hygiene package on an outpatient program for severe acute malnutrition: A pragmatic cluster-randomized controlled trial in Chad. *The American Journal of Tropical Medicine and Hygiene*, *98*(4), 1005–1012. https://doi.org/10. 4269/ajtmh.17-0699

Alvarez Morán, J. L., Alé, G., Charle, P., Sessions, N., Doumbia, S., & Guerrero, S. (2018). The effectiveness of treatment for Severe Acute Malnutrition (SAM) delivered by community health workers compared to a traditional facility-based model. *BMC Health Services Research, 1*8(1), 207. https://doi.org/10.1186/s12913-018-2987-z

Asres, D. T., Prasad, R., & Ayele, T. A. (2018). Recovery time and associated factors of severe acute malnutrition among children in Bahir Dar city, Northwest Ethiopia: An institution based retrospective cohort study. *BMC Nutrition*, *4*, 17. https://doi.org/10.1186/s40795-018-0224-0

Atnafe, B., Roba, K. T., & Dingeta, T. (2019). Time of recovery and associated factors of children with severe acute malnutrition treated at outpatient therapeutic feeding program in Dire Dawa, Eastern Ethiopia. *PloS One*, *14*(6), e0217344. https://doi.org/10.1371/journal.pone.0217344

Batis, C., Mazariegos, M., Martorell, R., Gil, A., & Rivera, J. A. (2020). Malnutrition in all its forms by wealth, education and ethnicity in Latin America: who are more affected? *Public Health Nutrition, 23*(S1), s1–s12. https://doi.org/10.1017/S136898001900466X

Bhutta, Z. A., Berkley, J. A., Bandsma, R., Kerac, M., Trehan, I., & Briend, A. (2017). Severe childhood malnutrition. *Nature Reviews Disease Primers*, *3*, 17067. https://doi.org/10.1038/nrdp.2017.67

Bitew, Z. W., Alemu, A., & Worku, T. (2020). Treatment outcomes of severe acute malnutrition and predictors of recovery in under-five children treated within outpatient therapeutic programs in Ethiopia: a systematic review and meta-analysis. *BMC Pediatrics*, *20*(1), 335. https://doi.org/10.1186/s12887-020-02188-5

Blaney, S., Menasria, L., Main, B., Chhorvann, C., Vong, L., Chiasson, L., Hun, V., Raminashvili, D. (2019). Determinants of undernutrition among young children living in Soth Nikum District, Siem Reap, Cambodia. *Nutrients, 11*(3), 685. https://doi.org/10.3390/nu11030685

Boyd, E. M. (2022). Individual, environmental, and programmatic determinants of effective severe wasting treatment among children 6–59 months old in Afghanistan and Mali [ProQuest Information & Learning]. In *Dissertation Abstracts International: Section B: The Sciences and Engineering* (Vol. 83, Issue 3–B). https://www.proquest.com/dissertations-theses/individual-environmental-programmatic/docview/2569997436/se-2?accountid=10639

Braxton, M. E., & Larson, K. L. (2019). In sickness and health: Views on child health from a Mayan village. *Journal of Transcultural Nursing, 30*(3), 242-249. https://doi.org/10.1177/1043659618794845

Bronfenbrenner, U. (1979). The ecology of human development. Harvard University Press.

Brown, K., Henretty, N., Chary, A., Webb, M. F., Wehr, H., Moore, J., Baird, C., Díaz, A. K., & Rohloff, P. (2016). Mixed-methods study identifies key strategies for improving infant

and young child feeding practices in a highly stunted rural indigenous population in Guatemala: Infant feeding practices in Guatemala. *Maternal and Child Nutrition, 12*(2), 262-277. https://doi.org/10.1111/mcn.12141

Bhujade, R., Mishra, B. N., Ibrahim, T., Sinha, A., & Chouhan, D. S. (2021). Can severe acute malnourished children be effectively rehabilitated physically, biochemically and developmentally at nutritional rehabilitation centers: A follow up study from Ujjain. *Journal of Family Medicine and Primary Care*, *10*(1), 343–349. https://doi.org/10.4103/jfmpc.jfmpc_1268_20

Burroway, R. (2017). Are all jobs created equal? A cross-national analysis of women's employment and child malnutrition in developing countries. *Social Science Research, 67*, 1-13. https://doi.org/10.1016/j.ssresearch.2017.07.003

Ceballos, F., Hernandez, M. A., & Paz, C. (2021). Short-term impacts of COVID-19 on food security and nutrition in rural Guatemala: Phone-based farm household survey evidence. *Agricultural Economics*, *52*(3), 477–494. https://doi.org/10.1111/agec.12629

Central Intelligence Agency [CIA]. (2018). Field listing: Physicians density. https://www.cia.gov/the-world-factbook/field/physicians-density/

Chary, A. N., Messmer, S. E., & Rohloff, P. J. (2011). Male influence on infant feeding in rural Guatemala and implications for child nutrition interventions. *Breastfeeding Medicine, 6*(4), 227-231. https://doi.org/10.1089/bfm.2011.0015

Chary, A., Messmer, S., Sorenson, E., Henretty, N., Dasgupta, S., & Rohloff, P. (2013). The normalization of childhood disease: An ethnographic study of child malnutrition in rural Guatemala. *Human Organization, 72*(2), 87-97. https://doi.org/10.17730/humo.72.2.f2014210742702r2

Chaturvedi, A., Patwari, A. K., Soni, D., Pandey, S., Prost, A., Gope, R. K., Sharma, J., & Tripathy, P. (2018). Progress of children with severe acute malnutrition in the malnutrition treatment centre rehabilitation program: evidence from a prospective study in Jharkhand, India. *Nutrition Journal, 17*(1), 69. https://doi.org/10.1186/s12937-018- 0378-2

Chomat, A. M. (2021). Maternal stressors impact maternal wellbeing and cortisol, and infant growth in rural Guatemala: Insights from qualitative and quantitative approaches [ProQuest Information & Learning]. In *Dissertation Abstracts International: Section B: The Sciences and Engineering* (Vol. 82, Issue 10–B).

Cordon, A., Asturias, G., De Vries, T., & Rohloff, P. (2019). Advancing child nutrition science in the scaling up nutrition era: a systematic scoping review of stunting research in Guatemala. *BMJ Paediatrics Open, 3*(1), e000571. https://doi.org/10.1136/bmjpo-2019-000571

Cuj, M., Sattler, M., & de Beausset, S. (2020). Maya K'iche' food groups and implications for Guatemalan food guidelines. *Food and Nutrition Bulletin*, *41*(2), 261–274. https://doi.org/10.1177/0379572120912161

Cuneo, C. N., Dansereau, E., Habib, A. R., Davies, M., Ware, S., & Kornetsky, K. (2017). Treating childhood malnutrition in rural Haiti: program outcomes and obstacles. *Annals of Global Health*, *83*(2), 300–310. https://doi.org/10.1016/j.aogh.2017.05.003

Daures, M., Phelan, K., Issoufou, M., Kouanda, S., Sawadogo, O., Issaley, K., Cazes, C., Séri, B., Ouaro, B., Akpakpo, B., Mendiboure, V., Shepherd, S., & Becquet, R. (2020). New approach to simplifying and optimising acute malnutrition treatment in children aged 6-

59 months: The OptiMA single-arm proof-of-concept trial in Burkina Faso. *The British Journal of Nutrition, 123*(7), 756–767. https://doi.org/10.1017/S0007114519003258

Davis, J., & Brazil, N. (2016). Migration, remittances and nutrition outcomes of left-behind children: A national-level quantitative assessment of Guatemala. *PloS One, 11*(3), e0152089-e0152089. https://doi.org/10.1371/journal.pone.0152089

Deeney, M., & Harris-Fry, H. (2020). What influences child feeding in the Northern Triangle? A mixed-methods systematic review. *Maternal & Child Nutrition, 16*(4), e13018. https://doi.org/10.1111/mcn.13018

Dhawan, T., Kumari, P., & Dhawan, S. K. (2019). Role of nutritional rehabilitation center (NRC) in district Ambedkar Nagar, Uttar Pradesh. *Indian Journal of Health and Wellbeing, 10*(4-6), 122-125.

Doak, C. M., Campos Ponce, M., Vossenaar, M., & Solomons, N. W. (2016). The stunted child with an overweight mother as a growing public health concern in resource-poor environments: a case study from Guatemala. *Annals of Human Biology, 43*(2), 122–130. https://doi.org/10.3109/03014460.2015.1136356

Doocy, S., Tappis, H., Villeminot, N., Suk, A., Kumar, D., Fazal, S., Grant, A., & Pietzsch, S. (2018). Point-of-use water treatment improves recovery rates among children with severe acute malnutrition in Pakistan: results from a site-randomized trial. *Public Health Nutrition*, *21*(16), 3080–3090. https://doi.org/10.1017/S1368980018001647

Dorion, C., Hunter, P. R., Rafael Van den Bergh, Roure, C., Delchevalerie, P., Reid, T., & Maes, P. (2012). Does village water supply affect children's length of stay in a therapeutic feeding program in Niger? lessons from a médecins sans frontières program. *Plos One, 7*(12), e50982. https://doi.org/10.1371/journal.pone.0050982

Ekbrand, H., Halleröd, B. (2018). The more gender equity, the less child poverty? A multilevel analysis of malnutrition and health deprivation in 49 low- and middle-income countries. *World Development, 108,* 221-230. https://doi.org/10.1016/j.worlddev.2018.01.028

Fagbamigbe, A. F., Kandala, N. B., & Uthman, O. A. (2020). Severe acute malnutrition among under-5 children in low- and middle-income countries: A hierarchical analysis of associated risk factors. *Nutrition,*75-76, 110768. https://doi.org/10.1016/j.nut.2020.110768

Fernandes MB, López RV, de Albuquerque MP, Marchesano AC, Clemente AP, Martins VJ, Sawaya AL, Fernandes, M. B. F., López, R. V. M., de Albuquerque, M. P., Marchesano, A. C., Clemente, A. P. G., Martins, V. J. B., & Sawaya, A. L. (2012). A 15-year study on the treatment of undernourished children at a nutrition rehabilitation centre (CREN), Brazil. *Public Health Nutrition, 15*(6), 1108–1116. https://doi.org/10.1017/S1368980011002758

Fikrie, A., Alemayehu, A., & Gebremedhin, S. (2019). Treatment outcomes and factors affecting time-to-recovery from severe acute malnutrition in 6–59 months old children admitted to a stabilization center in southern Ethiopia: A retrospective cohort study. *Italian Journal of Pediatrics, 45*(1), 46-46. https://doi.org/10.1186/s13052-019-0642-x

Flores-Quispe, M., Restrepo-Méndez, M. C., Maia, M., Ferreira, L. Z., & Wehrmeister, F. C. (2019). Trends in socioeconomic inequalities in stunting prevalence in Latin America and the Caribbean countries: differences between quintiles and deciles. *International Journal for Equity in Health, 18*(1), 156. https://doi.org/10.1186/s12939-019-1046-7

Ford, N. D., Behrman, J. R., Hoddinott, J. F., Maluccio, J. A., Martorell, R., Ramirez-Zea, M., & Stein, A. D. (2018). Exposure to improved nutrition from conception to age 2 years and

adult cardiometabolic disease risk: A modelling study. *The Lancet Global Health, 6*(8), e875-e884. https://doi.org/10.1016/S2214-109X(18)30231-6

Fore, H. H., Dongyu, Q., Beasley, D. M., & Ghebreyesus, T. A. (2020). Child malnutrition and COVID-19: The time to act is now. *The Lancet, 396*(10250), 517–518. https://doi.org/10.1016/S0140-6736(20)31648-2

Gaensbauer, J. T., Lamb, M., Calvimontes, D. M., Asturias, E. J., Kamidani, S., Contreras-Roldan, I. L., Dominguez, S. R., Robinson, C. C., Zacarias, A., Berman, S., & Melgar, M. A. (2019). Identification of enteropathogens by multiplex PCR among rural and urban Guatemalan children with acute diarrhea. *The American Journal of Tropical Medicine and Hygiene, 101*(3), 534–540. https://doi.org/10.4269/ajtmh.18-0962

Gatica-Domínguez, G., Victora, C., & Barros, A. (2019). Ethnic inequalities and trends in stunting prevalence among Guatemalan children: an analysis using national health surveys 1995-2014. *International Journal for Equity in Health, 18*(1), 110. https://doi.org/10.1186/s12939-019-1016-0

Gentry, J., & Metz, B. (2017). Adjusting photovoice for marginalized indigenous women: Eliciting Ch'orti' Maya women's perspectives on health in Guatemala. *Human Organization, 76*(3), 251-263. https://doi.org/10.17730/0018-7259.76.3.251

Ghimire, U., Aryal, B. K., Gupta, A. K., & Sapkota, S. (2020). Severe acute malnutrition and its associated factors among children under-five years: a facility-based cross-sectional study. *BMC Pediatrics*, *20*(1), 249. https://doi.org/10.1186/s12887-020-02154-1

Golandaj, J. A., Vatavati, S. R., & Kallihal, K. G. (2017). Effect of nutritional interventional measures on admitted children in selected nutritional rehabilitation centres of Karnataka, India. *Nutrition and Food Science, 47*(1), 53-66.

https://doi.org/10.1108/NFS-06-2015-0078

Gebremedhin, K., Ayele, G., Boti, N., Andarge, E., & Fikadu, T. (2020). Predictors of time-to-recovery from severe acute malnutrition treated in an outpatient treatment program in health posts of Arba Minch Zuria Woreda, Gamo zone, Southern Ethiopia: A retrospective cohort study. *PloS One, 15*(6), e0234793. https://doi.org/10.1371/journal.pone.0234793

Grossmann, V. M., Turner, B. S., Snyder, D., Stewart, R. D., Bowen, T., Cifuentes, A. A., & Cliff, C. (2015). Zinc and vitamin supplementation in an under-5 indigenous population of Guatemala: Influence of lay health promoters in decreasing incidence of diarrhea. *Journal of Transcultural Nursing, 26*(4), 402-408. https://doi.org/10.1177/1043659614524786

Guzmán-Abril, A., Alajajian, S., Rohloff, P., Proaño, G. V., Brewer, J., & Jimenez, E. Y. (2021). A home garden intervention improves child length-for-age z-score and household-level crop count and nutritional functional diversity in rural Guatemala. *Journal of the Academy of Nutrition and Dietetics*. https://doi.org/10.1016/j.jand.2021.04.002

Hassen, S. L., Astatkie, A., Mekonnen, T. C., & Bogale, G. G. (2019). Survival status and its determinants among under-five children with severe acute malnutrition admitted to inpatient therapeutic feeding centers in south wollo zone, amhara region, Ethiopia. *Journal of Nutrition and Metabolism, 2019*, 2643531-9. https://doi.org/10.1155/2019/2643531

Healthy People. (2020). Law and health policy: Social-ecological model graphic. https://www.healthypeople.gov/2020/law-and-health-policy-social-ecological-model-graphic

Hussain, I., Habib, A., Ariff, S., Khan, G. N., Rizvi, A., Channar, S., Hussain, A., Fazal, S., Kumar, D., Alvarez, J. L., Guerrero, S., Grant, A., & Soofi, S. B. (2021). Effectiveness of management of severe acute malnutrition (SAM) through community health workers as compared to a traditional facility-based model: a cluster randomized controlled trial. *European Journal of Nutrition*, Advance online publication. https://doi.org/10.1007/s00394-021-02550-y

Ireen, S., Raihan, M. J., Choudhury, N., Islam, M. M., Hossain, M. I., Islam, Z., Rahman, S., & Ahmed, T. (2018). Challenges and opportunities of integration of community based Management of acute malnutrition into the government health system in Bangladesh: a qualitative study. *BMC Health Services Research*, *18*(1), 256. https://doi.org/10.1186/s12913-018-3087-9

Isanaka, S., Grantz, K. H., Berthé, F., Schaefer, M., Adehossi, E., & Grais, R. F. (2020). Extended follow-up from a randomized clinical trial of routine Amoxicillin in the treatment of uncomplicated severe acute malnutrition in Niger. *JAMA Pediatrics*, *174*(3), 295–297. https://doi.org/10.1001/jamapediatrics.2019.5189

Isanaka, S., Langendorf, C., Berthé, F., Gnegne, S., Li, N., Ousmane, N., Harouna, S., Hassane, H., Schaefer, M., Adehossi, E., & Grais, R. F. (2016). Routine Amoxicillin for uncomplicated severe acute malnutrition in children. *The New England Journal of Medicine*, *374*(5), 444-453. https://doi.org/10.1056/NEJMoa1507024

Jensen, M. L., Frongillo, E. A., Leroy, J. L., & Blake, C. E. (2016). Participating in a food-assisted maternal and child nutrition and health program in rural Guatemala alters household dietary choices. *The Journal of Nutrition*, *146*(8), 1593-1600. https://doi.org/10.3945/jn.116.232157

John, C., Diala, U., Adah, R., Lar, L., Envuladu, E. A., Adedeji, I., Lasisi, K., Olusunde, O., James, F., & Abdu, H. (2018). Survival and nutritional status of children with severe acute malnutrition, six months post-discharge from outpatient treatment in Jigawa state, Nigeria. *PloS one, 13*(6), e0196971. https://doi.org/10.1371/journal.pone.0196971

Johns Hopkins. (2022). Corona virus resource center. https://coronavirus.jhu.edu/region/guatemala

Joshi, P., Yadav, J. N., & Gautam, R. (2020). Impact of indigenously prepared therapeutic food for children with acute malnutrition at nutritional rehabilitation center. *Birat Journal of Health Sciences, 5*(1), 891-896. https://doi.org/10.3126/bjhs.v5i1.29604

Juarez, M., Dionicio, C., Sacuj, N., Lopez, W., Miller, A. C., & Rohloff, P. (2021). Community-based interventions to reduce child stunting in rural Guatemala: A quality improvement model. *International Journal of Environmental Research and Public Health*, *18*(2), 773. https://doi.org/10.3390 /ijerph18020773

Kabalo, M. Y., & Seifu, C. N. (2017). Treatment outcomes of severe acute malnutrition in children treated within Outpatient Therapeutic Program (OTP) at Wolaita Zone, Southern Ethiopia: retrospective cross-sectional study. *Journal of Health, Population, and Nutrition*, *36*(1), 7. https://doi.org/10.1186/s41043-017-0083-3

Kabalo, M. Y., & Yohannes, B. (2018). Children with oedema recover better than those with severe wasting in outpatient therapeutic program at Boloso Sore district, southwest Ethiopia. *BMC Research Notes, 11*(1), 118-5. https://doi.org/10.1186/s13104-018-3232-x

Kabir, M., Saqib, M. A. N., Zaid, M., Ahmed, H., & Afzal, M. S. (2020). COVID-19, economic impact and child mortality: A global concern. *Clinical Nutrition*, *39*(7), 2322–2323. https://doi.org/10.1016/j.clnu.2020.05.027

Kadetz, P. (2014). Positive deviance: Employing an assets-based approach to foster community agency and reduce chronic malnutrition in indigenous Guatemala. *Social Development Issues, 36*(3), 56.

Kamsvåg, T., Hedén, L., von Essen, L., & Ljungman, G. (2021). Ibuprofen in needle procedures in children with cancer-A feasibility and pilot study. *Acta Paediatrica, 110*(2), 704–710. https://doi.org/10.1111/apa.15449

Kassaw, M. W. (2020). Treatment outcome of Severe Acute Malnutrition and associated factors among under-five children in outpatient therapeutics unit in Gubalafto Wereda, North Wollo Zone, Ethiopia, 2019. *PloS one, 15*(9), e0238231. https://doi.org/10.1371/journal.pone.0238231

Kassier, S. M., Kajjura, R. B., & Veldman, F. J. (2019). Maternal socio-demographic characteristics and associated complementary feeding practices of children aged 6–18 months with moderate acute malnutrition in Arua, Uganda. *Journal of Human Nutrition & Dietetics, 32*(3), 303–310. https://doi.org/10.1111/jhn.12643

Kragel, E. A., Merz, A., Flood, D., & Haven, K. E. (2020). Risk factors for stunting in children under the age of 5 in rural Guatemalan highlands. *Annals of Global Health*, *86*(1), 8. https://doi.org/10.5334/aogh.2433

Krebs, N. F., Mazariegos, M., Chomba, E., Sami, N., Pasha, O., Tshefu, A., Carlo, W. A., Goldenberg, R. L., Bose, C. L., Wright, L. L., Koso-Thomas, M., Goco, N., Kindem, M., McClure, E. M., Westcott, J., Garces, A., Lokangaka, A., Manasyan, A., Imenda, E., Hartwell, T.D., Hambidge, K. M. (2012). Randomized controlled trial of meat compared with multimicronutrient-fortified cereal in infants and toddlers with high stunting rates in

diverse settings. *The American Journal of Clinical Nutrition, 96*(4), 840-847. https://doi.org/10.3945/ajcn.112.041962

Kroker-Lobos, M. F., Ford, N. D., Gonzalez-Casanova, I., Martorell, R., Ramirez-Zea, M., & Stein, A. D. (2020). Improved nutrition in early life and pulse wave velocity and augmentation index in mid-adulthood: Follow-up of the INCAP nutrition supplementation trial longitudinal study. *PloS One*, *15*(10), e0239921. https://doi.org/10.1371/journal.pone.0239921

Kumar, P., Rohatgi, S., Singh, P., & Daniel, A. (2021). Strengthening psychosocial stimulation in the management of children with Severe Acute Malnutrition: Experience from a Nutrition Rehabilitation Center. *Indian Pediatrics*, *58 Suppl 1*, S42–S45.

Lanou, H. B., Osendarp, S., Argaw, A., De Polnay, K., Ouédraogo, C., Kouanda, S., & Kolsteren, P. (2019). Micronutrient powder supplements combined with nutrition education marginally improve growth amongst children aged 6-23 months in rural Burkina Faso: A cluster randomized controlled trial. *Maternal & Child Nutrition, 15*(4), e12820. https://doi.org/10.1111/mcn.12820

Lee, J., Houser, R., Must, A., Palma, P., & Bermudez, O. (2017). Association of the familial coexistence of child stunting and maternal overweight with indigenous women in Guatemala. *Maternal and Child Health Journal, 21*(11), 2102-2113. https://doi.org/10.1007/s10995-017-2325-9

Lelijveld, N., Godbout, C., Krietemeyer, D., Los, A., Wegner, D., Hendrixson, D. T., Bandsma, R., Koroma, A., & Manary, M. (2021). Treating high-risk moderate acute malnutrition using therapeutic food compared with nutrition counseling (Hi-MAM Study): a cluster-

randomized controlled trial. *The American Journal of Clinical Nutrition, 114*(3), 955–964. https://doi.org/10.1093/ajcn/nqab137

Liben, M. L., Wuneh, A. G., Shamie, R., & G/Her, K. (2019). Factors associated with child survival in children admitted to outpatient therapeutic program at public health institutions in Afar Regional State, Ethiopia: a prospective cohort study. *Journal of Health, Population, and Nutrition, 38*(1), 35. https://doi.org/10.1186/s41043-019-0193-1

López-Ejeda, N., Charle Cuellar, P., Vargas, A., & Guerrero, S. (2019). Can community health workers manage uncomplicated severe acute malnutrition? A review of operational experiences in delivering severe acute malnutrition treatment through community health platforms. *Maternal & Child Nutrition, 15*(2), e12719. https://doi.org/10.1111/mcn.12719

Luna-González, D. V., & Sørensen, M. (2018). Higher agrobiodiversity is associated with improved dietary diversity, but not child anthropometric status, of Mayan Achí people of Guatemala. *Public Health Nutrition, 21*(11), 2128–2141. https://doi.org/10.1017/S1368980018000617

Maataoui, N., Langendorf, C., Berthe, F., Bayjanov, J. R., van Schaik, W., Isanaka, S., Grais, R. F., Clermont, O., Andremont, A., Armand-Lefèvre, L., & Woerther, P. L. (2020). Increased risk of acquisition and transmission of ESBL-producing Enterobacteriaceae in malnourished children exposed to amoxicillin. *The Journal of Antimicrobial Chemotherapy*, *75*(3), 709–717. https://doi.org/10.1093/jac/dkz487

Mambulu-Chikankheni, F. N., Eyles, J., & Ditlopo, P. (2018). Exploring the roles and factors influencing community health workers' performance in managing and referring severe acute malnutrition cases in two subdistricts in South Africa. *Health & Social Care in the Community, 26*(6), 839-848. https://doi.org/10.1111/hsc.12595

Mamo, W. N., Derso, T., Gelaye, K. A., & Akalu, T. Y. (2019). Time to recovery and determinants of severe acute malnutrition among 6–59 months children treated at outpatient therapeutic programme in North Gondar zone, Northwest Ethiopia: a prospective follow up study. *Italian Journal of Pediatrics, 45*(1), 136. https://doi.org/10.1186/s13052-019-0732-93

Maupin, J. N., & Brewis, A. (2014). Food insecurity and body norms among rural Guatemalan schoolchildren. *American Anthropologist, 116*(2), 332. https://doi.org/10.1111/aman.12098

Mazariegos, M., Kroker-Lobos, M. F., & Ramírez-Zea, M. (2020). Socio-economic and ethnic disparities of malnutrition in all its forms in Guatemala. *Public Health Nutrition, 23*(S1), s68-s76. https://doi.org/10.1017/S1368980019002738

Mengesha, M. M., Deyessa, N., Tegegne, B. S., & Dessie, Y. (2016). Treatment outcome and factors affecting time to recovery in children with severe acute malnutrition treated at outpatient therapeutic care program. *Global Health Action*, *9*, 30704. https://doi.org/10.3402/gha.v9.30704

Merriam-Webster. (n.d.). Marasmus. https://www.merriam-webster.com/dictionary/marasmus

Miller, M. A., Mallory, K., Escobedo, M., Tarot, A. C., & Abdel-Rahman, S. (2019). Assessing effectiveness of a novel mid-upper arm circumference Z-score tape in a community setting in Guatemala. *Archives of Public Health*, *77*, 44. https://doi.org/10.1186/s13690-019-0370-0

Million, M., Lagier, J. C., & Raoult, D. (2017). Meta-analysis on efficacy of amoxicillin in uncomplicated severe acute malnutrition. *Microbial Pathogenesis*, *106*, 76–77. https://doi.org/10.1016/j.micpath.2016.06.025

Minority Rights. (2018). Guatemala minorities and indigenous peoples. https://minorityrights.org/country/guatemala/

Monroy-Valle, M., Coyoy, W., De León, J., & Flórez, I. D. (2017). Dietetic determinants of zinc consumption in stunted children under five in Maya communities from Guatemala. *Revista Peruana De Medicina Experimental y Salud Publica, 34*(3), 451-458. https://doi.org/10.17843/rpmesp.2017.343.2276

Muros, J. J., Briones, M., Rodríguez, G., Bouzas, P. R., Giménez, R., & Cabrera-Vique, C. (2016). Double burden of malnutrition in rural and urban Guatemalan schoolchildren. *Nutrición Hospitalaria, 33*(2), 345-350. https://doi.org/10.20960/nh.115

Nagata, J. M., Gippetti, J., Wager, S., Chavez, A., & Wise, P. H. (2016). Prevalence and predictors of malnutrition among Guatemalan children at 2 years of age. *PloS One, 11*(11), e0164772-e0164772. https://doi.org/10.1371/journal.pone.0164772

National Academies of Sciences, Engineering, and Medicine. (2021). The future of nursing 2020-2030: Charting a path to achieve health equity. *The National Academies Press*. https://doi.org/10.17226/25982.

Nel E. (2018). Severe acute malnutrition. *Current Opinion in Clinical Nutrition and Metabolic Care, 21*(3), 195–199. https://doi.org/10.1097/MCO.0000000000000465

Ng, C. D. (2019). From birth to adulthood: Anthropometric trajectories and their implications for chronic diseases in Guatemala. *Journal of Biosocial Science*, *51*(2), 292–306. https://doi.org/10.1017/ S0021932018000238

NHS. (2019). Kwashiorkor. https://www.nhs.uk/conditions/kwashiorkor/

Ntambara, J., & Chu, M. (2021). The risk to child nutrition during and after COVID-19 pandemic: what to expect and how to respond. *Public Health Nutrition, 24*(11), 3530–3536. https://doi.org/10.1017/S1368980021001610

Oddo, V. M., Surkan, P. J., Hurley, K. M., Lowery, C., Ponce, S., & Jones-Smith, J. C. (2018). Pathways of the association between maternal employment and weight status among women and children: Qualitative findings from Guatemala. *Maternal & Child Nutrition, 14*(1), e12455. https://doi.org/10.1111/mcn.12455

Olney, D. K., Leroy, J., Bliznashka, L., & Ruel, M. T. (2018). PROCOMIDA, a food-assisted maternal and child health and nutrition program, reduces child stunting in Guatemala: A cluster-randomized controlled intervention trial. *The Journal of Nutrition, 148*(9), 1493. https://doi.org/10.1093/jn/nxy138

Olsen, M. F., Iuel-Brockdorff, A. S., Yaméogo, C. W., Cichon, B., Fabiansen, C., Filteau, S., Phelan, K., Ouédraogo, A., Michaelsen, K. F., Gladstone, M., Ashorn, P., Briend, A., Ritz, C., Friis, H., & Christensen, V. B. (2020). Impact of food supplements on early child development in children with moderate acute malnutrition: A randomised 2x2x3 factorial trial in Burkina Faso. *PLoS Medicine, 17*(12), e1003442. https://doi.org/10.1371/journal.pmed.1003442

Palacios, A. M., Hurley, K. M., De-Ponce, S., Alfonso, V., Tilton, N., Lambden, K. B., Reinhart, G. A., Freeland-Graves, J. H., Villanueva, L. M., & Black, M. M. (2020). Zinc deficiency associated with anaemia among young children in rural Guatemala. *Maternal & Child Nutrition, 16*(1), e12885. https://doi.org/10.1111/mcn.12885

Pandey, P., Jain, S., & Sharma, A. (2018). How healthy are children one year after discharge from nutritional rehabilitation centres? *Tropical Doctor*, *48*(4), 277–282. https://doi.org/10.1177/0049475518786854

Pehlke, E. L., Letona, P., Hurley, K., & Gittelsohn, J. (2016). Guatemalan school food environment: Impact on schoolchildren's risk of both undernutrition and overweight/obesity. *Health Promotion International, 31*(3), 542-550. https://doi.org/10.1093/heapro/dav011

People for Guatemala. (2020, June). Coronavirus crisis in Guatemala: A timeline. https://www.peopleforguatemala.org/covid-19/coronavirus-crisis-in-guatemala-a-timeline/

Pelletier, J. H., Rakkar, J., Au, A. K., Fuhrman, D., Clark, R., & Horvat, C. M. (2021). Trends in US Pediatric Hospital Admissions in 2020 Compared with the Decade Before the COVID-19 Pandemic. *JAMA Network Open*, *4*(2), e2037227. https://doi.org/10.1001/jamanetworkopen.2020.37227

Pries, A. M., Filteau, S., & Ferguson, E. L. (2019). Snack food and beverage consumption and young child nutrition in low- and middle-income countries: A systematic review. *Maternal & Child Nutrition*, 15. https://doi.org/10.1111/mcn.12729

Ramírez-Luzuriaga, M. J., DiGirolamo, A. M., Martorell, R., Ramírez-Zea, M., Waford, R., & Stein, A. D. (2021a). Influence of enhanced nutrition and psychosocial stimulation in early childhood on cognitive functioning and psychological well-being in Guatemalan adults. *Social Science & Medicine, 275*, 113810-113810. https://doi.org/10.1016/j.socscimed.2021.113810

Ramírez-Luzuriaga, M. J., Hoddinott, J., Martorell, R., Patel, S. A., Ramírez-Zea, M., Waford, R., & Stein, A. D. (2021b). Linear growth trajectories in early childhood and adult cognitive and socioemotional functioning in a Guatemalan cohort. *The Journal of Nutrition, 151*(1), 206-213. https://doi.org/10.1093/jn/nxaa337

Ramírez-Luzuriaga, M. J., Hoddinott, J. F., Martorell, R., Ramírez-Zea, M., & Stein, A. D. (2021c). Early-life nutrition and subsequent international migration: A prospective study in rural Guatemala. *The Journal of Nutrition, 151*(3), 716-721. https://doi.org/10.1093/jn/nxaa379

Ramirez-Zea, M., Kroker-Lobos, M. F., Close-Fernandez, R., & Kanter, R. (2014). The double burden of malnutrition in indigenous and nonindigenous Guatemalan populations. *The American Journal of Clinical Nutrition, 100*(6), 1644S-1651S. https://doi.org/10.3945/ajcn.114.083857

Rastogi, S., Maheshwari, C., Raghav, S. K., & Muzammil, K. (2018). A prospective observational study to evaluate the efficacy of facility-based management in malnourished children at NRC, district Meerut. *Journal of Family Medicine and Primary Care, 7*(6), 1341–1345. https://doi.org/10.4103/jfmpc.jfmpc_157_18

Rogers, E., Guerrero, S., Kumar, D., Soofi, S., Fazal, S., Martínez, K., Morán, J., & Puett, C. (2019). Evaluation of the cost-effectiveness of the treatment of uncomplicated severe acute malnutrition by lady health workers as compared to an outpatient therapeutic feeding programme in Sindh Province, Pakistan. *BMC Public Health, 19*(1), 84. https://doi.org/10.1 186/s12889-018-6382-9

Rohloff, P. (2021). On the frontlines of chronic paediatric undernutrition in Guatemala. *EBioMedicine, 64*, 103223. https://doi.org/10.1016/j.ebiom.2021.103223

Saccone, D. (2021). Can the Covid19 pandemic affect the achievement of the 'zero hunger' goal? Some preliminary reflections. *The European Journal of Health Economics, 22*(7), 1025–1038. https://doi.org/10.1007/s10198-021-01311-2

Saha, J., & Chouhan, P. (2021). Do malnutrition, pre-existing morbidities, and poor household environmental conditions aggravate susceptibility to Coronavirus disease (COVID-19)? A study on under-five children in India. *Children and Youth Services Review*, *128*. https://doi.org/10.1016/j.childyouth.2021.105962

Sanghvi, J., Mehta, S., & Kumar, R. (2014). Predicators for weight gain in children treated for severe acute malnutrition: A prospective study at nutritional rehabilitation center. *ISRN Pediatrics, 2014*, 808756-5. https://doi.org/10.1155/2014/808756

Schauer, C., Sunley, N., Hubbell Melgarejo, C., Nyhus Dhillon, C., Roca, C., Tapia, G., Mathema, P., Walton, S., Situma, R., Zlotkin, S., & Dw Klemm, R. (2017). Experiences and lessons learned for planning and supply of micronutrient powders interventions. *Maternal & Child Nutrition*, *13 Suppl 1*(Suppl 1), e12494. https://doi.org/10.1111/mcn.12494

Scrimshaw, N. S. (1980). Food and nutrition policy: A look at the incaparina experience in Guatemala. *Food and Nutrition Bulletin, 2*(2), 1-2. https://doi.org/10.1177/156482658000200201

Siu C. (2020). Can Central America and the Dominican Republic overcome malnutrition in all its forms? *Food and Nutrition Bulletin*, *41*, S86–S88. https://doi.org/10.1177/0379572120906639

Sphere Project. (2011). The Sphere handbook: Humanitarian charter and minimum standards in humanitarian response. http://www.sphereproject.org/handbook

Suarez-Balcazar Y. (2020). Meaningful engagement in research: Community residents as co-creators of knowledge. *American Journal of Community Psychology, 65*(3-4), 261–271. https://doi.org/10.1002/ajcp.12414

Tadesse, E., Ekström, E., & Berhane, Y. (2016). Challenges in implementing the integrated community-based outpatient therapeutic program for severely malnourished children in rural southern Ethiopia. *Nutrients, 8*(5), 251. https://doi.org/10.3390/nu8050251

Tadesse, E., Worku, A., Berhane, Y., & Ekström, E. C. (2018). An integrated community-based outpatient therapeutic feeding programme for severe acute malnutrition in rural Southern Ethiopia: Recovery, fatality, and nutritional status after discharge. *Maternal & Child Nutrition*, *14*(2), e12519. https://doi.org/10.1111/mcn.12519

Taneja, G., Dixit, S., Khatri, A. K., Yesikar, V., Raghunath, D., & Chourasiya, S. (2012). A Study to evaluate the effect of nutritional intervention measures on admitted children in selected nutrition rehabilitation centers of Indore and Ujjain divisions of the state of Madhya Pradesh (India). *Indian Journal of Community Medicine*, *37*(2), 107–115. https://doi.org/10.4103/0970-0218.96096

Teshome, G., Bosha, T., & Gebremedhin, S. (2019). Time-to-recovery from severe acute malnutrition in children 6–59 months of age enrolled in the outpatient treatment program in Shebedino, southern Ethiopia: A prospective cohort study. *BMC Pediatrics,19*. http://dx.doi.org/10.1186/s12887-019-1407-9

Tirado, M. C., Galicia, L., Husby, H. M., Lopez, J., Olamendi, S., Pia Chaparro, M., González, M. A., & Grajeda, R. (2016). Mapping of nutrition and sectoral policies addressing malnutrition in Latin America. *Revista Panamericana De Salud Pública, 40*(2), 114-123.

Trehan, I., & Manary, M. J. (2015). Management of severe acute malnutrition in low-income and middle-income countries. *Archives of Disease in Childhood, 100*(3), 283-287. https://doi.org/10.1136/archdischild-2014-306026

Tumilowicz, A., Habicht, J., Pelto, G., & Pelletier, D. L. (2015). Gender perceptions predict sex differences in growth patterns of indigenous Guatemalan infants and young children. *The American Journal of Clinical Nutrition, 102*(5), 1249-1258. https://doi.org/10.3945/ajcn.114.100776

United States Agency for International Development [USAID]. (2021). Nutrition profile: Guatemala. https://www.usaid.gov/sites/default/files/documents/Guatemala-Nutrition-Profile_1.pdf

United Nations. (2020a). Sustainable development goals: 17 goals to transform our world. https://www.un.org/sustainabledevelopment/

United Nations. (2020b). Goal 2: Zero hunger. https://www.un.org/sustainabledevelopment/hunger/

United Nations International Children's Emergency Fund [UNICEF]. (2021, April). Malnutrition. https://data.unicef.org/topic/nutrition/malnutrition/

United Nations International Children's Emergency Fund [UNICEF]. (2015, December). Severe Acute Malnutrition. https://www.unicef.org/nutrition/index_sam.html

van Immerzeel, T. D., Camara, M. D., Deme Ly, I., & de Jong, R. J. (2019). Inpatient and outpatient treatment for acute malnutrition in infants under 6 months; a qualitative study from Senegal. *BMC Health Services Research*, *19*(1), 69. https://doi.org/10.1186/s12913-019-3903-x

Vossenaar, M., Hernández, L., Montenegro-Bethancourt, G., Soto-Méndez, M. J., Bermudez,

O. I., & Solomons, N. W. (2015). The nutritional contribution of foods and beverages provided by government-sponsored day care centers in Guatemala. *Food and Nutrition Bulletin, 36*(3), 299-314. https://doi.org/10.1177/0379572115596634

Victora, C. G., Christian, P., Vidaletti, L. P., Gatica-Domínguez, G., Menon, P., & Black, R. E. (2021). Revisiting maternal and child undernutrition in low-income and middle-income countries: Variable progress towards an unfinished agenda. *The Lancet, 397*(10282), 1388–1399. https://doi.org/10.1016/S0140-6736(21)00394-9

Villatoro Santos, C. R. (2020). Micronutrients and metabolic syndrome in children and adults [ProQuest Information & Learning]. In *Dissertation Abstracts International Section A: Humanities and Social Sciences* (Vol. 81, Issue 8–A).

Voth-Gaeddert, L. E., & Oerther, D. B. (2019). Acute to chronic malnutrition: How significant water, sanitation, and hygiene factors change with health outcomes and geographies in the western highlands of Guatemala. *Journal of Environmental Health, 82*(1), 20–28.

Warring, S. K., & Fischer, P. R. (2016). Antibiotic Use in treatment of children with uncomplicated Severe Acute Malnutrition. *Infectious Disease Alert*, *35*(7), 76–78. https://www.proquest.com/trade-journals/antibiotic-use-treatment-children-with/docview/1986441854/se-2?accountid=10639

Welsh, T. (2021). Why Guatemala's COVID-19 vaccination campaign is so slow. https://www.devex.com/news/why-guatemala-s-covid-19-vaccination-campaign-is-so-slow-100009

Williams, P., & Berkley, J. A. (2018). Guidelines for the treatment of severe acute malnutrition: a systematic review of the evidence for antimicrobial therapy. *Paediatrics and International Child Health*, *38*(sup1), S32–S49.

https://doi.org/10.1080/20469047.2017.1409453

Wong, E., Molina-Cruz, R., Rose, C., Bailey, L., Kauwell, G., & Rosenthal, J. (2022). Prevalence and disparities in Folate and Vitamin B12 deficiency among preschool children in Guatemala. *Maternal and Child Health Journal*, *26*(1), 156–167. https://doi.org/10.1007/s10995-021-03257-6

World Bank. (2020). Crecer Sano: Guatemala nutrition and health project. https://projects.worldbank.org/en/projects-operations/project-detail/P159213

World Health Organization [WHO]. (2020, April). Archived: WHO timeline- COVID-19. https://www.who.int/news/item/27-04-2020-who-timeline---covid-19

World Health Organization [WHO]. (2013). Guideline: updates on the management of severe acute malnutrition in infants and children. https://www.who.int/publications/i/item/9789241506328

World Health Organization [WHO]. (2021a, June). Malnutrition fact sheet. https://www.who.int/news-room/fact-sheets/detail/malnutrition

World Health Organization [WHO]. (2019). Micronutrient intake in children with severe acute malnutrition. https://www.who.int/elena/titles/micronutrients_sam/en/

World Health Organization [WHO]. (2021b). Severe acute malnutrition. https://who.int/nutrition/topics/severe_malnutrition/en/index.html

World Health Organization [WHO]. (2021c). Social determinants of health. https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1

World Health Organization [WHO]. (2016). Severe acute malnutrition update: Current WHO guidelines and the WHO essential medicine list for children.

https://www.who.int/selection_medicines/committees/expert/21/applications/s6_paed_antibiotics_appendix7_s am.pdf

Wright, C. M., Gurney, J. M., Mutoro, A. N., Shum, C., Khan, A., Milligan, B., Indriani, W., Georgiou, L., Chambers, S., Bryant-Waugh, R., & Garcia, A. L. (2021). Development of a scale to measure infant eating behaviour worldwide. *Nutrients*, *13*(8), 2495. https://doi.org/10.3390/nu13082495

Zar, H. J., Dawa, J., Fischer, G. B., & Castro-Rodriguez, J. A. (2020). Challenges of COVID-19 in children in low- and middle-income countries. *Paediatric Respiratory Reviews*, *35*, 70-74. https://doi.org/10.1016/j.prrv.2020.06.016

APPENDIX A: IRB APPROVAL LETTER

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **rede.ecu.edu/umcirb**/

Notification of Initial Approval: Expedited

From: Biomedical IRB
To: Morgan Braxton
CC: Kim Larson
Date: 9/13/2021
Re: UMCIRB 21-001884
Understanding the Relationship between Key Clinical Variables of Childhood Malnutrition and Time-to-Recovery in Guatemala

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) occurred on 9/9/2021. The research study is eligible for review under expedited category # 5. The Chairperson (or designee) deemed this study no more than minimal risk.

As the Principal Investigator you are explicitly responsible for the conduct of all aspects of this study and must adhere to all reporting requirements for the study. Your responsibilities include but are not limited to:

1. Ensuring changes to the approved research (including the UMCIRB approved consent document) are initiated only after UMCIRB review and approval except when necessary to eliminate an apparent immediate hazard to the participant. All changes (e.g. a change in procedure, number of participants, personnel, study locations, new recruitment materials, study instruments, etc.) must be prospectively reviewed and approved by the UMCIRB before they are implemented;

2. Where informed consent has not been waived by the UMCIRB, ensuring that only valid versions of the UMCIRB approved, date-stamped informed consent document(s) are used for obtaining informed consent (consent documents with the IRB approval date stamp are found under the Documents tab in the ePIRATE study workspace);

3. Promptly reporting to the UMCIRB all unanticipated problems involving risks to participants and others;

4. Submission of a final report application to the UMICRB prior to the expected end date provided in the IRB application in order to document human research activity has ended and to provide a timepoint in which to base document retention; and

5. Submission of an amendment to extend the expected end date if the study is not expected to be completed by that date. The amendment should be submitted 30 days prior to the UMCIRB approved expected end date or as soon as the Investigator is aware that the study will not be completed by that date.

The approval includes the following items:

Name	Description
NRC study protocol	Study Protocol or Grant Application

For research studies where a waiver or alteration of HIPAA Authorization has been approved, the IRB states that each of the waiver criteria in 45 CFR 164.512(i)(1)(i)(A) and (2)(i) through (v) have been met. Additionally, the elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

IRB00000705 East Carolina U IRB #1 (Biomedical) IORG0000418
IRB00003781 East Carolina U IRB #2 (Behavioral/SS) IORG0000418