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Nutritional Status and Anthropometric Data Quality of US-bound Refugees, October 2018- September 2019

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By

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November 30, 2020

INTRODUCTION: According to The World Health Organization, malnutrition refers to deficiencies, excesses, or imbalances in an individual's nutrient intake. Refugees are at a higher risk for all forms of malnutrition. According to the WHO, report on global burden of malnutrition, in 2019 the rates of malnutrition included 21.3% of stunting, 6.9% of wasting and 5.6% of overweight in children under 5 globally.

AIM: To describe the nutritional status and anthropometric data quality of US-bound refugee children arriving from the top 10 processing countries. Recommendations to overseas partners may be made to improve anthropometric data quality thus improving prevalence estimates.

METHODS: We used data from the CDC's Electronic Disease Notification (EDN) System. The study population includes all refugees from the top ten processing countries that arrived in the U.S. during fiscal year 2019. The refugees included in this analysis are <18 years old. The mean z-scores and estimated prevalence of acute and chronic malnutrition were calculated per country in this analysis. Data quality was assessed through the assessment of number of missing data, percentage of flagged data, digit preference score and standard deviation.

RESULTS: Overall, the majority of refugees were Congolese (54.2%) and Burmese (18.2%). The percentage of missing data and biologically implausible values were low, yet standard deviations were high in some countries. Prevalence estimates for wasting and stunting were generally considered medium risk according to WHO thresholds.

DISCUSSION: Findings revealed areas where data quality can be improved through intervention with trainings. Further studies over longer periods of time and stratified by refugee setting (camp vs urban) can provide the program with a better understanding of malnutrition in US-bound refugees.

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Author’s Statement Page

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Glossary

Term	Definition	Population
DGMQ	Division of Global Migration and Quarantine	
IOM	International Organization for Migration	
Acute Malnutrition	Includes: moderate and severe wasting	
Moderate Wasting	Weight-for-length < -2SD Weight-for-height < -2SD BMI-for-Age < -2SD	Children < 2 years Children < 5 years Children ≥ 5 years
Severe Wasting	Weight-for-length < -3SD Weight-for-height < -3SD BMI-for-Age < -3SD	Children < 2 years Children < 5 years Children ≥ 5 years
Chronic Malnutrition	Includes: moderate and severe stunting	
Moderate Stunting	Length-for-age < -2SD Height-for-age < -2SD	Children < 2 years Children ≥ 2 years
Severe Stunting	Length-for-age < -3SD Height-for-age < -3SD	Children < 2 years Children ≥ 2 years

Chapter I Introduction

Background

According to The World Health Organization, malnutrition refers to deficiencies, excesses, or imbalances in an individual's nutrient intake[1]. Forms of malnutrition include undernutrition, overweight/obesity, micro and macronutrient-related malnutrition, and diet related non communicable diseases[1]. Children are at particular risk of malnutrition and its severe consequences, because it can impair cognitive ability, weaken performance and learning abilities, and increase risk of death from infections[2]. Undernutrition in children can present as wasting (low weight-for-height), stunting (low height-for-age), and underweight, (low- weight for-age)[1]. Wasting reflects acute weight loss, and can be a result of various factors including low birth weight, poor diet, and infections[2]. Wasting is linked to increased risk of disease and mortality[2],and therefore, it is important to implement timely interventions to address wasting. Children that are severely wasted, are on average 11 times more likely to die compared to their healthy counterparts[3]. Stunting reflects chronic undernutrition and can be attributed to compromised maternal health, poor feeding practices in infants, and unhealthy environments for children including poor hygiene[2]. Additionally, stunting can be due to the presence of frequent illness[1]. Stunting can place children at a higher risk for disease and poor cognitive development[2]. Micronutrient deficiencies are also part of malnutrition and can be defined as an individual's lack of minerals and vitamins that are necessary for growth and development[1]. Some of the most important micronutrient deficiencies identified among refugee populations include iron deficiency and vitamin A deficiency[4].

Anthropometry is the science that defines physical measures of a person's size, form and functional capacities[5], and is an important tool used to assess the nutritional status of individuals in a population. Anthropometric data can also be used to guide nutritional programs, and for public health and nutrition planning[6]. However, obtaining quality anthropometric data can be a challenge, since specific, calibrated equipment is needed, and staff must be trained and supervised to conduct accurate measurements[7]. High quality anthropometric measurements are important, because they can accurately identify malnutrition in persons, estimate the prevalence of malnutrition in a population, and impact funding for nutrition programs[7].

Refugees and other forcibly displaced populations are at a particularly high risk for malnutrition[8]. A refugee is defined as a person who has been forced to flee their country due to war, violence, or fear of persecution[9]. In 2019, there were an estimated 26 million refugees worldwide, of which nearly 50% were children below 18 years of age[10].

Factors such as displacement, conflict, economic insecurity, and famine all contribute to food insecurity and inadequate food intake among refugees, and can result in malnutrition[8]. Further, refugees often face many legal restrictions on working rights, access to land to grow food, and freedom of movement, placing them at even greater risk for undernutrition. Refugees typically are not included in national food distribution programs, and many rely heavily on humanitarian support to meet their basic food needs[8]. There have been humanitarian support efforts from the United Nations High commissioner for Refugees (UNHCR) such as food distribution, supplemental and therapeutic feeding, and micronutrient programs. Food security strategies in refugee camps have included multi-story gardens which support dietary diversity, and allow refugees to have access to their own food consumption[4]. Refugee mothers have access to infant feeding programs with support networks to ensure that children and mothers receive nutrition and care[4]. Micronutrient programs have also been prioritized and targeted towards refugees in camps specifically to address iron deficiency anemia and vitamin A deficiency[4].

By the end of 2019, 79.5 million people were forcibly displaced worldwide; of these, 26 million are refugees who are fleeing conflict or persecution[10]. UNHCR has identified 3 durable solutions, in order of preference, for refugees: 1) voluntary repatriation to their country of origin, 2) integration into their countries of asylum or 3) resettlement to a third country[11]. Although annually, a small number of refugees- less than 1% of the total global number become eligible for resettlement to a third country, the United States has been historically the largest receiving country for resettlement. Refugee resettlement to the US began in an organized manner in 1948 with the Displaced Persons Act to address the post-World War II migration crises. In 1980, the US passed the Refugee Act as part of an amendment to the Immigration and Nationality Act and thereby established the parameters of the current refugee resettlement program[12]. Since the Refugee Act was passed in 1980, the US has admitted more than 3 million refugees[13]. Annually, the President establishes an overall refugee admissions ceiling. Historically, the ceiling was set at 70,000-80,000 but recently the ceiling has ranged from 30,000 to 15,000 in Fiscal Year 2021.

The US Refugee Admissions Program (USRAP) is administered by the Bureau of Population, Refugees and Migration (PRM) in the US Department of State and involves partnerships across the US Government. In general, UNHCR refers refugees with no other durable solution for resettlement to the US. By the time they are referred for resettlement, most refugees have been outside their country of origin for many years and sometimes decades, for example, in fiscal year 2019 (the year of this data analysis), the US resettled refugees who originally fled from the Democratic Republic of Congo (DRC) to Rwanda between 1994 to 2005[14]. Congolese refugees fled to several countries of asylum, including Rwanda, Tanzania, Burundi and Uganda, from which they applied and underwent processing for the US resettlement program. Importantly, for understanding the data analyzed for this thesis data, many of the children were born in the country of asylum (i.e., Tanzania, etc. rather than DRC) even though they retain the nationality of their parents' country of origin. After referral by UNHCR, the refugee apply for resettlement and this process is coordinated by PRM. The Department of Homeland Security performs an adjudication to determine eligibility of entry based on the US criteria for refugee status and conducts detailed security screenings of each applicant. The Department of Health and Human Services, including the Office of Refugee Resettlement and the Centers for Disease Control and Prevention (CDC) develops and monitors the implementation of the overseas and domestic medical examinations and social service assistance that refugees receive for a short period of time after arrival.

The Division of Global Migration and Quarantine (DGMQ) within CDC oversees a required overseas medical examination for US-bound refugees as specified in the Immigration and Nationality Act (8 US Code 1522) [15]. The examination includes a medical history, physical examination, tuberculosis evaluation, laboratory testing for gonorrhea and syphilis, and other communicable disease[16]. The exams are performed by U.S. panel physicians who are medically trained, licensed, and experienced medical doctors who are appointed by the local

U.S. embassy and who follow the CDC screening guidelines[17]. The International Organization for Migration (IOM) performs the exams for approximately 75% of the refugees based on whether they have physicians or a clinic present in the country of processing. The remaining refugees are examined by local panel physicians identified by the US Embassy in that country of processing. In all clinic sites, nurses collect vital signs, such as temperature, blood pressure, and heart rate, and perform the anthropometric measurements, such as weight and height. Exams are performed 3-6 months before travel and are completed in the countries where refugees are currently residing (these are typically the host country of asylum and where the refugees undergo processing for resettlement to the US). In the processing countries, US-bound refugees may be in camps or urban areas, and depending on the settling, have variable access to preventative and therapeutic health services, including nutritional programs such as food rations and infant feeding programs. The required medical examination for resettlement focuses on the detection and treatment inadmissible public health conditions primarily tuberculosis as specified by regulations [16]. The time period between the required overseas health exam and departure for the US presents a window of opportunity for implementing additional interventions to improve refugee health. As part of its mission to reduce morbidity and mortality among resettling refugees[18], DGMQ has collaborated with partner organizations, primarily IOM, in implementing overseas public health initiatives to improve the health of the US-bound refugees during this window of time in the resettlement process. One such initiative was the development of standard operating procedures (SOP) to guide health care providers conducting the overseas medical examination to appropriately identify and manage acute malnutrition among US-bound refugee children, and among adults with certain medical conditions. This SOP includes guidance on proper anthropometric measurement, documentation during the overseas health examination, since nutritional interventions are prompted by anthropometric data, and recommendations for treatment when undernutrition is identified. Due to the large number of healthcare providers globally who screen for refugees, the SOP was created to standardize the process of obtaining the most accurate measurements. The SOP focuses on assessment for acute malnutrition, and referrals to feeding programs for acutely malnourished individuals.

Purpose and Objectives

The purpose of this evaluation is to 1) conduct an analysis of anthropometric data from the overseas medical examination of US-bound refugee children from leading processing countries for US-bound refugees, 2) report estimates of prevalence of wasting and stunting for US- bound refugee children for some leading processing countries and 3) assess the quality of anthropometric data collected during the overseas health examination. The results of this analysis will be used to enhance overseas program quality, including targeted nutritional intervention programs for the refugees before travel to the US and enhanced accuracy of anthropometric measurements and their documentation. Furthermore, domestically, such data can assist US state health departments and clinics in planning for the medical and nutritional needs of arriving refugee populations. This data can place into context how the nutrition needs of resettling children may be similar or different from children they're providing care to in their health jurisdictions or clinic. For example, data from the overseas medical examination of refugee children resettling to WA state identified that refugee children had a statistically significant higher prevalence of wasting and stunting than low-income children in WA[19].

Chapter II Literature Review

Overview of Acute and Chronic Malnutrition

Ending hunger is the second of the United Nations Sustainable Development Goals because millions of people experience malnutrition globally[20]. Many decades of work to support preventing and treating malnutrition globally lead to a decrease in malnutrition, however, since 2015 the rates of malnutrition globally are again rising[21]. Malnutrition can be thought of as undernutrition- a deficit of sufficient nutrients, and overnutrition an overabundance of calories. All forms of malnutrition can be prevented and treated.

Children are at particular risk for undernutrition since childhood is such a critical time in both physical and cognitive growth for children. Undernutrition includes three areas: 1)acute malnutrition (also known as wasting) which is defined by the child's weight-for-length or height z-score or their BMI z-score based on age or their mean-upper-arm-circumference MUAC; 2)chronic malnutrition (also known as stunting) which is defined by the child's length-for-age or height-for-age; and 3) micronutrient deficiencies including iron deficiency anemia[1]. Acute and chronic malnutrition are both further divided into moderate and severe as displayed in the glossary. According to UNICEF "wasting in children is the life-threatening result of poor nutrient intake and/or disease. Children suffering from wasting have weakened immunity and are susceptible to increased risk of death" [22]. Among children less than 5 years old, it is estimated that 3.1 million child deaths of 45% of all child deaths in 2011 were attributable to undernutrition[6]. Among children with severe acute malnutrition they have 3-8 times higher risk of death than a child with eunutrition[23], and children with moderate acute malnutrition have a 2 times higher risk of death than children with eunutrition[23]. While chronic malnutrition does not share the risk of mortality that acute malnutrition does, it is associated with significant morbidity for children. Chronic malnutrition has the potential to have long term effects and impair a child's physical and cognitive development[6]. Chronic malnutrition impacts 144 million children under 5 globally and can be due to poor nutrition in early childhood.[22] Broad risk factors for chronic malnutrition include socioeconomic status, food insecurity, poor sanitation and care-taking behavior[24]. Some of the risk factors associated with chronic malnutrition in children include chronic micronutrient dietary insufficiency, infectious disease, environmental enteric dysfunction and low birthweight[24]. While children under 5 years old are common the focus of malnutrition prevention and treatment, older children that are approaching puberty should also be a key area to focus on in considering recovery from stunting. Similar to chronic malnutrition, childhood overnutrition can cause long term health conditions such as diabetes, hypertension and cancer[19], compared to short term mortality risk like acute malnutrition. For the purposes of this thesis we will focus on undernutrition.

Refugees are at a higher risk for all forms of malnutrition including undernutrition and overnutrition[19]. Refugee children are at higher risk for wasting and stunting because they have faced adverse circumstances while in transit and often come from countries with high rated of wasting and stunting[25]. Refugees that rely on food rations are dependent on organizations such as the World Food Program, and if funding is decreased for a particular year, refugees are at greater risk for poor nutritional outcomes[25]. The dual burden of overnutrition and undernutrition in refugee populations needs to be further explored to inform targeted interventions pre and post arrival.

Anthropometric Data Quality

High quality data and proper anthropometric measurements are important in determining prevalence of malnutrition in refugees. Obtaining precise measurements for weight and height are important for referral into malnutrition treatment programs pre-resettlement in order to ensure safe transit of refugee children. The quality of the anthropometric measures is also important post arrival to ensure clinicians are receiving the most accurate medical information for the U.S. bound refugees. One study done by Leidman, Mwirigi [7], evaluated the anthropometric data quality that was assessed in nationally represented surveys. In this analysis, data from the Kenya Demographic and Health Survey (DHS) in 2008-2009 and 2014 was used to demonstrate how data quality impacts nutrition programs, and the importance of improved data quality. There are many challenges that comes with obtaining anthropometric data such as proper calibration of equipment, training, and supervision for tens or hundreds of team members. From 2014 to the 2008-2009 survey, new technical and training improvements have been implemented in the DHS survey and the results have had a positive impact on the overall data quality. The standard deviation for weight-for-height z-score (WHZ), height for age z-score(HAZ), and weight for age z (WAZ) were all significantly narrower in 2014 compared to 2008-2009. WHZ, HAZ, and WAZ, declined from -0.09(1.32) between 2008-2009 to 0.0(1.17) in 2014, -1.39 (1.67) between 2008-2009 to -1.14(1.44) in 2014, -0.85(1.26) between 2008-2009 to -0.64(1.18) respectively. The proportion of outliers significantly decreased in WHZ from 1.92% to 0.59%, and HAZ from 2.48% to 0.65%). The digit preference for weight was low in both surveys, but digit preference for height significantly improved between 2008-2009 to 2014 from 12.83 to 4.09. There were no eligible children with missing weight, height, or age measurements in 2014 compared to 2008-2009 where WHZ, HAZ, and WAZ were 3.21% 3.10%, and 2.68% respectively. This analysis demonstrates that despite inherent challenges in measuring children, with support in calibration of equipment, training and support for individuals collecting anthropometric measurements can be improved. These high-quality measurements will enhance the value of prevalence estimates and inform nutrition programs and policies.

A study done by Permual, assessed anthropometric data quality in children 0-59 months of age from 145 different publicly available demographic and health surveys globally. Some of the indicators of data quality in this analysis included date of birth completeness, anthropometric completeness, digit preference for weight and height, proportion of biologically implausible values, and dispersion of z-scores (SD). The WHO standard was used in assessing the biologically implausible values and SD for HAZ and WHZ. The results of this analysis show that overall, completeness of date of birth and anthropometric measures were high with percentages ranging from 70%-100% for all surveys[27]. The median SD range for HAZ was wider (1.74) than WHZ (1.22) across all surveys[27]. There was a range of digit preference for weight and height including values from 3.1 – 83[27]. The proportion of biologically implausible values were similar for WHZ and HAZ (1.8%)[27]. The findings from this study show the importance how the assessment of anthropometric data quality across surveys can be used as a tool to check the robustness of inferences related to nutritional status in a population.

In a study done by Daniel, child anthropometric data quality in the West Central Africa Region was assessed across various national surveys including the Demographic Health Survey, Multiple Indicator Cluster Surveys, and National Nutrition Survey. These surveys were focused on children aged 0-59 months and the aim of the study was to compare data quality finding across surveys related to missing data values for weight and height, biologically implausible z-scores, and terminal digit preference. The key findings from this analysis were that there was a substantial number of missing or implausible values for weight and height measurements in the DHS (8 %) and MICS (12 %) survey than the NNS (3%). There was evidence of terminal digit preference for height (scores above 20) in 44% and 61% of surveys in DHS and MICS and the score was less than 20 in the NNS. 7% and 14% of surveys in DHS and MICS respectively had weight digit preference above 20, while no NNS did [28]. This study highlights the importance of understanding the different strengths and weaknesses associated with different population-based surveys, to get a better grasp on which sources that should be considered when determining prevalence estimated across countries.

Nutritional Status in Refugees

It is important to understand the prevalence of acute and chronic malnutrition among refugees prior to resettlement in order to support referrals and treatment to ensure the safe transit and health outcomes for refugee children[29]. Children with chronic medical conditions and disability are at heightened risk for poor nutrition outcomes[24], and identification of malnutrition can support the need for additional investigation into children's comorbidities. Further, an understanding of malnutrition before resettlement can help support program guidelines and factors after resettlement. In an analysis conducted by Pernitez, and colleagues, the nutritional profile of Syrian refugee children before resettlement was assessed for children between the ages of 6-59 months[30]. In this analysis a total of 14,552 children underwent a health assessment between January 1, 2015-December 31, 2016 in Jordan, Lebanon, Turkey, Greece, Egypt, and Iraq. Results from this analysis showed that most children had a normal weight-for-height (85.6%, n=12,466) and height for age (85.2%, n=12,398).The prevalence of wasting was 3.7%, and among these, 73% had moderate wasting and 27% had severe wasting. The prevalence of stunting was 9.1% and among these 72% were moderately stunted and 28% were severely stunted. Although there was an overall low prevalence of undernutrition in this study population, prevalence did vary per country and that could be attributable to refugee assistance programs, and differences in access to resources in urban and rural refugee settings.

According to the WHO report on global burden of malnutrition, in 2019 the percentage of malnutrition included 21.3% of stunting, 6.9% of wasting and 5.6% of overweight in children under 5 globally. An estimated 54% of these stunted children lived in Asia and 40% lived in Africa, while 69% of wasted children lived in Asia, and 27% lived in Africa. An estimated 45% of overweight children lived in Asia, and 24% lived in Africa[31]. The prevalence thresholds for children less than 5 as defined by WHO are as followed; for wasting and overweight, low (2.5% - <5%) medium(5% - <10%) high (10%- <15%) and very high (≥15%), and for stunting low (2.5%- <10%), medium (10%- <20%), high 20%- <30%) and very high (≥ 30%)[31]. Some of these children suffer from more than one form of malnutrition, which includes a combination of stunting and overweight or stunting and wasting[31].

Nutritional Outcomes Post Resettlement

It is important to understand the nutritional status of refugee's post arrival for the continuity of care, and to identify interventions that can support the growth trajectories of refugee children. Chronic malnutrition can have long term health impairment especially for older children that are approaching puberty. In a retrospective study by Dawson-Hahn, Pak-

Gorstein [21], nutrition outcomes in refugee children after U.S. resettlement was assessed and compared to a matched nonrefugee low-income sample from Washington. This study aimed to assess the changes in weight-based nutrition status between 0-3 months and 10-24 months post arrival and compare the BMI or weight for length z-scores to non-refugee children. The study cohort included 512 refugee children aged 0-16 years that had domestic medical screenings and 1175 nonrefugee children from low income who are at greater risk for malnutrition. In this analysis refugee children from 4 countries Bhutan, Burma, Iraq, and Somalia made up the majority of the cohort. Among refugee children the prevalence of obesity increased from 8.9% to 21%, and 38.9% to 45.7% for the nonrefugee children. In the adjusted linear mixed effects regression model, refugees aged 2-16 years had a steeper BMI z-score per 12 months compared with non-refugees. Refugees from Somalia and Burma had steeper increases in their BMI z-scores per 12 months compared to nonrefugee children. Using the same model, children <2 years of age in the non-refugee cohort had a steeper increase to their weight-for-length z-score per 12 months compared to the refugee children. This study is an important piece of literature that assessed nutrition status of US bound refugees domestically and shows an increased risk of obesity for refugee's post arrival.

In a study done by Fabio, nutrition for refugee children post arrival was examined to understand risks, screening and treatment. This study highlights the importance for domestic clinicians to understand how to interpret anthropometric data in refugee children, taking into account certain nuances such as a non-exact birth date/age and how to properly identify nutritional status. Treatment includes following guidelines that suggest every arriving pediatric refugee should receive multivitamin with iron[32]. There may be other supplemental nutrients given depending on the screening, but newly arrived refugees also need an orientation to help adjust to new food systems in the United States. Culturally appropriate programs such as that can assist refugees in making better food choices can positively impact their long-term health outcomes. Evaluating nutritional status during the domestic medical examination is a critical step that can address wasting and stunting and provide children with access to services that will improve long-term care.

Chapter III Methods

Participants and Data Collection

We examined data from all US-bound refugee children between the ages of 6 months to less than 18 years (≥6 months - <18 years) arriving to the US between October 1, 2018-September 30, 2019 (Fiscal Year 2019) from the top ten processing countries. Since refugee admissions vary by year, we selected the most recent complete data set available with the aim of focusing on information to aid in the development of targeted nutritional interventions. These ten countries represent the top countries where refugees are processed for resettlement to the US. The country of processing is usually different than nationality and/or country of birth. Country of processing is usually the country of asylum to which refugees fled and where they currently residing, either in a refugee camp or in an urban area. One country, Ukraine, is unique in this dataset as the USRAP has an in-country processing program, meaning that the refugees are mostly Ukrainian nationals who are being resettled directly from Ukraine to the US[12]. This is important because, as citizens, they have access to other routine services, such as health care, nutritional programs, housing, land for gardening or farming, and employment, that are not usually available to refuges who have fled their country of origin and are residing as non-citizens in a country of asylum, where rights and access to services are often more limited. Data for birth country and nationality is presented. For young children born in a country of asylum (which is usually, but not always, the processing country), the nationality reflects the nationality of their parents, not country of birth, for example, a child born in the refugee camp in Tanzania to parents from Democratic Republic of Congo would be considered to be of Congolese nationality with birth country in Tanzania. These variables are important to nutritional status analysis because they may reflect access to different services at various timepoints in growth and development. Children less than 6 months of age were excluded because treatment for acute malnutrition in this age group is notably different than for children ≥ 6 months old. Infants < 6 months old can rarely be supported through community based therapeutic care programs, and commonly require inpatient admission. This age group warrants further study and evaluation globally and in program development for support of refugees prior to resettlement.

All data used for this cross-sectional analysis were collected as part of the routine overseas medical examination, which is performed 3-6 months before refugees depart for the US. Health information from the overseas medical exams are electronically transferred from the International Organization for Migration (IOM) health information system (MiMOSA) to CDC's Electronic Disease Notification System (EDN). EDN is a centralized electronic reporting system that collects health information from the overseas medical examinations of all US bound refugees and transfers the information to receiving US state and local health departments and clinics where refugees will receive their follow-up care[17]. This project was determined to be non-research by the CDC Human Subjects Advisor, and therefore, IRB approval was not required.

Generally, anthropometric measurements, such as length, height, and weight, are collected by nurses working for IOM or the non-IOM panel physicians. The nurses or panel physicians may enter the data into MiMOSA and at the end of the medical examination, the panel physician must sign off on all the data collected and entered into MiMOSA. In 2013, CDC developed a standard operations procedure (SOP) for assessing nutritional status and managing malnutrition in refugee children. This SOP includes guidance on proper anthropometric measurement, documentation during the overseas health examination, since nutritional interventions are prompted by anthropometric data, and recommendations for treatment when undernutrition is identified. Due to the large number of panel physicians globally who screen for refugees, the SOP was created to standardize the process of obtaining the most accurate measurements. The SOP focuses on assessment for acute malnutrition, and referrals to feeding programs for acutely malnourished individuals. The rollout of the SOP started with training of IOM physicians and nurses in Malaysia and Thailand in 2013. Although the SOP has been distributed to other processing countries, many staff at IOM and the panel physician clinics have received minimal training to date and implementation is likely variable. In addition, although the SOP recommends certain equipment for obtaining the measurements, for example wooden *shorr* board for measuring length in children under 2 years of age, the use of that equipment has not yet been fully standardized. All sites, except Turkey, are clinics managed by IOM physicians and nurses while Turkey is a local panel physician clinic site appointed by the US Embassy.

Variables of interest

EDN variables for this analysis included age, sex, processing country, birth country, country of nationality, and measured height and weight from the overseas medical examination.

Analysis

Two areas of analysis were conducted: 1) an assessment of nutrition status, specifically the prevalence of acute and chronic malnutrition, in refugee children in this dataset, and 2) an examination of the quality of the anthropometric data using four different measures.

Nutritional Status

Frequencies and proportions were calculated to describe demographic characteristics and prevalence of acute and chronic malnutrition among US-bound refugees from the top ten processing countries. Acute malnutrition encompasses moderate and severe wasting. Chronic malnutrition encompasses moderate and severe stunting. The mean z-scores and standard deviations (SD) were calculated for weight-for-length in children <2 years , weight-for-height in children <5 years, and BMI-for-age for children ≥5 years, length-for-age, and height-for-age using the World Health Organization (WHO) Anthro survey analyzer and statistical analysis software macros[33],[34]. These are the standard age-appropriate measures used to assess malnutrition in children. The mean z-score is an indication of the nutritional status of the population. A negative mean z-score indicates a more underweight population, while a positive mean z-score indicates a more overweight population.

Indicators	**Definitions**	**Population**
Acute Malnutrition Indicators		
Moderate Wasting	Weight-for-length < -2SD Weight-for-height < -2SD BMI-for-Age < - 2SD	Children < 2 years Children < 5 years Children ≥ 5 years
Severe Wasting	Weight-for-length < -3SD Weight-for-height < -3SD	Children < 2 years Children < 5 years

	BMI-for-Age < -3SD	Children ≥ 5 years
Chronic Malnutrition Indicators		
Moderate Stunting	Length-for-age < -2SD Height-for-age < -2SD	Children < 2 years Children ≥ 2 years
Severe Stunting	Length-for-age < - 3SD Height-for-age < -3SD	Children < 2 years Children ≥ 2 years

Anthropometric data quality

Four measures of anthropometric data quality were assessed: 1) standard deviation of z-scores for the age-appropriate measurements (weight-for-height, height-for-age or BMI-for-age), 2) proportion of flagged data, 3) digit preference score and 4) number of missing z-scores per processing country.

Anthropometric data quality was assessed using the World Health Organization's recommended cut-off points for standard deviation(SD)[35]. These cut off points are based on statistical plausibility and excludes values out of (< -5 and > +5) z-score for weight-for-height, (< -6 and >+6) for height-for-age, and (<-5 and ≥+5) for BMI-for-age.

Data Quality Indicators: **Standard Deviation (SD)**	**Lower SD**	**Upper SD**
Weight-for-height	-5	+5
BMI-for-Age	-5	+5
Length/height-for-age	-6	+6

Children with biologically improbable z-scores per WHO recommendations (i.e., below -5 z-score for wasting and -6 z-score for stunting) were excluded from this analysis. Statistical analyses were performed in the R statistical system (R Core Team, 2020). Children less than 18 years of age during the overseas medical examination were included and children <6 months were excluded in the z-score and estimated prevalence calculations. Age at exam was calculated with date of birth and initial overseas examination date.

Three additional data quality measures: proportion of flagged data, digit preference score and number of missing z-scores per processing country, were assessed using the Emergency Nutrition Assessment (ENA) for Standardized Monitoring and Assessment of Relief and Transitions (SMART). ENA is an analytic program that has automated functions for sample size calculations, quality checks and standardization for anthropometric measurements[36]. ENA is an internationally accepted tool for assessing anthropometric data and includes WHO standards for data quality. The proportion of flagged data was calculated by using the WHO exclusion cut-offs. The percentage of flagged data was chosen as a metric of data quality because a high proportion of flagged data (outliers) can mean that measurements were poorly taken. The digit preference score test assesses the last digits of each anthropometric measure to identify if there has been rounding. The output is the proportion of measurements recorded with a specific number as the terminal digit. A Chi-squared test of the observed frequencies against the expected frequencies are performed, and a digit preference score is calculated by the formula: **DPS = 100 * (χ2 / (df * N))1/2.** N is the number of observations, X^2 is the Chi-square statistic for the test of homogeneity of the terminal digits, and df, the degrees of freedom of 9 since there are 10 possible terminal digits[37]. The digit preference range is reported as a number between 0-100. Scores that are low reflect non-preference in terminal digits, while scores above 20 are indicative of preference of the terminal digit.

Chapter IV Results

During fiscal year 2019, 13,226 children between birth and less than 18 years of age were resettled to the United States. Of these children, 11,317 (86%) were resettled from ten processing countries. Excluding children under 6 months of age, this analysis included a total of 11,125 children from the top ten processing countries that arrived in the United States between October 1, 2018 and September 30, 2019. In descending order, the ten processing countries by volume of refugees were: Tanzania (2,173), Ukraine (1,674), Uganda (1,345), Burundi (1,299), Rwanda (1,272), Malaysia (1,106), Thailand (1,040), Ethiopia (687), Turkey (383) and Kenya (328). The sex of the children in our sample was roughly half males (51%) and half females (49%). The majority of children in our sample were between 5 years - <18 years of age (67%). Most of the refugees processed in East Africa (Tanzania, Burundi, Uganda, Rwanda) are Congolese nationality and born in the country of processing. Refugees processed in Ethiopia are primarily Eritrean nationality and about half were born in Eritrea or Ethiopia. Most refugees processed in Asia (Malaysia, Thailand) are Burmese nationality and born in the country of processing. In contrast, Ukraine has an in-country refugee processing program and therefore most are born in Ukraine and are Ukrainian nationals. Kenya and Turkey have the most diverse populations in terms of country of origin and birth country. Overall, 54.2% of the children in this analysis were of Congolese nationality and 18.2% were of Burmese nationality across all processing countries.

Nutritional status

Mean z-scores and estimated wasting prevalence are summarized in Table 3. Overall, the prevalence of wasting was highest in Ethiopia and Burundi, and lowest in Tanzania and

Ukraine. Overall, the estimated prevalence of moderate wasting (<-2 SD) ranged from 0.0% to 8%, 0.0% to 12.9%, and 1.3% to 21.4% in age groups 6 months to < 2 years, 2 years to <5 years, and 5 years to <18 years, respectively. The estimated prevalence of severe wasting (<-3 SD) ranged from 0.0% to 6.0%, 0.0% to 1.0% and 0.1% to 4.9% in in age groups 6 months to < 2 years, 2 years to <5 years, and 5 years to <18 years respectively.

Overall, the observed mean wasting z-scores were highest in children aged 6 months to 2 years (0.17). The observed mean weight-for-height z-scores ranged between -0.82 to 0.85 across all ten processing facilities, with Burundi having the lowest z-scores, and Tanzania having the highest z-scores. The observed mean BMI-for-age z-scores across all ten processing countries ranged from -1.04 in Ethiopia, to 0.16 in Tanzania. The observed overall BMI-for-age z-scores (-0.13) were lower than the observed overall weight-for-age z-scores for age group 6 month to <2 years (0.17) and 2 years to < 5 years (-0.02).

Mean z-scores and estimated stunting prevalence are summarized in Table 3. Overall, the prevalence of stunting was highest in Tanzania and Ethiopia, and lowest in Malaysia and Ukraine. Overall, the estimated prevalence of moderate stunting (<-2 SD) ranged from 2.6% to 23.2%, 2.2% to 32.0%, and 0.8% to 22.1% in age groups 6 months to < 2 years, 2 years to <5 years, and 5 years to <18 years respectively. The estimated prevalence of severe stunting (<-3 SD) ranged from 0.0% to 21.6%, 0.2% to 10.5% and 0.2% to 5.8% in in age groups 6 months to < 2 years, 2 years to <5 years, and 5 years to <18 years respectively.

The lowest in children aged 6 months to 2 years (-0.91). The observed mean stunting z-scores ranged between -1.93 to 0.05 across all ten processing facilities, with Tanzania having the lowest z-scores, and Ukraine having the highest z-scores. The overall observed mean stunting z-scores in children 2 years to < 5 years (-0.80) was slightly lower than the mean stunting z-scores in children 5 years to <18 years (-0.78).

Data Quality

The standard deviations (SDs) for wasting were higher among age groups 6 months to <2 years, and 5 years to <18 years. This reflects poorer quality data. Countries with SDs that fell within the WHO recommended range in age group 6 months to < 2years include Burundi, Malaysia, Thailand, and Ukraine. Countries with higher SDs in children ages 5 years to <18 years, include Kenya, Malaysia, and Turkey. The majority of the standard deviations that were within the WHO suggested range were among children 2 years to <5 years.

The standard deviations for stunting were highest among children 6 months to <2 years. The high standard deviation in this age group indicates poorer data quality. The only countries that fall within the WHO range in all countries are Malaysia, Thailand, and Ukraine. Among children 5 years to <18 years, the SD's for stunting were within the WHO recommendations, suggesting better data quality. There were seven sites for age group 6 months to < 2 years, and 1 site for age groups 2 years to <5 years that did not meet the WHO recommendations.

Overall, the percentage of data flagged for weight-for-height z-scores ranged from 0.0% to 0.85% in children aged 6 months to less than 2 years, and 2 years to <5 years across all ten processing facilities. The percentage of data flagged for BMI-for-age z-scores ranged from 0.0% to 0.2%. The percentage of data flagged for length/height-for-age z-scores ranged from 0.0% to 0.4%.

The digit preference for weight ranged from 4 to 100, and 22 to 100 for height. The digit preference for weight and height was generally considered problematic according to the ENA standards across all ten processing facilities. Digit preference scores above 20 indicate a statistically significant preference for the terminal digit. The difference in digit preference scores above 20 have no practical implications. The number of missing z-score values per age group for weight-for-height, BMI-for-age, and length/height-for-age was minimal: between 0 and 6 across all sites.

Chapter V Discussions

Discussions and Limitations

The anthropometric nutrition data presented here provide actionable information for improving the quality of data and the health of refugee children. This is an analysis of anthropometric nutritional data for refugee children in the US resettlement program aged 6 months to < 18 years collected at the time of the overseas health assessment (3-6 months before arrival in the US). We analyzed two measures of nutritional status: mean z-scores and prevalence of wasting and stunting. The analysis showed a prevalence range from 0.0% to 14.0% in wasting, and 2.7% - 44.8% in stunting and highlighted actionable differences in malnutrition prevalence among children of various ages undergoing processing in several top processing countries. For wasting, a prevalence of 14.0% is considered high, and for stunting a prevalence of 44.8 % is considered very high in children under 5 years old. Although these WHO thresholds are for children under 5, if we were to apply the same standards on children 5 years-<18 years, the prevalence of wasting ranged from 1.7% to 26.3% (very high), and prevalence of stunting ranged from 1.0% to 27.9% (high). The mean z-scores highlighted that most sites were wasted, and a few sites with positive mean z-scores tended to reflect a more overweight population. For stunting, the majority mean z-scores were negative reflecting stunting in populations, notability lower z-scores in some sites that had positive mean z-scores.

The four-part data quality analysis revealed specific areas for improving anthropometric measurements, including the tendency to round digits. Despite the data quality gaps and other study limitations, these issues do not preclude using the prevalence data to direct additional investigations and develop nutritional interventions to improve the health of refugees in the US resettlement program. The anthropometric data form the backbone of targeted nutritional activities, both at an individual level to identify children who need treatment for wasting and/or chronic malnutrition before and after resettlement, and at a population-level to establish programs to benefit certain large population groups of refugees selected for resettlement over several years from various countries, such as the Congolese refugees from East Africa. These areas for data quality improvement, as described in this study, can be prioritized as the nutritional standard operating procedure (SOP) is rolled out, monitored, evaluated and continuously improved.

Overall, the four measures of data quality: 1) number of missing z-scores, 2) percentage of flagged data, 3) standard deviation of mean z-scores and 4) digit preference (rounding tendency) identified some issues to be addressed. There is limited literature on anthropometric data quality for US-bound refugees. Our analysis was consistent with the data quality results reported in a previous study that examined the health profile of pediatric Special Immigrant Visa (SIV) holders arriving in the United States and reported similar standard deviations.

In this analysis, missing z-scores were rare, less than 6 per country, indicating that the anthropometric measurements are being documented by IOM and panel physician clinical staff. This is also important to assuring that the US healthcare providers receive this information.

The percentage of flagged data across all ten sites was miniscule (less than 1%) which means the sites are not making major mistakes. This quality data variable does not help determine errors in rounding or measurement. Since the WHO range for flagged data are extremely wide (-5SD and +5SD), only those that are extremely implausible are flagged and is most likely that these mistakes are recording errors. This is a limitation in the parameters themselves and therefore may not identify other incorrect measurements. This is an area for further discussion with WHO.

The standard deviation is the most encompassing measure of quality because it reflects rounding errors, recording errors, and errors in measurement techniques which all contribute to widening the standard deviation. Ideally, the standard deviation should be close to 1. Some countries in our analysis had wide standard deviations. The best quality is in the middle age group of children 2 -5 years. Although getting accurate length measurements for children <2 years can be a greater challenge, it is not typical to see higher standard deviations in the children in the older age groups. Some sites, such as Burundi, Malaysia, Thailand, and Ukraine, demonstrate good data quality in children 6 months to < 2 years. However, the standard deviations for the younger age group in such as Kenya, Malaysia and Turkey, have a wider standard deviation than that of the older age groups of 5 -18 years and likely reflects in small errors in measurements and rounding. This should be discussed and rectified with the programs because it is not generally difficult to obtain height measurements in older children. In Tanzania, which appears to have children who are overweight and stunted, if the standard deviation is wide, this may be a result of data quality. By including multi-year, rather than 1-year analysis, it may also be possible to have a more reliable distribution.

The digit preference score indicates that the rounding is quite substantial and reflects a lack of training to properly measure the children. A digit preference score of 100 reflects that every measurement was rounded to the nearest integer. In Ukraine, the rounding was 100%. This is very problematic for weight, especially in younger children in whom half kilo of weight can make large difference in weight. In all the USRAP clinical sites, there is no programmatic reason for rounding for weight; all have electronic scales available. At the same time, rounding is one of the easiest factors to change by telling staff to report all decimals on weight and millimeters on height measurements. Malaysia, which was the first site for the rollout of the nutritional SOP and training has no rounding for weight and therefore, encouraging for the possibility of improving the digit preference through training and follow-up.

Overall, the data quality indicators raise some questions about the findings in some countries. Some of the standard deviations did not meet the WHO recommendations for younger children. A possible reason may be because children less than 2 years of age are measured on a board laying down, and older children greater than 2 years of age are standing. Obtaining accurate length measurements can be a more challenging method of measurement due to movements in the child. There are high rates of stunting in sites where there is lower data quality such as Tanzania, Ethiopia, and Uganda. Although Malaysia had the least amount of data rounding, it has a higher standard deviation, especially in older children. This may be due to poor techniques but also depends the degree of homogeneity of the resettlement populations. If the populations resettling from Malaysia represent a mix of ethnic groups, for examples, different Burmese populations, such as Chin and Rohingya, and refugees from Afghanistan and Pakistan, there may be other reasons for a wide standard deviation in the mean z-scores.

The analysis of data quality has several limitations. One of the limitations of our analysis is the sample size by country. Ideally, the sample size for each country would be at least 400 children. Kenya is low at 323 thus, the estimates for this country may be unstable (table 1). For the 0 – 6-month age group, the sample size by country was very small and part of the reason for excluding them from this one-year analysis. In the future, a multi-year analysis may allow inclusion of that age group.

One important variable is date of birth, which is often estimated for older refugees. When an exact date is unknown, refugees, who are required to have a date of birth for USRAP processing, are assigned the date of January 01 with an estimated year. The impact of differences in age can be important for the younger age group.

The data quality may have had an impact on the estimated prevalence depending on the type of errors. Non-directional bias may have been present because there was an overestimation and underestimation of weight and height measurements. This was apparent because of the strong rounding from the digit preference score. The non-directional bias can widen the standard deviation but will not have a big effect on the mean z-scores. The prevalence should be interpreted with caution in some of the sites with the wider standard deviations that fell outside the recommended range. Directional bias, or systematic bias may have been present with an overestimation or underestimation of z-scores due to rounding in the measurements of length, height, and weight. Based on this analysis, it is not possible to decipher if sites are generally rounding up, or down and this can change the prevalence estimates. Rounding can affect the mean z-scores more than the standard deviation. For example, in wasting, if a site tends to generally round weight measurements down, the estimated prevalence will be higher. In comparison, if they round up, the percentage of wasting will appear to be lower. In some of the smaller sample sizes, especially those with <50, the standard deviation can be easily swayed, and the results should be interpreted with caution. For example, in Kenya, the wide standard deviation for young children may be due to the small sample size of only 20 children. The wasting standard deviations are based on the data quality for weight and height measurements, and the stunting standard deviations are based on the data quality for height and age measurements. In countries with wide standard deviations, the next step of analysis would be to parse out rates by locations within the countries as some countries, such as Kenya and Uganda, have refugees coming from 2-3 camps and urban locations. Another limitation to wasting estimates are measuring practices across sites, and if children are measured with clothes on or not. Clothes can drive down the prevalence of wasting and increase the overweight, depending on if children are undressed or not during the weight measurements. These factors should be explored by working with staff and conducting on-site observations and discussions about practices.

Children with significant medical conditions such as cerebral palsy, or missing limbs were not excluded from this analysis. The US resettlement program does include many children with medical conditions since this is one of many criteria that are used to identify refugees for resettlement. This could have also influenced the data quality for weight and height depending on the child's specific condition. For example, a child with a missing limb could potentially have a lower weight measurement than normal but may not necessarily be considered malnourished. Children who are spastic cannot be easily straightened out to obtain an accurate height measurement. A child that has certain medical conditions that hinder obtaining the most accurate length and height measurements should also be noted and interpreted differently for nutritional status. Children who are spastic or missing a limb (both conditions which occur in refugee children in USRAP) should be reported separately, rather than in the overall prevalence figures. For example, children with a missing limb, height-dependent measurements such as stunting can be calculated, but not wasting, which depends on weight. For children with spasticity, height measurements cannot be used to measure stunting but weight for age can still be calculated. Generally, older children tend to be more stunted, but in our analysis, specifically Tanzania, the older children are less stunted than the younger children. This needs further investigation.

In SMART surveys conducted in humanitarian emergencies, other data quality measures may be more important than our observations. For example, the standard deviation for wasting was better than stunting because weight and height fall within the direct control of the person collecting the measurements. In contrast, stunting often reflects challenges with vital records registration with a lot of noise coming from age, not height. We do not observe that problem in our analysis because all refugees in USRAP must have a documented birth date, even if it is assigned and estimated by the program. We see the opposite than what is commonly seen in humanitarian emergencies in which the wasting (weight/height) standard deviation is higher than stunting, which is affected by age.

In this analysis of US-bound refugee children, the estimated prevalence of wasting was highest in children between 5 years - <18 years of age. The highest estimated prevalence of both moderate and sever stunting was in children 6 months - <2 years of age. Notably, refugees resettling from Ethiopia have very high levels of wasting in children between 5 years to < 18 years, with a moderate wasting prevalence of 21% and severe wasting prevalence of 5%. In our analysis, children in age group 5 years - <18 years have a higher prevalence of malnutrition. Although often drawing less attention than wasting, stunting is just as important and has the potential to impair cognitive development even for older children. These findings are consistent than previous reported prevalence among refugees[22]. While this data is generally consistent with reports of wasting in children under 5 years of age, there is much less published about older children. This data is useful for USRAP because most studies focus on children 6 months – <5 years of age with relatively few studies focusing on children over 5 years of age, representing a gap in the published literature. Although nutritional status data is reported about refugees in UNHCR Health Information System, the data is usually limited to refugees in camp settings and focuses on children under 5 years of age. There may be other reasons why data reported on a camp population is not reflective of USRAP refugees: refugees are often referred by UNHCR and selected by PRM for resettlement because they are considered to be among the most vulnerable refugees, for example, children with complex or chronic medical conditions that increase the risk of malnutrition.

In this analysis, the overall stunting mean z-scores are negative, suggesting that all age groups experienced stunting. The prevalence of stunting was highest in Tanzania, Ethiopia, and Uganda. The overall prevalence of stunting is at or below medium risk (<20%) as defined by the WHO. The prevalence is worse among children 5-18 years old[22].Micronutrient deficiencies, repeated bouts of diarrhea, generational transmission of stunting are all possible factors which could have contributed to high prevalence rates of stunting. This age group is a critical period for children entering into their second growth spurt and offers a window of time for nutritional interventions that can support catch-up growth.

Although children under 5 years of age are thought to be the highest risk group for malnutrition, the finding of increased prevalence of malnutrition in the older age group of 5 - <

18 years is not entirely unexpected. One reason that older age group may have a higher prevalence of wasting is that they are not typically included in supplemental and therapeutic food distribution programs. For refugees residing in camp settings, nutrition programs usually target children 6 months – < 5 years of age and include treatment with Plumpy Nut or other ready-to-use therapeutic foods. In discussion with colleagues working with the refugees resettling from Nyarugusu camp in Tanzania, they reported that all children under 2 years of age are routinely included in a blanket supplemental feeding program and therefore have additional feeding support beyond basic food rations. The lower prevalence of wasting in the children less than 5 years of age may demonstrate the success of humanitarian assistance and supplemental nutrition programs for this age group in camps while also highlighting the hidden burden among older age children (5 – < 18 years of age) who still need continued supplemental nutritional support.

Interestingly, in some countries, such as Tanzania, there are overall positive z-scores for wasting, indicating the population is more overweight or obese. In this analysis, refugees resettling from Tanzania demonstrated a high prevalence of both overweight and stunting, suggesting a double burden of malnutrition in the same population. This is in line with some studies in refugees and data from low- and middle-income countries showing a growing burden of overweight related to low nutrient-density, high calorie food availability and sugar sweetened beverages[38]. Reasons for this possible distribution in Tanzania should be further studied.

For children in the US refugee resettlement program, country of processing, country of birth and nationality are often different; the extent to which these factors influence nutritional status is not fully understood. Differences in prevalence across countries could reflect access to and composition of food rations, which is not consistent across all countries or even within multiple camps in the same country; access to supplemental and therapeutic feeding programs and other means for supplementing food and income to assure adequate nutritional intake; cultural practices related to breastfeeding, weaning and introduction of solid foods among other factors. Refugees in camp settings, such as those in Thailand, Tanzania and Rwanda, usually have access to food rations and supplemental nutrition programs as these services are supported by UNHCR and non-governmental organizations that implement specific humanitarian assistance programs. In some camps, refugees may have small plots of land to grow vegetables and other crops. They also barter or sell food rations and fuel rations, such as firewood, to acquire other products, such as vegetables, which might not be included in the food rations. In contrast, refugees in urban areas, such as those resettling from Turkey and Malaysia, have little to no access to routine nutritional support programs and food rations. Urban refugees may have to work in an undocumented status in irregular employment status while trying to provide basic support for themselves and their families. Increasingly, UNHCR is promoting the use of cash-based assistance to refugees so that they can purchase and prepare their own food[39].

Some of the major limitations of our analysis, such as stratification by country of birth, nationality, urban versus camp location, familial clustering, and co-existing medical conditions, can be addressed with future studies. Questions that merit investigation include exploring risk factors for malnutrition in older age children; comparing malnutrition prevalence by age group among processing countries and examining prevalence in the same populations across countries, for example, Congolese across East Africa and Burmese in Asia. Additional analysis could have practical applications, for example, a domestic healthcare provider would usually know that a refugee is Congolese but it might not have realized that there could be a difference in the nutritional status of children who came from camps in Tanzania versus Rwanda, as the data from this preliminary investigation suggest. Other useful comparisons would be to examine the prevalence in urban versus camp-based refugees, for example Congolese refugees resettling from Uganda who are camp-based versus those residing in urban areas, and the prevalence among different groups coming from the same locations, for example, Congolese and Ethiopian refugees coming from camps in Kenya. One limitation from this study is that we did not examine whether the children were from the same families; the possibility of familial clustering should be studied. Additional work is needed to determine prevalence of malnutrition in children have complex or chronic medical conditions that can affect nutritional status. Another limitation is that this analysis is limited to wasting rather than the more general classification of acute malnutrition, which would consider edema, the retention of fluid observed in protein-energy malnutrition and that can affect weight measurements. This analysis can be accomplished by incorporating additional clinical information.

Implications of Findings

Although the number and composition of refugees in US refugee resettlement program can vary by year, in general, large group resettlement programs (referred to as P2 groups) often occur over several years, for example between 2007 - 2014, the US resettlement over 105,000 Iraqi and 77,000 Burmese from camps in Thailand between 2006 -2015[14]. By analyzing multi-year date for large population groups, we can increase the robustness of this nutritional analysis and explore whether there are any statistically significant differences in the processing countries and populations, and possible changes over time. In multi-year resettlements, refugees with family who have already arrived in the US often benefit from remittances sent back to them; these resources can be used to address food insecurity. It was noted anecdotally by IOM during a large resettlement of Somali refugees from Kenya over multiple years that many refugees in the initial resettlement group suffered from wasting. However, as the program continued, the latter groups, who were receiving remittances, suffered from overweight conditions, diabetes, hypertension and dental caries as diagnosed by IOM during their overseas medical examination, thus generating hypotheses that their diets had changed as a result of increased income. If nutritional issues in these large group resettlements can be identified during their resettlement trajectory, this information can be used for overseas activities and to facilitate programs after arrival over several years.

Another important reason to conduct nutritional analyses of USRAP over time has to do with global humanitarian crisis assistance. The world is facing an unprecedented migration crisis with more forcibly displaced persons than any other time in history. Recent acute crises, such as the Syrian crisis with more than 5.6 million refugees Syrians who have fled to other countries in the region and 6.6 million Syrians displaced internally [40], has exacerbated an existing shortfall in humanitarian assistance, leading to a redirection of resources from chronic refugee crises to acute emergencies. Food rations have decreased in several long-term camps due to insufficient resources[41]. The US resettlement program tends to accept refugees from long-term camps and humanitarian emergencies (those who have no other durable solution after years of displacement). The strain on food assistance resources may result in increased malnutrition among those refugees who are US-bound and highlights the importance of monitoring nutritional trends in US-bound refugees over time.

Recommendations and Conclusion

This data can help identify interventions focusing on nutritional issues that are critical and can be addressed in the 3-6 months between the time the refugee undergoes the medical exam overseas and arrival in the US. Some conditions, such as micronutrient deficiencies, may be particularly well-suited for intervention in the 3 – 6 month pre-departure period. Certain conditions – such as severe and moderate wasting – may be more critical and actionable in the short timeframe, but even for children with stunting, a 3 – 6 month period of improving nutritional status can be impactful for children who are still growing. In practice, the potential period for overseas nutritional interventions may be longer in many refugees – in the last several years, as many as 50% of refugees have been delayed in their departure – some for many months or years - due to a variety of reasons. These refugees repeat their required health examinations, which expire after 3-6 months, and thus have a longer period during which they could benefit from overseas nutritional interventions. Although IOM and panel physicians are not primary care providers, refugees can be referred to nutritional programs, or provided with supplements, such as iron and vitamin A. The nutritional SOP seeks to provide the foundation for these nutritional assessments and to create a country-by-country plan for referring, assisting and managing USRAP refugees with malnutrition tailored to country-specific options. For example, in Malaysia where refugees have wasting and/or stunting and no routine access to food rations or nutritional supplement programs, IOM has been able to refer children with acute malnutrition to local pediatricians for management. In addition to the overseas interventions, this work has important domestic implications. Refugees usually undergo a domestic health examination 14-90 days after arrival in the US. With accurate anthropometric measurements, proper nutritional classification and documentation in EDN, refugees can be flagged for prompt follow-up after arrival and receive the treatment needed for malnutrition.

The results from this analysis can be used to target intervention in overseas medical screening practices to ensure proper training and proper equipment are implemented moving forward to ensure high quality anthropometric data. The nutrition SOP has only been implemented in Thailand, Malaysia, and Nepal in the past and focused on acute malnutrition for travel and improved outcomes in the long term. The findings of this study will identify areas for growth and improvement for better data quality measures from the SOPs which can be shared across sites. The next steps include focusing training in sites with variation in data quality such as Tanzania, Ethiopia, and Turkey. We can use this preliminary analysis to follow trends in the prevalence over time in US-bound refugees. The issues of data quality highlight the importance of observing practices in the clinics to determine if they are interjecting systematic or nonsystematic biases.

Table 1: Demographic Characteristics among US- bound Refugee Children by Country of Exam, Electronic Disease Notification System, October 1, 2018 – September 30, 2019 (n =11,125)

Demographic characteristics	All N (%)	Burundi N (%)	Ethiopia N (%)	Kenya N (%)	Malaysia N (%)	Rwanda N (%)	Tanzania N (%)	Thailand N (%)	Turkey N (%)	Uganda N (%)	Ukraine N (%)
Total	11,125	1,275 (11.5)	688 (6.2)	324 (2.9)	1,068 (9.6)	1,258 (11.3)	2,119 (19.0)	1,036 (9.3)	382 (3.4)	1,327 (11.9)	1,648 (14.8)
Sex	**N (%)**										
Males	5,718 (51%)	641 (50.2)	352 (52.1)	172 (53.1)	558 (52.2)	664 (52.8)	1,073 (50.6)	541 (52.2)	202 (52.9)	651 (49.1)	864 (52.4)
Females	5,407 (49%)	634 (49.7)	336 (48.8)	152 (46.9)	510 (47.8)	594 (47.2)	1,046 (49.4)	495 (47.8)	180 (47.1)	676 (50.9)	784 (47.6)
Age	**N (%)**										
6m - <2y	1,106 (9.7)	119 (9.1)	50 (7.1)	21 (6.4)	155 (14.0)	109 (8.5)	260 (11.9)	67 (6.4)	21 (5.4)	110 (8.1)	194 (11.5)
2y - <5y	2,478 (21.8)	202 (15.5)	140 (20.0)	70 (21.3)	485 (43.8)	219 (17.2)	439 (20.2)	234 (22.5)	51 (13.3)	266 (19.7)	372 (22.2)
5y - <18y	7,541 (66.6)	954 (73.4)	498 (71.4)	233 (71.0)	428 (38.6)	930 (73.1)	1,420 (65.3)	735 (70.6)	310 (80.9)	951 (70.7)	1,082 (64.6)
Country of Birth											
Top Countries of Birth		**Burundi** (84.4%) **D.R.C.** (15.4%) **Tanzania** (0.2%) **Other** (0.1%)	**Ethiopia** (49.9%) **Eritrea** (46.2%) **Somalia** (1.7%) **Other** (2.2%)	**Kenya** (58.5%) **D.R.C.** (27.1%) **Ethiopia** (4.9%) **Other** (9.5%)	**Malaysia** (83.6%) **Myanmar** (13.5%) **Pakistan** (0.7%) **Other** (2.2%)	**Rwanda** (90.5%) **D.R.C.** (8.3%) **Burundi** (1.1%) **Others** (0.1%)	**Tanzania** (98.5) **D.R.C.** (1.4%) **Burundi** (0.1%)	**Thailand** (91.3%) **Myanmar** (5.0%) **Pakistan** (3.7%) **Other** (.1%)	**Afghanistan** (50.7%) **Iran** (26.9%) **Turkey** (18.3%) **Other** (4.1%)	**Uganda** (71.9%) **D.R.C.** (26.4%) **Burundi** (0.8%) **Other** (0.9%)	**Ukraine** (98.1%) **Bangladesh** (0.2%) **Others** (1.7%)
Nationality											
Top Countries of Nationality		**D.R.C.** (99.1%) **Burundi** (0.9%)	**Eritrea** (94.1%) **Somalia** (2.2%) **D.R.C.** (1.9%) **Other** (1.8%)	**D.R.C.** (51.8%) **Ethiopia** (21.5%) **Burundi** (11.4%) **Other** (15.3%)	**Burma** (97.7) **Afghanistan** (0.7%) **Pakistan** (0.7%) **Other** (0.9%)	**D.R.C.** (98.6%) **Rwanda** (0.8%) **Burundi** (0.6%)	**D.R.C.** (98.1%) **Burundi** (1.8%) **Rwanda** (.0.1%)	**Burma** (95.7%) **Pakistan** (4.0%) **Thailand** (0.2%) **Other** (0.1%)	**Afghanistan** (93.0%) **Iran** (2.9%) **Iraq** (1.0%) **Other** (3.1%)	**D.R.C.** (96.1%) **Rwanda** (1.8%) **Burundi** (1.3%) **Other** (0.8%)	**Ukraine** (98.9%) **Afghanistan** (0.4%) **Turkmenistan** (.2%) **Others** (0.5%)

Table 2: Flagged Data, Standard Deviation, and Digit Preference Score among Refugee Children, ENA Software for SMART, October 1, 2018 – September 30, 2019

Data Quality Indicators	Burundi	Ethiopia	Kenya	Malaysia	Rwanda	Tanzania	Thailand	Turkey	Uganda	Ukraine
Percentage of flagged data [a]										
6 months- <2 years										
WHZ Flag	n=117	n=50	n=20	n=155	n=107	n=259	n=66	n=21	n=110	n=194
	0.85%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%
HAZ Flag	n=119	n=50	n=20	155	n=108	n=259	n=66	n=21	n=110	n=194
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2 years to < 5 years										
WHZ Flag	n=202	n=139	n=70	n=479	n=218	n=438	n=234	n=51	n=263	n=366
	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%
HAZ Flag	n=202	n=140	n=70	n=485	n=218	n=437	n=234	n=51	n=266	n=369
	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.2%
5 to <18 years										
BMIZ Flag	n=952	n=496	n=233	n=427	n=929	n=1,417	n=734	n=309	n=951	n=1,081
	0.1%	0.0%	0.0%	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.09%
HAZ Flag	n=952	n=496	n=233	n=427	n=929	n=1,418	n=732	n=310	n=950	n=1,081
	0.1%	0.2%	0.0%	0.2%	0.0%	0.1%	0.4%	0.0%	0.1%	0.09%
Standard Deviation [b]										
6 months to <2 years										
WHZ SD	1.06	1.49	1.68	1.01	1.29	1.24	1.02	1.46	1.30	1.06
HAZ SD	1.56	1.66	1.37	1.06	1.40	1.32	0.95	1.61	1.39	1.29
2 years to <5 years										
WHZ SD	1.13	1.36	0.94	1.34	1.14	1.01	1.03	1.08	1.13	1.01
HAZ SD	1.25	1.38	1.24	1.07	1.18	0.94	0.95	1.18	1.21	1.03
5 to <18 years										
BMIZ SD	1.07	1.20	1.27	1.41	1.00	0.87	1.03	1.26	1.05	1.20
HAZ SD	1.16	1.13	1.20	1.11	1.04	1.00	1.02	1.18	1.23	1.02
Digit Preference Score [c]										
6 months to <2 years										
Weight	32	100	23	11	61	42	16	67	84	83
Height	92	98	80	54	90	75	98	100	88	100
2 years to <5 years										
Weight	22	96	15	4	59	77	14	83	91	99
Height	85	98	63	26	83	70	99	100	81	100
5 to <18 years										
Weight	26	98	15	6	65	75	13	92	92	100
Height	83	97	56	22	80	53	100	100	86	100

[a] The World Health Organization (WHO) flags are based on statistical plausibility and excludes values out of (< -5 and > +5) z-score for weight-for-height (WAZ) and (< -6 and >+6) for height-for-age (HAZ) Reference: https://www.who.int/childgrowth/software/anthro_pc_manual.pdf . WHO BMI-for-age z-score flags range is (< -5 and > +5 (reference https://www.who.int/growthref/tools/who_anthroplus_manual.pdf?ua=1)

[b] WHO states that standard deviations (SDs) for Z-scores greater than 1.3 are suggestive of inaccurate data, with the expected SD range of 0.85 to 1.10 for weight-for-height Z-score; 1.10 to 1.30 for height-for-age Z-score; and 1.00 to 1.20 for weight-for-age Z-score. (*reference:* https://www.who.int/nutgrowthdb/about/introduction/en/index5.html)

[c] Digit preference score assesses the last digits of each anthropometric measurement to see if there has been rounding. Digit preference score 0-7 excellent, 8-12 good, 13-20 acceptable, and >20 problematic). Reference (https://smartmethodology.org/survey-planning-tools/smart-methodology/?doing_wp_cron=1603060412.4530880451202392578125)

**The n in this table represents the number of individuals for all three measures

Table 3: Mean Z-scores and Prevalence of Wasting among Refugee Children, Electronic Disease Notification System, October 1, 2018 – September 30, 2019 (n =11,125)

Nutrition Indicators and Status	All	Burundi	Ethiopia	Kenya	Malaysia	Rwanda	Tanzania	Thailand	Turkey	Uganda	Ukraine
Anthropometric Measures	**Mean Z-score**										
Weight-for-height or BMI-for-age*											
6 months to < 2 years	**1,099**	**n=117**	**n=50**	**n=20**	**n=155**	**n=107**	**n=259**	**n=66**	**n=21**	**n=110**	**n=194**
	0.17	-0.2	-0.23	-0.10	-0.44	-0.13	0.69	-0.22	0.61	0.12	0.60
2 years to < 5 years	**2,460**	**n=202**	**n=139**	**n=70**	**n=479**	**n=218**	**n=438**	**n=234**	**n=51**	**n=263**	**n=366**
	-0.02	-0.82	-0.16	-0.23	-0.30	-0.35	0.85	-0.03	-0.33	0.07	0.06
5 to <18 years	**7,529**	**n=952**	**n=496**	**n=233**	**n=426**	**n=929**	**n=1,417**	**n=734**	**n=309**	**n=951**	**n=1,081**
	-0.31	-0.73	-1.04	-0.43	-0.04	-0.65	0.16	-0.31	-0.24	-0.30	-0.07
Total	**11,088**	**1,271**	**685**	**323**	**1,060**	**1,254**	**2,114**	**1,034**	**381**	**1,324**	**1,641**
Wasting [a]	**(%)**										
6 months to <2 years	**1,099**	**n=117**	**n=50**	**n=20**	**n=155**	**n=107**	**n=259**	**n=66**	**n=21**	**n=110**	**n=194**
Moderate (<-2 SD)	3.0%	3.4%	8.0%	5.0%	5.2%	4.7%	1.2%	7.6%	0.0%	2.7%	0.0%
Severe (<-3 SD)	0.8%	0.9%	6.0%	5.0%	0.6%	0.0%	0.4%	0.0%	0.0%	1.8%	0.0%
Total	3.8%	4.3%	14.0%	10.0%	5.8%	4.7%	1.6%	7.6%	0.0%	4.5%	0.0%
2 years to <5 years	**2,460**	**n=202**	**n=139**	**n=70**	**n=479**	**n=218**	**n=438**	**n=234**	**n=51**	**n=263**	**n=366**
Moderate (<-2 SD)	4.4%	12.9%	8.6%	0.0%	5.6%	7.8%	0.5%	2.1%	9.8%	4.2%	1.1%
Severe (<-3 SD)	0.3%	1.0%	0.7%	0.0%	0.4%	0.9%	0.0%	0.4%	0.0%	0.0%	0.0%
Total	4.7%	13.9%	9.3%	0.0%	6.0%	8.7%	0.5%	2.5%	9.8%	4.2%	1.1%
5 to <18 years	**7,455**	**n=952**	**n=496**	**n=233**	**n=426**	**n=929**	**n=1,417**	**n=734**	**n=309**	**n=951**	**n=1,081**
Moderate (<-2 SD)	6.2%	9.9%	21.4%	8.0%	4.5%	7.6%	1.3%	4.8%	7.1%	4.5%	3.9%
Severe (<-3 SD)	1.3%	2.3%	4.9%	2.2%	1.2%	0.9%	0.4%	1.0%	0.1%	1.2%	0.5%
Total	7.5%	12.2%	26.3%	10.2%	5.7%	8.5%	1.7%	5.8%	7.2%	5.7%	4.4%

[a] Wasting (acute malnutrition) is defined as a weight-for-height Z score < -2.

Table 4: Mean Z-scores and Prevalence of Stunting among Refugee Children, Electronic Disease Notification System, October 1, 2018 – September 30, 2019 (n =11,125)

Nutrition Indicators and Status	All	Burundi	Ethiopia	Kenya	Malaysia	Rwanda	Tanzania	Thailand	Turkey	Uganda	Ukraine
Anthropometric Measures	**Mean Z-score**										
Height-for-age											
6 months to < 2 years	**1,102**	**n=119**	**n=50**	**n=20**	**n=155**	**n=108**	**n=259**	**n=66**	**n=21**	**n=110**	**n=194**
	-0.91	-0.62	-1.63	-0.34	-0.35	-1.05	-1.93	-0.99	-0.61	-0.98	0.05
2 years to < 5 years	**2,472**	**n=202**	**n=140**	**n=70**	**n=485**	**n=218**	**n=437**	**n=234**	**n=51**	**n=266**	**n=369**
	-0.80	-0.42	-1.18	-0.60	-0.36	-0.61	-1.82	-1.43	0.04	-1.02	0.03
5 to <18 years	**7,530**	**n=952**	**n=496**	**n=233**	**n=427**	**n=929**	**n=1,418**	**n=732**	**n=310**	**n=950**	**n=1,081**
	-0.78	-0.78	-1.19	-0.59	-0.50	-0.65	-1.48	-1.33	-0.13	-0.88	0.37
Total for all ages	**11,104**	**1,273**	**686**	**323**	**1,067**	**1,255**	**2,114**	**1,032**	**382**	**1,326**	**1,644**
Stunting [a]	**(%)**										
6 months to <2 years	**1,102**	**n=119**	**n=50**	**n=20**	**n=155**	**n=108**	**n=259**	**n=66**	**n=21**	**n=110**	**n=194**
Moderate (<-2 SD)	13.0%	10.9%	16.0%	10.0%	2.6%	15.7%	23.2%	13.6%	4.8%	18.2%	4.6%
Severe (<-3 SD)	8.4%	5.9%	20.0%	0.0%	0.6%	6.5%	21.6%	0.0%	9.5%	7.3%	1.0%
Total	21.4%	16.8%	36.0%	10.0%	3.2%	22.2%	44.8%	13.6%	14.3%	25.5%	5.6%
2 years to <5 years	**2,472**	**n=202**	**n=140**	**n=70**	**n=485**	**n=218**	**n=437**	**n=234**	**n=51**	**n=266**	**n=369**
Moderate (<-2 SD)	13.1%	5.4%	17.9%	8.6%	4.9%	8.3%	32.0%	21.4%	3.9%	14.7%	2.2%
Severe (<-3 SD)	3.6%	3.0%	5.7%	1.4%	0.2%	2.3%	10.5%	3.8%	2.0%	4.1%	0.5%
Total	16.7%	8.4%	23.6%	10.0%	5.1%	10.6%	42.5%	25.2%	5.9%	18.8	2.7%
5 to <18 years	**7,528**	**n=952**	**n=496**	**n=233**	**n=427**	**n=929**	**n=1,418**	**n=732**	**n=310**	**n=942**	**n=1,081**
Moderate (<-2 SD)	12.5%	10.4%	17.7%	10.7%	8.6%	8.6%	22.1%	20.6%	4.2%	13.5%	0.8%
Severe (<-3 SD)	3.0%	3.0%	4.8%	2.1%	1.4%	1.5%	5.8%	3.4%	1.0%	3.9%	0.2%
Total	15.5%	13.4%	22.5%	12.8%	10.0%	10.1%	27.9%	24.0%	5.2%	17.4%	1.0%

[a] Stunting (chronic malnutrition) is defined as a height-for-age Z score < -2.

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