Evaluation of a nutrition risk screening tool to identify risk of malnutrition among newly admitted hospitalized patients in Lao PDR: a pilot study

By

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CERTIFICATE OF APPROVAL

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List of Abbreviations

The Academy: Academy of Nutrition and Dietetics

AIDS: acquired immune deficiency syndrome

ASPEN: American Society for Parenteral and Enteral Nutrition

AUC: area-under-the-curve

BMI: body mass index

BAPEN: British Association for Parenteral and Enteral Nutrition

CM: centimeter

ESPN: European Society of Enteral and Parental Nutrition

GLIM: Global Leadership Initiative on Malnutrition

GHI: global hunger index

HIV: human immunodeficiency virus

INMUCAL: Institute of Nutrition Mahidol University Calculation

KG: kilogram

LANI: Lao-American Nutrition Institute

Lao PDR: Lao People's Democratic Republic

Lao NRST: Lao Nutrition Risk Screening Tool

LDC: least developed country

LR: likelihood ratio

LTPHI: Lao Tropical & Public Health Institute

MN: month

MUAC: mid-upper-arm-circumference

MUST: malnutrition universal screening tool

NFPE: nutrition-focused physical exam

NRS-2002: Nutrition Risk Screen-2002

OHSU: Oregon Health and Science University

ROC: receiver operator curve

SDGs: sustainable development goals

STRONGkids: Screening Tool Risk on Nutritional Status and Growth

TB: tuberculosis

UXO: unexploded ordinance

WK: week

WHO: World Health Organization

YR: year

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Abstract

Background. In 2017, an estimated 33% of children under five years of age were stunted in Lao People's Democratic Republic (Lao PDR), 21.1% were underweight, and 9% were wasted. In addition, 17% of adults in Lao PDR were malnourished. Malnutrition rates may be even higher in hospitalized patients in Lao PDR, yet malnutrition risk screening does not occur as part of the admission or ongoing care process. To address this gap, this pilot study aimed to determine the prevalence of malnutrition among hospitalized patients and to investigate the inter-user reliability and validity of the Lao nutrition-risk screening tool (NRST).

Methods. A cross-sectional study was performed at two national hospitals in Vientiane, Lao PDR between August-September 2018. Participants in this study included male and female pediatric patients (n=69), 1 month to 17 years of age, and adult patients (n=125), 18 to 83 years of age. The Academy/ASPEN consensus criteria were used to diagnose acute/chronic, mild, moderate, or severe malnutrition in pediatric patients and acute/chronic, moderate or severe malnutrition in adult patients. Inter-observer reliability of the nutrition risk-screening tool was determined by comparing the Lao NRST final scores of two independent observers (Observer 1 and Observer 2) using Cohen's Kappa Coefficient (κ). Validity of the Lao NRST was determined using sensitivity, specificity, and area-under-the-receiver-operating-characteristics (ROC) curve analyses.

Results. Among participants 0-4 years of age, 51% were diagnosed with mild, moderate, or severe malnutrition. Among participants 5-17 years of age, 58% were diagnosed with mild, moderate, or severe malnutrition. Among participants 18 years of

age or older, 47% were diagnosed with moderate to severe malnutrition. The prevalence of adults with moderate to severe malnutrition was 70% among those admitted to the diabetes ward and 69% among those admitted to the pulmonary ward. Additionally, over half of patients admitted to the internal medicine and infectious disease wards presented with malnutrition, while only 7% of those admitted to the obstetrics/gynecology ward and 28% admitted to the surgery ward were malnourished. The Lao NRST showed 'fair' agreement between Observer 1 NRST final scores and Observer 2 NRST final scores (κ=0.3762, p-value <0.001). The Lao NRST area-under-the ROC curves for Observer 1 and Observer 2 were 0.64 and 0.70, respectively. The Lao NRST had a sensitivity of 85% and a specificity 35%. Our results suggest a need to modify criteria of the Lao NRST to improve inter-observer reliability, specificity, and area-under-the ROC curve.

Conclusions. The high prevalence of malnutrition among recently admitted hospitalized pediatric and adult patients determined in this study reinforces the need for a tool to identify risk of malnutrition among pediatric and adult patients admitted to Lao hospitals. Our results also indicate that implementing a nutrition risk screening tool in the national hospitals in Vientiane, Lao PDR is feasible. Nutrition screening and efforts to address hospital-based malnutrition may be more important in certain wards with high rates of malnutrition such as the diabetes, pulmonary, internal medicine, and infectious disease wards. Timely identification of malnutrition among newly admitted hospitalized patients will help minimize adverse patient health outcomes and reduce the economic burden of healthcare in Lao, PDR.

Chapter 1

Introduction & Significance

Malnutrition is a universal concern that exists in many forms and at any stage of life. The predominant causes of malnutrition are associated with famine and disease related conditions.[1] By definition, malnutrition is the development of an imbalance of nutrients, in which varying degrees of overnutrition or undernutrition with or without inflammatory activity results in an alteration of body composition and a decline in function.[2] Accordingly, malnutrition may negatively impact cognitive and physical development, immunity, wound healing, mortality, and other important health outcomes.[3]

While no country is untouched by malnutrition, low-income countries such as Lao People's Democratic Republic (PDR) are particularly vulnerable.[4] In Lao PDR, household poverty, low education levels, limited access to clean water and food, poor sanitation, and lack of health services increase the risk of malnutrition among Lao citizens.[5,6] In 2017, an estimated 33% of children under five years of age were stunted in Lao People's Democratic Republic (Lao PDR), 21.1% were underweight, and 9% were wasted.[7] Similarly, malnutrition exists among Lao adults. From 2014 to 2016, there was an estimated 1.2 million malnourished people in Lao PDR, comprising 16.6% of the popualtion.[8]

Although not yet described in literature, prevalence of malnutrition among pediatric and adult hospitalized patients is likely to be even higher than in the general population in Lao PDR. Presumably high rates of hospital based malnutrition in Lao PDR

may be caused by certain disease states and decreased ability to obtain adequate nutrition.[9] Inflammatory disease states commonly seen in hospital settings may increase energy expenditure and muscle catabolism, raising risk for malnutriton.[1] Additionally, certain disease states can result in decreased intake or assimilation of nutrients, which can lead to malnutrition in patients admitted to hospitals.[1] Furthermore, in Lao PDR, there are no hospital-based food service systems, leaving hospitalized patients responsible for identifying and obtaining sources of food and feeding themselves. Patients typically rely on family members to provide food and hydration. Economic challenges, limited access to food near hospitals, lack of food preparation and cooking areas, and work responsibilities or childrearing constraints all serve as barriers for family members to provide adequate nutrition for hospitalized patients. In addition to the high prevalence of malnutrition among the general population in Lao PDR, the presence of certain disease states and decreased ability to obtain food suggests the need to address malnutrition among patients admitted to Lao hospitals.

Various international studies have confirmed that timely identification of malnutrition with subsequent initiation of nutrition interventions can improve clinical outcomes in those who are malnourished or at risk for becoming malnourished.[10-13] In developed countries with adequate resources, the use of nutrition risk screening tools upon hospital admission is a method that quickly identifies patients at risk for malnutrition. A positive screen prompts a full nutrition assessment and appropriate intervention by a registered dietitian.[2] With timely nutrition intervention, there can be decreased risk of malnutrition and related complications, including: impaired wound

healing, increased risk of infection, higher treatment costs, and increased risk of mortality. [3,14,15] In the United States (U.S.), The Joint Commission hospital accreditation organization considers screening all patients admitted to a hospital within 24 hours a mandated standard of practice, as it is the critical first step of the nutrition care process.[9,16,17]

Despite evidence supporting use of nutrition-risk screening tools in hospital settings, pediatric and adult hospitalized patients are currently not screened for malnutrition risk in Lao PDR. To the best of our knowledge, no one has attempted to identify a culturally appropriate nutrition-risk screening tool or to routinely administer a hospital nutrition-risk screening tool in the low resource setting of Lao PDR. Our review of previously established nutrition-risk screening tools suggests the need for a nutrition-risk screening tool that is specifically developed for use in Lao PDR. A valid and culturally appropriate nutrition-risk screening tool would permit more extensive evaluation and, if warranted, appropriate nutrition interventions for patients with malnutrition or at risk of becoming malnourished. Based on the identification of this need, we customized a nutrition-risk screening tool, the Lao Nutritional Risk Screen Tool (Lao NRST), to administer among newly admitted hospitalized adult and pediatric patients in Lao PDR.

Specific Aims & Hypotheses

The objective of this cross-sectional pilot study was to investigate the validity and reliability of administering the Lao NRST in two national hospitals in Vientiane, Lao PDR. Specifically, we aimed to:

1. Determine the inter-user reliability of the Lao NRST.
2. Determine the specificity and sensitivity of the Lao NRST in pediatric and adult hospitalized patients.
3. Determine the prevalence of protein-energy malnutrition among newly admitted adult and pediatric patients to two national hospitals in Vientiane, Lao PDR using criteria from the Academy of Nutrition and Dietetics (The Academy) and the American Society for Parenteral and Enteral Nutrition (ASPEN) consensus statement.

The hypotheses that we tested included:

1. Clinical staff who administer the Lao NRST would correctly determine nutrition risk in newly hospitalized patients at least 90% of the time when compared to nutrition risk scores generated by the research team.
2. The Lao NRST would identify both pediatric and adult patients who were at risk for malnutrition, producing a true positive result. Likewise, the Lao NRST would identify both pediatric and adult patients who were not at risk for malnutrition, yielding a true negative result.
3. We anticipated that greater than 60% of adult and pediatric patients admitted to two national hospitals in Vientiane, Lao PDR would present with protein-energy malnutrition upon admission.

Chapter 2

Background

Lao PDR is a land-locked country in Southeast Asia bordering Myanmar, Cambodia, China, Thailand, and Vietnam (Figure 1). The tropical climate of Lao PDR is accompanied by a largely mountainous landscape, with fertile land found near the Mekong river that traverses the country. Among this vast landscape are 49 different ethnic groups, each possessing unique languages, cultural constructs, and traditions.[18] Within Lao PDR's 18 provinces, there is a total population of around 7.2 million people, the majority of whom (about 68%) reside in rural areas.[18,19] The capital of Lao PDR, Vientiane, is the largest city in the country with about 665,000 people.[19]

Figure 1. Map of Lao PDR and bordering countries[20]

Malnutrition in Lao PDR

Despite being a "least developed country" (LDC), Lao PDR is committed to fulfilling the Sustainable Development Goals (SDGs) implemented by the United Nations in 2015 that collectively promote global development. There is a total of 17 SDGs; two of which, SDG 2 and SDG 3, are specifically related to nutrition and healthcare. SDG 2 aims to end hunger, achieve food security and improve nutrition.[21] SDG 3 aims to ensure healthy lives and promote wellbeing for all ages, specifically by increasing health financing and the recruitment, development, training and retention of the health workforce in developing countries.[22] Coupled with the SDGs, is the long-term Lao Government National Socio-Economic Development Plan in Lao PDR, which has strategic objectives as part of the National Nutrition Strategy Report to increase investments in nutrition interventions, improve access to nutrition services, improve nutrition institutions and coordination, and ultimately improve nutrient intake.[5] Lao PDR's commitment to the SDGs and National Nutrition Strategy objectives are demonstrated by their improved Global Hunger Index (GHI) severity ratings.

The GHI severity ratings established by the United Nations and other multilateral agencies are determined by rates of insufficient caloric intake, child undernutrition, and child mortality. The GHI severity ratings suggested that the levels of hunger in Lao PDR dropped from 'alarming' in 2000 to 'serious' in 2018.[21] Organizations including the World Food Programme and the United Nations have partnered with the Lao Ministry of Health to improve community nutrition and nutrition education. However, few resources have been invested in addressing hospital-based malnutrition in Lao PDR.

With continuation and enhancement of efforts to improve malnutrition in Lao PDR, the country can be removed from the list of LDC and promoted to 'developing country' status.

Causes of Malnutrition in Lao PDR

The causes of malnutrition in Lao PDR are multifaceted. Access to and availability of foods through agriculture and foraging, infectious diseases, cultural constructs, and nutrient composition of the Lao diet are several important factors impacting the nutritional status of Lao citizens.[23] Furthermore, food accessibility is heavily driven by substance farming, and impacted by the presence of unexploded ordnance (UXO) and declining forest biodiversity.

Growing food crops to feed one's family, referred to as substance farming, is the primary source of food production for Lao families.[23] Approximately 80% of the population works in agriculture and practices subsistence farming, primarily growing the country's staple crop, rice.[8] The amount of rice harvested annually by households can vary dramatically depending on natural disasters including floods and droughts.[23] Though 90% of households report meeting their rice consumption requirements throughout the year, during the rainy season (May-October), up to 15% are unable to meet these requirements through their own production.[23] Meanwhile, commercial food markets are geographically and economically inaccessible for many household. Only one third of villages in Lao PDR have commercial markets, which may be difficult to reach from more remote locations during the rainy season when roads become impassible.[23]

A unique barrier to agriculture in Lao PDR is the presence of unexploded ordnance (UXO). During the Vietnam war in the 1960's and 1970's, more than 2 million tons of cluster bombs were dropped over the majority of the country.[18] Around 30 percent of the bombs failed to detonate when dropped. UXO related injuries have occurred among individuals when farming, digging, or venturing off a well-traveled path.[23] To this day, UXOs continue to destroy lives and inhibit agricultural expansion on arable land.[18,23]

Furthermore, decreasing forest biodiversity is an additional factor limiting food availability in Lao PDR. In northern hill villages, foraging and hunting are the mainstays for nutrition.[23] The practice of monoculture for crops including noxious rubber trees has resulted in plummeted diversity and reduced numbers of edible plants and animals available to families in surrounding villages.[23] To summarize, the reliance on substance farming, the prevalence of UXOs on arable land, and the decline in forest biodiversity limit availability and access to food in Lao PDR.[23]

Apart from accessibility of food, infectious diseases in Lao PDR also play a role in the nutritional of status of Lao citizens. Commonly seen infectious diseases in Lao PDR include malaria, parasitic infection, measles/rubella, and dengue fever.[5] Such infectious diseases can reduce appetite, increase energy expenditure due to fevers, and cause severe diarrhea, which impairs absorption of water and nutrients. Nearly 54% of children aged 24-59 months have intestinal parasitic infections, possibly impacting growth during an essential stage of development.[5] The National Nutrition Strategy

Report recognized the importance of controlling food, water, and vector-borne diseases as an avenue to improve nutrition status.[5]

Nutrition status is further impacted by cultural constructs in Lao PDR, particularly regarding maternal and child health. Among women of child bearing age in various ethnic groups, adherence to traditional peripartum food restrictions are common. Women of these ethnic groups often limit their diet to rice, salt, and ginger for up to three months after delivery.[23] A study by Barennes *et al.* found that only half of Lao mothers consumed adequate protein during this postpartum period.[24] This cultural practice leads to a deficit of protein, energy, and micronutrients including thiamin, which can exacerbate pre-existing malnutrition in mothers and contribute to malnutrition among infants and young children.[25]

A more widespread impact on nutritional status in Lao PDR is the nutrient composition of the Lao diet.[23] The Lao diet is largely dominated by polished glutinous sticky rice, providing 69% of the average energy intake, which is complimented with small portions of vegetables, pork, chicken, and fish.[23] In 2015, the most commonly consumed animal protein was fish, which on average was consumed every other day.[23] Eggs were consumed around 3 days per week and domesticated meat including beef, pork, or chicken was consumed even less often at 2.5 days per week.[23] Likewise, with the typical diet centered on rice, there tends to be adequate consumption of carbohydrate and possibly energy but insufficient consumption of protein and micronutrients.[23]

The traditional processing of rice further compromises micronutrient intake. In Lao, the rice is polished, removing the bran and hull which contains fiber, vitamins, and minerals. The rice is then washed three times before cooking. Fortification of rice to replace nutrients lost through processing is a challenge due to the large number of households that produce their own rice, poor distribution of fortification devices due to limited access to rural villages, and cultural hesitation to accept rice with "something added to it".[23] With unfortified rice providing the majority of the energy intake in the Lao diet, consuming food with diverse micronutrients becomes difficult.[5,23]

In Lao PDR, diversity of dietary intake is generally of greater concern than insufficient energy intake.[23] For example, with 70% of an adult male's energy intake coming from unfortified rice, 19% of riboflavin requirements, 5% of calcium requirements, and none of the vitamin A requirements would be met based on this amount of rice consumption.[23] Thus, to meet his micronutrient requirements, the remaining 30% of his dietary intake would need to be considerably nutrient dense. In reality, the consumption of fats, oils, and fruits in Lao PDR is also low.[5] Dietary diversity in rural areas of Lao is even less, where an average of only three of the nine major food groups are consumed regularly.[23] With high rice consumption and low dietary diversity in Lao PDR, it is difficult to meet requirements of protein, calcium, thiamin, riboflavin, folic acid, iron, and zinc.[5,23]

The diet composition of children in Lao PDR is further impacted by less-than-optimal infant and young child feeding practices including low rates of exclusive breastfeeding, and low meal frequency and diversity. Despite nearly all children being

breastfed to some extent in Lao PDR, only 45% of infants under six months of age are exclusively breastfed in Lao PDR.[26] Barriers to exclusive breastfeeding include: insufficient knowledge about infant feeding practices, women's early return to work, and societal status. There are geographical variations in breastfeeding rates likely related to different practices among ethnic groups. Those in the northern regions exclusively breastfeed at much higher rates than populations in the south.[23] Some mothers believe that colostrum is 'dirty milk' and not good for babies.[23] As a result, the nutrient and immunologically dense colostrum is commonly expressed then discarded, instead of being fed to the newborn.

Additionally, the use of infant formula is common in certain parts of Lao PDR. Thai formula companies have been observed to target Lao mothers of higher socioeconomic status. In 2017, the Lao Social Indicator Survey II[26] found that infant formula or other non-infant breastmilk alternatives (i.e. rice water, coffee creamer) were given to an average of one third of Lao infants below six months of age. If not prepared properly or provided in adequate quantities, use of infant formula can contribute to protein-energy and micronutrient malnutrition.[5] Use of infant formula can also be dangerous if un-safe drinking water is used in its preparation.[5]

The most concerning improper infant feeding practice is the use of non-infant formula breastmilk alternatives among children less than six months of age. A sugar-based coffee creamer was marketed towards mothers as a breastmilk alternative and was fed to their infants when they returned to work, or in the unfortunate case of a

mother's death during childbirth.[24] Due to education efforts and community-based interventions, this practice has declined over recent years.

Children 6-23 months of age are often not fed nutrient dense or diverse meals or fed often enough. Dietary diversity of Lao children is extremely low, considering only 16% of children aged 6-23 months consumed foods from more than four food groups per week.[23] Additionally, minimum meal frequency (less than four meals per day) was met by only 43% of children aged 6-23 months.[23] In conclusion, suboptimal infant and child feeding practices are important causes of undernutrition in Lao PDR.

Prevalence of Malnutrition in Lao Children

Malnutrition related to overnutrition, micronutrient undernutrition, and protein-calorie undernutrition exists in Lao children. Overweight related to overnutrition is only present in 3% of boys and 1% of girls under five years of age.[23] Furthermore, data on micronutrient deficiencies among children is lacking in Lao PDR. However, due to parasitic infections and low micronutrient intake, particularly of iron, approximately one in four children under the age of five years is found to be anemic.[23]

Malnutrition in children is often identified by three characteristics: inadequate linear growth (stunting), low rate of weight gain for linear growth (wasting), and underweight for age.[27] Stunting, underweight, and wasting are defined by median length- or height-for-age and sex, weight-for-age and sex, and weight-for-height and sex values two or more standard deviations below of the World Health Organization (WHO) reference standards, respectively.[15,27] Deviations from the median standard reference

values are referred to as a *z*-scores, which are calculated as the median reference value minus the observed value divided by the standard deviation of the reference population. Stunting (height for age z-score below -2) is an indicator of chronic malnutrition and is associated with reduced rate of linear growth. Severe acute wasting (weight-for-height *z*-score below -3) may be characterized by visible severe muscle wasting (marasmus) or nutritional edema (kwashiorkor). Malnutrition can result in the wasting of muscle stores and the depletion of body fat stores due to inadequate intake of all nutrients, particularly macronutrients.

Lao PDR has one of the highest rates of child undernutrition in the Western Pacific Region.[28] In 2017, an estimated 33% of children under five years of age were stunted in Lao PDR, 21.1% were underweight, and 9% were wasted.[7] Children living in poverty, with mothers with low education levels, or in remote areas with no access to clean water, sanitation, environment and health services are at higher risk of malnutrition.[5,28]

Prevalence and Double Burden of Malnutrition in Lao Adults

Malnutrition related to micronutrient undernutrition, protein-calorie undernutrition, and overnutrition also exists among Lao adults. As with children, there is a lack of data on rates of micronutrient deficiencies in Lao adults. However, in Lao PDR it is difficult for adults to meet intake requirements of calcium, thiamin, riboflavin, folic acid, iron, and zinc.[5,23] In regards to protein-calorie undernutrition, in 2016 one in five Lao citizens routinely consumed less than their minimum estimated daily energy

requirement, thereby increasing their risk for malnutrition. In Lao PDR an average of 16.6% of those over 18 years of age are malnourished.[8] This rate is higher than in neighboring countries, where 9% of adults in Thailand and 11% of adults in Vietnam are reported to be malnourished.[8]

Despite the high prevalence of undernutrition among adults in Lao PDR, there is also a rise in overweight, obesity, and noncommunicable diseases; known as the double burden of malnutrition. The prevalence of obesity in adults has doubled in the past decade, rising from 2.2% in 2006 to 4.5% in 2016.[8] Undernutrition early in life may predispose an individual to overweight and noncommunicable diseases such as diabetes and heart disease later in life.[29] While overnutrition is a growing burden in Lao PDR this condition will not be further discussed in this thesis.

Healthcare in Lao PDR

Inpatient health services in the Lao PDR are provided through four national general hospitals and three specialist hospitals in Vientiane, Lao PDR, in addition to four regional and twelve provincial hospitals throughout the country.[30] There are also approximately 130 district hospitals, 860 health centers, and around 5239 village drug kits for provision of primary health care.[30] Despite the presence of these facilities, geographic and economic access to health services is recognized as a concern in Lao PDR.[5] Patients are typically referred to national hospitals from district and provincial hospitals if they require higher acuity of care. Means of transportation and impassibility of roads may create a barrier to accessing higher levels of care. Additionally, health care

services may not be financially feasible as they are paid for out-of-pocket, with the exception that healthcare is provided to children under age five years, and antenatal care, delivery services, and postnatal care are publicly financed free services.[30]

The most common health care professionals include doctors, nurses, and midwives. Doctors require six years of schooling after completing upper secondary school (i.e. high school) to earn a bachelor's level medical degree (MD).[30] Nurses require two to four years of schooling after completing upper secondary school. [30] Most midwives are nurses who complete an additional year of training in midwifery.[30] Coupled with the absence of registered dietitians in the healthcare system, doctors and nurses receive limited amounts of training in medical nutrition therapy or identification and treatment of malnutrition.

Despite the lack of nutrition specialists in Lao PDR, there are numerous communicable and non-communicable diseases that increase risk for malnutrition. Common acute communicable diseases include malaria, parasitic infection, measles/rubella, and dengue fever. Common chronic illnesses in Lao PDR include Type 2 diabetes mellitus, human immunodeficiency virus (HIV), kidney disease, cancer, thalassemia, and tuberculosis.[5] Frequently seen acute illnesses in Lao PDR include helminthic infections, burns, physical injury, enterocolitis, and diarrheal diseases, all of which require increased energy and nutrient consumption to overcome.[5]

Foodservice in Lao Hospitals

There is no formal food service in hospitals in Lao PDR. Patients rely on family members or caregivers to provide food and hydration while admitted to the hospital. Caregivers often lack knowledge of healthy and appropriate food choices, access to healthy foods, and food preparation facilities; all of which can exacerbate the risk for malnutrition in hospitalized patients. Additionally, in many instances it is not feasible for health care providers to assess specific components of the diet (i.e. sodium and carbohydrate intake) due to the lack of standardized cooking utensils (measurement tools) and recipes used by family members providing meals and the lack of access to nutrition analysis software to analyze diet composition.

Availability of enteral and parenteral nutritional formulas are limited within Lao hospital systems, yet have rapidly expanded within the past few years. The most common enteral formulas and oral nutrition supplements are supplied by companies including Abbott (Abbott Park, IL, USA) and DSKH (Bangkok, Thailand). Parenteral nutrition solutions are available but there are barriers to use including lack of health provider education and training, quality control, temperature control, and laboratory testing to ensure safe administration. Products used for nutrition support are also cost prohibitive to most families.

Etiologies of Malnutrition

Muscle and adipose stores have a defining role in the nutritional status of individuals. Starvation and disease-related-malnutrition both involve decline of muscle

and fat mass, however, these two types of malnutrition differ in utilization rates of these two energy stores.[31]

*Starvation***.** Starvation-related-malnutrition, associated with social, economic, or behavioral circumstances is seen in the absence of inflammation. During starvation, the body's main goal is to preserve brain function and lean body mass. In the absence of any substantial food intake or in the initial stages of starvation, cellular glucose requirements, particularly in brain, are supplied by muscle and liver glycogen, which is the primary storage form of glucose in humans.[32] Glycogen stores deplete within approximately 18 hours of fasting, after which the body uses amino acids derived from muscle catabolism for glucose production to support energy needs.[32] After three days of fasting, resting energy expenditure decreases as ketones from fat metabolism become the main energy source for the brain and cardiac function and the remaining muscle mass is spared.[32,33] Unlike the adaptation that occurs during starvation to preserve lean body mass, in an inflammatory state muscle wasting continues while the disease state persists.

*Disease-related-malnutrition***.** Acute and chronic inflammation secondary to infection or trauma is recognized to be consistent with severe deterioration of lean body mass.[34] Insult to the body by pathogens, trauma, or other disease-causing agents initiate a stress response, leading to a state of inflammation. This stress response stimulates the production hormones and cell mediators including: cytokines, catecholamines, glucagon, and cortisol which initiate a hyper-metabolic state to support immune defense systems and repair tissue.[35] Consequently, there is an elevation in the rate of

muscle catabolism causing amino acids to be released from muscle tissue for use in gluconeogenesis to fuel the hyper-metabolic state.[14,32] A prolonged inflammatory induced hyper-metabolic state can result in significant wasting of muscle mass.[31,33] Additionally, some disease states and clinical interventions (i.e. medications with side effects of nausea or vomiting and drug-nutrient interactions) may impact the patient's ability to ingest or absorb nutrients and can result in anorexia or food avoidance, further exacerbating the risk of malnutrition. These observations have led to the consensus that identification of inflammation is integral to determine the proposed cause of malnutrition.[3,35] Consequently, health care providers should consider the differences between starvation and disease-related-malnutrition while conducting assessments and developing an intervention.[3]

Diagnosing Malnutrition

Malnutrition is a prevalent, yet often unrecognized disease state in hospitalized patients. Malnutrition is the development of an imbalance of nutrients, in which varying degrees of overnutrition or undernutrition with or without inflammatory activity results in an alteration of body composition and decline in function.[2] The deficiency of nutrients is related to at least one of the following factors: insufficient intake, impaired absorption, increased nutrient requirements, and altered nutrient transport and utilization.[3] For the purpose of this thesis, malnutrition will refer to the deficit of protein and energy, rather than micronutrient related malnutrition, or overnutrition resulting in overweight/obesity.

In regards to the diagnosis of malnutrition, there is a lack of global acceptance for a singular existing approach.[1] To help standardize identification and documentation of adult protein-calorie malnutrition, nutrition associations including the Global Leadership Initiative on Malnutrition (GLIM), the Academy of Nutrition and Dietetics (The Academy) and the American Society for Parenteral and Enteral Nutrition (ASPEN) have created consensus reports suggesting criteria for malnutrition diagnoses.[1,3]

The Global Clinical Nutrition Community published a consensus report in 2018 titled "Global Leadership Initiative on Malnutrition (GLIM) Criteria for the Diagnosis of Malnutrition"[1], which suggests criteria for the diagnosis of moderate or severe adult protein-calorie malnutrition in a global clinical setting.[1] The GLIM[1] criteria for diagnosing malnutrition are based on three phenotypic criteria (non-volitional weight loss, low body mass index (BMI), and reduced muscle mass) and two etiologic criteria (reduced food intake or assimilation of food/nutrients, and inflammation or disease burden) as summarized in Table 1. At least one characteristic from each category must be present for the diagnosis of malnutrition. GLIM[1] classification of moderate or severe malnutrition is based on more severe phenotypic criteria as described in Table 2.

A limitation for using this set of GLIM criteria to diagnose malnutrition among hospitalized patients in Lao PDR is the lack of population specific reference data for BMI and reduced muscle mass measures in Asian populations. Due to this limitation, this study used the Academy/ASPEN consensus criteria[3] for the diagnosis of protein-calorie malnutrition in adults.

Table 1. Global Leadership Initiative on Malnutrition (GLIM) malnutrition diagnosis criteria used to assess adult patients[1]

Phenotypic Criteria			Etiological Criteria	
Weight Loss (%)	**Low BMI (kg/m2)[a]**	**Reduced Muscle Mass[b]**	**Reduced Intake or Assimilation[c,d]**	**Inflammation[e]**
>5% within 6 months >10% beyond 6 months	<20 if <70 years <22 if >70 years Asia: <18.5 if <70 years <20 if >70 years	Indicated by validated body composition measuring techniques	<50% of ER >1 week Any reduction for >2 weeks Any chronic GI condition that adversely impacts food assimilation or absorption	Acute disease/injury Chronic disease-related

ER, energy requirements; GI, gastrointestinal. [a] Further research is needed to secure consensus reference body mass index for Asian populations in a clinical setting. [b]For example, fat-free mass index (kg/m^2)) by dual-energy absorptiometry or corresponding standards using other body composition methods such as bioelectrical impedance analysis, computed tomography, or magnetic resonance imaging. Physical examination or standard anthropometric measures such as mid-arm muscle or calf circumferences may be used. Thresholds for reduced muscle mass need to be adapted to race (Asia). Functional assessments such as hand-grip strength may be considered as a supportive measure. [c]Consider gastrointestinal symptoms as supportive indicators that can impair food intake or absorption. [d]Reduced assimilation of food/nutrients is associated with malabsorptive disorders. [e]C-reactive protein may be used as a supportive laboratory measure.

Table 2. Global Leadership Initiative on Malnutrition (GLIM) thresholds for severity grading of malnutrition into stage 1 (moderate) and stage 2 (severe) malnutrition[1]

	Thresholds for Severity Grading		
	Weight loss (%)	**Low BMI (kg/m²)[a]**	**Reduced Muscle Mass[b]**
Moderate Malnutrition*	5%−10% in ≤ 6 months, 10%−20% in > 6 months	<20 if <70 years <22 if ≥70 years	Mild-to-moderate deficit
Severe Malnutrition*	10% in ≤ 6 months, >20% in > 6 months	<18.5 if <70 years <20 if ≥70 years	Severe deficit

[a] Further research is needed to secure consensus reference body mass index for Asian populations in a clinical setting.[b] For example, fat-free mass index (kg/m^2)) by dual-energy absorptiometry or corresponding standards using other body composition methods such as bioelectrical impedance analysis, computed tomography, or magnetic resonance imaging. Physical examination or standard anthropometric measures such as mid-arm muscle or calf circumferences may be used. Thresholds for reduced muscle mass need to be adapted to race (Asia). Functional assessments such as hand-grip strength may be considered as a supportive measure.

The Academy and ASPEN published a consensus statement in 2012 recommending adult diagnostic criteria for moderate or severe protein-calorie malnutrition in a clinical setting in the United States.[3] The Academy/ASPEN consensus[3] statement uses three etiological based definitions of malnutrition: social and environmental circumstances, chronic illness, and acute illness. These definitions are determined by the presence or degree of inflammation and duration of the disease state (Figure 2).

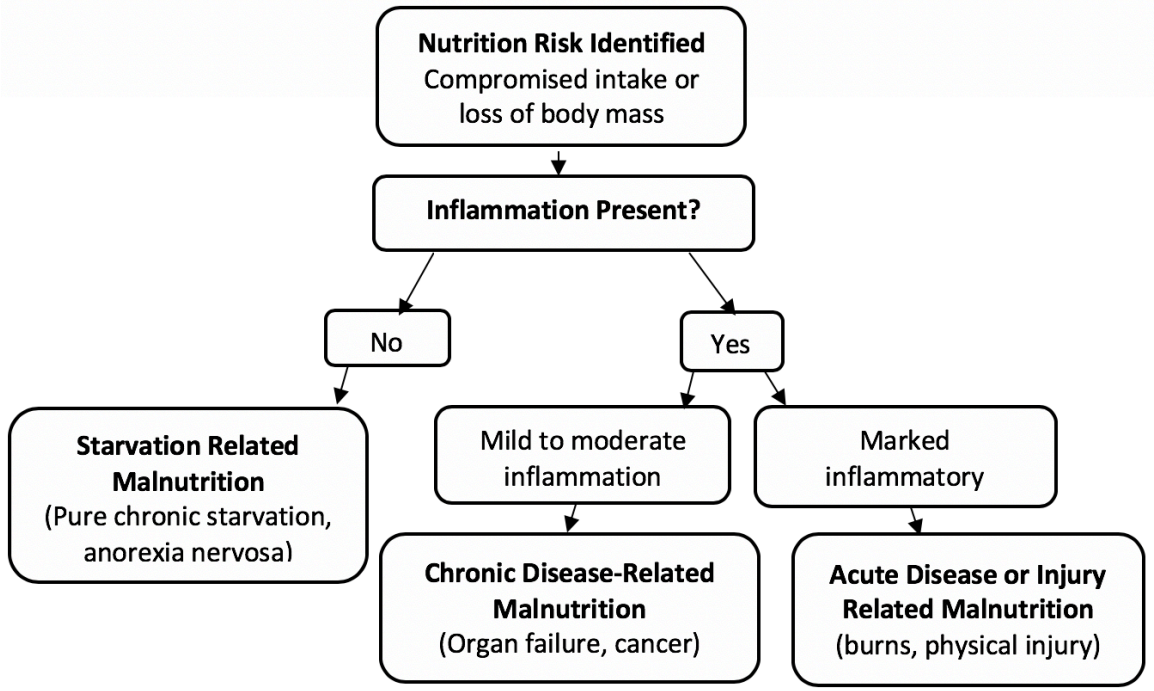

Figure 2. Etiology-based approach to the classification of malnutrition in adult patients[3]

Despite the distinction of three categories of malnutrition, these conditions are dynamic and often overlap. For example, a patient may change from acute to chronic malnutrition with starvation coinciding. The distinction between chronic and acute malnutrition in adults is based on the duration of the illness. The Academy/ASPEN uses the U.S. National Center for Health Statistics definition of chronic, "a disease or condition that lasts three months or longer".[36]

According to the Academy/ASPEN consensus[3] statement, the diagnosis of malnutrition in adults is made when two or more of the following six characteristics are present: insufficient energy intake, weight loss, loss of muscle mass, loss of subcutaneous fat, localized or generalized fluid accumulation (edema), and diminished functional status as measured by serial handgrip strength measurements (Table 3).[3]

Table 3. Academy/ASPEN malnutrition diagnostic tool used to assess hospitalized adult patients[3]

Type of Malnutrition	Acute Illness or Injury		Chronic Illness		Social or Environmental	
Degree of Malnutrition	**Moderate**	**Severe**	**Moderate**	**Severe**	**Moderate**	**Severe**
Energy Intake As evidence by nutrition history	<75% of needs for >7 days	≤50% of needs for ≥5 days	<75% of needs for ≥1 mo	≤75% of needs for ≥1 mo	<75% of needs for ≥3 mo	≤50% of needs for ≥1 mo
Weight Loss (% of unintentional wt loss from UBW)	1%-2% in1 wk 5% in 1 mo 7.5% in 3 mo	>2% in 1 wk >5% in 1 mo >7.5% in 3 mo	5% in 1 mo 7.5% in 3 mo 10% in 6 mo 20% in 1 yr	>5% in 1 mo >7.5% in 3 mo >10% in 6 mo >20% in 1 yr	5% in 1 mo 7.5% in 3 mo 10% in 6 mo 20% in 1 yr	>5% in 1 mo >7.5%i n 3 mo >10% in 6 mo >20% in 1 yr
Body Fat Wasting (eg, orbital, triceps, ribs)	Mild	Moderate	Mild	Severe	Mild	Severe
Muscle Wasting (eg, wasting of the temporalis, clavicles, shoulders)	Mild	Moderate	Mild	Severe	Mild	Severe
Fluid Accumulation Generalized or localized fluid accumulation	Mild	Moderate to Severe	Mild	Severe	Mild	Severe
Reduced Grip Strength Consult normative standards supplied by the maker of the device	N/A	Measurably Reduced	N/A	Measurably Reduced	N/A	Measurably Reduced

wk, week; mo, month; yr, year; UBW, usual body weight. The National Center for Health Statistics defines “chronic” as a disease/condition lasting 3 months or longer. Social or environmental malnutrition is related to pure chronic starvation or anorexia nervosa.

The Academy/ASPEN also published a consensus statement outlining a set of diagnostic indicators to identify mild, moderate, or severe protein-energy malnutrition specifically for the pediatric population.[15] Chronic undernutrition or stunting is defined by the WHO as a height (or length) for age that is less than 2 SD (*z*-score) below the median reference value.[27] On the occasion that a child does not have historical medical information, one data point from the following list may be used to diagnosis malnutrition: *z*-scores of weight-for-height/length and sex, weight-for-age and sex for children <2 years of age, and body mass index (BMI)-for-age and sex for children >2 years of age, length/height-for-age and sex or mid-upper arm circumference (MUAC) (Table 4). When medical history information is available, two or more of the following indicators can be used to diagnose malnutrition: weight gain velocity in grams/day for children <2 years of age, weight loss for children 2 to 20 years of age, reduction in weight-for-length/height *z*-score, and inadequate nutrient intake (Table 5).

Table 4. Primary indicators of malnutrition in children when only one data point is available[15]

Primary indicators	Mild malnutrition	Moderate malnutrition	Severe malnutrition
Weight-for-height/length *z*-score	-1 to -1.9	-2 to -2.9	-3 or greater
BMI-for-age *z*-score	-1 to -1.9	-2 to -2.9	-3 or greater
Length/height-for-age *z*-score	No data	No data	-3 or greater
Mid upper arm circumference (MUAC) *z*-score	-1 to -1.9	-2 to -2.9	-3 or greater

Table 5. Primary indicators of malnutrition in children when two or more longitudinal data points are available[15]

Primary indicators	Mild malnutrition	Moderate malnutrition	Severe malnutrition
Weight gain velocity (<2 years of age) (grams/day)	<75% of normal value	<50% of normal value	<25% of normal value
Weight loss (2-20 years)	5% loss	7.5% loss	10% loss
Decline in weight for length/height *z*-score	Decline of 1	Decline of 2	Decline of 3
Inadequate nutrient intake	51-75% of estimated energy/protein needs	26-50% of estimated energy/protein needs	<25% of estimated energy/protein needs

Nutrition Screening vs Nutrition Assessment

Evaluation of published methods used to identify malnutrition in a hospital setting often does not differentiate the discrepancies between nutrition screening and nutrition assessment, which can create confusion between the terminology and practices.[37] There are specific steps in the nutrition care process to identify and address malnutrition in hospitalized patients. In order, these steps include nutrition-risk screening, nutrition assessment, and diagnosis of malnutrition.

Furthermore, screening hospitalized patients is considered the critical first step in identifying malnutrition.[9] Nutrition screening has been defined by ASPEN as "a process to identify an individual who is malnourished or who is at risk for malnutrition to determine if a detailed nutrition assessment is indicated."[38] Nutrition-risk screening is a rapid process performed using a tool that identifies patients at nutritional risk, not involving malnutrition diagnosis .[39] Depending on the care setting, screening should be performed within the first 24 hours after admission and thereafter at regular intervals.[39] A patient who has been screened and identified to be at risk for malnutrition is flagged for a trained nutrition professional to complete a more in-depth nutrition assessment.

Nutrition assessment allows the clinician to gather the following confirmatory information: anthropometric, biochemical, clinical history, diet history, and nutrition focused physical exam findings. Information gathered during the nutrition assessment is then used to develop the nutrition diagnosis and to plan an appropriate intervention. A standard nutrition assessment used to make a nutrition related diagnosis incorporates five domains: patient/client history; food and nutrition-related history; anthropometric

measurements; biochemical data, medical tests, and procedures; and nutrition-focused physical examination findings. In addition to these five standard domains, nutrition assessments for patients at risk of malnutrition should also incorporate presence of chronic illness and include indicators of social, cognitive, and functional status. Access and ability to prepare food may be impeded by social or economic status. Additionally, cognitive and functional status may indicate that a person is physically unable to procure, cook, or eat food. Critical evaluation of the nutrition assessment should tailor a patient's intervention to their specific and individualized needs.

Nutrition-Risk Screening in the United States

Malnutrition is a prevalent, yet often under-recognized disease state in hospitalized patients in the U.S.[3,9] Hospitalized patients of any BMI are at risk for malnutrition due to illness-induced poor appetite, gastrointestinal symptoms, impaired ability to safely chew or swallow food, or being placed on "nil per os" or "nothing by mouth" (NPO) status.

Prevalence rates of malnutrition range from 15% to 60% among adult hospitalized patients in the U.S., with estimates that upon hospital admission one third of patients are malnourished.[2,38,40] If malnutrition is left untreated, those patients will likely experience a further decline in their nutrition status during their hospitalization.[10] Among patients who are not malnourished upon admission to the hospital, one third may develop malnutrition while hospitalized.[10] Despite the high prevalence of malnutrition among hospitalized patients, a survey of 1,777 hospital-based clinicians in

2014 indicated that only 50% completed nutrition screening upon admission, meanwhile, 37% of the respondents indicated that screening occurred within 24 hours of admission.[41] Nutrition screening and identification of malnutrition among hospitalized patients continues to be an area of continuous improvement in the U.S. to help improve health outcomes, prevent hospital readmissions, and reduce medical/health-related costs.[9]

Criteria for Nutrition-Risk Screening Tools

Criteria for an effective nutrition screening tool include (1) a high degree of validity and reliability; (2) simple and easy implementation without extensive training for the user; (3) quick, inexpensive, and noninvasive clinical utility.[42-44] A screening tool is considered to be quick and easy if it can be completed within ten minutes or less.[45] Validity refers to the extent a tool accurately measures a trait. Validity is measured by specificity and sensitivity.[44] An accurate, or valid, tool should be *specific* enough to identify those who are not at risk for malnutrition, while *sensitive* enough to pick up those who are truly at risk for malnutrition.[44] For the validity of a screening tool, sensitivity is considered to be more important than specificity for capturing the greatest number of people at risk.[45]

The most common measures of validity for screening tools are criterion validity and predictive validity.[42] Criterion validity compares measurements made by a screening tool to measurements made by a gold standard.[42] Predictive validity assesses the extent to which a screening tool predicts the effects of nutritional intervention on actual

outcomes, including mortality, quality-of-life, length of hospital stay and complications.[42]

Reliability refers to the consistency of risk scores between users, or the inter-user error.[46] A reliable screener will yield similar results between the judgment of two or more users.[44,46] Low inter-user reliability may indicate that users of the tool interpreted the questions differently.[45] For a tool to be considered valid, results must be consistent and reliable for all who use the tool.[45]

Review of Nutrition Risk Screening Tools

Common internationally used nutrition-risk screening tools include the Malnutrition Universal Screening Tool (MUST)[47] and the Nutrition Risk Screen (NRS) 2002[48] for adults and the STRONGkids[49] for children. The MUST[47] is a screening tool developed and validated by the British Association for Parenteral and Enteral Nutrition (BAPEN) to identify adults who are malnourished or at risk of malnutrition. The European Society of Enteral and Parental Nutrition (ESPEN) recommended the MUST[47] for use in a community setting. This tool utilizes three items to determine malnutrition risk: BMI, unplanned weight loss in the past 3-6 months, and no nutritional intake for >5 days due to acute disease affect. Each criterion is given a score between 0 and 2 based on severity, with a maximum score of 6. A score of 0 indicates low risk for malnutrition, a score of 1 identifies medium risk for malnutrition, while a score of 2 or greater suggests high risk for malnutrition.

The NRS-2002[48] tool was developed and validated by the ESPEN, screening for hospitalized adult patients who would likely benefit from nutrition intervention. This tool is comprised of two parts, an initial screening and a final screening. The initial screening assesses the following items: BMI <20.5 kg/m^2, weight loss in the last three months, reduced dietary intake over the last week, and severity of illness. If a patient screens positive for any item in the initial screen then a final screen in performed. The final screen includes more in-depth information on two items: nutritional status (i.e. weight loss >5% in 1 month) and severity of disease (i.e, bone marrow transplant versus hip fracture). Each item on the final screen allocates a score from 0 to 3, with a final maximum score of 6. A score of 3 or higher identifies a patient as at risk for malnutrition. The NRS-2002[48] contains the same components as the MUST[47], in addition to an item that assesses severity of disease.

A study by Kyle *et al.*[50] comparing four screening tools to the Subjective Global Assessment (SGA), found that the NRS-2002[48] had the highest degree of sensitivity and specificity. The NRS-2002[48] correctly classified malnutrition risk 73% of the time, whereas the MUST correctly classified malnutrition risk 59% of the time. A meta-analysis by Bokhost-de van der Schuerne *et al.* [51] concluded that the MUST[47] and NRS-2002[48] had 'fair' to 'good' validity in predicting length of stay (LOS), mortality, or complications.

For the pediatric population, the Screening Tool Risk on Nutritional Status and Growth (STRONGkids)[49], was developed by Hulst *et al.*[49] and validated by Huysentruyt *et al.*[52] in the Netherlands. STRONGkids[49] was designed to be a quicker and more simple method of screening for malnutrition among hospitalized children.[49] This screening tool

consists of four items: subjective clinical assessment (diminished subcutaneous fat and/or muscle mass and/or hollow face), high-risk disease, nutritional intake and losses (vomiting or diarrhea), weight loss or poor weight gain. A STRONGkids[49] score of 0 indicates nutrition-risk is low, a score of 1-3 identifies medium risk, and a score of 4-5 suggests high risk. Unique to the STRONGkids[49] tool, is a secondary validation by an independent institution.[52] A comparison of criteria used in the STRONGkids[49], MUST[47], and NRS-2002[48] nutrition screening tools is illustrated in Table 6.

Table 6. Comparison of items found in the MUST, NRS-2002, and STRONGkids screening tools

Tool	Components	Population
MUST[47]	BMI Nutritional intake Weight loss	Adults
NRS-2002[48]	BMI Nutritional intake Weight loss Severity of disease	Adults
STRONGkids[49]	Subjective assessment Nutritional intake/losses* Weight loss or poor weight gain Severity of disease	Children

MUST, Malnutrition Universal Screening Tool; NRS-2002, Nutrition Risk Screen 2002; STRONGkids, Screening Tool Risk on Nutritional Status and Growth. *Nutritional losses is defined as presence of vomiting or diarrhea.

After an in-depth review of commonly used nutrition-risk screening tools, including MUST[47], NRS-2002[48] and STRONGkids[49], and considering the context of this thesis, a major limitation of each of these tools is that they were developed and validated for use in countries with high-resource hospital systems. To our knowledge, no nutrition-risk screening tool has been developed or validated for use in the low-resource country of Lao PDR.

Development of the Lao Nutrition Risk Screening Tool (NRST)

The Lao NRST used in this study was developed for use in Lao PDR to identify risk of malnutrition in hospitalized adult and pediatric patients. The screening tool was modified from STRONGkids[49] because of its usability and timeliness, making it appealing for use in Lao PDR. The Lao NRST uses the same four criteria as STRONGkids[49]: subjective assessment, nutritional intake/losses, weight loss or poor weight gain, and severity of disease. The Lao NRST classifies patients at low, moderate, or high risk of developing malnutrition. Similar to STRONGkids[49], a final NRST score of 0 indicates low risk of malnutrition, a score of 1-3 indicates moderate risk of malnutrition, while a score of 4-5 indicates high risk of malnutrition.

Modifications made to the STRONGkids[49] screening tool aimed to simplify information, incorporate screening criterion relative to adults, and increase usability. For ease of translation and understanding by clinic staff, terminology used in the Lao NRST was simplified. The Lao NRST was adapted to include criterion relative to adults by incorporating adult specific diseases and anthropometric measurements. Additionally,

to compensate for limited resources and the low level of knowledge about nutrition-risk screening by Lao practitioners, the Lao NRST included examples of high-risk diseases. Clinical nutrition specialists from Oregon Health & Science University (OHSU) and the Lao government visited national hospitals in the capital city of Vientiane, Lao PDR to obtain a comprehensive list of common diseases associated with increased nutrition risk (Table 7). This information was included in the Lao NRST.

Table 7. High risk diseases of patients in two national hospitals in Vientiane, Lao PDR

Anorexia nervosa	Prematurity* (corrected age 6 months)	Liver disease, chronic	Surgery/Expected major surgery
Inflammatory Bowel Disease	Chronic cardiac disease	Chronic kidney disease	Short bowel syndrome
Bronchopulmonary dysplasia (maximum age 2 years)	Infectious disease (TB, HIV/AIDS)	Pancreatitis	Mental handicap
Cleft lip and palate	Burns	Trauma	Metabolic disease (diabetes)
Dysphagia	Cancer	Muscle disease	Hypertension

TB, tuberculosis; HIV, human immunodeficiency virus; AIDS, acquired immune deficiency syndrome. *Prematurity is defined as a neonate born less than 37 weeks gestation.

Conclusion

While community-based nutrition education and public health efforts have helped improve Global Hunger Index (GHI) severity ratings, malnutrition continues to be recognized as a critical area for improvement in Lao PDR. Hospitals may provide a strategic avenue to mitigate malnutrition, considering high rates of inflammatory disease states and decreased ability to obtain adequate nutrition among patients in the hospital setting.[9] Administering a culturally appropriate nutrition-risk screening tool upon admission to the hospital in Lao PDR, would be the first step in identifying and creating treatment options for patients who are malnourished to prevent further complications including morbidity and mortality.[3,14,15] We believe that addressing malnutrition among hospitalized patients will contribute to Lao PDRs advancement from Least Developed Country (LCD) status to Developing Country status.

Chapter 3

Methods

General Design & Setting

This cross-sectional pilot study was performed over a four-week period from August 13th to September 7th 2018 at Mahosot and Settathirath Central Hospitals, two national hospitals in Vientiane, Lao PDR. Mahosot Hospital, dedicated to the diagnosis and treatment of infectious disease, has 31 wards with 450 inpatient beds. Settathirath Hospital is a general hospital with 186 inpatient beds. Patients were referred to these two hospitals from district and provincial hospitals if they required higher acuity of care. Participants in this study included pediatric and adult male and female patients. Pediatric participants were one month to 17 years of age. Adult participants were 18 to 83 years of age.

Study Participant Recruitment

Study participants were admitted to the pediatric, diabetes, obstetrics/gynecology, internal medicine, surgery, pulmonary, and infectious disease wards of Mahosot and Setthathirath Hospitals. Patients were recruited to participate in this study within 24 hours of admission to the hospital. Patients who died or were discharged within 24 hours, who were admitted to the ICU, or who had incomplete nutrition screening or nutrition assessment information were excluded from the study.

IRB Approval

The study protocol was approved by the Lao Health Research Board for Ethical Review and by the Oregon Health & Science University Institutional Review Board (IRB# 00017306).

Study Documents

There was a total of six forms that were completed for each study participant. All forms for this study were designed by OHSU faculty and graduate students and developed specifically for use in Lao PDR. A unique participant identification number and the date of completion was documented on each form. Each form will be described in detail later in the methods sections. Below is a complete list of forms used for data collection:

1. Informed Consent (Appendix A & B)
2. Observer 1 Nutrition-Risk Screening Tool (NRST) (Appendix C)
3. Observer 2 Nutrition-Risk Screening Tool (NRST) (Appendix C)
4. Nutrition Assessment (Appendix D)
5. 24-hour Dietary Recall (Appendix E)
6. Nutrition Interview (Appendix F)

Study Personnel

There were two research teams, one located at Mahosot Hospital and one located at Setthathirath Hospital. Each team had six people: five research assistants and

a research team coordinator. Research assistants were Lao doctors or nurses associated with the Lao-American Nutrition Institute (LANI) Clinical Nutrition Education Program and were trained according to their assigned research role. The research team coordinators were master's students in the Graduate Programs in Human Nutrition at Oregon Health & Science University, Portland, Oregon, USA. Each member of the research team was responsible for collecting a specific set of data from each participant (Table 8). Detailed descriptions on research team position roles and training will be discussed later in the methods section.

Table 8. Study research assistant roles

Research Team Position	Role
Coordinator	Organized and collected research forms Facilitated communication between team members
Research Assistant A	Collected Observer 1 NRST form from nurse (or completed Observer 1 NRST for newly admitted patients not screened by the nurse) Obtained consent, created patient list and assigned a unique participant ID Shared patient list and participant IDs with the team
Research Assistant B	Measured weight and height and completed the Observer 2 NRST form
Research Assistant C	Reviewed paper chart; collected pertinent data and medical history (if documented)
Research Assistant D	Completed the 24-hour diet recall form Completed the nutrition interview form
Research Assistant E	Conducted nutrition-focused physical exam and collected anthropometric measurements

Confidentiality/Data Management

The completed Observer 1 and Observer 2 NRST forms, nutrition assessment form, 24-hour diet recall form, and patient interview form were stapled together and given to the research team coordinator after each ward visit. Patient health information was linked to a unique participant identification number, only. At the end of each study day all documents were placed in a file locked in the LANI office at the Lao Tropical and Public Health Institute (LTPHI) in Vientiane, Lao PDR. The research team coordinators scanned all study forms and uploaded them to the secure OHSU sanctioned cloud-based data storage platform, Box.com. Hard copies of the forms remain in a locked file within the LANI office.

Informed Consent

Prior to the retrieval of any medical information or measurements, informed consent was obtained from all caregivers of pediatric participants (Appendix A) and adult participants (Appendix B). Informed assent was obtained from each pediatric participant, as able. The purpose of the study and all study procedures were explained in the Lao language before consent was obtained.

Nutrition Risk Screening with the Lao NRST Form

The Lao NRST (Appendix C) was adapted from the STRONGkids screening tool[52] and consists of four items: presence of a high-risk disease, subjective clinical assessment, adequacy of nutritional intake, weight loss or inadequate rate of weight

gain. In addition to the four criteria items on the Lao NRST forms, the following information was documented on each form: unique participant identification number, admission date, reason for admission, admission diagnosis, age, sex, date, height/length, and weight.

Lao NRST Scoring System. Each criterion was allocated a score of 1-2 points with a maximum total score of 5 points. The presence of a high-risk disease was allocated 2 points if indicated, while the adequacy of nutritional intake, weight loss or inadequate rate of weight gain were allocated 1 point each if indicated. A NRST final score of 0 indicated low risk of malnutrition, a score of 1-3 indicated moderate risk of malnutrition, while a score of 4-5 indicated high risk of malnutrition. Each participant in this study received two NRST final scores one by each independent observer.

Administration of the Lao NRST. Two independent observers completed the NRST forms (Observer 1 and Observer 2) within 24-hours of patient admission to the hospital. First, blank Observer 1 NRST forms were distributed to all wards at each hospital. Upon patient admission to a ward at one of the hospitals, the ward nurse assigned to the patient completed the Observer 1 NRST form. Observer 1 NRST forms were collected from each ward nursing station at approximately the same time each day by research assistant A. If the ward nurses were unable to complete the Observer 1 NRST form, research assistant A completed the Observer 1 NRST form on all newly admitted but not screened patients on that ward. Subsequently, research assistant B independently completed the Observer 2 NRST form on all newly admitted and enrolled participants. Research assistant A and B gave all completed Observer 1 NRST and

Observer 2 NRST forms, respectively, to the research team coordinator after all information was collected for each ward.

Training for Administration of the Lao NRST. Prior to data collection, research assistant A, research assistant B, and the head ward nurses for each ward within both Mahosot and Setthathirath Hospitals completed a brief five-minute training on how to administer the Lao NRST. This training was provided by a research team coordinator. Head ward nurses trained other ward nurses on how to administer the Lao NRST. Training consisted of an overview of the Lao NRST criteria, followed by a question and answer session.

Nutrition Assessment

Administration of the Nutrition Assessment. A complete nutrition assessment was conducted by research assistants C, D, and E for each study participant using three forms: the nutrition assessment form, the 24-hour dietary recall form, and the patient interview form. The nutrition assessment process took place after research assistant B completed the NRST form. Research assistants C, D, and E, were provided with a twenty-minute training on how to complete their respective roles in the nutrition assessment process for constancy of data. This training was provided by a research team coordinator.

Nutrition Assessment Form. The nutrition assessment form (Appendix D) was used to collect anthropometric measurements, patient history, and nutrition focused physical exam (NFPE) findings. The nutrition assessment form was completed

collectively by research assistant C, who collected patient history information, and research assistant E, who collected anthropometric and NFPE information. The following patient history information was collected: diagnosis, signs/symptoms, medical history, medications, social environment, and previous medical history. The following anthropometric measurements were conducted: height/length, weight, and mid-upper arm circumference (when appropriate). Muscle and fat wasting were recorded to a mild, moderate, or severe degree if observed during the NFPE. All NFPE results were confirmed by the research team coordinator.

The 24-hour Dietary Recall Form. The 24-hour dietary recall form (Appendix E) was completed by research assistant D in the Lao language and was used to estimate energy, protein, and fluid intake over the past 24-hours. Portion sizes were compared to intake in handfuls or commonly used bowls and utensils.

Nutrition Interview Form. The nutrition interview form (Appendix F) was completed by research assistant D and was used to collect information on appetite, presence of nausea or vomiting, bowel movements, perceived weight loss, perceived decline in intake, usual body weight, and alcohol or tobacco use.

After nutrition assessment forms were completed, a registered dietitian trained at OHSU used nutrition assessment information that was collected to calculate pediatric *z*-scores (weight-for-height/length, BMI-for-age, length/height-for-age, mid upper arm circumference), estimate energy and protein requirements, determine percent of protein and energy requirements met based on actual intake, and approximate percent weight loss.

Overview of the Data Collection Process

The data collection process for obtaining consent and completing the Observer 1 NRST occurred in consecutive order: the Observer 1 NRST forms were distributed to all wards by the research team coordinator; ward nurses completed the NRST upon patient admission to the hospital; Observer 1 NRST forms were collected from nursing station by research assistant A; consent was obtained in the Lao language for those with complete Observer 1 NRST forms; if Observer 1 NRST forms were not completed by the ward nurse, research assistant A obtained a list of all newly admitted patients, and then obtained consent and completed the Observer 1 NRST form; after consent was acquired research assistant A assigned each participating patient with a unique study identification number. The unique study identification number, patient bed number, and room number for the participating patient was shared with rest of the research team.

The data collection process for the Observer 2 NRST form and the nutrition assessment occurred in consecutive order as followed: once a unique participant identification number, bed number, and room number were obtained, research assistant B measured weight and height and completed the Observer 2 NRST form; research assistant C collected patient medical history from the paper charting system, while research assistant D completed the nutrition interview and 24-hour dietary recall forms and research assistant E conducted the NFPE and measured mid upper arm circumference (MUAC); research assistant E and the research team coordinator came to consensus on NFPE findings. After all data was collected on each ward the research

team coordinator compiled documents by unique participant identification number and removed the bed number and room number from each form. At the end of each day all forms were placed in a locked file in the locked LANI office.

Anthropometric and Body Composition Measurements

Height/length. Height was measured to the nearest 0.1 cm using a stadiometer with participants standing without shoes straight against a fixed vertical backboard with an adjustable head piece (Seca 213 Portable Stadiometer, Chino, CA, USA). Participants under two years of age were measured using a portable Seca length board (model #417). Measurements were taken until two measurements were consistent within 0.1 cm. If the patient was unable to stand or the stadiometer was not available, estimated height or last documented height in the medical chart was used.

Weight. Weight was measured with participants wearing light clothing using a digital scale and recorded to the nearest 0.1 kg (Seca 876 Flat Scale, Chino, CA, USA). If the patient was unable to stand, the most recent recorded weight in the patient's medical chart was used or weight values were estimated per participant recall. Weight of infants was measured using a hanging basket scale, in which infants were placed in the basket and weighed, or by calculating the difference in the caregiver's weight when holding the infant and not holding the infant using a calibrated digital scale.

Body Mass Index (BMI). BMI was calculated as weight in kg divided by height in meters squared (m^2). Pediatric BMI was used to generate BMI-for-age *z*-score and sex.

*Weight changes***.** Weight change was calculated by subtracting the weight measured by research assistant from the participant's self-reported usual body weight. Percent weight loss was calculated by subtracting the usual weight from the actual weight and dividing that number by the usual weight, then multiplying by 100. Severity of weight change in relation to malnutrition was determined as outlined in Table 9.

Mid upper arm circumference (MUAC). MUAC was measured using a flexible, non-stretch measuring tape. Participants were seated with the right arm extended and relaxed at their side. The measurement was taken at the midpoint between the elbow and the acromion of the right arm. Measurements were taken in triplicate to the nearest 0.1 cm and averaged.

Table 9. Criteria for adult moderate to severe malnutrition based of weight loss[3]

Type of Malnutrition	**Acute Illness or Injury**		**Chronic Illness**	
Degree of Malnutrition	**Non-Severe (Moderate) Malnutrition**	**Severe Malnutrition**	**Non-Severe (Moderate) Malnutrition**	**Severe Malnutrition**
Weight Loss (% of unintentional wt loss from UBW)	1%-2% in 1 wk 5% in 1 mo 7.5% in 3 mo	>2% in 1 wk >5% in 1 mo >7.5% in 3 mo	5% in 1 mo 7.5% in 3 mo 10% in 6 mo 20% in 1 yr	>5% in 1 mo >7.5% in 3 mo >10% in 6 mo >20% in 1 yr

Wk, week; mo, month; yr, year; UBW, usual body weight.

Pediatric z-Scores. Weight-for-height/length and sex, BMI-for-age and sex, length/height-for-age and sex, mid upper arm circumference *z*-scores were generated by a registered dietitian using World Health Organization (WHO) reference standards.[53] For participants under the age of five years, WHO *z*-score calculators were used. For participants over the age of five years, WHO *z*-score calculators were not available and *z*-scores were analyzed by hand using WHO growth charts.

Muscle and fat wasting. A Nutrition Focused Physical Exam (NFPE) is the suggested method of the Academy/ASPEN diagnosis malnutrition consensus statement for assessment of subcutaneous fat loss and wasting of skeletal muscle.[3] NFPE was performed on adult participants by research assistant E and the research team coordinator during the assessment portion of data collection. NFPE was completed visually and with palpation.

Muscle mass was assessed by inspection of the following muscular areas: temporalis, pectoralis major, deltoid, trapezius, quadriceps, gastrocnemius, interosseous. Muscle and fat wasting were classified as moderate or severe depending on the extent of wasting. Moderate muscle loss may present as: slight depression of the temporalis, slight protrusion of acromion process, knee cap less prominent and more rounded, mild depression on inner thigh, and not well-developed gastrocnemius muscle.[54] Severe muscle loss may present as: hollowing and scooping depression of the temporalis muscle, acromion protrusion very prominent, prominent knee bones with little sign of muscle around knee, and minimal to no muscle definition of the gastrocnemius.[54]

Assessment of fat wasting included the following anatomical areas: orbital fat pads, triceps, ribs, lower back, and midaxillary line. Moderate fat loss may present as: slightly dark and hallow orbital region, some depth of pinch in the triceps but not ample, apparent ribs and iliac crest.[54] Severe fat loss may present as: depression and loose dark skin in the orbital region, fingers touch during pinch of the triceps, very predominate rib bones and iliac crest.[54]

Estimated Nutrient Intake

*Nutrition History***.** Nutrition history information was collected by research assistant D using the nutrition interview form (Appendix F). Participants were asked whether their intake during the previous day was more than usual, typical, less than usual, or significantly less than usually and how long their intake was less than normal.

Diet Analysis. Nutrient composition of food described during the 24-hour dietary recall interview was analyzed using INMUCAL Diet Analysis software (Mahidol University, Bangkok, Thailand) by a registered dietitian. INMUCAL is a computer-based nutrient database for foods and dishes commonly found in Thailand and Lao cuisine. Foods and portion sizes included in the 24-hour recall were entered into the INMUCAL software and total energy and protein intake was calculated.

Estimated Nutrient Needs

Adult Participants. Energy needs were calculated using a weight-based predictive equation of 25-30 kcal/kg/day for healthy adults, 30-35 kcal/kg/day for adults with

moderate stress, and 35-45 kcal/kg/day for adults in a state of high stress such as human immunodeficiency virus (HIV), burns over 20% or more of their body or tuberculosis (TB).[55,56] An additional 340 kcal/day was added for pregnant women in their second trimester and 450 kcal/day for women in their third trimester.[57] Protein requirements for adults were estimated using the weight-based equation of 0.8 g/kg/day and was adjusted based on severity of disease, up to a maximum of 2.0 g/kg/day. Protein requirements for pregnant women were calculated using 1.1 g/kg/day.[57] Energy and protein needs compared to actual intake were used to determine if the participant met criteria for the diagnosis of malnutrition.[3]

Diagnosis of Malnutrition

Nutrition assessment information was used to diagnose malnutrition in both adults and pediatric participants. For participants with a questionable diagnosis, a second registered dietitian was consulted to ensure there was consensus in the malnutrition diagnosis.

Adult Participants. The diagnoses of malnutrition among adult participants were based on the 2012 Academy and ASPEN consensus criteria for moderate or severe malnutrition.[15] These criteria include weight loss, poor oral intake (<75% of estimated energy needs), depletion of body fat, and depletion of muscle mass. Handgrip strength was not used as a criterion in this study as there are currently no normative standards for handgrip strength in Lao adults. Additionally, fluid accumulation was not used as a criterion due to the limited time that was available to train research assistants to

differentiate between malnutrition-related fluid accumulation and fluid accumulation secondary to a disease state.

Pediatric Participants. The 2014 Academy and ASPEN consensus criteria for pediatric malnutrition was used to identify and document mild, moderate, or severe malnutrition in pediatric participants. One data point from the following list was used to diagnose malnutrition: *z*-scores for weight-for-height/length, BMI-for-age, length/height-for-age, or MUAC. Weight-for-length/height, length/height-for-age, BMI-for-age, and MUAC *z*-scores were analyzed for the 1-24 months and >2-4-year-old age groups. Height-for-age and BMI *z*-scores were analyzed for the 5-17-year-old age group.

Statistical Analysis

Descriptive statistics were used to characterize the study sample. Continuous variables were summarized using means and standard deviations if normally distributed, while medians and interquartile ranges were used to summarize data that was not normally distributed. Categorical variables were summarized by calculating frequency and percentages. STATA/IC.15 was used to complete all statistical analysis. Descriptive variables (i.e. reason for admission, malnutrition diagnosis, etc.) were coded with numerical values for ease of statistical analysis.

Reliability. Inter-observer reliability refers to the agreement of the NRST, or the ability to derive or reproduce the same Lao NRST final score for a patient by two independent observers. Cohens Kappa value, denoted by κ, was used as a descriptive measure of agreement between users. Using this statistical test, the degree to which

Lao NRST final scores (i.e. 1-5) agreed with each other was measured. Interpretation of kappa ratings was as followed: <0.0 poor, 0.00-0.20 slight, 0.21 - 0.40 fair, 0.41 - 0.60 moderate, 0.61 - 0.80 substantial, 0.81 - 1.00 almost perfect.[58]

Criterion Validity. Validity of the NRST criteria was done by comparing the Lao NRST final scores to a gold standard. The gold standard in this study was the malnutrition diagnosis made by a trained registered dietitian. Sensitivity, specificity, and area-under-the-receiver-operating-characteristics (ROC) curve were determined to assess the overall performance of the Lao NRST. ROC curves were generated by averaging true positive values (sensitivity) computed over the false positive values (1-speficitiy). Sensitivity was calculated as the probability (P) of having a positive screen for malnutrition (T^+) and a positive diagnosis for malnutrition (D^+) [sensitivity = P ($T^+|D^+$)], otherwise known as the probability of having a true positive. Whereas, specificity was calculated as the probability of having a negative screen (T^-) and a negative diagnosis (D^-) [specificity = P ($T^-|D^-$)] and is referred to as a true negative. The probability (P) of a having a positive screen (T^+) and having a negative diagnosis of (D^-) [1 – specificity=P ($T^+|D^-$)] is commonly known as a false positive. Sensitivity and specificity screening characteristic are summarized in Table 10.

Table 10. Sensitivity and specificity screening characteristics

$P(T^+\|D^+)$ = Sensitivity
$P(T^-\|D^+)$ = False Negative = 1 – Sensitivity
$P(T^+\|D^-)$ = False Positive = 1 – Specificity
$P(T^-\|D^-)$ = Specificity

An example of a receiver operating characteristic (ROC) curve is illustrated in Figure 3. The different plots on the graph correspond to different cut points, or scores, used to designate a screening result (Lao NRST final score of 1 to 5, where a score of 1 is low risk and a score of 5 is the highest risk for malnutrition). The area-under-the-ROC curve was used to summarize the overall performance of the Lao NRST by averaging true positive values computed over the possible range of false positive values. Referring to Figure 3, in this example the line designated by letter "C" indicates that the score of a screener is not correlated to a positive or negative diagnosis (slope of the line = 1). Conversely, the line with a substantial deviation to the left, as designated by "B", indicates that a higher score on the NRST is correlated with an increased probably of a malnutrition diagnosis. The perpendicular line designated by "A" in Figure 3, indicates perfect performance of a screening tool at detecting a diagnosis. An area-under-the-ROC curve of 0.90-1.0 designates excellent performance, 0.80-0.89 is good, 0.70-0.79 is fair, 0.60-0.69 is poor, and 0.50-0.69 suggests failed performance.

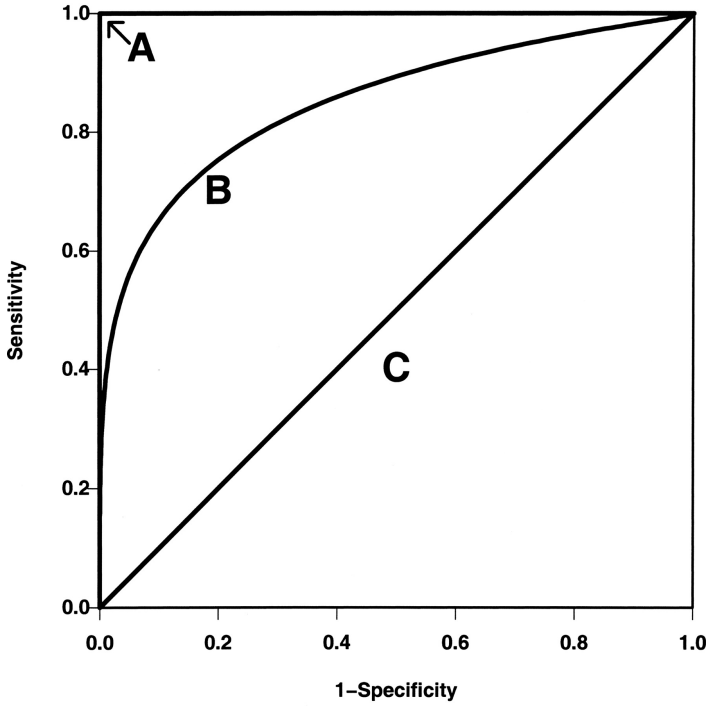

Figure 3. Example of a receiver operating characteristic (ROC) curve. The line designated by letter "C" indicates that the score of a screener is not correlated to a positive or negative diagnosis. A line with a substantial deviation to the left, as designated by "B", indicates that a higher score on a screener is correlated with an increased probably of a diagnosis. The perpendicular line designated by "A" indicates a perfect performance of a screening tool at detecting a diagnosis.

Chapter 4

Results

This study aimed to determine the prevalence of malnutrition in two national hospitals in Vientiane, Lao PDR and to investigate the reliability and validity of implementing the Lao Nutritional Risk Screen Tool (Lao NRST). It was hypothesized that more than 60% of hospitalized patients screened by the Lao NRST would present with a protein-calorie-malnutrition diagnosis. Additionally, it was hypothesized that the two Lao NRST observers would yield the same Lao NRST final score result at least 90% of the time. Lastly, we proposed that the Lao NRST would be both specific enough to identify those who are not at risk for malnutrition and sensitive enough to identify those who are truly at risk for malnutrition.

Participant characteristics

Between Mahosot and Setthathirath Hospitals, 316 hospitalized patients were screened using the Observer 1 NRST form. A total of 194 participants met inclusion criteria and were included in this study; 69 (36%) were <18 years of age and 125 (64%) were ≥18 years of age. The 124 patients excluded from the study did not meet the inclusion criteria, were discharged within 24 hours, did not provide consent, had incomplete Observer 1 NRST or Observer 2 NRST forms, or had inadequate information to make a malnutrition diagnosis (Figure 4).

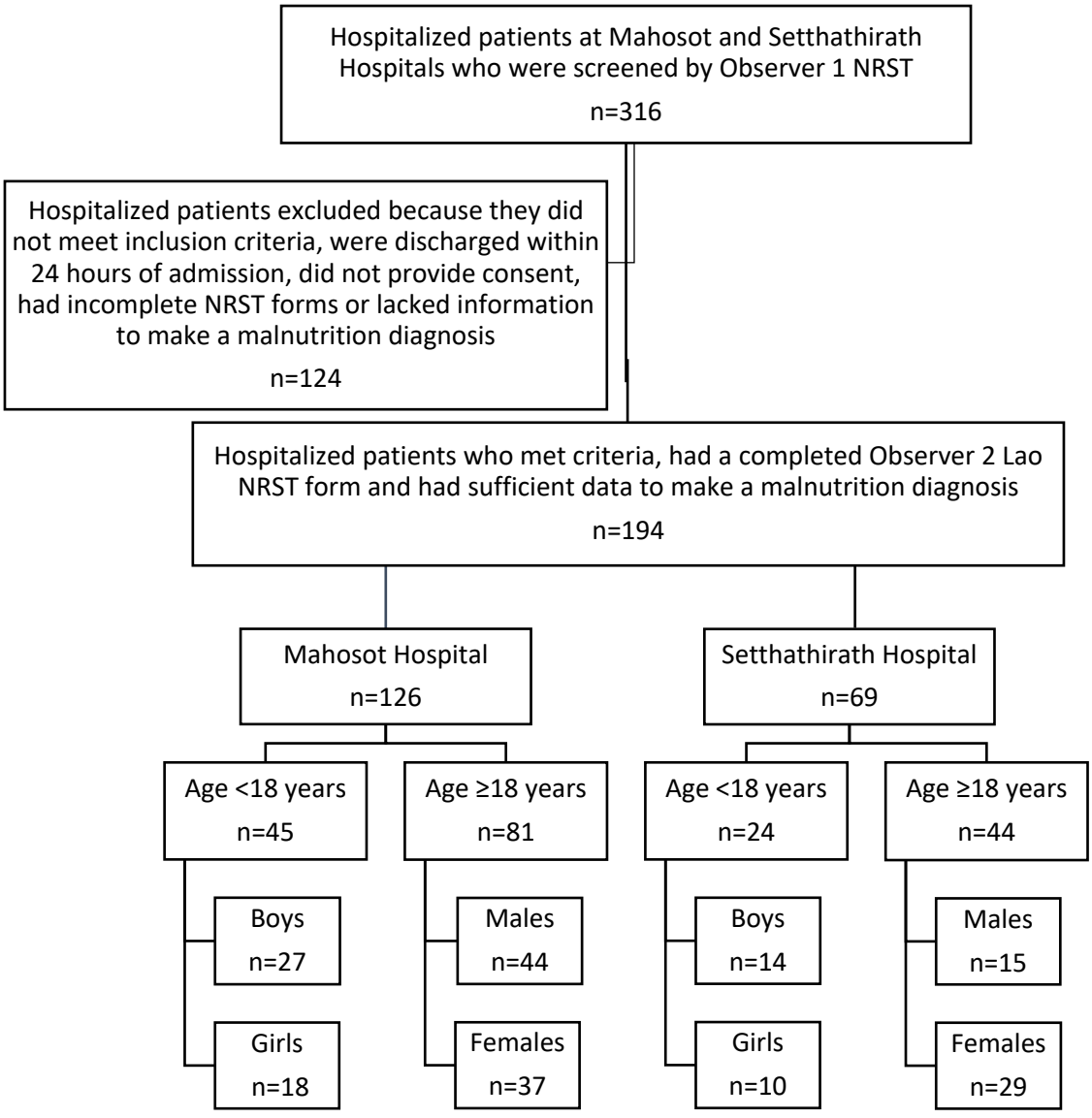

Figure 4. Flowchart of participants included in this study

The greatest number of participants were admitted to Mahosot Hospital comprising 65% of the study sample, while 35% of participants were admitted to Setthathirath Hospital. There was a similar distribution of males (51%) and females (49%) in this study. In the adult population, the wards with the greatest number of participants included the infectious disease (18%), surgery (16%), and pulmonary disease (14%) wards. The ward with the fewest number of participants was the diabetes (5%) ward (Table 11).

Table 11. Participant characteristics

Variable		**Hospital**	
		Mahosot	Setthathirath
	n (%)	**n (%)**	**n (%)**
Total Sample	194	126 (65)	68 (35)
Age (Years)			
0-4	45 (23)	27 (60)	18 (40)
5-17	24 (12)	18 (75)	6(25)
18-83	125 (64)	81 (65)	44 (35)
Sex			
Male	99 (51)	71 (71)	29 (29)
Female	95 (49)	55 (59)	39 (41)
Hospital Ward			
Pediatric	60 (31)	39 (78)	21 (35)
Surgery	32 (16)	17 (53)	15 (47)
Internal Medicine	16 (8)	0	16 (100)
Obstetrics/Gynecology	15 (8)	0	15 (100)
Infectious Disease	34 (18)	33 (97)	1 (3)
Pulmonary	27 (14)	27 (100)	0
Diabetes	10 (5)	10 (100)	0

The median age, height, weight, and BMI of adult participants was 41 years, 1.57 m, 56 kg, and 20 kg/m^2, respectively (Table 12). Participant's median energy intake was 1088 kcal/day, while the median estimated energy requirement was 1800 kcal/day (Table 12). The median energy requirements met by the study population was 65% of their estimated energy needs. There were two outliers, one of the outliers reported an energy intake of 5,550 kcal/day (Figure 5). This participant was included in all analyses due to the likely validity of energy intake reported.

Adults also had a lower median intake of protein 39 g/day compared to their estimated protein requirements 57 g/day. The median protein requirement met by the adult participants was 75% of their estimated protein requirement. Adult protein intake included three outliers, one of the outliers consumed more than 200 g protein/day (Figure 6). This participant was the same participant who was an outlier for energy intake.

Table 12. Median (IQR) anthropometric, dietary intake, and estimated nutrient needs of the adult participants

Variable	**Median (IQR)**
Age (years)	41 (28-59)
Weight (kg)	56 (49-64)
Height (m)	1.57 (1.52-1.65)
Body Mass Index (kg/m^2)	20 (22-25)
Total Energy Intake (kcal/day)	1088 (644-1617)
Estimated Energy Requirements (kcal/day)	1800 (1525-2005)
(% met)	65 (36-95)
Total Protein Intake (g/day)	39 (25-74)
Estimated Protein Requirements (g/day)	57 (47-72)
(% met)	75 (36-129)

IQR, interquartile range.

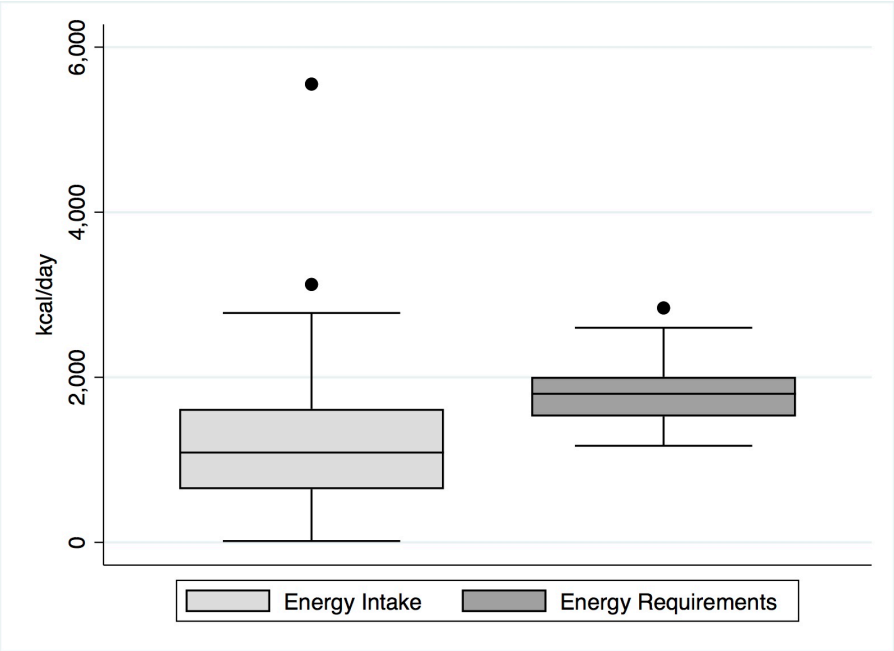

Figure 5. Distribution of adult energy intake and energy requirements. Box and whisker plot description – The ends of the box are the 25th and 75th quartiles. The median is marked by a horizontal line inside the box. The whiskers are the two lines outside the box that extend to the minimum and maximum values that are not outliers. The closed circles represent outliers.

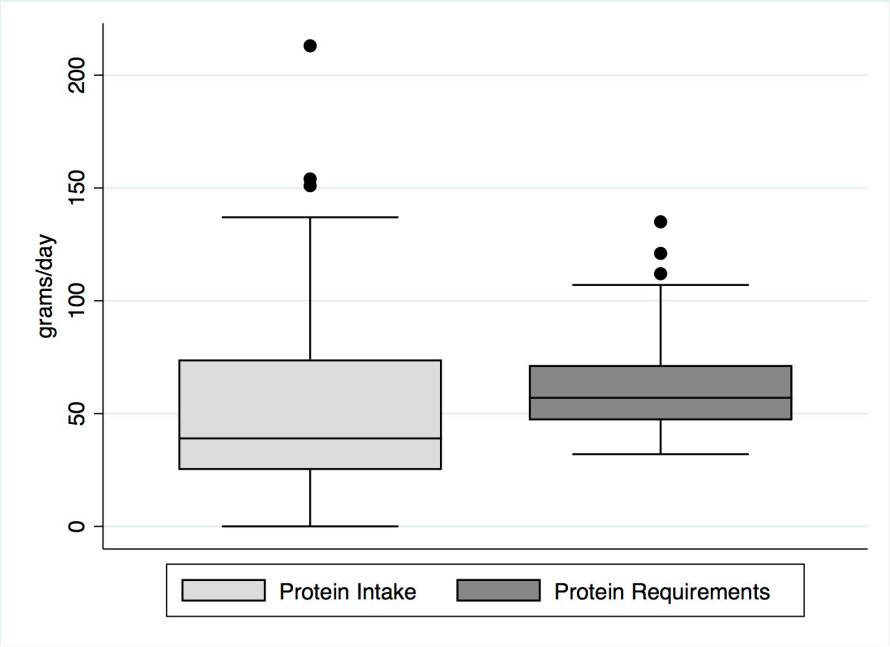

Figure 6. Distribution of adult protein intake and protein requirements. Box and whisker plot description – The ends of the box are the 25th and 75th quartiles. The median is marked by a horizontal line inside the box. The whiskers are the two lines outside the box that extend to the minimum and maximum values that are not outliers. The closed circles represent outliers.

Pediatric participant anthropometric data including *z*-scores are presented in Table 13 and grouped by age: 1-24 months, >2-4 years, and 5-17 years. Weight-for-length/height, length/height-for-age, BMI-for-age, and MUAC *z*-scores were analyzed for the 1-24 months and >2-4-year-old age groups. Height-for-age and BMI *z*-scores were analyzed for the 5-17-year-old age group. In Figure 7, Figure 8, and Figure 9, box and whisker plots display the median, upper and lower quartiles, minimum/maximum, and outlier information of the *z*-score distributions for each of these anthropometric indices for the three pediatric age groups.

Comparing the three age groups as summarized in Table 13, the 1-24-month-old age group had the lowest average length/height-for-age *z*-score (-1.35 ± 1.66) and MUAC *z*-score (-0.68 ± 1.50). The >2-4-year-old age groups had the lowest average weight-for-length/height *z*-score (-0.65 ± 1.62). The 5-17-year-old age group had the lowest average BMI-for-age *z*-score (-0.99 ± 1.22).

Within the 1-24-month-old age group, the average length-for-age *z*-score was the lowest indices (-1.35 ± 1.66) and the BMI-for-age *z*-score was the highest indices (0.20 ± 1.21). This trend is also illustrated in Figure 7. Compared to other anthropometric indices, the average MUAC *z*-score differed the most between boys (-0.42 ± 1.73) and girls (-0.99 ± 1.20) in this age group. Conversely, the average BMI-for-age and length/height-for-age *z*-scores were most similar between boys and girls (0.21 ± 0.93 and 0.19 ± 1.55) and (-1.36 ± 2.04 and -1.33 ± 1.10) of this age group, respectively.

Table 13. Anthropometric measurements of hospitalized pediatric patients

	Total	**Boys**	**Girls**
	Mean ± SD (Range)	Mean ± SD (Range)	Mean ± SD (Range)
1-24 months	n=23	n=13	n=10
Age (months)	11 ± 6 (1-23)	12 ± 6 (1-23)	11 ± 5 (3-22)
Weight (kg)	8.3 ± 2.03 (4.7-12.1)	8.5 ± 2.16 (4.7-12.1)	7.9 ± 1.91 (5.2-11)
Height (cm)	69 ± 7.54 (55-83)	70 ± 7.25 (58-83)	68 ± 8.18 (55-81)
MUAC (mm)	137 ± 17 (107-170)	143 ± 19 (107-170)	131 ± 12 (113-150)
Weight-for-length *z*-score	0.10 ± 1.29 (-2.53-2.88)	-0.04 ± 1.09 (-1.98-1.78)	0.29 ± 1.55 (-2.53-2.88)
Length-for-age *z*-score	-1.35 ± 1.66 (-5.75-1.64)	-1.36 ± 2.04 (-5.75-1.64)	-1.33 ± 1.10 (-2.74-0.23)
BMI-for-age *z*-score	0.20 ± 1.21 (-2.67-2.09)	0.21 ± 0.93 (-1.08-1.94)	0.19 ± 1.55 (-2.67-2.09)
MUAC *z*-score	-0.68 ± 1.50 (-4.21-1.79)	-0.42 ± 1.73 (-4.21-1.79)	-0.99 ± 1.20 (-3.32-0.69)
>2-4 years	n=22	n=13	n=9
Age (years)	3 ± 1 (2-4)	3 ± 1 (2-4)	3.23 ± 1 (2-4)
Weight (kg)	13 ± 3 (9-21)	13 ± 2 (11-16)	14 ± 4 (9-21)
Height (cm)	93 ± 8 (80-106)	91 ± 7 (80-103)	96 ± 9(80-106)
MUAC (mm)	151 ± 24 (130-213)	144 ± 12 (130-173)	161 ± 32 (130-213)
Weight-for-height *z*-score	-0.65 ± 1.62 (-3.59-3.52)	-0.52 ± 1.34 (-3.44-1.69)	-0.79 ± 1.95 (-3.59-3.52)
Height-for-age *z*-score	-0.82 ± 1.95 (-5.41-4.22)	-1.47 ± 1.91 (-5.41-1.92)	-0.07 ± 1.78 (-2.45-4.22)
BMI-for-age *z*-score	-0.59 ± 1.73 (-4.19-3.53)	-0.40 ± 1.49 (-3.43-2.09)	-0.81 ± 2.03 (-4.19-3.53)
MUAC *z*-score	-0.58 ± 1.58 (-2.72-3.66)	-1.08 ± 1.07 (-2.72-1.21)	0.02 ± 1.92 (-1.87-3.66)
5-17 Years	n=24	n=15	n=9
Age (years)	10 ± 4 (5-16)	9 ± 3 (6-16)	10 ± 5 (5-16)
Weight (kg)	28 ± 13 (14-50)	28 ± 13 (15-50)	29 ± 14 (14-49)
Height (cm)	130 ± 19 (102-162)	128 ± 18 (102-162)	131 ± 22 (105-157)
Height-for-age *z*-score	-0.88 ± 1.29 (-3.25-3.00)	-0.86 ± 1.49 (-3.00-3.00)	-0.92 ± 1.00 (-3.25-0.00)
BMI-for-age *z*-score	-0.99 ± 1.22 (-3.00-2.50)	0.80 ± 0.80 (-3.00 -2.50)	-1.28 ± 1.25 (-2.50-0.50)

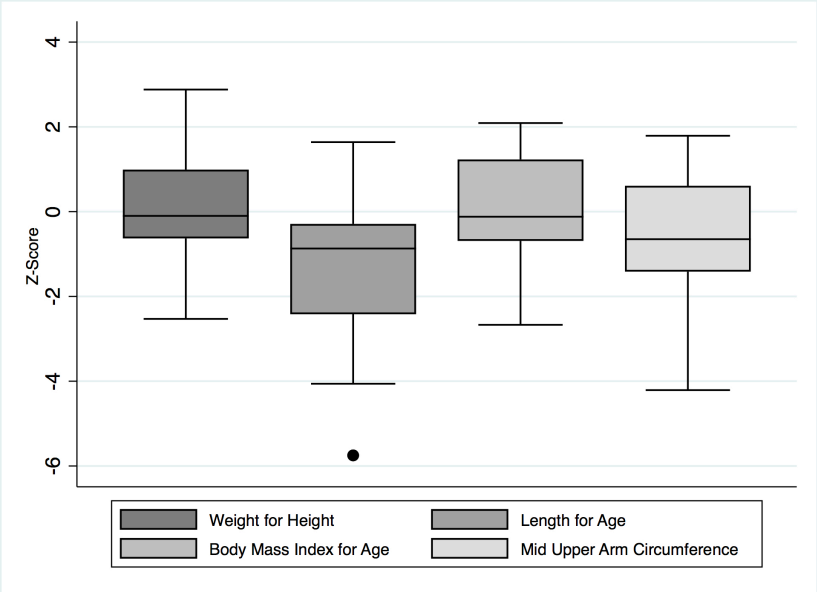

Figure 7. *Z*-score distribution for children 1-24 months of age. Box and whisker plot description – The ends of the box are the upper and lower quartiles. The median is marked by a horizontal line inside the box. The whiskers are the two lines outside the box that extend to the minimum and maximum values that are not outliers. The dots represent outliers.

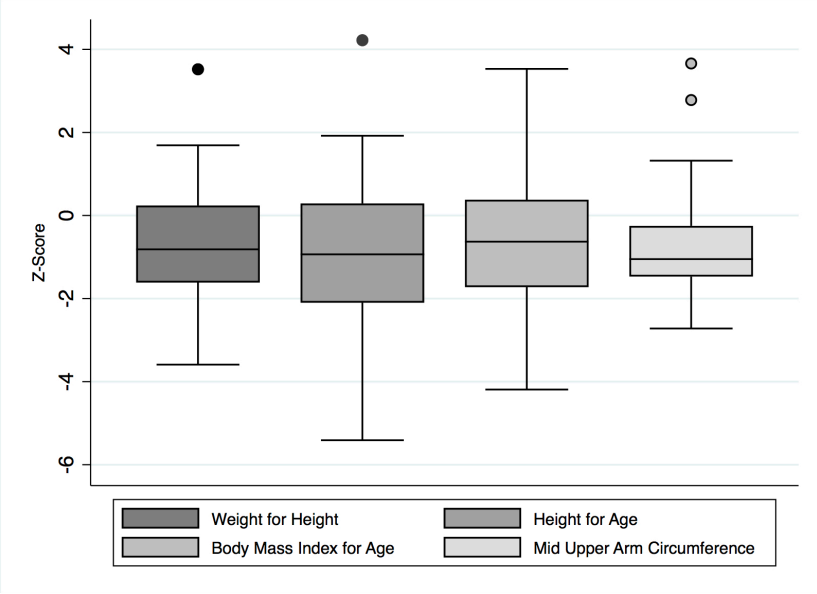

Figure 8. *Z*-score distribution for children 2-4 years of age. Box and whisker plot description – The ends of the box are the upper and lower quartiles. The median is marked by a horizontal line inside the box. The whiskers are the two lines outside the box that extend to the minimum and maximum values that are not outliers. The dots represent outliers.

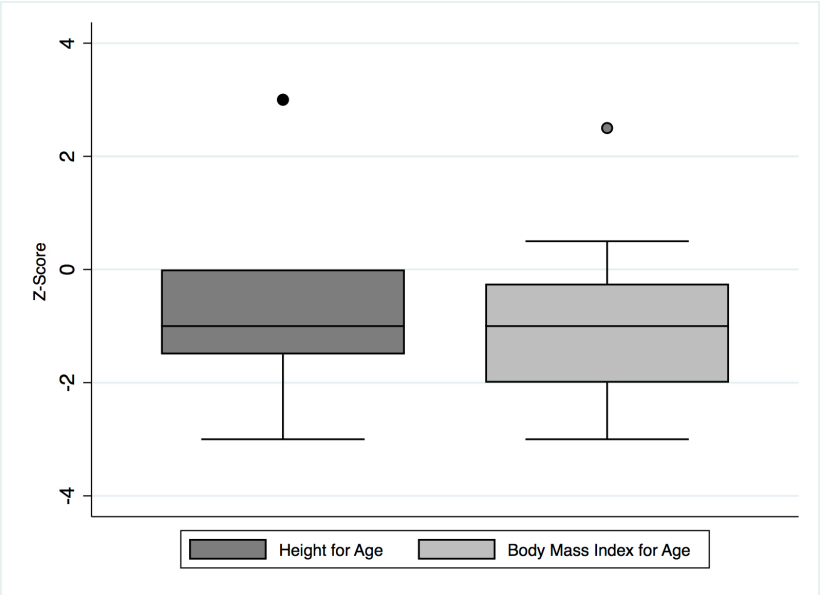

Figure 9. *Z*-score distribution for children 5-17 years of age. Box and whisker plot description – The ends of the box are the upper and lower quartiles. The median is marked by a horizontal line inside the box. The whiskers are the two lines outside the box that extend to the minimum and maximum values that are not outliers. The dots represent outliers.

Among the >2-4-year-old age group, the average height-for-age *z*-score (-0.82 ± 1.95) was the lowest average *z*-score indices and the average MUAC *z*-score (-0.58 ± 1.58) was the highest average *z*-score indices. However, it is important to note that the median MUAC *z*-score (-1.05) of children >2-4 years was the lowest median *z*-score compared to median weight-for-length/height, length/height-for-age, and BMI-for-age *z*-scores (Figure 8). This may be due in part to the MUAC *z*-scores in this age group not being normally distributed. The average height-for-age *z*-score differed the most between boys (-1.47 ± 1.91) and girls (-0.07 ± 1.78) in this age group, whereas, the average weight-for-height *z*-score differed the least between boys (-0.52 ± 1.34) and girls (-0.79 ± 1.95).

When observing the 5-17-year-old age group, the average BMI-for-age *z*-score was slightly lower (-0.99 ± 1.22) than the height-for-age *z*-score (-0.88 ± 1.29) and this trend is also observed in Figure 9 where the median values are compared. The average BMI-for-age *z*-score differed the most between boys (0.80 ± 0.80) and girls (-1.28 ± 1.25), whereas, the average height-for-age *z*-score differed the least between boys (-0.86 ± 1.49) and girls (-0.92 ± 1.00).

Prevalence of Malnutrition

Malnutrition diagnosis was determined using the Academy/ASPEN adult and pediatric malnutrition consensus criteria.[3,15] Distribution of participant malnutrition diagnosis categories are illustrated in Table 14. Among pediatric participants 0-4 years of age, 51% were malnourished, of which, 26% were acutely malnourished and 24% were chronically malnourished. Among participants 0-4 years of age, the majority were diagnosed with mild malnutrition (27%). However, it is noteworthy that 18% of participants aged 0-4 years of age were severely malnourished. Among pediatric participants aged 5-17 years of age, 58% were malnourished, of which, 38% were acutely malnourished and 21% were chronically malnourished. Of these older children, the majority were diagnosed with mild malnutrition (29%). Among adult participants, 47% were malnourished, of which, 29% were acutely malnourished and 18% were chronically malnourished. Of the adult participants, the majority were severely malnourished (25%)

Table 14. Malnutrition diagnosis by age group of hospitalized Lao patients

	Total n (%)	**Acute Malnutrition** n (%)	**Chronic Malnutrition** n (%)
Pediatric (0-4 years)	**n=45**		
Not Malnourished	22 (49)		
Malnourished	23 (51)	12 (26)	11 (24)
Mild Malnutrition	12 (27)	9 (20)	3 (7)
Moderate Malnutrition	3 (6)	1 (2)	2 (4)
Severe Malnutrition	8 (18)	2 (4)	6 (13)
Adolescent (5-17 years)	**n=24**		
Not Malnourished	10 (42)		
Malnourished	14 (58)	9 (38)	5 (21)
Mild Malnutrition	7 (29)	6 (25)	1 (4)
Moderate Malnutrition	4 (16)	2 (8)	2 (8)
Severe Malnutrition	3 (13)	1 (4)	2 (8)
Adults (≥18-83 years)	**n=125**		
Not Malnourished	66 (52)		
Malnourished	59 (47)	36 (29)	23 (18)
Moderate Malnutrition	28 (22)	22 (18)	6 (5)
Severe Malnutrition	31 (25)	14 (11)	17 (14)

Malnutrition diagnosis by criterion and severity among hospitalized Lao adult participants is illustrated Table 15. Of the six criteria, the most commonly met criterion by adult participants was reduced dietary intake (43%). Meanwhile, 17% of participants met criteria for moderate malnutrition based on reduced energy intake, which was the most commonly met criteria for moderate malnutrition. For severe malnutrition, 26% of participants met criteria based on reduced energy intake and fat wasting, which were the most commonly met criteria for severe malnutrition.

Prevalence of adult malnutrition varied among the hospitals and wards to which our participants were admitted. Mahosot Hospital had a higher prevalence of adult patients who were malnourished (56%) than Setthathirath Hospital (32%) (Table 16). The majority of patients admitted to Mahosot and Setthathirath hospitals who were malnourished were classified as having acute moderate malnutrition.

Table 15. Prevalence of malnutrition diagnosis criterion met by severity of malnutrition among hospitalized Lao adult participants (n=125)

	Diagnosis Criterion			
Diagnosis Status	**Reduced Dietary Intake** n (%)	**Weight Loss** n (%)	**Muscle Wasting** n (%)	**Fat Wasting** n (%)
Malnutrition	54 (43)	50 (40)	39 (31)	40 (32)
Moderate	21 (17)	19 (15)	10 (8)	8 (6)
Severe	33 (26)	31 (25)	29 (23)	32 (26)

Malnutrition diagnosis variables and severity of malnutrition are based the Academy/ASPEN adult consensus statement. A participant must meet 2 of the 5 variables to be diagnosed with malnutrition. Percent's may not add up to 100% due to the fact that not all participants provided information on reduced dietary intake and weight loss. Example: 21 or 17% of participants met criteria for moderate malnutrition based on reduced dietary intake.

Table 16. Prevalence of malnourished adults by hospital and ward admission (total n=125)

	Total n (%)	Malnutrition Diagnosis		Type and Severity of Malnutrition			
		Not Malnourished n (%)	**Malnourished n (%)**	**Acute Moderate n (%)**	**Acute Severe n (%)**	**Chronic Moderate n (%)**	**Chronic Severe n (%)**
Hospital Location							
Mahosot	81	36 (44)	45 (56)	17 (21)	11 (14)	3 (4)	14 (17)
Setthathirath	44	30 (68)	14 (32)	5 (11)	4 (9)	2 (5)	3 (7)
Ward Location							
Surgery	25	18 (72)	7 (28)	3 (12)	2 (8)	1 (4)	1 (4)
Internal Medicine	15	7 (47)	8 (53)	2 (13)	2 (13)	1 (7)	3 (20)
Obstetrics/ Gynecology	15	14 (93)	1 (7)	1 (7)	0 (0)	0 (0)	0 (0)
Infectious Disease	34	16 (47)	18 (53)	6 (18)	6 (18)	1 (3)	5 (15)
Pulmonary	26	8 (31)	18 (69)	5 (19)	3 (12)	3 (12)	7 (27)
Diabetes	10	3 (30)	7 (70)	5 (50)	1 (10)	0 (0)	1 (10)

Participants were determined to be malnourished if they received a moderate or severe malnutrition diagnosis based on the Academy/ASPEN adult consensus statement.

The majority of patients admitted to the internal medicine ward (53%), infectious disease ward (53%), pulmonary ward (69%), and diabetes ward (70%) were malnourished. In contrast, only 28% of those admitted to the surgery ward and 7% of those admitted to the obstetrics/gynecology ward were malnourished. The majority of malnourished patients admitted to a surgery, obstetrics/gynecology, or diabetes ward had acute moderate malnutrition. Chronic severe malnutrition was most common among patients admitted to internal medicine and pulmonary wards. Acute moderate and acute severe malnutrition were most common malnutrition classifications among patients admitted to the infectious disease ward.

Malnutrition diagnosis by severity and criterion among hospitalized Lao pediatric patients is presented in Table 17. Of the 45 children 1 month to 4 years of age, 20% had a weight-for-length z-score, 13% had a BMI-for-age z-score, and 31% had a MUAC z-score between -1 to -1.99, each of which suggests mild malnutrition. Fewer had a weight-for-length z-score, a BMI-for-age z-score, and a MUAC z-score between -2 and -2.99, each of which suggests moderate malnutrition. Importantly, 11% of children 1 month to 4 years of age had a length/height-for-age z-score $\leq$ -3, indicating severe malnutrition. When considering children 5-17 years of age, 8% had a height-for-age z-score of $\leq$ -3, suggesting severe malnutrition, whereas 29%, 25%, and 4% had BMI z-scores suggesting mild, moderate, and severe malnutrition, respectively.

Table 17. Malnutrition diagnosis criteria met by z-score severity classification among hospitalized Lao pediatric participants

z-Score classification	WfH/L z-score n (%)	L/HfA z-score n (%)	BMI z-score n (%)	MUAC z-score n (%)
1 month - 4 years (n=45)				n=42
-1 to -1.99 (mild)	9 (20)	-	6 (13)	14 (31)
-2 to -2.99 (moderate)	3 (7)	-	3 (7)	3 (7)
≤3 (severe)	2 (4)	5 (11)	2 (4)	2 (4)
5 -17 years (n=24)				n=22
1 to -1.99 (mild)	-	-	7 (29)	-
-2 to -2.99 (moderate)	-	-	6 (25)	-
≤3 (severe)	-	2 (8)	1 (4)	-

WfH/L, Weight for Height/Length; L/HfA, length/height-for-age; BMI, Body mass index, MUAC, mid-upper arm circumference. Malnutrition diagnosis variables and severity are based the Academy/ASPEN pediatric consensus statement. A participant must meet 1 of the 5 variables to be diagnosed with malnutrition. Example: for children 1 month to 4 years of age there were 5 participants, or 11% of participants, met criteria for severe malnutrition based on length/height for age z-score.

Observer 1 & 2 Inter-user Reliability

Inter-user reliability was determined by comparing agreement of Observer 1 and Observer 2 Lao NRST final scores, which suggested 'fair' agreement based on a kappa value of κ=0.3762 (p-value <0.001) (Table 18). When comparing kappa scores between age groups, the highest kappa score was in the 18-64-year-old group (0.32 ± 0.04). Conversely, inter-observer reliability was the weakest among the 5-17-year-old participants (-0.04 ± 0.08). Comparing inter-user reliability among hospitals, Mahosot Hospital and Setthathirath Hospitals had similar kappa scores of 0.27 ± 0.04 (fair) and 0.26 ± 0.06 (fair), respectively. When comparing kappa scores between wards regardless of hospital admission, inter-observer reliability was lowest when evaluating patients admitted to pediatric (κ=0.1256) and endocrinology (κ=0.1250) wards and highest when evaluating patients admitted to obstetrics/gynecology (κ=0.4000) and infectious disease (κ=0.3429) wards.

As Illustrated in Figure 10, when comparing kappa scores between malnutrition criterion, "presence of high-risk disease" was the most commonly met criteria on the Lao NRST with moderate agreement between observers (κ=0.51). "Subjective clinical assessment" was the least commonly met criteria on the Lao NRST with fair agreement (κ=0.3193) between observers. The criterion with strongest agreement between observers (κ=0.51) was "weight loss".

Table 18. Inter-user reliability of NRST final scores between Observer 1 and Observer 2 by variable

	Agreement (%)	Expected Agreement (%)	Kappa ± SE *	P-Value**
Total Population				
Final Score (n=194)	40.21	17.67	0.27 ± 0.03 (Fair)	< 0.0001
Risk Category (n=194)	60.31	36.37	0.38 ± 0.05 (Fair)	< 0.0001
Age Group (years)				
0-4 (n=45)	44.44	22.67	0.28 ± 0.07 (Fair)	<0.0001
5-17 (n=24)	12.50	16.15	-0.04 ± 0.08 (Poor)	0.695
18-64 (n=108)	44.00	17.36	0.32 ± 0.04 (Fair)	< 0.0001
≥65 (n=17)	41.18	20.42	0.26 ± 0.12 (Fair)	0.0118
Hospital				
Mahosot (n=126)	38.89	16.48	0.27 ± 0.04 (Fair)	< 0.0001
Setthathirath (n=69)	42.65	22.75	0.26 ± 0.06 (Fair)	< 0.0001
Ward				
Pediatric (n=60)	30.00	19.94	0.13 ± 0.06 (Slight)	0.02
Surgery (n=32)	39.29	20.54	0.24 ± 0.09 (Fair)	0.0048
Internal Medicine (n=16)	31.25	17.58	0.17 ± 0.10 (Slight)	0.0537
Obstetrics/Gynecology (n=15)	60.00	33.33	0.40 ± 0.11 (Fair)	0.0002
Infectious Disease (n=33)	43.45	16.99	0.34 ± 0.07 (Fair)	< 0.0001
Pulmonary (n=27)	48.15	21.95	0.34 ± 0.09 (Fair)	0.0002
Endocrinology (n=10)	30.00	20.00	0.13 ± 0.14 (Slight)	0.192

*Kappa agreement interpretations: < 0.0 poor, 0.00-0.20 slight, 0.21 - 0.40 fair, 0.41 - 0.60 moderate, 0.61 - 0.80 substantial, 0.81 - 1.00 almost perfect. **P-values <0.05 indicate that between observer agreement is not due to chance.

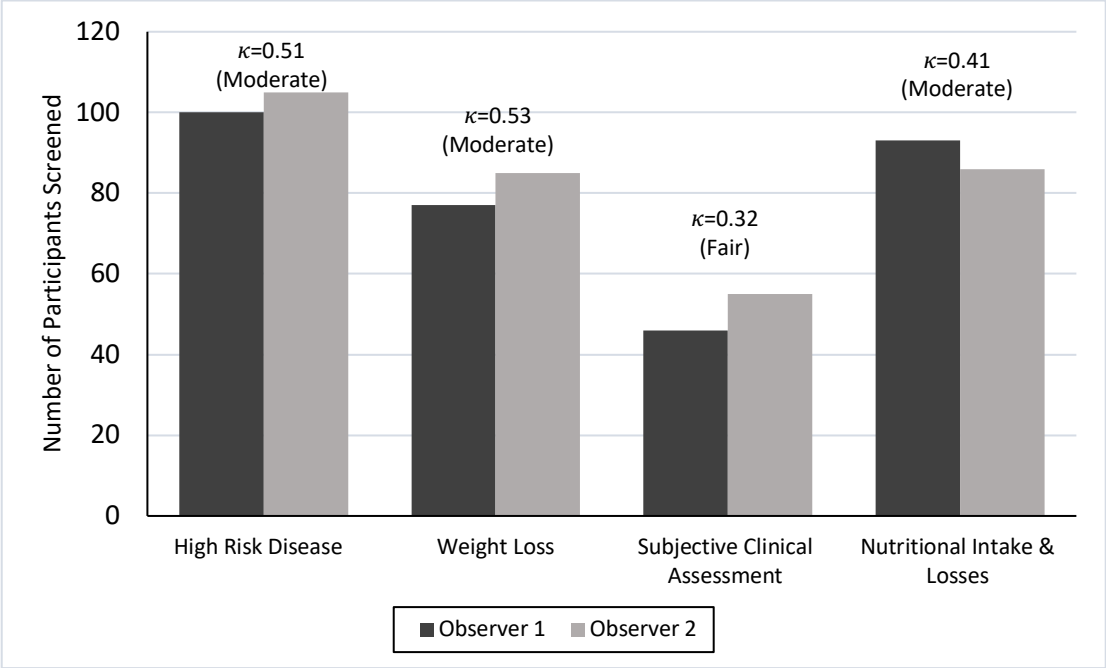

Figure 10. Inter-observer comparison of number of participants meeting Lao NRST criteria

NRST Criterion Validity

The accuracy of the Lao NRST was determined by comparing final scores to malnutrition diagnoses using a receiver operating curve (ROC). The overall performance of the Lao NRST is summarized by the area-under-the-ROC curve, a test variable is considered useful when the area-under-the-ROC curve is ≥ 0.70.

The area-under-the-ROC curve of the Observer 1 Lao NRST final score was 0.64. The area-under-the-ROC curve of the Observer 2 Lao NRST final score was 0.70 (Table 19). In other words, Observer 1 and Observer 2 had a 64% and 70% probability of correctly distinguishing a malnourished from a not malnourished participant based on

the relative ordering of the NRST final score. There was no significant difference between the Observer 1 and Observer 2 area-under-the-ROC curve (p-value >0.05). A Lao NRST final score of 3 was the value at which both Observer 1 (61%) and Observer 2 (66%) correctly classified the greatest percent of patients.

The likelihood ratio (LR) is the ratio of the probability that a specific Lao NRST final score identifies a patient with malnutrition divided by the probability of the same Lao NRST final score identifying a participant without malnutrition. As shown in Table 19, an Observer 1 NRST score of 3 is 1.77 times more likely to occur in a participant who is malnourished than a participant who is not malnourished. In comparison, an Observer 2 NRST final score of 3 is 2.08 times more likely to occur in a participant who is malnourished than a participant who is not malnourished.

As illustrated in Figure 11, each plot on the ROC curve corresponds to cut points used to designate a Lao NRST final score of 0 to 5, where a score of 1 designates no risk for malnutrition and a score of 5 designates the highest risk for malnutrition. The Observer 2 curve (closed circles) has a more substantial deviation to the left than the Observer 1 curve (closed diamonds), indicating that Observer 2 had better predictive validity than Observer 1. Additionally, Observer 2 consistently had higher sensitivity at each plotted score compared to Observer 1. However, as previously mentioned, there was no significant difference in the AUC for Observer 1 and Observer 2 (p-value >0.05).

Table 19. Validity of Observer 1 and Observer 2 Lao NRST final scores

Final NRST Score	Sensitivity (%)	Specificity (%)	Correctly Classified (%)	Likelihood Ratio	AUC ± SE (95% CI)
Observer 1					0.64 ± 0.04 (0.57 - 0.72)
≥ **0**	100	0	49	1.00	
≥ **1**	82	32	56	1.20	
≥ **2**	72	47	59	1.35	
≥ **3**	54	69	61	1.77	
≥ **4**	33	85	59	2.18	
≥ **5**	17	95	56	3.25	
Observer 2					0.70 ± 0.04 (0.63-0.77)
≥ **0**	100	0	49	1.00	
≥ **1**	86	35	60	1.32	
≥ **2**	76	48	62	1.46	
≥ **3**	61	70	66	2.08	
≥ **4**	45	82	60	2.58	
≥ **5**	23	67	51	7.49	
					P-Value > 0.05*

LR, likelihood ratio; AUC, area under the curve; SE, standard error. *There is no significant difference between the AUC of Observer 1 and Observer 2 (p-value of >0.05). Lao NRST final scores were compared to malnutrition diagnoses determined by a trained registered dietitian.

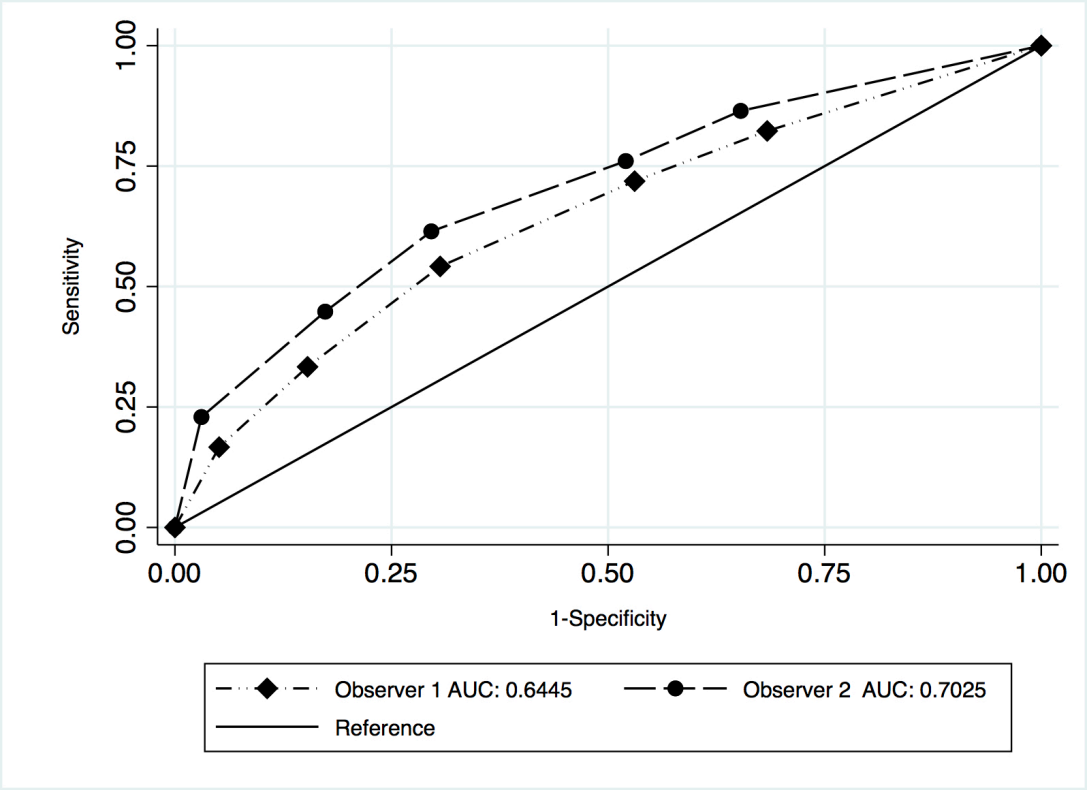

Figure 11. Receiver Operator Curve (ROC) of Observer 1 and Observer 2. Each curved line represents the NRST final scores ranging from 0 to 5 plotted form left to right. The reference line indicates an AUC of 0.50 and no correlation between the screening tool values and presence of malnutrition. An AUC of 1.00 indicates perfect discrimination. A substantial curve to the left of the dotted lines indicates an increased probably of predicative validity.

Chapter 5

Discussion

Addressing malnutrition in Lao national hospitals is a strategic avenue to aid in the success of Lao PDR meeting malnutrition related SDGs[57] and National Nutrition Strategy[5] objectives. This study explored the prevalence of malnutrition and effectiveness of using a culturally relevant nutrition-risk screening tool to assess risk of malnutrition in patients admitted to one of two national hospitals in Vientiane, Lao PDR.

We determined that 53% of pediatric patients (n=69) and 47% of adult patients (n=125) were malnourished upon admission to one of two national hospitals in Vientiane, Lao PDR during a five-week period from August to September 2018. As such, we rejected our hypothesis that greater than 60% of patients admitted to one of the two national hospitals in Vientiane in Lao, PDR would present with a protein-calorie-malnutrition diagnosis.

Furthermore, it was important to determine if the rates of malnutrition were different based on the ward in which a patient was admitted so that resources could be directed to specific disease states as indicated. The prevalence of adults with moderate to severe malnutrition was the greatest in the diabetes (70%) and pulmonary wards (69%), exceeding our hypothesized value (60%). Of those admitted to the internal medicine and infectious disease wards, over half were malnourished. In contrast, only 7% of those admitted to the obstetrics/gynecology ward and 28% of those admitted to the surgery ward were malnourished. These results indicate that nutrition screening and

follow-up assessment may be more important in certain wards such as the diabetes, pulmonary, internal medicine, and infectious disease wards, than others.

As expected, the rates of malnutrition among adult and pediatric patients recently admitted to one of two national hospitals in Vientiane in Lao, PDR were higher than community-based rates of malnutrition. The United Nations reported that an average of 16.6% of the Lao population is malnourished, considerably lower than the 47% of malnourished hospitalized patients identified in this study.[8] The World Health Organization reported that among children under five years of age in Lao PDR, 21% were underweight and 9% were wasted. In comparison, our results that indicated that among hospitalized children, 22% were underweight and 11% were wasted.[7] These results suggest the immediate and urgent need to address malnutrition among patients admitted to Lao hospitals in addition to those in community settings.

It is noteworthy that this study was conducted during the rainy season, which may have exacerbated rates of malnutrition diagnoses due to increased occurrences of infectious diseases and national rice shortages during that time of year.[5,23] Commonly seen infectious diseases in Lao PDR include vector borne malaria and dengue fever, which are more predominant during the rainy season.[5] In our study, the majority of adults (18%) were admitted to the infectious disease ward and 53% of those patients were diagnosed with moderate to severe malnutrition. In addition to an increase in infectious diseases, annual rice shortages and access to food markets in rural villages are particularly poor during the rainy season. Our study took place at national hospitals, which acquire patients by referral from rural district and provincial hospitals when

patients require higher acuity of care. Although we do not know the particular villages and provinces our participants originated from, it is likely that a portion were from rural areas that experience increased risk of malnutrition during the rainy season due to poor access to and availability of food.

Our study assessed inter-observer reliability and validity to analyze the effectiveness of the Lao NRST in screening hospitalized patients for malnutrition upon admission. Reproducibility is an essential characteristic of nutrition risk screening tools that is measured by comparing the agreement in scores between two observers.[43,44] We hypothesized that the two Lao NRST observers would yield the same result at least 90% of the time. Our results indicated that the Lao NRST final scores determined by two independent observers agreed 40% of the time and had 'fair' agreement score (κ=0.27 ± 0.03, p-value <0.001). Accordingly, we reject our reliability hypothesis.

Other commonly used nutrition risk screening tools had 'moderate' to 'perfect' agreement. A review of adult nutrition risk screening tool validation studies by Elia *et al.*[42] indicated that the NRS-2002 had 'moderate' to 'substantial' agreement (κ=0.67, κ=0.47)[48] and that the MUST had almost 'perfect' agreement (κ=0.80-1.00)[47]. A validation study of the pediatric nutrition risk screening tool STRONGkids indicated that it had a moderate agreement (κ=0.48).[52] The agreement scores of the screening tools mentioned compared to the 'fair' agreement score of the Lao NRST (κ=0.27 ± 0.03, p-value <0.001), indicates that our tool should be modified to improve agreement and that additional training of the Lao NRST is needed.

Measurements of area-under-the ROC curve, specificity and sensitivity are used to describe a screening tool's validity.[44] In general, a screening tool is considered 'useful' when the area-under-the ROC curve is ≥ 0.70. The Observer 1 NRST final scores generated an area-under-the ROC curve of 0.64. The Observer 2 NRST final scores generated an area-under-the ROC curve of 0.70. Although the Observer 2 NRST performance classifies as borderline 'useful', there was no significant difference between the performance, or area-under-the ROC curve, of Observer 1 NRST and Observer 2 NRST final scores.

Furthermore, a validation study of adult nutrition risk screening tools by Kyle *et al.*[50] indicated that the NRS-2002 and MUST had sensitivity values of 62% and 61%, respectively, and specificity values of 93% and 76%, respectively. Similarly, a validation study of the pediatric nutrition risk screening tool, STRONGkids, by Huysentruyt *et al.*[52] reported a sensitivity of 63%, and a specificity of 54%. The Lao NRST had a sensitivity of 85% and a specificity 35%. Compared to the other screening tools, the Lao NRST correctly classified nutrition risk in both pediatric and adult patients, however, our tool did not perform as well when classifying absence of nutrition risk in patients who were not malnourished.[50]

Based on area-under-the ROC curve, and sensitivity and specificity results from this study, we reject our hypothesis that the Lao NRST would be both specific enough to identify those who are not at risk for malnutrition and sensitive enough to identify those who are truly at risk for malnutrition.

Suggested Lao NRST Modifications

Pertaining to performance results indicated by this study, we identified the need to modify criterion of the Lao NRST to improve interobserver agreement and criterion validity. Interpreting the 'subjective clinical assessment' and classifying a patient as having a 'high-risk disease' are areas that could be improved to enhance Lao NRST inter-observer agreement. The 'subjective clinical assessment' criterion had the lowest kappa score compared to other Lao NRST criteria. Additionally, 'subjective clinical assessment' was a source of confusion for observers administering the NRST. One source of confusion was that the meaning of 'subjective clinical assessment' was not easily translated from English into the Lao language. Additionally, judgment of "poor nutrition status" was difficult for nurses and research assistants to distinguish. This may be due to lack of training on identification of signs of malnutrition, the predominance of malnutrition in Lao PDR, and/or the small stature with minimal fat and muscle stores typical of the Lao population, particularly older adults. The NRS-2002 and MUST do not use subjective clinical assessment as criterion, which may contribute to their higher agreement scores. To improve the performance of the Lao NRST, we suggest eliminating the "subjective clinical assessment" criterion because it had lowest inter-observer agreement (κ=0.3193) compared to the other criteria and there was confusion by observers around this criterion.

The 'presence of high-risk disease' was another Lao NRST criterion that was a source of confusion for observers administering the screening tool. According to observers, it was unclear that the box listing options of high-risk diseases was associated

with the question ‘presence of high-risk disease’ because the answer options ‘yes’ and ‘no’ were located above the high-risk disease box, as seen in question 2 of the Lao NRST (Appendix C). Reformatting the NRST document to provide the list of high-risk diseases before the answer options may reduce confusion around this criterion. In addition to revising the ‘subjective clinical assessment’ and ’presence of high-risk disease’ criteria to enhance the Lao NRST inter-observer reliability, our results also indicate the need to improve the validity of the Lao NRST.

Changing the Lao NRST score cut point used to indicate nutritional risk will help improve the validity of our tool. In the present study, we used a Lao NRST final score of 1 or higher to identify a patient at nutritional risk. When using a Lao NRST final score cut point of 1, the Lao NRST observer with the highest area-under-the-curve had a sensitivity of 85% and a specificity 35%. A high sensitivity and a low specificity indicate that there were more malnourished patients correctly classified as being at nutritional risk compared to patients who were not malnourished classified as not being as at nutritional risk. The low specificity indicates that there was a high rate of false positive results; those who were not malnourished being classified as at nutritional risk. A high rate of false positives may lead to an inefficient use of clinical nutrition specialist’s time because they may execute unnecessary full nutrition assessments. Establishing a Lao NRST final score of 2 as the cut point resulted in a sensitivity and specificity of 76% and 48%, respectively. To lower the rate of false positives, the authors suggest using a Lao NRST final score of 2 to indicate nutrition risk.

Study Strengths

This study has several strengths, the most significant being that it is a novel hospital-based nutrition risk screening study in Lao PDR. The results of this study indicate that it is possible to conduct an observational cross-sectional study in national hospitals in Lao PDR. Further, this study built research capacity and nutrition assessment knowledge of 12 local Lao research assistants who aided in the data collection process and gained an in-depth understanding of conducting clinical research. These individuals enhanced the efficiency in which the screening process was conducted by eliminating the need for interpretation.

Even more importantly, we collected a substantial amount of data on pediatric and adults hospitalized patients. There were over 50 study variables assessed as part of this study including anthropometric measurements, markers of diet composition, and nutrition-focused physical exam outcomes. We hope that dissemination our results will provide incentive to gather additional data and to acquire resources to conduct nutrition risk screening in all hospitals in Lao and ultimately change policy to implement nutrition-risk screening and subsequent nutrition interventions among hospitalized patients in Lao PDR.

The ability of the Lao NRST to identify nutritional risk among both adult and pediatric patients was a strength of this study. Despite the fact that the pediatric age group had a lower kappa score compared to the adult age group, there was no notable impact on the overall inter-observer reliability of the Lao NRST. The Lao NRST final score inter-observer agreement was classified as 'fair' when the pediatric age group was

included in the kappa analysis (κ=0.27) and when the pediatric age group was not included (κ=0.32). Therefore, including the pediatric population did not negatively impact the overall kappa rating of the Lao NRST.

Additionally, including pediatric and adult patients in this study did not significantly impact validity of the Lao NRST. When the pediatric age group was included in the validity analysis, the Observer 1 and Observer 2 Lao NRST area-under-the ROC curves were 0.64 (95% CI: 0.57-0.72) and 0.70 (95% CI: 0.63-0.77), respectively. When the pediatric age group was not included in the validity analysis, the Observer 1 and Observer 2 Lao NRST area-under-the-curves were 0.67(95% CI: 0.57-0.75) and 0.72 (95% CI: 0.64-0.82), respectively. Accordingly, there is no statistical difference in the performance of the Lao NRST when the pediatric age group was included in the analysis and when they were not included in the analysis, as evidenced by the similar 95% confidence intervals (CI) of the area-under-the ROC curves. Having one nutrition-risk screening tool for both pediatric and adult patients permitted more efficient data collection because there was only one screening tool to use.

Study Limitations

There were several limitations associated with this study. First, historical data was either limited or not accessible on numerous occasions. Many people in Lao do not have access to scales in their communities to weigh themselves. Consequently, the majority of weight loss quantified in this study was estimated. Additionally, lack of electronic medical records or even a standardized medical record system made it

difficult to acquire information such as anthropometric measurements from previous hospital admissions or outpatient visits. Approximately 30 participants included in this study were unable to provide information on usual body weight.

Furthermore, due to lack of historical data, only anthropometric measures from one point in time were used to determine pediatric malnutrition status. In the United States it is standard of practice to use supporting evidence such as dietary intake or nutrition focused physical exam results when only a single anthropometric data point is available.

Analogous to the lack of historical participant data in our study, absence of global pediatric reference data is a further limitation. The Academy/ASPEN pediatric consensus on malnutrition diagnosis suggests using WHO z-score data for children under the age of two years and CDC z-score data for those older than two years of age. CDC reference data is based on the United State population and is not applicable for the Lao population because of body composition differences. Consequently, our study used WHO reference data for all pediatric patients.

Other limitations of this study include inherent errors in assessing screening tool validity for a disease state as comprehensive and complicated as malnutrition. Our study assessed criterion validity using a full nutrition assessment to make a malnutrition diagnosis as the gold standard. Other nutrition risk screening tool validation studies used anthropometry such as BMI, and assessment tools such as Mini Nutritional Assessment (MNA) and Subjective Global Assessment (SGA) as gold standards to assess construct validity. The absence of a global consensus on the definition of malnutrition

diagnosis or a gold standard to use as a comparison may result in misclassification and an inherent subjective error. Moreover, the majority of nutrition risk screening tool validation studies use predictive validity to estimate sensitivity, specificity, and area under the ROC curve, while we used criterion validity. Predicative validity is the ability of a tool to predict clinical outcomes including hospital length of stay and mortality. We did not follow patients throughout their hospital stay, therefore; determining predictive validity was not feasible in this study. The discrepancy in validity methods used in nutrition screening tool validation studies lessens our ability to compare outcome data on sensitivity, specificity, and area under the ROC curve between nutrition screening tools.

In addition to data and analysis limitations, there were inherent limitations associated with conducting research in a foreign country. Many Lao and English words do not directly translate. All study forms were developed in English then translated to the Lao language for data collection and then afterward translated back into English for data entry, serving as a possible source of error. In addition, differences in cultural nuances may have decreased accuracy of 24-hour dietary recall information. Residents of Lao PDR rarely use food measuring utensils such as measuring cups, measuring spoons, or food scales. Therefore, when prompting information about amounts of food consumed, participants were asked to compare their intake to the amount in handful or common bowls and utensils. Additionally, 24-hour dietary recalls may have been misrepresented for individuals living in villages far away from the capital city of Vientiane, Lao PDR. Dietary intake of those who travelled long distances before being

admitted to the hospital may have been altered due to their journey and availability of food, not necessarily due to their health status.

Furthermore, forms such as screening tools and questionnaires are not commonly used in Lao PDR. Research assistants and nurses filling out the Lao NRST may have not been familiar with the concept of administering a screening tool, impacting the inter-observer reliability results. Nutrition-risk screening tools typically should not require extensive training, however, administration of the Lao NRST in Lao hospitals may require more thorough education than may be expected in higher resource settings. Users of the Lao NRST should be provided with information on what screening tools are, how they are used, what they are screening for, and what to do with the information collected.

Lastly, the limited amount of time (30 days) that we were permitted in Lao PDR restricted our ability to recruit patients. The small sample size in the 5-17-year-old age group likely influenced the overall Lao NRST inter-user reliability score. Additionally, it was only feasible for our study to assess malnutrition upon admission, which possibly decreased our overall malnutrition prevalence rates. As a patient's length of stay in the hospital progresses it is likely that they will experience further decline in their nutrition status.[10] In our study, participants were evaluated for the diagnosis of malnutrition upon admission and were not re-assessed during their stay at the hospital. We believe that prevalence rate of malnutrition in our study would have been higher if patients were re-assessed throughout their hospital stay.

Conclusion

To our knowledge this was the first study to assess prevalence of hospital-based malnutrition upon admission and feasibility of using a nutrition screening tool to identify risk for malnutrition in Lao, PDR. The high prevalence of malnutrition among recently admitted hospitalized pediatric and adult patients determined in this study reinforces the need for a tool to identify risk of malnutrition in patients admitted to Lao hospitals. Our results also indicate that implementing a nutrition risk screening tool in the national hospitals in Vientiane, Lao PDR is feasible.

To continue to address hospital-based malnutrition in Lao, we suggest including follow-up nutrition assessments to assess predictive validity and modifying the NRST criteria used in this study. Our results suggest adapting or eliminating the subjective clinical assessment criteria, altering the format of the high-risk disease criteria on the Lao NRST form, and re-classifying the nutrition risk cutoff score from 1 to 2. Once revisions have been made, a follow-up prospective validation study of the Lao NRST should be performed to assess construct and predictive validity.

Dissemination of study data and a validated nutrition risk screening tool is needed to advocate for policy changes to implement mandatory malnutrition screening at admission among hospitalized patients in Lao PDR. Identification of risk for malnutrition upon admission to the hospital is essential to provide medical nutrition therapy and nutrition interventions. Alongside the need to identify nutrition risk in Lao hospitals, appropriate nutrition intervention strategies and resources need to be established. For example, protocols to prevent refeeding syndrome for severely

malnourished patients are needed. Additionally, there needs to be a protocol to identify patients who do not have access to food or economic means to acquire food while admitted to the hospital. That being said, the development of hospital-based food service systems to adequately rehabilitate patients identified to be malnourished should be a priority. Timely and appropriate nutrition interventions will help prevent or minimize adverse patient health outcomes and reduce the economic burden of healthcare in Lao PDR. In turn, addressing malnutrition among hospitalized patients will contribute to Lao PDRs advancement from Least Develop Country status to Developing Country status.

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Appendix A.

OREGON HEALTH & SCIENCE UNIVERSITY

Child Assent Form

IRB#_____
Protocol Approval Date:_____

TITLE: Nutrition Risk Screening Tool for Lao PDR

PRINCIPAL INVESTIGATOR: Dr. Diane Stadler (503) 494-0168

CO-INVESTIGATORS: Joanna Cummings, MS RD CNSC (303) 204-6444
Slackchay (Nina) Rasprasith, BsN
+856-020-2882-7625

This research study was explained to me. I know how it may or may not help me. I also know that this study will help doctors learn more about malnutrition. To be sure that I know what is going to happen, the investigator will ask me the following:

1. To explain what I will do and what will happen in this study.

2. If I have any questions or want to know anything else about this study or malnutrition.

3. To explain some of the good and bad things that might happen to me if I enter this study.

I have thought about being a part of this study. I have asked and received answers to my questions. I agree to be in this study. I know that I don't have to agree to be in the study. Even though I agree to be in it now, I know I may feel differently later on and can ask to stop being in the study. I know that I may talk with my parents and/or doctor about not being in this study at any time.

Name/signature:_____ Date:_____

Appendix B.

OREGON HEALTH & SCIENCE UNIVERSITY

IRB#: _____

MED. REC. NO. _____
NAME _____
BIRTHDATE _____

Clinical Research Consent and Authorization Form

TITLE: *Nutrition-risk screening Tool for Lao PDR.*

PRINCIPAL INVESTIGATOR: Dr. Diane Stadler (503) 494-0168

CO-INVESTIGATORS: Joanna Cummings, MS RD CNSC (303) 204-6444
Slackchay (Nina) Rasprasith, BsN
+856-020-2882-7625

The Principal Investigator (PI) must be listed on the consent form. Listing co-investigators on the consent form is optional. It is recommended that you limit the number of co-investigators listed here by only listing those most likely to conduct the consent discussion.

WHO IS PAYING FOR THE STUDY?: *This study is unfunded and will be conducted with volunteer support from the Lao-American Nutrition Institute and the Lao Ministry of Health.*

WHO IS PROVIDING SUPPORT FOR THE STUDY?: *Lao-American Nutrition Institute*

DO ANY OF THE RESEARCHERS HAVE A CONFLICT OF INTEREST WITH THIS STUDY?: *No conflicts of interest exist between researchers and this study.*

WHY IS THIS STUDY BEING DONE?:
You have been invited to be in this research study because you are being admitted to the hospital. The purpose of this study is to conduct a nutrition-risk screen to identify malnutrition or risk for malnutrition in hospitalized patients.

This study aims to identify patients at risk or currently malnourished upon admission to the hospital. The study aims to validate an easy to use screening tool to quickly identify patients in need of nutrition support in the hospital.

This study begins upon your admission to the hospital and ends upon your discharge. No bodily specimens or genetic material will be collected during this study.

This study will be conducted at both Mahosot Hospital and Setthathirath Hospital in Vientiane Capital, Lao PDR. The study has also been approved through the Lao Health Research Portal Review Board.

This study will require a minimum of 2 visits from trained clinicians but you may receive on-going follow-up care if determined you are at risk for malnutrition.

	Admission Day 1	Within 24 hours of admission	Discharge
Consent Discussion, Height & Weight taken, Screening form completed	X		
Nutrition Assessment & Diagnosis completed		X	
Weight taken			X
Total time	10 minutes	30 minutes	2 minutes

A brief questionnaire, height and weight will be collected upon admission. Within 24 hours of admission, a complete nutrition assessment will be conducted by a trained research professional. This assessment may take up to 30 minutes. Upon discharge your weight will be recorded.

Your medical records will not be reviewed but your diagnosis upon admission will be recorded.

During this study you may be photographed. We will use the photographs for educational materials and research publications. We will put a black bar over your eyes and private parts in the photograph for privacy.

WILL I RECEIVE RESULTS FROM THE SCREENING TOOL IN THIS STUDY?

We will give you the results of your nutrition risk screen and nutritional assessment. The results will be placed in your medical chart and family book.

WHAT RISKS CAN I EXPECT FROM TAKING PART IN THIS STUDY?:
Some of the questions in the screening may seem very personal or embarrassing. They may upset you. You may refuse to answer any of the questions that you do not wish to answer. If the questions make you very upset, we will help you to find a counselor.

WHAT ARE MY CHOICES IF I DECIDE NOT TO TAKE PART IN THIS STUDY?:
You may choose not to be in this study.

WHO WILL SEE MY PERSONAL INFORMATION?
We will take steps to keep your personal information confidential, but we cannot guarantee total privacy.

We will create and collect health information about you as described in the WHY IS THIS STUDY BEING DONE? and the WHAT EXAMS, TESTS AND PROCEDURES ARE INVOLVED IN THIS STUDY? sections of this form. Health information is private and is protected under federal law and Oregon law. By agreeing to be in this study, you are giving permission (also called authorization) for us to use and disclose your health information as described in this form.

The investigators, study staff, and others at OHSU may use the information we collect and create about you in order to conduct and oversee this research study.

We may release this information to others outside of OHSU who are involved in conducting or overseeing research, including:

- Lao Health Research Portal
- The Office for Human Research Protections, a federal agency that oversees research involving humans

Those listed above may also be permitted to review and copy your records, including your medical records.

We will not release information about you to others not listed above, unless required or permitted by law. We will not use your name or your identity for publication or publicity purposes, unless we have your special permission.

Under Oregon law, suspected child or elder abuse must be reported to appropriate authorities.

When we send specimens or information outside of OHSU, they may no longer be protected under federal or Oregon law. In this case, your specimens or information could be used and re-released without your permission.

Data from this study may be shared with other investigators for future research studies. A code number will be assigned to you, as well as to information about you. Only the investigators and people involved in the conduct of the study will be authorized to link the code number to you.

We may continue to use and disclose your information as described above indefinitely.

WILL ANY OF MY INFORMATION OR SAMPLES FROM THIS STUDY BE USED FOR ANY COMMERCIAL PROFIT?

Information about you or obtained from you in this research may be used for commercial purposes, such as making a discovery that could, in the future, be patented or licensed to a company, which could result in a possible financial benefit to that company, OHSU, and its researchers. There are no plans to pay you if this happens. You will not have any property rights or ownership or financial interest in or arising from products or data that may result from your participation in this study. Further, you will have no responsibility or liability for any use that may be made of your samples or information.

WHAT ARE THE COSTS OF TAKING PART IN THIS STUDY?: *(NOTE: You may not modify the language in this cost section without seeking the permission of the Clinical Research Billing Office (CRBO).)*

To determine the correct costs language for the study, please go to the IRB Policies and Forms Page and refer to the document entitled "Consent Form Language – Costs."

WHAT HAPPENS IF I AM INJURED BECAUSE I TOOK PART IN THIS STUDY?:

To determine the correct liability language for the study, please go to the IRB Policies and Forms Page and refer to the document entitled "Consent Form Language – Liability."

WHERE CAN I GET MORE INFORMATION?:

If you have any questions, concerns, or complaints regarding this study now or in the future, contact Dr. Diane Stadler 503-494-0168 or Joanna Cummings 303-204-6444 or Slackchay (Nina) Rasprasith +856-020-2882-7625

This research is being overseen by an Institutional Review Board ("IRB"). You may talk to the IRB at (503) 494-7887 or irb@ohsu.edu if:

- Your questions, concerns, or complaints are not being answered by the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get more information or provide input about this research.

You may also submit a report to the OHSU Integrity Hotline online at https://secure.ethicspoint.com/domain/media/en/gui/18915/index.html or by calling toll-free (877) 733-8313 (anonymous and available 24 hours a day, 7 days a week).

DO I HAVE TO TAKE PART IN THIS STUDY?:

Your participation in this study is voluntary. You do not have to join this or any research study. You do not have to allow the use and disclosure of your health information in the study, but if you do not, you cannot be in the study.

IF I DECIDE TO TAKE PART IN THIS STUDY, CAN I STOP LATER?

If you do join the study and later change your mind, you have the right to quit at any time. This includes the right to withdraw your authorization to use and disclose your health information.

If you no longer want your health information to be used and disclosed as described in this form, you must send a written request or email stating that you are revoking your authorization to:

Dr. Diane Stadler, stadlerd@ohsu.edu

Your request will be effective as of the date we receive it. However, health information collected before your request is received may continue to be used and disclosed to the extent that we have already acted based on your authorization.

If in the future you decide you no longer want to participate in this research, we will remove your name and any other identifiers from your screening form, but the material will not be destroyed and we will continue to use it for research.

You may be removed from the study if the funder stops the study or you do not follow study instructions.

We will give you any new information during the course of this research study that might change the way you feel about being in the study.

Your signature below indicates that you have read this entire form and that you agree to be in this study.

We will give you a copy of this signed form.

Subject Printed Name	Subject Signature	Date

Person Obtaining Consent Printed Name	Person Obtaining Consent Signature	Date

Appendix C.

Nutritional Risk Screening Tool for Lao PDR

Please complete this nutrition risk screen upon admission. This questionnaire consists of 4 items. Each item is allocated a score of 1-2 points with a maximum total score of 5 points.

Time at start of screening: _____

Patient Identifier: _____ Age: _____ Sex: M F

Admit Date: _____ Admit Diagnosis:_____

Height/length (cm): _____ Weight (kg):_____

Reason for Admission:

☐ Respiratory
☐ Trauma
☐ Infection
☐ Surgical
☐ Oncology (Cancer)
☐ Gastrointestinal
☐ Cardiac
☐ Neurological
☐ Other:_____

1. Is the patient in poor nutritional status judged by subjective clinical assessment (diminished subcutaneous fat and/or muscle mass and/or hollow face)? (Circle yes or no)

   ☐ **Yes (1 point)** ☐ **No (0 points)**

2. Does this patient have an underlying illness with a risk of malnutrition or expected major surgery? (Refer to table of "high risk diseases" below) (Circle yes or no)

   ☐ **Yes (2 point)** ☐ **No (0 points)**

High Risk Disease			
Anorexia nervosa	Dysmaturity/prematurity (corrected age 6 months)	Liver disease, chronic	Surgery/Expected major surgery
Inflammatory Bowel Disease	Cardiac disease, chronic	Kidney disease, chronic	Short bowel syndrome

Bronchopulmonary dysplasia (maximum age 2 years)	Infectious disease (TB, HIV/AIDS)	Pancreatitis	Mental handicap
Cleft lip and palate	Burns	Trauma	Metabolic disease (diabetes)
Dysphagia	Cancer	Muscle disease	Hypertension
Pneumonia	Not specified: (Other)_____		

Has the patient experienced any of the following conditions?

Excessive diarrhea (>5 episodes/day) and/or vomiting (>3 times/day) during the last 3 days? (Circle yes or no)

Yes **No**

Lower consumption of food/beverages than normal during the last few days before admission? (not including fasting for a procedure/surgery) (Circle yes or no)

Yes **No**

If yes, is lower consumption of food due to: (Circle yes or no)

- Low appetite: **Yes** **No**
- Pain: **Yes** **No**
- No access to food: **Yes** **No**

☐ **Yes to any of the questions (1 point)** ☐ **No to all questions (0 points)**

If the patient is an **adult**, have they experienced weight loss over the past 3-4 weeks? (Circle yes or no)

☐ **Yes (1 point)** ☐ **No (0 points)**

If the patient is an **infant** or **child**, have they had no weight gain (infants <1 year old), or is -2 SD on WHO growth chart?

☐ **Yes (1 point)** ☐ **No (0 points)**

Nutrition Screen Score Interpretation and Action Plan:

4-5 points: High Risk of Malnutrition

Action plan: Consult a Clinical Nutrition Specialist for immediate nutrition assessment and intervention. A Clinical Nutrition Specialist should see this patient immediately, provide nutrition diagnosis and documentation to medical team. The Clinical Nutrition Specialist should continue to assess this patient at least every 3 days, if not sooner. Nursing should provide daily weights.

1-3 points: Moderate Risk of Malnutrition

Action plan: Consult a Clinical Nutrition Specialist for nutrition assessment and intervention within 48 hours of admission. The Clinical Nutrition Specialist should follow-up every 5-7 days during admission. Nursing should provide daily weights.

0 points: Low Risk of Malnutrition

Action plan: No additional nutrition assessment or intervention is required at this time. Check weights regularly. Reassess after 1 week.

Completed by: _____ Date: _____ Time at end of screening:_____

Appendix D

Nutrition Risk Screen Study
Initial Nutrition Assessment

Patient Identifier: _____ Date: _____

1) **Was a nutrition-risk screen completed upon admit for this patient? ____Yes ___No**
2) **Complete a re-screen to validate answers.**

Admit weight: kg

Height/length: (m/cm)

BMI: (kg/m2)

Weight-for-height/length (W/L) z-score: _____

Weight-for-age (W/A) z-score: _____

Height/length-for-age (H/A) z-score: _____

Head circumference (HC):_____ _____ _____ Average: _____cm

UBW (adults): kg

%UBW (adults):

MUAC (take 3 measures): _____ _____ _____

Average: _____cm

Hand-grip strength (take 3 measures on each hand):

Right hand _____ _____ _____ Average: _____kg

Left hand _____ _____ _____ Average: _____kg

NUTRITION ASSESSMENT:

Patient is a _____year old _____ admitted for _____. Patient reports _____.

Patient Hx:
Personal history:

Past medications/supplements:

Social/environmental (cigarettes, alcohol):

Previous medical history:

Biochemical Data: (only collect if time allows)

Electrolyte	**Date**	**Values**	**CBC**	**Date**	**Values**
Glucose			WBC		
Potassium (K)			LYM		
Sodium (Na)			HGB		
Calcium (Ca)			MCH		
Magnesium (Mg)			MCV		
Phosphorus (P)			RBC		
			HCT		
			PLT		

Current Medications:

Nutrition-Focused Physical Examination (NFPE) – check all that apply

Body Parts	**Condition**		**Notes**
Hair	❑ Brittle hair	❑ Easily pulled out	
Temporal	❑ Depressed	❑ Hollow	
Eye	❑ Discolored		
Orbital Areas	❑ No fat pads	❑ Sunken/hollow	
Cheeks	❑ No fat pad	❑ Sunken/hollow	
Lips	❑ Cracked	❑ Pale or red/bleeding	
Teeth	❑ Missing		
Gums	❑ Red/bleeding		
Tongue	❑ Swollen/red	❑ Glossy	
Swallow/suck	❑ Unable to suck	❑ Unable to swallow	
Appetite	❑ Hungry	❑ No appetite	
Breathing ability	❑ Difficulty breathing		
Collarbones	❑ Prominent	❑ No muscle/fat cover	
Shoulder bones	❑ Squared off	❑ Bony point	
Triceps	❑ Muscle wasting	❑ Fat wasting	
Biceps	❑ Muscle wasting		
Skin	❑ Red papillae	❑ Discolored/dry	

Nails	❑ Ridges or cracks	❑ Do not blanch	
Interosseous muscles	❑ Depleted muscle		
Knee bones	❑ Prominent		
Calves	❑ Muscle wasting		
Toenails	❑ Ridges or cracks		

☐ Edema ☐ Skin Muscle Wasting ☐ Hydration Status ☐ Nausea

☐ Vomiting ☐ Diarrhea ☐ Constipation ☐ Anorexic

☐ Early Satiety ☐ Dysphagia ☐ Dentures ☐ None

☐ Other: _____

Diet Recall: (use 24hour Diet recall form)

Estimated Total intake q 24 hrs: (ໃ/ງກ ິນທ ັ້ງໝ ົດ) =

Energy:
Protein:
Fluid:

Estimated Needs:
Energy:
Protein:
Fluid:

% of actual needs
Energy = %
Protein = %

Form completed by: _____

Date/Time:_____

Appendix E.

Dietary 24 Hour Recall Form

Participant Identifier:_____

Please check applicable boxes:

Season: ☐ Rainy ☐ Dry

Person who provided information:
☐ Care taker ☐ Care taker and patient ☐ Patient

Date of interview:_____

Sex: ☐ Male ☐ Female **Age:** _____

Food consumed yesterday: ☐ Normal day ☐ Holiday

Quantity of food consumed yesterday as compared to a typical day:
☐ Less than usual ☐ Equal ☐ More than usual

Time	**Meal**	**Individual Food Items**	**Total amount consumed (mL or g)**	**Ingredients in mixed food**	**Amount of ingredients consumed (mL or g)**	**Notes**

Name of interviewer: _____

Adapted from FAO Diet Recall Form provided by NIOPH/Dr. Sengchanh, Lao PD

Appendix F.

Nutrition Risk Screen Study
Patient Interview

Study Participant ID:_____

Please ask the patient or their caregiver the following questions and circle/write their answer.

1. Do you have an appetite? YES NO
2. Do you have the following symptoms?
    a. Nausea? YES NO
    b. Vomiting? YES NO
    c. Diarrhea? YES NO
    d. Constipation? YES NO
    e. If YES, for how long? _____
3. Has your intake of food decreased over:
    a. 1 week? YES NO
    b. 1 month? YES NO
    c. 3 months? YES NO
    d. If YES, has it decreased by <50% or <75% ?
4. What is your usual body weight? _____kg
5. Have you lost weight over:
    a. 1 week? YES NO
    b. 1 month? YES NO
    c. 3 months? YES NO
    d. 6 months? YES NO
    e. 1 year? YES NO
6. Do you drink alcohol? YES NO
7. Do you use tobacco? YES NO
    a. If YES, how often? _____

Appendix G. Data Collection Flow Chart