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Development and implementation of a nutritional-risk screening procedure for pregnant mothers in a Honduran community hospital system

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ABSTRACT

Previous research has demonstrated the negative implications that poor maternal nutrition has on morbidity and mortality for both the mother and the unborn child. Although malnutrition is known to make pregnant women susceptible to miscarriage or birth of a child with stunted growth and development, many Central American countries such as Honduras lack a screening tool to detect maternal malnutrition. The purpose of this study was to develop and pilot a screening protocol for malnutrition during pregnancy using best practice and evidence-based recommendations from the AND and the ACOG, and creating a training protocol for obstetric nurse education to foster sustainability of the experimental screening tool within the Honduran medical system. The results of testing performed on women in the public health center versus public hospital showed significant differences in blood glucose levels and fundal height measurements. A two-sample *t*-test of blood glucose (mg/dL) was statistically significant between the two groups, BG $t(15)=4.463$, $p \leq 0.001$ ($d=38.4$ mg/dL ± 8.6 mg/dL). Relative risk assessment determined women in the hospital are 2.8x more likely to present with a low fundal height than those in the public health center, indicating underdevelopment of the fetus ($\varphi = 0.59$). Upon completion, comparison of mothers who were evaluated in the public health center versus the public hospital demonstrated how prenatal care can positively influence maternal health and evaluation of six major factors (fetal heart rate, maternal heart rate, blood glucose, hemoglobin, fundal height and mid-arm circumference) can help to identify mothers who potentially present as an at-risk pregnancy due to malnutrition.

CHAPTER 1

INTRODUCTION

Malnutrition across the globe contributes to an overwhelming number of deaths annually, particularly prevalent in young children raised in developing countries. United Nations International Children's Emergency Fund [UNICEF] (2016), along with the World Health Organization [WHO] (2016), found that in 2015, out of the 1.5 million children who died, 45% of these deaths resulted because of malnutrition or associated conditions (UNICEF, 2016; WHO, 2016).

Malnutrition not only poses an increased risk of morbidity and mortality for both the mother and the fetus, but can also lead to the birth of underweight infants whose risk of stunted growth and development is greatly increased (Tappenden et al., 2013). However, there are many known factors resulting from maternal malnutrition that have been directly correlated to poor pregnancy outcomes or birth defects. Factors such as maternal weight gain, hemoglobin, and fasting plasma glucose, as well as records maternal food consumption and physical activity engagement are important determinants in a women's prenatal health (Procter & Campbell, 2014). Other methods of detection in relation to chronic malnutrition of the mother are changes in weight, mid-arm circumference measurements, subcutaneous fat and/or muscle loss and visual observation of temporal and buccal wasting and fetal heart rate (Litchford, 2012; Mahan, Escott-Stump, & Raymond, 2012). Assessment of fundal height can also indicate if the fetus is developing appropriately in relation to the mother's gestational age (Mohanty, Das, Mishra, 1998).

The current public healthcare system in Honduras does not have a nutritional screening system for expectant mothers. Due to this, little to no nutritional screening and care transpires to identify and rectify possible nutrition-related complications during pregnancy. The purpose of this research is to develop and pilot a minimally-invasive screening protocol to identify maternal malnutrition and fetal development complication risk in a regional hospital system in Honduras. By creating a pilot screening protocol, promising secondary prevention mechanisms could be implemented to improve outcomes of complications that would otherwise go undetected. This research will be supported by the Central American Medical Outreach (CAMO) nutrition services (CAMO, 2016) using cross-section and anonymously collected data from pregnant mothers who provide informed consent with the intention to both pilot the screening protocol and provide mothers with the screening medical tests.

The two objectives were to: 1.) Develop and pilot a screening protocol for malnutrition during pregnancy using best practice and evidence-based recommendations from the Academy of Nutrition & Dietetics (AND) and the the American Congress of Obestestrician and Gynecologist (ACOG)2.) Develop and implement a training protocol for obstetric nurse education to foster sustainability of the experimental screening tool within the Honduran medical system. The central hypothesis was that those mothers utilizing public health services for regular prenatal care would present with values in the normative healthy ranges outlined by the American Congress of Obstetrics and Gynecologists and the Academy of Nutrition and Dietetics when screening for a number of medical factors related to nutrition that impact pregnancy outcomes.

Compared and evaluated impact of prenatal care demonstrated that mothers who received regular prenatal care from the public health center in Santa Rosa de Copan, Honduras presented on average with a higher number of values in the normative range for evaluation of fundal

height, hemoglobin, blood glucose levels, mid-arm circumference, fetal heart rate and maternal heart rate. This indicated that those receiving consistent care were at much lower risk for complications during pregnancy compared to those evaluated in the public hospital receiving acute care. This project included multiple aims:

1. The first aim was to develop and pilot a screening protocol for malnutrition during pregnancy using best practice and evidence-based recommendations from the Academy of Nutrition and Dietetics (AND) and the American Congress of Obstetrics and Gynecologists (ACOG).
2. The second aim is to create a training protocol for obstetric nurse education to foster sustainability of the experimental screening tool within the Honduran medical system and public health infrastructure.

CHAPTER 2

LITERATURE REVIEW

Malnutrition across the globe contributes to an overwhelming number of deaths annually, particularly in children. Malnutrition is particularly prevalent in young children raised in developing countries; UNICEF, along with the World Health Organization (WHO), found that in 2015, out of the 1.5 million children who died, 45% of these deaths resulted because of malnutrition or associated conditions (UNICEF, 2016; WHO, 2016). One factor largely influencing the development of malnutrition and its comorbidities in children is the health of mothers during pregnancy (Belmonte & Langevin-Falcon, 2009). In many developing countries, maternal malnutrition has often been the consequence of low socioeconomic status, indicating that the lower a mother's income, the higher risk of complications during pregnancy and after delivery, assuming the child survives. Maternal malnutrition results in the mother's children developing poor immunity and impaired cognitive development, as well as stunted growth throughout childhood. The physical and cognitive issues that develop as a result of malnutrition in utero continue to affect the child throughout their lifespan, causing poor performance in school and decreased productivity or ability to earn income when they reach adulthood (Belmonte & Langevin-Falcon, 2009). This often fosters the cycle of economic disparity as seen in many third world countries today, where malnutrition continues to be a problem particularly for low-income families.

In addition to the dangers posed to the fetus, malnutrition during pregnancy can pose a risk to the mother's health. These complications associated with malnutrition include:

preeclampsia, low birth weight, chance of hemorrhage, anemia, gestational hypertension, and neural tube defects that can be fatal for both the mother and child (Papathakis, Singh, & Manary, 2016). Studies conducted by the Academy of Nutrition and Dietetics (2016) and Lutter, Chapparro, and Muñoz (2011) discovered the major outcome of malnutrition during pregnancy in Central American countries to be stunted growth, a condition that impacts roughly half of all Latin American children. Maternal malnutrition was found to have the greatest impact on neural development beginning in the third trimester of pregnancy and continuing throughout the first 2 years postpartum while the brain of the infant is rapidly growing (Souza, Santos, Fernandes, & Graças-Tavares, 2011). Another crucial factor in the health of the fetus during development is maternal hemoglobin levels. Chronically low hemoglobin, defined as below 11 mg/dL was found by Sawant & Venkat (2013) to cause restricted fetal growth and increased risk for placenta accrete where the placenta attaches too deeply in the uterine wall or placental abruption in which the placenta detaches prematurely from the uterus.

It is estimated that in rural areas, chronic malnutrition can range from 34% to 48.5 % because of inadequate public health care systems (World Food Programme, 2016). One country with a particularly high rate of underweight children is Honduras. UNICEF ranked Honduras number four in prevalence for underweight children under age 5, as they accounted for 16.6% of the total number in Latin American and Caribbean countries (UNICEF, 2016).

Although malnutrition is a serious issue for both mother and child, there are steps that can be taken to prevent mortality and morbidity. The 2014 Academy of Nutrition and Dietetics position paper titled *Nutrition and Lifestyle for a Health Pregnancy,* detailed some of the ways in which maternal malnutrition or undernutrition could be detected and how to intervene. Contained in the position paper is a protocol developed by Procter & Campbell (2014) which requires a

screening that tests maternal weight gain, hemoglobin and fasting plasma glucose, as well as records maternal food consumption and physical activity engagement. Another indicator of health of the fetus is fetal heart rate, which can be assessed using Doppler technology, a recommendation made in 2009 by the American Congress of Obstetricians and Gynecologists. Other methods of detection in relation to chronic malnutrition of the mother are changes in weight, mid-arm circumference measurements, subcutaneous fat and/or muscle loss and visual observation of temporal and buccal wasting (Litchford, 2012; Mahan, Escott-Stump, & Raymond, 2012). While these are helpful places to begin screening, both the areas of detection and the impacts of maternal nutrition prior to and during gestation remain uncertain. The Academy of Nutrition and Dietetics has highlighted the need to act in combating malnutrition for hospital patients with the aim to decrease preventable related morbidity and mortality (Tappenden et al., 2013). It is imperative to develop a protocol for screening methods as well as education for mothers and appropriate nutritional supplementation, particularly in low-income areas. By addressing malnutrition in the early months of pregnancy, nutritional deficiencies and the subsequent complications can be rectified using medical nutrition therapy. This will lead to a decrease in further malnourishment, as well as mortality rates in both children and mothers (Litchford, 2012; Mahan, Escott-Stump, & Raymond, 2012; WHO, 2016).

CHAPTER 3

METHODOLOGY

Participants

The participants in this study included pregnant mothers with established pregnancies who were utilizing the public health center established by CAMO or had been admitted to the Hospital Occidente in Santa Rosa de Copan, Honduras. Public health and community hospital services in the city are provided to mothers who have demonstrated a need of support for their pregnancy. The only standard that must be met to demonstrate need included being a member of the target community regardless of income, insurance coverage, and/or ability to pay. The experimental screening protocol utilized in this study was intended to provide mothers with a secondary prevention mechanism to improve the development of their baby, prevent complications, and, if implemented in the future, provide a mechanism for nutritional intervention to improve outcomes for both mothers and their children.

Protocol

The two subject groups were split based on whether they were utilizing prenatal care at the public health center (n=8) or acute care at the community hospital (n=10). The approximate screening time spent on each mother was approximately 15-30 minutes based on time for the participant and interpreter to assist in completing assessment. The physical assessment was conducted to detect any physical signs on malnutrition. The examination included screening for temporal and buccal wasting, presence and severity of edema in the upper and lower extremities,

lanugo, and a visual inspection of the skin, hair and nails. All abnormal findings were recorded on the subject's chart. Additional information recorded included their age, gestational age in weeks, previous pregnancies (Gravida and Parity), and diagnosis/presentation (if they were hospital patients). Anthropometric measures of the patients were obtained and recorded, which included weight (kg) via slide scale, height (cm) via stadiometer, and mid-arm circumferences (cm) using a metric vinyl tape measure.

Following the prior assessment, physiological measurements were taken. Heart rate and blood pressure were measured using an Amron automatic blood pressure cuff . Hemoglobin and oxygen saturation levels were obtained using a pulse oximetry, non-invasive method (Massimo Pronto Rad 5). This method allowed for hemoglobin level to be determined by light pulses being administered through a small probe that fits on the finger of the subject rather than a collection of capillary blood. Plasma glucose was measured 60 minutes after ingestion of a 50g dextrose-sucrose solution in 5 oz. of water, therefore the carbohydrate drink has a ratio of 10g CHO:1 oz water.. Fasting plasma glucose measures are contraindicated in pregnant women, and therefore plasma glucose standards were based off time since the last meal of each subject was ingested, following the protocol outlined by "*Practice Bulletin No. 137: Gestational Diabetes Mellitus*" from the American Congress of Obstetrics and Gynecologists (2013). This measure was collected through a 1-2 microliter sample of blood from each patient. The sample was collected by first sanitizing the puncture site with isopropyl alcohol, performing the puncture with a one-time use 24 gauge lancet, wiping the first droplet of blood, then collecting the second droplet captured using the glucometer (OneTouch Point of Care) and a one-time use test strip. After collection, the site was again disinfected and bandaged, and all materials were discarded appropriately into a biohazard container. This screening method was simply preliminary, and if

significant upon testing would need to be followed up with an oral glucose tolerance test (OGTT) in order to diagnosis gestational diabetes.

The last two measurements recorded from the subject were fundal height (in all subjects at gestational age greater than 15weeks) and fetal heart rate. Fundal heart rate is measured by first palpating the uterus. The uterus was palpated by walking the fingers. A vinyl measuring tape was then used to determine the length from the naval to the top of the symphysis pubis and then multiplied by 2. Lastly, fetal heart rate was measured using Doppler (Edan Sonotrax Pro 2Mhz), which amplifies the fetal heart sounds using a ultrasonic sound waves that are refracted and collected by placing the wand outside of the uterus to estimate heart rate and tone of the fetus in pregnant mothers.

Normal Limits for the Physiological and Fetal Measures are as follows:

- Hemoglobin (Hgb): 1st trimester 11mg/dl; 2nd 10.5mg/dl; 3rd 11mg/dl; ≥13-13.5mg/dl is indicative of pre-eclampsia (AND, 2014)
- Glucose:1-hr glucose challenge, Normal >140 mg/dL (ACOG, 2013)
- Fetal Heart Rate (FHR): Normal 120-160 bpm (ACOG, 2009)
- Mid-Arm Circumference (MAUC) for Malnourishment: Normal: Male >23cm and Females >22cm (AND, 2014)
- Fetal development (Fundal): Agreement between fundal height ([distance from naval to top of the pelvic bone (cm)] x 2 and number of weeks gestation (±2 weeks)

Statistical Analysis

A two-sample *t*-test was employed to assess differences between care setting (hospital and public health center) with statistical significance set at $p \leq 0.05$. The sample size for the two subject groups were n=10 in the community hospital and n=8 at the public health center. The Shapiro-Wilk test was used to assess normality, with any results of the test producing a *p*-value less than 0.05 indicating non-normality within groups. Levene's test of equal variances was used to test for homogeneity of variance between care setting with *p*-value of less than 0.05 indicated not equal variances. Following these statistical analyses, relative risk, X^2 test of independence and phi (φ) values to indicate statistical associations were obtained for nominal variables (Fetal development and hemoglobin) by care setting.

CHAPTER 4

RESULTS

Patient Descriptions

The patients evaluated in this study ranged in age from 16-37, and included women at all different stages of pregnancy, with an average of 26±11gestational weeks. The average weight among the subjects was 73.6± 32.2kg, and average height was 147.9±19.3cm. Some of the common diagnoses among the women evaluated in the hospital included preeclampsia (n = 1), Placenta Previa (n = 1), threatened miscarriage (n = 2), and oligohydramnios (n =6).

Table 1: Descriptive Statistics by Setting

	Total (n=18)	Public Health (n=8)	Hospital (n=10)
Age	23.83±6.71	25.70±7.53	21.5±5.01
Ht (cm)	147.9±19.32	144.4±26.48	151.9±4.32
Wt (kg)	73.65±32.18	86.89±38.26	58.75±14.68
Gest. Weeks	26.22±10.89	31.2±10.16	20.0±8.70
Iron (mg/dL)	13.94±1.26	14.0±1.33	13.88±1.25
BG (mg/dL)	104.6±25.79	120.4±20.20	82±12.25
FHR	143.8±10.39	141.1±9.94	149.8±9.94
HR	84.89±12.52	89.3±12.04	79.38±11.49
MAC(cm)	28.39±5.61	30.4±2.80	25.88±7.30

Values expressed as M±SD. Ht = Height, Wt = Weight, BG = Blood Glucose, FHR = Fetal Heart Rate, HR = Heart Rate, & MAC = Mid Arm Circumference

Differences by Prenatal Setting

Based on the t-test analysis of hemoglobin levels by care setting, there was no significant difference (p = 0.841). However based on relative risk, women in the hospital setting were 2.14 times more likely to present with abnormal hemoglobin. There was a statistically significant

difference of blood glucose by care setting, $t(15)=4.463$, $p \leq 0.001$ with a mean difference of 38.4±8.6 mg/dL more in the hospital (120mg/dL) versus the public health center (82mg/dL). Analysis of fetal heart rate and maternal heart rate both showed no significant differences by care setting, $p = 0.176$ and 0.895, respectively. The mid-arm circumference between the two groups also did not reach statistical significance ($p = 0.089$). There was a statistically significant association between care setting and fetal development, $X^2(1) = 4.55$, $p = 0.033$, $\varphi = 0.59$. Relative risk assessment determined women in the hospital were 2.8 times more likely to present with a low fundal height than those in the public health center, indicating underdevelopment of the fetus with a linear association by care setting.

CHAPTER 5

DISCUSSIONS

The current investigation sought to evaluate the feasibility and impact of a prenatal nutrition screening protocol in a Latin American community hospital. The first aim was to develop and pilot a screening protocol for malnutrition during pregnancy using best practice and evidence-based recommendations from the Academy of Nutrition and Dietetics (AND) and the American Congress of Obstetrics and Gynecologists (ACOG). Upon admittance to the public hospital, a majority of these measurements obtained from a simple medical screening tests that can be utilized as diagnostic tools are not obtained. Therefore, medical conditions that develop as a result of nutritional deficiencies during pregnancy are not being detected and monitored. This investigation revealed that mothers who obtained regular prenatal care in the public health center presented with controlled blood glucose levels and fundal heights consistent with their gestational weeks, as opposed to those in the hospital. Moreover, following the glucose challenge, those mothers in the community hospital were more likely to present with indices of Gestational Diabetes. Low fundal height in particular is a concerning statistic as a low fundal height is indicative of an underdeveloped fetus, often leading to a low birthweight child (Mohanty, Das, Mishra, 1998). Low fundal height can be caused due to low amniotic fluid, correlating with the frequent diagnoses of oligohydramnios in the hospital subjects. Our results indicated that mothers receiving care in the public hospital were more than twice as likely to present with a fetus that was underdeveloped according to fundal height standards compared to the mothers in the public health center. The need to implement a nutritional screening assessment

for pregnant mothers in order to decrease the morbidity and mortality of children in countries such as Honduras is of paramount importance to improve pregnancy outcomes (Litchford, 2012; Mahan, Escott-Stump, & Raymond, 2012; WHO, 2016). Future research should investigate the impact which medical nutrition therapy has when provided to the mother upon early detection of low fundal height as opposed to those mothers who do not receive medical nutrition therapy and present with low fundal height measurements.

The second aim wasto create a training protocol for obstetric nurse education to foster sustainability of the experimental screening tool within the Honduran medical system and public health infrastructure. In both the public health center and public hospital, there is no screening tool to assess patients for malnutrition or prenatal risk factors. By developing a standard form and method for assessing pregnant mothers, early detection of malnutrition and at-risk pregnancies can help provide immediate and possibly life-saving care to both the mother and the fetus throughout the course of gestation. Past research has indicated the efficacy of implementing a nutritional screening tool for pregnant mothers based solely on dietary recalls, allowing healthcare professionals to identify at risk mothers and provide them with dietary counseling and supplementation (Langstroth, Wright, Parkington, 2011). Therefore, it is indicated that further screening with the inclusion of both dietary recall and medical screening in a single nutritional tool would greatly improve the outcomes of pregnant women in countries like Honduras. Further investigation should seek to obtain information on how effectiveness of different screening tools, methods of education for obstetric nurses to screen for malnutrition and high-risk pregnancies, and the outcomes of implementing a medical screening tool for pregnant mothers and their children.

The results of the study indicated two major areas affected by malnutrition during pregnancy are glucose tolerance and fundal height. This indicates that poor nutrition throughout gestation can place the mother at higher risk for gestational diabetes and a low birthweight or underdeveloped baby, placing them at higher risk for stunted growth and development, death, and a variety of associated medical conditions. By implementing a screening for malnourished mothers in a Honduran community hospital and delivering regular prenatal care (as is done in the public health center) as well as nutritional interventions for mothers who require it, better outcomes can be achieved for both mothers and their children. Past research has found that by addressing malnutrition in the early months of pregnancy, nutritional deficiencies and the subsequent complications can be rectified using medical nutrition therapy (Litchford, 2012; Mahan, Escott-Stump, & Raymond, 2012; WHO, 2016). Additionally, 2014 Academy of Nutrition and Dietetics position paper titled *Nutrition and Lifestyle for a Health Pregnancy* not only outlined methods for screening and detection of malnutrition in mothers, but also methods to intervene and prevent further nutritional deficits.

The results of the current investigation are consistent with past findings that low fundal height is indicative of an underdeveloped fetus, often leading to a low birthweight infant with cognitive and developmental delays (Mohanty, Das, Mishra, 1998). Additionally, low blood glucose levels contribute to impaired fetal growth as well as a dangerous environment for the mother if she gives birth in a hypoglycemic state (Rogne & Jacobsen, 2014).

Implications for Practice

Ability to detect risk factors for poor pregnancy outcomes in malnourished women indicates that it is possible to improve pregnancy outcomes for patients even in low-income countries like those of Central America. By assessing the six major indicators of pregnancy complications resulting from poor nutrition (fetal heart rate, maternal heart rate, blood glucose, hemoglobin, fundal height and mid-arm circumference), it is possible to detect and rectify nutritional deficits in the mother's diet to improve the health of both the mother and the fetus during pregnancy. Challenges to implementing a screening protocol include the cost and the time required to effectively execute screening using this tool. Public hospitals often lack equipment such as a Doppler sonographer, a pulse oximeter, and glucometers due to low funding. Not having this equipment makes screening much more complex and time consuming, and therefore it is harder to perform on a large number of patients. Additionally, nurses in the public hospital lack public education and are not given time at work to participate in continuing education so they can be taught new medical techniques to help assess their patient's health extensively. Finally, this public hospital in particular struggles with access to adequate amounts of food for patients. Therefore, even if malnutrition in pregnant mothers is evaluated and need for

intervention is identified, it is possible they will not possess the resources to provide medical nutrition therapy to mothers.

Limitations

Some limitations encountered during the study were the number of subjects available for testing, limiting the sample size of the groups. By repeating the study with a larger number of subjects, the differences between mothers receiving regular care and proper nutrition versus those in the hospital may be more apparent. Given the limitations in sample size, generalizations from the above results you be used with caution. Future investigation is warranted using a more robust sample to elucidate the impact of a prenatal nutrition screening protocol in Latin American hospitals. In addition to sample size, the setting of the study presented a language barrier between researchers and subjects so communication had to be facilitated by interpreters. Finally, the record-keeping of El Hospital Occidente in Honduras is less regulated than that in the U.S. hospital system, and therefore some of the charting in the hospital lacked information regarding the subject's condition and necessary measurements.

Conclusion

In summary his investigation demonstrated that developing and piloting a screening protocol for malnutrition during pregnancy, as well as creating a training protocol for obstetric nurse education to foster sustainability of the experimental screening tool within the Honduran medical system and public health infrastructure could improve maternal and fetal outcome in the Honduran public health system. Upon completion, comparison of mothers who were evaluated in the public health center versus the public hospital demonstrated how prenatal care could

positively influence maternal health and evaluation of six major factors (fetal heart rate, maternal heart rate, blood glucose, hemoglobin, fundal height and mid-arm circumference) could help to identify mothers who potentially present as an at-risk pregnancy due to malnutrition.

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