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Dr. Melody Ryan, Committee Chair

Dr. Sarah Wackerbarth, Director of Graduate Studies

Evaluation of anemia in communities served by Shoulder to Shoulder Global: A Cross-Sectional Study in Santo Domingo, Ecuador

Capstone Project Paper

A paper submitted in partial fulfillment of the requirement for the degree of Master of Public Health in the University of Kentucky College of Public Health

by

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Louisville, Kentucky

Lexington, Kentucky
9 November 2018

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DISCLOSURE

Kevin Mercer has no real or potential financial conflicts of interest related to the subject matter in this manuscript.

ABSTRACT

BACKGROUND: Shoulder to Shoulder Global (STSG) recognizes anemia as a cause of morbidity among patients in Santo Domingo, Ecuador. Little research has been done to assess targetable anemia risk factors to serve as a foundation for future pharmacotherapeutic interventions. This study sought to identify risk factors for anemia in this population.

METHODS: Data obtained from existing patient records from January 1, 2010 to August 31, 2016 included hemoglobin/hematocrit, age, sex, pregnancy status, and presenting community. Chi-square tests compared means to examine risk factors associated with anemia. Poisson regression and incidence rate ratios (IRR) were used to estimate risk factors associated with anemia.

RESULTS: Of the 1145 subjects with complete data for analysis, 67.2% were female, 33% were children under five, 1.6% were pregnant, and 42.8% were anemic. Subjects were distributed throughout the seven communities with 11.2% presenting from an indigenous community. Risk factors for anemia were age <5 years and presenting from the communities of Plan de Vivienda, Los Naranjos, or El Bua. Neither sex, nor pregnancy were significantly associated risk factors with anemia.

CONCLUSION: Risk factors for anemia in this population have not previously been determined. In this study, risk factors were age group <5 years and presentation from three different communities. A limitation of the study is its observational design. Additional research should evaluate the effectiveness of STSG health interventions on anemia.

INTRODUCTION

Shoulder to Shoulder Global (STSG) at the University of Kentucky is a global organization seeking to improve the health and well-being of impoverished and underserved communities worldwide. STSG began in 2002 when a physician from the University of Kentucky led a small medical brigade to Santo Domingo, Ecuador. In Santo Domingo, urban crowding has resulted in the formation of *cooperativas* or *barrios* generally located on the outskirts of the city.[1] Many of these communities lack electricity, improved water sources, sanitation, and access to healthcare.[2] STSG established partnerships with community health organizations in the area to work towards a more sustainable impact. Nearly sixteen years have passed and STSG has grown exponentially. In 2007, a clinic, Centro de Salud Hombro a Hombro (CSHH), was opened in the "cooperativa" of Carlos Ruiz Burneo to provide primary care, pharmacy services, oral health, and preventative health workshops.[1] In line with its vision to support the local community, the CSHH employs local staff with the support of STSG to provide healthcare to nearly 50 patients per day. The clinic serves about 20,000 people from the barrios of Carlos Ruiz Burneo, Plan de Vivienda, and Luz del Dia.

While the CSHH has served the community for over a decade, STSG continues to provide support to the clinic in the form of interprofessional health brigades. Interprofessional health brigades began in 2008 with the aim to provide acute care to brigade attendees and refer more extensive health problems back to CSHH.[1] Additionally, STSG has partnered with Timmy Global Health (TGH) which assists in providing support to health brigades. Throughout each academic year, health professionals and their students from dentistry, medicine, pharmacy, nursing, physical therapy, physician assistant studies, psychology, communication sciences and disorders, education, and public health travel to

Santo Domingo, Ecuador for brigades in March, May, June, and August.[1] The brigade teams work together to supplement existing quality healthcare to patients across various sites in Santo Domingo. In 2010, TGH implemented an electronic medical record (EMR), TimmyCare (Timmy Global Health, Indianapolis), in the CSHH clinic, which is also used by the brigades. TimmyCare allows clinic staff and brigade volunteers to follow a patient from registration at reception to discharge at the pharmacy. The implementation of an EMR has allowed for improved efficiency, accuracy of patient care, and systematic data inquiry for research purposes.

A large majority of patients served by CSHH present from peri-urban communities. As STSG has continued to develop, CSHH has formed partnerships with the indigenous Tsáchila people who live in small, isolated rural communities outside city limits with little access to healthcare (Figure I).[1] However, through partnerships with Tsáchila community leaders, STSG and TGH are able to reach these communities three times per year to provide healthcare services. While the health brigades provide health screenings and healthcare to patients in the community away from the clinic, the goal is to establish relationships with these patients and refer them to CSHH in order to improve continuity of care. However despite these efforts, many patients presenting to the health brigades from the Tsáchila communities continue to report that their only access to health care is via brigade.[1]

Globally, anemia is considered the most common nutritional deficiency, affecting approximately a quarter of the world population, especially children and women of reproductive age.[3] Iron deficiency is one of the most common cause of anemia.[3] Severe anemia is associated with fatigue, weakness, dizziness, and drowsiness.[4] Pregnant women and children are most vulnerable to the deleterious effects of anemia. For the developing

fetus, major risks of anemia include preterm birth and low birth weight.[3,5] In children, anemia can negatively affect cognitive development, school performance, growth stunting, and immunity.[6] According to the World Health Organization (WHO), Ecuador is classified as moderate to severe with regard to level of public health significance for anemia (Table I).[4] However, these data do not describe which Ecuadorian subpopulations are most affected and how to best address the underlying issue.

While STSG continues to provide assistance to the CSHH by allocating funds and other resources for nutritional supplements, little has been done to characterize specific risk factors for anemia in this population. Previous efforts to improve anemia via iron supplementation have been unfocused with questionable evidence of benefit. This study aims to provide demographic information for the anemic population and determine specific risk factors for anemia at STSG brigades and the CSHH clinic in order to take actionable steps for iron supplementation in the future. It is hypothesized that women will have a higher prevalence of anemia than men and subjects from indigenous communities will have a higher prevalence of anemia than other communities.

METHODS

Data collection

This retrospective cross-sectional study was declared exempt by the University of Kentucky Institutional Review Board. Due to limited resources and cost considerations for the CSHH, only subjects from 1 to 6 years of age, female subjects greater than 12 years of age, or any subject with clinical signs of anemia were routinely screened in accordance with standard clinic protocol. In order to determine anemia status, hemoglobin (Hgb) levels were

measured via capillary blood obtained with one-way lancets fitted to an ACCU-CHEK® lancing device (Roche; Mannheim, Germany) and analyzed using portable HemoCue Hb 201+ hemoglobinometers (HemoCue America; Ängelholm, Sweden). If Hgb levels were unattainable due to instrument malfunction or maintenance, hematocrit (HCT) concentrations were obtained. All HCT concentrations were converted to Hgb equivalents for data analysis by dividing the HCT concentration by three.[7] Subjects were considered anemic if they met mild anemic status or greater with hemoglobin levels consistent with the WHO Anemia Definitions (Table II) for their age group and gender, if adult.[8] Subjects were grouped into their respective communities from which they presented to the brigade or the CSHH. Duplicate patient information was removed by excluding duplicate subject encounters.

To extract the data, TimmyCare was queried for patient demographics, including patient and visit identification number, age, gender, pregnancy status, and community location. TimmyCare assisted in harvesting further information pertinent to anemia diagnoses, including Hgb level or HCT concentrations. Data from all subjects who received Hgb or HCT testing from January 1, 2010 to August 31, 2016 were compiled. No subjects were excluded based on age, sex, gender, or race. Duplicate subjects were excluded based on patient identification number and only the first visit was included for statistical analyses.

Statistical analyses

Univariate and bivariate analyses of selected variables were conducted using Chi-squared tests and Fisher's exact tests for ordinal, nominal, and categorical variables. Incidence rate ratios (IRR) and 95% confidence intervals (CIs) were calculated via Poisson regression. Statistical significance ($p \leq 0.05$) was used to guide regression model variable

selection. Stratified bivariate analyses were used to guide the selection of stratified models. Poisson regression analysis was conducted with STATA software, version 13.1 (StataCorp; College Station, TX, USA). For categorical variables, age group and community location, age >15 years and CSHH were used as referent groups, respectively.

RESULTS

A total of 1328 subjects were collected for the study. Subjects with Hgb levels indicative of anemia were included according to WHO Anemia Definitions (Table II).[8] Of the 1328 subjects initially screened, 1145 were unique subject encounters. Of the 1145 subjects with complete data for analysis, 67.2% were female, 33% were children under five, 1.6% were pregnant, and 42.8% were anemic. Notice that over 42% of anemic subjects are young (<5 years of age) compared with only 26% of non-anemic subjects. Subjects were distributed throughout the seven communities with 11.2% presenting from an indigenous community. Demographic characteristics of the study population are further summarized in Table III. Figure II depicts row percentages for each of the variables tested in this study for anemia in order to demonstrate the effect of anemia within each group. When subjects with anemia were compared to subjects without anemia via Chi-square analysis, a statistically significant result was seen for age group ($p<0.001$).

A Poisson regression generating the incidence rate ratios of anemia with a number of covariates including age, sex, pregnancy status, and community location estimated risk of anemia (Table IV). The five subjects from the Congoma were excluded from the Poisson regression, due to the low sample size for this location. The youngest subjects (<5 years of age) have 1.46 times the incident rate of being anemic compared to the oldest age group

(p=0.001). Additional groups with increased incidence rate for anemia presented from the communities of Plan de Vivienda (IRR=1.36; 95% CI [1.09, 1.69]), Los Naranjos (IRR=1.50; 95% CI [1.04, 2.17]), or El Bua (IRR=1.61; 95% CI [1.12, 2.32]). Female sex (IRR=1.02; 95% CI [0.83, 1.25]) and pregnancy status (IRR=1.25; 95% CI [0.61, 2.54]) were determined to not be statistically significant per the model (Table IV). Protective factors for anemia were age group 2 (IRR=0.94; 95% CI [0.72, 1.23]), age group 3 (IRR=0.84; 95% CI [0.53, 1.32]), and presenting from the community of Laura Flores (OR=0.98; 95% CI [0.72, 1.33]) but were determined to not be statistically significant by the Poisson regression model.

DISCUSSION

To my knowledge, this is the first study to investigate risk factors for anemia among subjects living in Santo Domingo, Ecuador, and the public health implications for risk-related factors. Several risk factors were found to be associated with anemia. Subjects greater than five years of age were less likely to be anemic than subjects less than five years of age. This finding is consistent with WHO anemia estimates for Ecuador in 2011 (Table I). Although a large proportion of children were included in the study population, the male adult group is most likely an overestimate due to selection bias.

This study demonstrated that males were more likely to be anemic than females. However, sex was not a statistically significant predictor of anemia in the regression model. According to the WHO, all Ecuadorian women of reproductive age are at moderate risk of developing anemia. Large demographic differences and potential selection bias in this study could account for reduced risk of anemia for females in this population. Due to standard clinic procedures, only subjects from 1-6 years, all females ≥12 years, and any other subject

with clinical concerns for anemia are screened. Therefore, male subjects with a higher clinical suspicion for anemia may have been included and tested positive for anemia. Despite more females being routinely tested, including a large majority of males who have a high clinical probability of testing positive for anemia may account for the inability of the study to demonstrate female sex, a known risk factor for anemia, as having a higher risk of anemia.[3]

Pregnancy was also not a statistically significant predictor of anemia in this study. A higher incidence of anemia in this population was expected due to gestational iron demands for fetal development. However, prenatal supplement use and/or low sample size in this population could have affected the lack of statistical significance in this study. STSG brigades provide large amounts of prenatal vitamin supplements to patients during brigades; the extent and impact of these interventions are unknown. Despite this, on average, up to 85% of Ecuadorian women access prenatal health care less than once per month throughout pregnancy.[9] Therefore, it is difficult to draw conclusions from this population. Additional studies are required in order to determine the relationship between anemia and specific risk factors for this population.

Location was a statistically significant predictor of anemia. Presenting from the communities of Plan de Vivienda, Los Naranjos, or El Bua was associated with higher incidence rate ratios of anemia. Although subjects from indigenous Tsáchila communities only comprised a small proportion of the total population (11.2%), Los Naranjos and El Bua accounted for two of the three communities with higher risk of anemia. These communities are more rural, often several miles from community centers, and lack access to proper nutrition and routine healthcare.[10] In contrast, Plan de Vivienda is one of the most proximal community locations to CSHH. The poverty within this community severely limits access to

basic resources, such as nutritious food and clean water. Due to the close proximity of this community to CSHH, subjects from this community may be over-represented because of how easily accessible it is to health brigades. Previous work with CSHH shows approximately 33% of children in the first age group had evidence of developmental stunting as evidenced by height-for-age Z-scores of -2.0 or worse (29 of 89 children), around 50% of preschool children had stunting, and 25% had wasting (low weight-for-age).[10] While growth stunting can be caused by low birth weight, other factors such as parasitic infection can play a role in development.[11] Although low birth weight and parasitism may play a role in the prevalence of anemia, additional research is required to clarify the relationship between parasitism and anemia in these communities.

This study has many limitations. First, data input into TimmyCare could have potential flaws during patient registration as there are many volunteers who assisted with registration of subjects during health brigades and at CSHH. Despite this limitation, however, this condition may be more reflective of real-world data. Additionally, due to the non-profit nature of STSG and TGH, laboratory collection resources are limited and many subjects who received blood testing for anemia may have had other symptoms of anemia, such as fatigue, and been referred for official testing by a healthcare provider after preliminary examination. This could have introduced significant selection bias into the study. With regard to laboratory testing, more subjects received HCT testing than Hgb testing due to limitations of available instruments. Due to instrument maintenance and laboratory error in the clinic, it is possible that some HCT concentrations or Hgb levels were falsely reported. Additionally, there is data to suggest that it is impossible to accurately convert HCT to Hgb, which may have resulted in false positives or negatives for anemia.[12] However, this method has been

historically accepted and is standard practice within the clinic and on health brigades. This study is based on a convenience sample of subjects within close proximity to the CSHH in Santo Domingo, Ecuador in addition to the more remote Tsáchila communities. Thus, these results are not generalizable to a larger population in Ecuador. Despite these limitations, this study identifies risk factors associated with anemia in this population that may allow STSG and its partners to make more mindful pharmacotherapeutic interventions in the future.

Anemia is an important public health issue due to potential adverse effects on maternal and child health. There is little published research on geographical implications on anemia in developing South American countries, although there are likely to be important public health implications of anemia given the high prevalence of anemia and the possible additional effects of poor diet or parasitic infection. Public health recommendations include increasing access to sufficient iron supplementation and providing health education messages that increase awareness of the potentially adverse nutritional consequences of poor diet.[13] Public health policies aimed at improving rates of anemia should continue to support programs that provide iron supplementation and/or improve access to iron-rich foods.

In summary, this study identified two risk factors for anemia. Age less than five years and residing in some communities was predictive of anemia. These findings are of public health relevance and will be the focus of greater targeted pharmaceutical and supplemental efforts for STSG in the future. Although there were many limitations to this study, such as potential selection bias, the overall concept will assist in the formation of a uniform strategy to develop education and intervention programs to reduce the prevalence of anemia in these populations in Santo Domingo. Health education programs led by the CSHH and health

brigades should be explored as an entry point to decrease the burden of anemia in peri-urban and rural areas of Santo Domingo.

Figure I: Tsáchila Communities Served by the Centro de Salud Hombro a Hombro in Santo Domingo, Ecuador

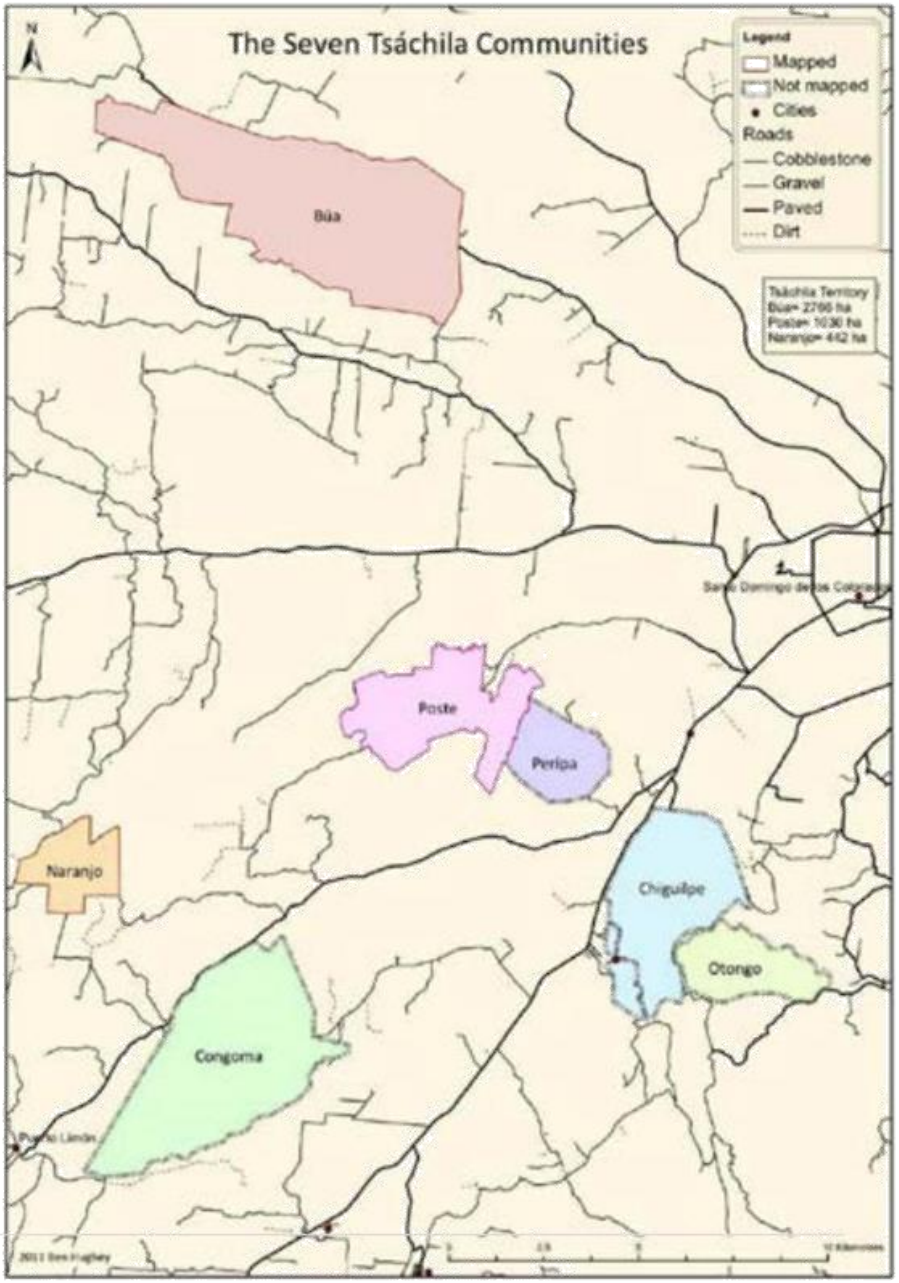

Table I: Ecuadorian Anemia Estimates in 2011 adapted from "The Global Prevalence of Anaemia in 2011."[4]

Population	Mean Hemoglobin Concentration, g/dL (95% CI)	Percentage of Population with Anemia, % (95% CI)	Level of Public Health Significance
Children (0.50 – 4.99 years)	11.2 (10.4, 12.0)	40 (18, 67)	Severe
Non-pregnant Women (15.00 – 49.99 years)	12.8 (11.9, 13.6)	24 (9, 50)	Moderate
Pregnant Women (15.00 – 49.99 years)	11.8 (10.9, 12.7)	29 (12, 54)	Moderate
All Women of Reproductive Age (15.00 – 49.99 years)	12.8 (11.9, 13.6)	24 (10, 49)	Moderate

Table II: Hemoglobin levels and associated hematocrit concentrations to diagnose anemia at sea level per the anemia definitions adapted from the World Health Organization.[7,8]

	Non-Anemia		Anemia					
			Mild		Moderate		Severe	
Population	**Hgb (g/dL)**	**HCT (%)**	**Hgb (g/dL)**	**HCT (%)**	**Hgb (g/dL)**	**HCT (%)**	**Hgb (g/dL)**	**HCT (%)**
Children (0.50 – 4.99 yrs)	≥11.0	≥33	10.0 – 10.9	<33	7.0 – 9.9	<30	<7.0	<21
Children (5.00 – 11.99 yrs)	≥11.5	≥34.5	11.0 – 11.4	<34	8.0 – 10.9	<33	<8.0	<24
Children (12.00 – 14.99 yrs)	≥12.0	≥36	11.0 – 11.9	<36	8.0 – 10.9	<33	<8.0	<24
Non-pregnant Females (≥15.00 yrs)	≥12.0	≥36	11.0 – 11.9	<36	8.0 – 10.9	<33	<8.0	<24
Pregnant Females	≥11.0	≥33	10.0 – 10.9	<33	7.0 – 9.9	<30	<7.0	<21
Males (>15.00 yrs)	≥13.0	≥39	11.0 – 12.9	<39	8.0 – 10.9	<33	<8.0	<24

Table III: Selected demographics of anemic population (n=489) and non-anemic population (n=651) from Santo Domingo, Ecuador for 2010 – 2016. Column percentages are in parentheses. Asterisks indicated significance at the *a*=0.05 level. Crosses denote indigenous Tsáchila communities.

	Total, n (%) n=1145	**Anemic, n (%)** n=490 (42.8)	**Non-Anemic, n (%)** n=655 (57.2)	**p-value**
Age Group (years)				
1) 0.50 – 4.99	378	208 (55.0)	170 (45.0)	<0.001*
2) 5.00 – 11.99	238	85 (35.7)	153 (64.3)	
3) 12.00 – 14.99	67	21 (31.3)	46 (68.7)	
4) ≥15.00	462	176 (38.1)	286 (61.9)	
Sex				
Female	770	320 (41.6)	450 (58.4)	0.226
Male	375	170 (45.3)	205 (54.7)	
Pregnancy Status				
Pregnant	18	8 (44.4)	10 (55.6)	0.887
Not Pregnant	1127	482 (42.8)	645 (57.2)	
Community Location				
Laura Flores	141	52 (36.9)	89 (63.1)	<0.001*
Plan de Vivienda	281	146 (52.0)	135 (48.0)	
CSHH	501	183 (36.5)	318 (63.5)	
Los Naranjos†	62	34 (54.8)	28 (45.2)	
9 de Marzo	94	39 (41.5)	55 (58.5)	
El Bua†	61	35 (57.4)	26 (42.6)	
Congoma†	5	1 (20.0)	4 (80.0)	

Figure II: Row percentages for anemia stratified age group, sex, pregnancy status, and community location are depicted for the anemic population (n=489) and non-anemic population (n=651) from Santo Domingo, Ecuador for 2010 – 2016 below. Crosses denote indigenous Tsáchila communities.

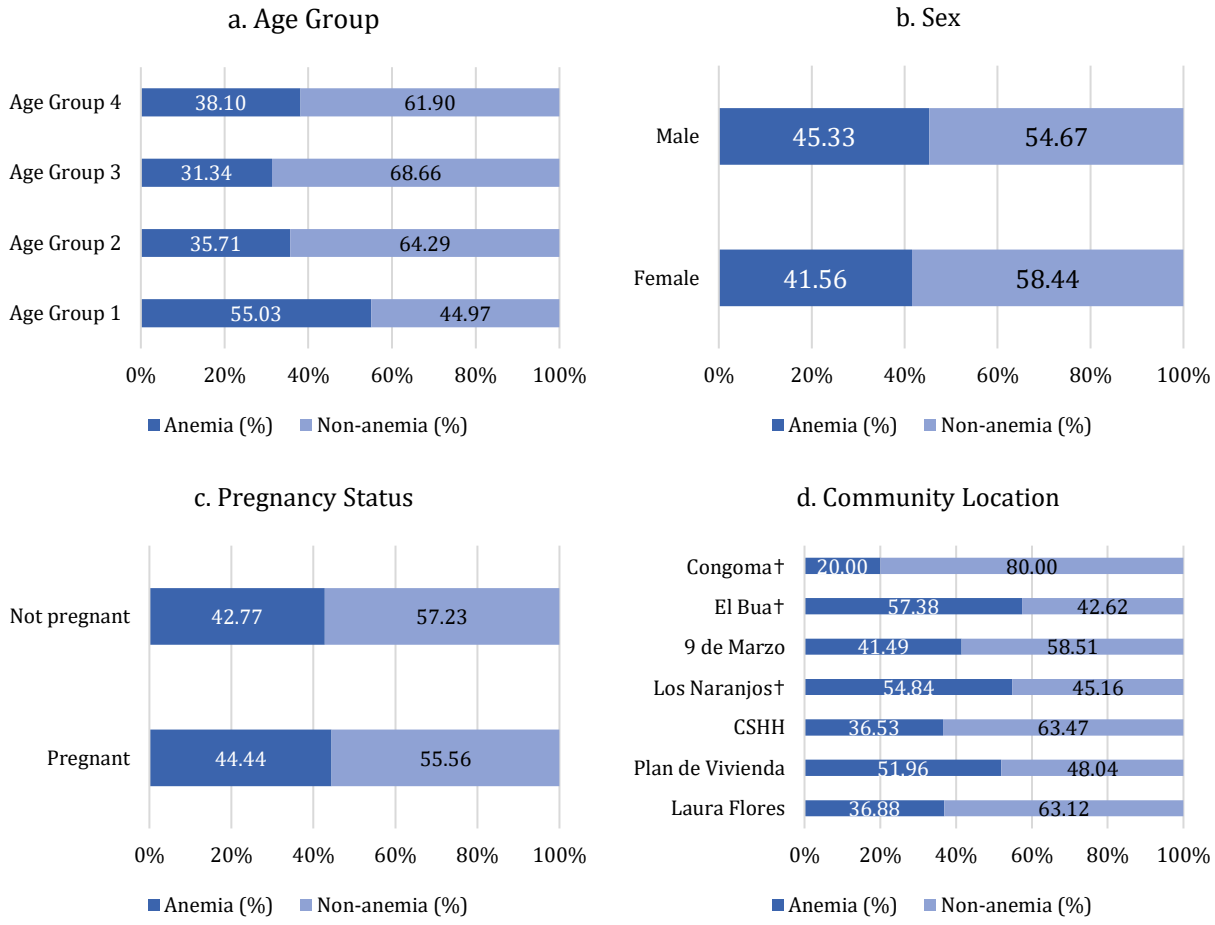

Table IV: Results of a Poisson regression with incidence rate ratios (IRR) for anemia from Santo Domingo, Ecuador for 2010 – 2016. The referent groups for age group and community location were age ≥15.00 and CSHH, respectively. Asterisks indicated significance at the *a*=0.05 level. Crosses denote indigenous Tsáchila communities.

	IRR	Standard Error	p-value	95% CI
Age Group (years)				
1) 0.50 – 4.99	1.46	0.165	0.001*	(1.17, 1.82)
2) 5.00 – 11.99	0.94	0.130	0.664	(0.72, 1.23)
3) 12.00 – 14.99	0.84	0.195	0.442	(0.53, 1.32)
ref				
Female Sex	1.02	0.106	0.871	(0.83, 1.25)
Pregnancy	1.25	0.452	0.545	(0.61, 2.54)
Community Location				
Laura Flores	0.98	0.154	0.874	(0.72, 1.33)
Plan de Vivienda	1.36	0.152	0.006*	(1.09, 1.69)
ref				
Los Naranjos†	1.50	0.281	0.029*	(1.04, 2.17)
9 de Marzo	1.21	0.214	0.292	(0.85, 1.71)
El Bua†	1.61	0.299	0.010*	(1.12, 2.32)

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