PUBLIC HEALTH ASSESSMENT FOR THE INDIGENOUS PEOPLE OF THE CHAYANTA PROVINCE OF BOLIVIA

A Dissertation

by

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ABSTRACT

Bolivia, a country of approximately 10 million people as of 2011, is one of the poorest countries in South America. Extending deep into the Andes Mountains are indigenous people who were denied access to education, political participation, and economic growth until the early 1950s. As a result, due in part to the remote locations of many indigenous people, villagers remain poor and lack basic health infrastructure, sanitation and education. The goal of this research is to: 1) examine access to healthcare in the Pocoata Municipality near the village of Quesimpuco; 2) identify health problems of the indigenous population of the Chaupirana Valley; and 3) develop a tailored public health surveillance program that will help track the incidence of water-borne disease morbidity in villages near Quesimpuco.

Results indicate the need for more healthcare clinics in the study area. In addition, the main medical problems identified in the villages were gastrointestinal upset (including parasitic infection, gastritis, diarrhea, abdominal pain) possibly due to contaminated water supplies, musculoskeletal pain and back problems, an increased prevalence of eye issues, and respiratory morbidity. With community-specific health needs identified, a public health surveillance system can be implemented and monitored by local, community members. Village leaders can then allocate the appropriate workforce, training needs and resources to ensure progress in community health initiatives. Further, the use of Epi Info can assist with the organizational structure of health data management in the remote villages of Bolivia.

Ensuring a safe, potable water supply and proper hygiene infrastructure such as hand washing stations and latrines can greatly improve the lives of the indigenous people of the Chayanta Province. The long-term outcome of this research will assist leaders in identifying specific health needs, focusing limited resources, educating the population about ways to improve and sustain a healthy life, and ultimately eliminate common diseases through preventative measures.

DEDICATION

This dissertation is dedicated to the hardworking staff of Servants and Faith & Technology (SIFAT), Centro Nacional de Tecnologia Sustenible (CENATEC) and the indigenous people of the Chayanta Province. Thank you for making this dissertation possible and for opening my eyes and heart to the gift of service. My wish is that this dissertation can support the mission of establishing a Community Health Watch Program and assist in the expansion of service for a larger coverage area in the Chaupirana Valley of Bolivia.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Introduction

According to the Institute of Medicine of the National Academies (IOM), the core functions of public health are to assess community health, promote policies that are evidenced based, and assure availability and access to health services that are deemed appropriate and necessary by the community served (IOM, 1988). An underlying moral assumption of public health is that the perceived suffering of others deserves a response and is worthy of action with a focus on commitment of resources (Hahn, 1999). Public health professionals have long recognized that problems with inadequate allocation of resources can have detrimental effects on a population's health (Hahn, 1999). Rural communities, in particular, suffer from health disparities related to socio-economic status, access to healthcare, education and health outcomes (Wycliff, 2008).

There are many factors that contribute to the inefficiency of public health sectors in developing countries. Health disparities and inequities among populations within regions and countries remain distinct. Public health systems often provide little coverage to those who need it most such as the rural poor. Service expenditures are often allocated towards hospitals, and public health services are often not distributed equally. In addition, though public health knowledge provides information about how to address these problems, there are still many unmet deficiencies where public health systems do not adequately meet the needs of the entire population (Mills, 1995 & Hahn, 1999). In addition, healthcare professionals are often underpaid and undertrained; lack

motivation to work in rural areas and often seek opportunities in wealthier countries (Mills, 1995).

Research challenges in rural areas such as the Altiplano of Bolivia are related to the inefficiencies discussed above and also include cultural barriers, rugged topography, harsh climate, limited transportation infrastructure, and access and allocation of resources from the government. Many roads to small villages are often not navigable by vehicle and present limitations in providing supplies and resources. In addition, the lack of basic health infrastructure and access to healthcare also provide many limitations and challenges. Although great strides have been made recently to improve the general healthcare system of Bolivia, many rural areas have somewhat been left behind compared to the more densely populated areas. These isolated populations buried deep in the Andes Mountains have felt the stark pain of scarce resources for generations.

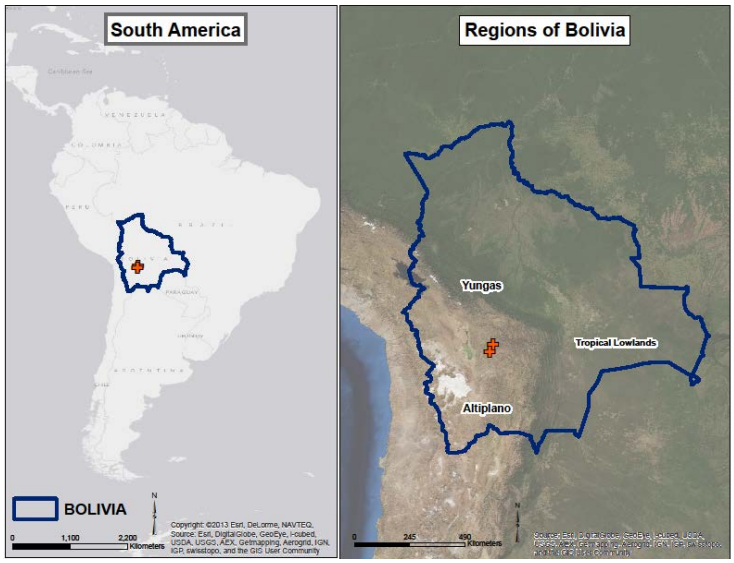

Figure 1 Reference Maps Depicting the Regions of Bolivia in South America

Geography and History of Bolivia

Geography

In order to fully understand the extent of health disparities in Bolivia, it is important to have an understanding of the vast geography and treacherous history of the region. Bolivia is a landlocked country that includes the Andes Mountains, the longest mountain chain in the world. The area consists of three main terrains: the Altiplano and Andes, the Yungas and Chapare and the Tropical Lowlands (Arnade, 2014). The study area for this research resides is in the Altiplano region, or "high plateau", that extends from southern Peru to northern Argentina and is cold with sparse vegetation (Figure 1). The region lies between two chains of the Andes, has an average elevation of 12,000 feet and is approximately 560 miles long by 80 miles wide (Arnade, 2014). As of 2001, approximately 45% of the Bolivian population lived in the Altiplano region (PAHO, 2007). The geologic activity that formed the Andes Mountains created mineral riches beneath the Altiplano land that brought much wealth to Spain during the colonial exploration (Arnade, 2014). The Yungas and Chapare regions are the eastern portions of the high Andes adjacent to the Altiplano. The Yungas geography consists of steep, rugged terrain that eventually meets the eastern tropical lowland (NWE, 2013). The climate in this region is hot and humid, with the exception of the rainy season from December through March (NWE, 2013). As of 2001, approximately 30% of the Bolivian population lived in this area (PAHO, 2007). The Tropical Lowlands in the central and south-central portion of the country have a temperate climate where the majority of the country's fruits and vegetables are found. The Upper Amazon in the north and east of

the lowlands consists of vast savannahs and thick jungles. The Parana in the southeast of the region consists of grasslands and jungles and is filled with plentiful flora and fauna (NWE, 2013). As of 2001, approximately 25% of the population lived in the Parana area (PAHO, 2007).

History

Bolivia has a complicated history filled with multiple wars and disparities. Historians suggest that the Andean region has been inhabited for nearly 20,000 years. It is estimated that around 2000 B.C., the Aymara-speaking Tiwanakan culture inhabited the southern portion of Lake Titicaca before disappearing about 1200 A.D. During the same time period, the Moxos inhabited the eastern lowlands while the Mollos occupied the northern section of present-day La Paz. Around 1450, the Incas entered the Altiplano region and controlled the area until the Spanish conquest in 1525 (USDOS, 2012). Although the Incas tried to resist the intruders, the Spaniards defeated Inca forces near Lake Titicaca and discovered vast amounts of silver. In the 1570s, the Spanish enforced an intense labor law, the mita, which required indigenous males to spend every sixth year working in the mines. The silver mines began to flourish and produced much wealth for the Spanish empire (LOC, 2011).

In the early-eighteenth century, Spanish authority began to weaken. In 1809, an indigenous group of Upper Peru led one of Latin America's first independence revolts, and although defeated, many others followed until independence was proclaimed (USDOS, 2012). The region was in a state of unrest for nearly sixteen years before Simon Bolívar's victory over the Spaniard royal troops at the Battle of Ayacucho in

1824, bringing an end to Spanish rule (USDOS, 2012). Named after Bolivar, the new country of Bolivia faced many challenges including The War of the Pacific (1879-83) when Bolivia was defeated by Chile and lost rich mineral lands and access to the sea (LOC, 2011). In addition, in 1932, Bolivia and Paraguay went to war over the Chaco region, a region of about 100,000 square miles north of the Pilcomayo River and west of the Paraguay River. Paraguay defeated Bolivia and gained the majority of the region; however, Bolivia was given a corridor to the Paraguay River and a port. Due to the war, the Bolivian economy suffered significant impacts and nearly 65,000 lives were lost (LOC, 2011).

Historians suggest that the Chaco war was a pivotal turning point in Bolivia's history, as the loss of human lives, and economic power led to dissatisfaction with the ruling elite (LOC, 2011). The Nationalist Revolutionary Movement (MNR), made up of primarily mine workers, indigenous subsistence farmers and the middle class, eventually became Bolivia's first political party when Victor Paz Estenssoro was denied victory in the 1951 presidential elections (LOC, 2011). After Paz Estenssoro led a successful revolt in 1952, the MNR introduced "universal adult suffrage, carried out a sweeping land reform," promoted rural education and voting rights of the indigenous people, and "nationalized the country's largest tin mines" (NWE, 2013). The MNR was supported by all classes; however, farm productivity declined, resulting in reduced economic growth. Paz Estenssoro was eventually overthrown by armed forces in 1964. After a period of political turmoil from 1964-1969, the military, the MNR, and others installed Hugo Banzer Suarez as president from 1971-1978. Although the economy grew significantly

during most of Banzer's presidency, human rights violations diminished his support, and he was forced out of office. In 1980, under Gen. Luis Garcia Meza, human rights abuse continued, narcotics trafficking flourished, and economic mismanagement swept the country, leading to unrest. Paz Estenssoro returned in 1985, reduced inflation, and eventually established succession of orderly elections every four years (NWE, 2013).

In 2005, Evo Morales, coca farmer and indigenous leader of the MAS (Movement towards Socialism) party, was elected by 54% of the population's vote (NWE, 2013). Morales pledged to diminish poverty and discrimination toward indigenous Bolivians (LOC, 2011). In addition, the administration promised greater investment in infrastructure, education, health, and a "great leap forward" in industrialization (NWE, 2013). The 2009 Constitution of Bolivia mandated the creation of a unified health system. The mandate focused on the relationship between health and development and recognized interculturalism. Traditional medicine of the indigenous people were recognized within the framework and were guaranteed access to health services. The new Constitution aimed to establish that access to health and education are essential rights. The mandate also included the creation of a social security system (PAHO, 2013). As of 2014, Bolivia continues to have corruption in government, issues with human rights and access to healthcare; however, significant measures have been taken to aid the indigenous people.

History of Health Disparities of Indigenous People in Bolivia

Bolivia, a country of approximately 10 million people as of 2011, is one of the poorest countries in South America, although poverty declined from 63% in 2002 to

45% of the total population in 2011 (World Bank, 2014). Approximately 33% of its population lives in rural areas where mountains, rivers, and lack of roads make travel extremely difficult because it must be accomplished using only foot trails (World Bank, 2014). Bolivia covers an area of 1,098,580 square miles and in 2011 had a population density of 9.2 per square miles and a population growth rate of 1.5% per year (World Bank, 2014). As of 2011, 36% of the population was less than 15 years old (World Bank, 2014). In 1993, approximately 20% of deaths were certified by a health professional (PAHO, 2013). During that time, hospital mortality included diseases of the circulatory system (27%), respiratory system (7%), digestive system (14%), urinary system (3.5%), cerebrovascular disease (4%), certain conditions originating during the perinatal period (3%), endocrine and metabolic diseases as well as disorders of the immune system (0.6%), tuberculosis (0.6%), injuries (2.5%), and malignant neoplasms (1.5%) (PAHO, 2007). In 2008, Bolivia had one of the highest rates of infant mortality in Latin America of 36 per 1,000 live births in urban areas and 67 per 1,000 in rural areas. At the same time, the mortality rate in children under 5 years old was 43 per 1,000 live births in urban areas and 87 per 1,000 in rural areas (PAHO, 2013). The mortality rate for children under age 5 (per 1,000 live births) was 42.2 in 2011, and malnutrition and anemia were significant causes of mortality (World Bank, 2014). The main causes of infant and child mortality are acute diarrheal infections, acute respiratory infections, perinatal infections, and infections preventable by immunization (Bastien, 1990). Respiratory infections are the leading cause of death for children under age 1.

The maternal mortality ratio (national estimate, per 100,000 live births) from 2003-2008 was 310 mainly due to infection, hemorrhage and induced abortion (PAHO, 2013).

As mentioned previously, from the 1570's to the early 1950s, the indigenous people of Bolivia were forced to work under primitive conditions in silver mines and were denied access to education, political participation and economic growth (LOC, 2011). As a result, due in part to the remote locations of many indigenous people, many remain poor and excluded from society leading to neglect of health care needs and necessary health infrastructure (PAHO, 2007). A 1994 report indicated that nine of Bolivia's ten poorest provinces are located in predominantly Quechan areas (PAHO, 2007). As a result, these populations are extremely vulnerable to communicable diseases (PAHO, 2007). For example, in 1994, the incidence of tuberculosis in the indigenous population was five to eight times greater than the national average (PAHO, 2007). The 2012 census results estimated that the indigenous people represent approximately 42% of Bolivia's population over 15 years of age, compared to 62% in the 2001 census. The difference may be attributed to the fact that 58% of the population did not identify themselves as part of an indigenous group in 2012 (INE, 2012).

Figure 2 Map of Bolivia Departments, (Boliviabella.com, 2015)

Organization of the Health Sector

In 1994, as a response to the country's health status, the Bolivian government passed the Government Community Involvement Act, which transferred all local service infrastructures to the municipalities and allocated funding based on the population per capita (see Figures 2 and 3 departments and provinces). In addition, the municipalities were required to formulate social and economic development plans for the local population. As of 1994, the healthcare network was divided into three levels of care: health centers and health posts, primary hospitalization services, and highly specialized consultations/care (PAHO, 2007). The Bolivian health system has been based on two kinds of management arrangements: (1) control by sector institutions, such as the Ministry of Health, was responsible for the administration of all actions involved in the government of programs, policies and plans for the delivery of health care services and (2) management with the local community that allows for local leaders to administer medical services in a given municipality (PAHO, 2007). Nongovernmental organizations (NGOs) and churches, especially in indigenous areas, play a significant role in health care delivery at the local level and surveys (as of 1994) reveal that this sector provides health care for about 60% of the Bolivian population (PAHO, 2007). In 2010, as part of the 2009 Constitution, Bolivia enacted the Andrés Ibáñez Framework Law on Autonomy and Decentralization to regulate the autonomy system and the territorial structure. The central level became responsible for the unified health system and health insurance provision. The implementation, management, and financing of the health system fell to the departmental and municipal governments along with the indigenous governments

who received equal responsibilities (PAHO, 2013). In 2003, the Universal Maternal and Child Insurance (SUMI) was established to reduce maternal and child morbidity and mortality. Women were given free pre-natal care and six months post–delivery care, as well as free benefits to children under five years of age. In 2005, the coverage was extended to non–pregnant women under 60 years old. In 2006, the Health Insurance for Older Adults (SSPAM) greater than 60 years of age was created that assesses an annual premium of US$ 56 per person (PAHO, 2013).

According to the National Health Information System (SNIS), 26,180 staff were employed in the public health sector in 2009. At that time, there were 4.58 physicians, 0.93 dentists, and 2.19 nurses for every 10,000 inhabitants at the national level. However, these resources were mainly concentrated in the larger cities such as LaPaz, Cochabamba, and Santa Cruz. As of 1994, 20% of Bolivia's 311 municipalities lacked qualified health personnel (PAHO, 2007). By comparison, in the United States, from 2005-2012 there were approximately 24.2 doctors and 98.2 nurses for every 10,000 people (WHO, 2013). In addition, Bolivia educates many doctors; however, approximately 70% migrate to other countries (Bastien, 1990). Adding to the problem, doctors rarely speak the indigenous Quechuan language, consider the remote citizens inferior, and are not committed to working in rural areas, but are required and paid by the Bolivian Government to work a year in rural areas after graduation (Bastien, 1990).

Program Information (CENATEC/SIFAT/TAMHSC)

The idea of National Center of Sustainable Technology (CENATEC) and Servants in Faith and Technology (SIFAT) was conceived in the jungles of Bolivia in

1976 when Ken and Sarah Corson moved to Sapecho to be pastors of a Bolivian Church. The Corsons began working with the people of the village to develop basic practices of sustainable living. The Quechuan mayor of the village and community leader, Benjo Paredes, began to work with the Corsons extensively. As a result of this collaboration, the nonprofit organization, CENATEC, was established in Bolivia. In 1979, the Corsons returned to Alabama and established SIFAT as a training center in the United States for meeting the basic human needs of the international community. Importantly, both SIFAT and CENATEC encourage long-term development, instead of short-term relief. Their mission is "to not do things for the people, but with the people." Since their inception, CENATEC and SIFAT have continued to work closely in many endeavors in Bolivia, Ecuador, Zambia and Uganda (SIFAT, 2013).

Figure 3 Provinces of the Potosi Department, (Boliviabella.com, 2015)

Chayanta Province

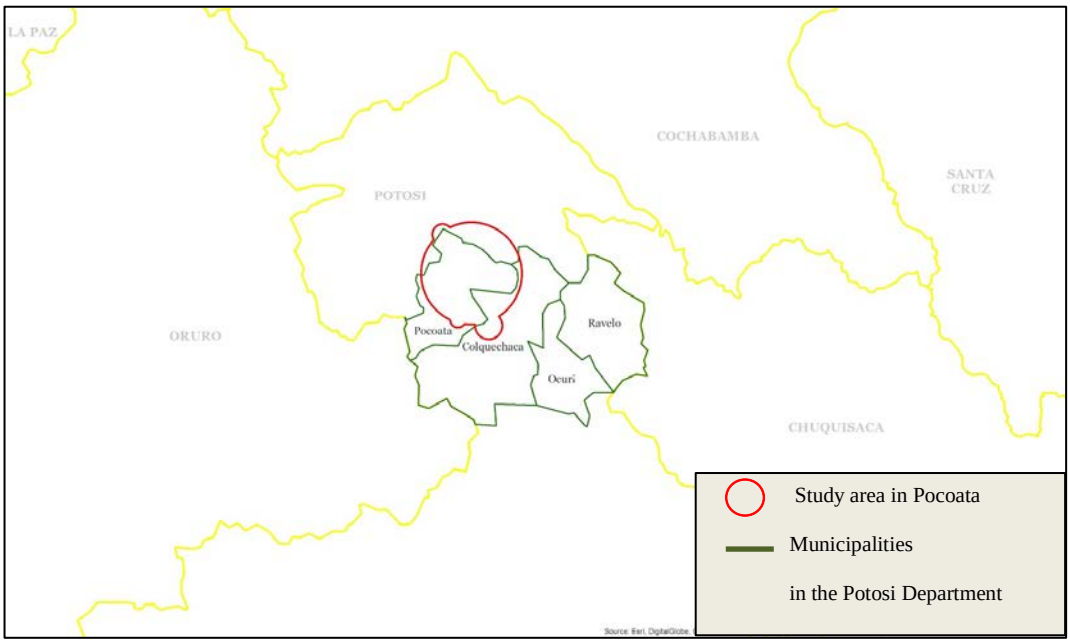

Figure 4 Study Area in the Pocoata Municipality, Chayanta Province, Potosi Department, (Schaefer, 2014)

SIFAT has worked in the Chayanta region since 1995. Short-term mission teams have built a church, a high school, a clinic and a boarding home for students from remote villages. High school graduates have gone on to study at universities and have become nurses, agronomists, teachers, medical doctors and are now returning to Quesimpuco and Chayanta to work in their communities (SIFAT, 2013). SIFAT and CENATEC have conceived a development program that includes many villages in the Chaupirana Valley and Chayanta Province. SIFAT's five-year plan for Quesimpuco and surrounding villages addresses needs related to education and training, community health, and socioeconomics. To assist with community health needs, medical teams from various universities and organizations were formed to visit Quesimpuco and Futina. In addition, CENATEC and local and provincial health authorities are in the

process of planning a larger public health program to include coverage into isolated areas. Part of this plan is to establish a Community Health Watch Program through training the local village inhabitants. Dr. Ruth Mamani, the first female graduate of SIFAT's John Wesley High School in Quesimpuco, is leading this effort (SIFAT, 2013).

In order to assist SIFAT/CENATEC in their efforts and as part of this research, recent cross-sectional surveys were collected in the region. Preliminary analysis of the assessments has helped to identify health problems of the indigenous population of the Chayanta Valley. Bolivia is divided into departments, provinces and municipalities (Figures 2, 3 & 4). The surveys were administered in villages near Quesimpuco in the Pocoata Municipality of the Chayanta Province in the Potosí Department (Figure 4) where nearly 50% of the population is of Quechua descent (INE, 2012). According to the National Institute of Statistics (INE), 97.9 % of the people in the municipality live in extreme poverty. In addition, according to the 2001 census, basic service coverage is extremely low in the Pocoata municipality, and 97% lack access to potable water and electricity, and there are no sewage systems (INE, 2012). Safe drinking water is a significant issue of concern because of its limited availability and poor community hygiene practices in the area. For example, in the village of Chijmu near Quesimpuco, in 2014, 100% of the community members reported using the river for defecation purposes (data obtained during the summer of 2014).

Studies such as these can provide estimates of the magnitude of disease prevalence and can help determine risks associated with exposures and health outcomes (WHO, 2001). The Bolivian Government and non-governmental organizations working

in study areas can then provide programs to the community to increase awareness of basic sanitation principles and water disinfection techniques. In addition, establishing a public health surveillance system that increases such awareness will ultimately help eliminate common diseases through preventative measures. Research suggests that improved water supply, sanitation, hygiene and water resource management can contribute to reducing community disease burdens (IOM, 2009).

Dissertation Overview

Approaches to improve knowledge of critical healthcare barriers and issues in the defined research area are presented in this dissertation. It is anticipated that this research will increase the focus of technical capability for future international medical teams, assist in focusing resources of SIFAT/CENATEC, and help develop a tailored public health surveillance program for the Chaupirana Valley. Using Geographic Information Systems (GIS) to document access to healthcare and mapping disease distributions in the region focuses efforts on eliminating risks, assisting with community health, and improving health services in the area (Cromely & McLafferty, 2012). This will transform the way SIFAT/CENATEC operates in this region. Chapter II presents methods to identify gaps in access to healthcare based on distances between rural villages and established Bolivian clinics in the Chaupirana Valley. Although great strides have been made to improve the general healthcare system of Bolivia, many rural areas have somewhat been left behind compared to the more densely populated areas. GIS was used to model paths from villages to the nearest Bolivian health clinics in order to identify locations that do not have sufficient access to a clinic and determine the best

location for a new facility. Chapter III defines the needs of the rural, indigenous people of the Chaupirana Valley through cross-sectional assessments of basic living conditions and health problems. One obstacle in providing health care to this area, is a lack of knowledge of common health issues faced by its inhabitants. The major health problems of the people from select villages in the Chaupirana Valley were mapped using the most recent 2012 census data and recent cross-sectional surveys. Disease patterns were identified to assist in focusing resources of stakeholders and will ultimately help in identifying gaps in the Bolivian health care system. Chapter IV develops a public health surveillance program to reduce morbidity related to water-borne disease in the Chaupirana Valley. In order to tackle common health problems such as parasites that occur due to contaminated drinking water, a culturally appropriate public health surveillance system that focuses on village morbidity due to water-borne disease was developed in association with SIFAT/CENTATEC and the local community doctor. Public health surveillance involves monitoring and evaluation to better understand the magnitude of health problems in communities. The objective of this effort is to build a public health surveillance system in the remote areas of rural Bolivia so that village leaders and stakeholders can better understand the health of the population.

The goal of this research is to reduce the risk of individuals becoming ill in these areas, and spatial data will assist in improving knowledge and understanding the impacts of the village-specific health problems. This will allow for reaping the largest benefit from the limited available resources. Further, health issues and hygiene techniques are culturally sensitive topics that vary from region to region and recommendations must

remain culturally appropriate in context (Bastein, 1990). SIFAT/CENATEC personnel have an established reputation in the villages and understand how programs and suggestions need to blend into culturally appropriate customs and beliefs. In addition, as described previously, native individuals have received training through SIFAT/CENATEC funded programs and are now working with village leaders in Quesimpuco and the Chayanta Province to help build healthy, sustainable communities.

CHAPTER II

NETWORK ANALYSIS TO MODEL PATHS FROM VILLAGES TO THE NEAREST BOLIVIAN HEALTH CLINICS

Introduction

A deficiency in access to basic, primary health care is known to have a negative impact on infant mortality, morbidity, pregnancy outcomes and the control of communicable disease (Tanser, 2006). However, access to healthcare is complicated and requires multifaceted approaches to reach practical solutions. There are five main parts of the access equation that describes a population's ability to use health services when needed: availability, accessibility, accommodation, affordability and acceptability (Cromley & McLafferty, 2012). Availability refers to services in relation to needs. Determining whether needs are being met and if the serving capacity is suitable for the population being served are important questions to consider in measuring the effectiveness of availability. Accessibility refers to the geographical relation to services in connection with the population in need. For example, geographical barriers often impair individuals from accessing care during critical times. In rural Bolivia, many villagers must walk hours over difficult terrain to reach the established health clinics. In addition, during the rainy season that lasts from December to March, many footpaths are washed away and prevent travel to and from clinics (information obtained from community nurse during the 2014 trip to Chijmu). Accommodation highlights whether a facility is meeting the needs of a population such as hours of operation, application of procedures and waiting times. For example, according to a local community doctor and

nurse, the Bolivian maternal child health policy in written form is excellent. However, most of the time, doctors and nurses are not available at particular health posts and designated clinics to assist patients (information obtained from community doctor during the 2014 trip to Chijmu). In addition, when nurses are visiting certain villages, many residents have priorities of fieldwork and miss the opportunity when help is available. Affordability refers to the price of service in regards to a population's ability to pay. The majority of persons living in rural Bolivia do not have the means to pay for doctor's visits, medicine, and preventative care. Lastly, acceptability describes a patient's view of health services as related to gender, culture, etc. (Cromley & McLafferty, 2012). For example, in rural Bolivia, males discourage their wives from receiving contraception due to cultural beliefs of the need to have a male child. For this reason, many women do not seek medical advice due to fear that their husband will discover the medication (information obtained from the community nurse during the 2014 trip to Chijmu). Transforming health care delivery in developing countries requires a focus on all aspects listed above to enhance the overall accessibility of primary care to the majority of a population (Tanser, 2006).

Geographic information Systems (GIS) can assist governments and non-governmental organizations in solving critical public health problems such as access to healthcare. For example, the Closest Facility and Location-Allocation analysis tools in the Network Analyst Extension of ArcGIS can effectively contribute to determining an optimal location for a new clinic that will deliver health care services to those most in need (ESRI, 2014). These tools will be used as a methodology to model paths from

villages to the nearest health clinics in order to identify gaps in service and determine the best location for a new facility in the Pocoata Municipality of Bolivia. Although this research mainly focuses on the availability and accessibility components of the access equation listed above, this is an important first step in solving the complex issue of access to healthcare in rural Bolivia.

Background

Study Area

The study area is an approximate 12 radial mile circular area centered on the town of Quesimpuco (Chaupirana Valley) in the Pocoata Municipality of the Chayanta Province in the Potosí Department. According to the 2012 Institute of National Statistics of Bolivia (INE) census, the Potosi' department had a population of 823,517 inhabitants with nearly two-thirds living in rural areas (INE, 2012). Approximately 50% of the Potosi Department is of Quechua decent and lives in Chayanta Province. According to the INE, the Potosi Department has the worst health conditions with nearly 67% of the population living in poverty and almost 91% lack access to adequate healthcare services (INE, 2012). As of 2005, based on a study funded by United States Agency for International Development (USAID), nearly one-third of women in the Potosi Department do not receive prenatal care, two-thirds of children under the age of 3 have never been vaccinated and approximately 63% of births take place at home (Salguero, Martin, Mendoza & Vernon, 2005). The 2012 census indicated that there are approximately 175 villages in the Pocoata municipality with a total population of 26,330

(INE, 2012). The topography surrounding the villages in the study area of 131 villages ranges from 11,500 ft. to nearly 16,000 ft. in elevation.

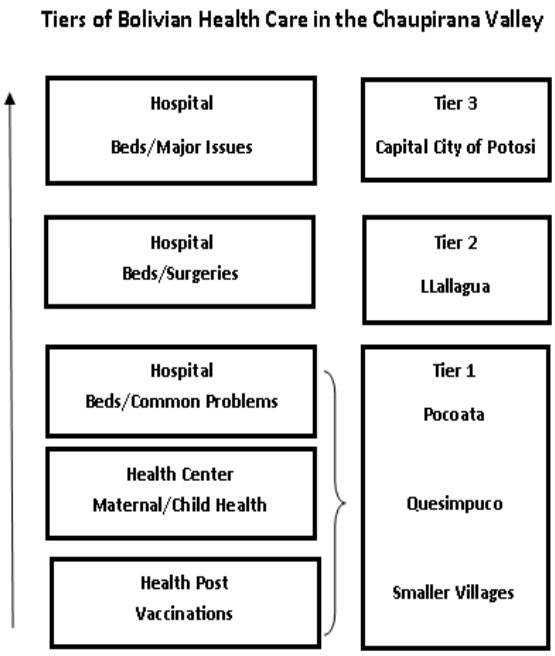

Figure 5 Tiers of Health Care in the Chaupirana Valley

Overview of the Bolivian Healthcare System

There are multiple tiers in the Bolivian health care system (see Figure 5) located throughout the Chaupirana Valley. In Tier 1, health posts are used to provide vaccinations to surrounding villagers and generally are not readily equipped to diagnose and treat patients. Health centers are mainly used for maternal and child health. Health posts and centers have limited hours of operation, service volume, and procedural capacity. Tier 1 hospitals generally have few beds where diagnosis and medication can be administered for common problems. Villagers with moderate to severe health issues

are often required to travel great distances to the Tier 2 hospital in the City of Llallagua and the Tier 3 hospital in the Capital City of Potosi to obtain the necessary care (information obtained from the community doctor during the 2014 trip).

As of 2012, the Bolivian Government reported that the Potosi Department consisted of 334 health posts, 199 health centers, 10 basic hospitals and 2 general hospitals (INE, 2012). According to the 2001 census, the Pocoata municipality has 19 health facilities (8 health centers and 11 health posts) managed by the Bolivian Government (INE, 2012). In general, one nurse is responsible for the health centers in a health district and rotates to nearby health posts on a monthly basis. The Quesimpuco health center has one nurse who travels by foot to Ureka and several other smaller villages on a rotating basis. All major issues are referred to the general hospital in the city of Pocoata, approximately 22 miles (nearly 7 hours of walking time) from the remote village of Quesimpuco (information obtained during the 2014 trip to Quesimpuco).

Methods

Distances from Villages to Clinics (2012 Quesimpuco and Futina)

Due to the lack of health personnel and supplies in the remote villages, SIFAT/CENATEC is occasionally contacted by village leaders and senators to assist with medical care and supplies for their communities. As part of this effort, approximately 30 faculty and students from the Texas A&M Health Science Center (TAMHSC) began participating in mission trips led by SIFAT/CENATEC in 2010. In 2012, TAMHSC students and faculty from nursing, medicine, dentistry, public health

and pharmacy participated in the program to experience the inter-professional nature of health care delivery that TAMHSC offered in conjunction with CENETEC and SIFAT. The trip took place from May 30th - June 9th, 2012, with objectives to perform public health assessments and assist with the set-up of Bolivian clinics in two remote communities (Quesimpuco and Futina).

Many residents from surrounding villages walked greater than 5 miles over dry, rugged, high altitude terrain to reach the established clinics. These communities differed geographically by distance to the closest clinic, the topography separating a village and clinic, time of travel, availability of clean water, medical problems and cultural views on public health needs. In order to provide a better understanding of how many people traveled to the clinics from the adjacent villages, distances from patient home villages to the 2012 clinic locations were mapped to determine if and where additional locations are needed. A thematic map of the 2012 clinics was created to provide a visualization of the distance traveled from each village to the clinic locations. A multiple buffer ring analysis around the clinics at distances of 1, 5, 10, 25 and 50 kilometers was used to determine the distance from the villages to the clinics. Latitude and longitude coordinates of each of the clinic locations and villages were obtained from SIFAT/CENTATEC and by identifying additional villages during a 2014 trip through the community doctor and by purchasing maps through the Military Museum in LaPaz. The analysis was limited in that the distances provided between villages and clinic locations did not capture the actual time, path, distance and extremity of the patient's

travel; therefore, the distances projected in the buffer analysis do not account for topography and other geographic conditions.

Building of a Network

Due to the limitations of the previous buffer analysis and to further enhance the spatial analysis capabilities of this research, an Austin Community College GIS-student traveled with the team to Quesimpuco in July of 2014 to collect spatial data. The project sought to build a network dataset consisting of roads, trails, villages, housing structures, health clinics, and water sources surrounding the village of Quesimpuco using a 12-mile radius. The data was desired to analyze the movement of people from villages to the closest existing Bolivian health clinic and to select a candidate village that is best located to maximize coverage and improve service gaps in access to healthcare. Further, to be able to use and perform certain functions in ArcGIS, such as the Location-Allocation Analysis tool, the Network Analyst Extension requires a network dataset that has roads and travel times assigned to the road segments (ESRI, 2014). In rural Bolivia, maps of roads and travel times do not exist. The availability of data on the area infrastructure is extremely limited. Therefore, satellite images from Environmental Systems Research Institute (ESRI), Bing, Google, and MapBox were used to digitize features from satellite images of roads and trails, villages, structures (buildings), watercourse (streams/rivers), and water body (lakes/ponds/tanks).

GIS Data

All data were created in the South America Equidistant Conic Projection. This projection is based on the South American 1969 Geographic Coordinate System. Data

were digitized at a scale of 1:1,500 to 3,000. Satellite images from ESRI, Bing, Google, and MapBox were used. The features created from satellite images were roads and trails, villages, structures (buildings), watercourse (streams/rivers), and waterbody (lakes/ponds/tanks). Additionally, OSM data was used to obtain clinic locations and a few roads that were obscured by clouds or too new to be shown in other images.

Transportation Analysis

A transportation network dataset was built to model the paths from villages to health clinics to help identify service gaps and determine the best location for a new facility. In order to build a transportation network, roads and trails were classified into types based on their appearance in satellite images. The created categories include: Highway, High Quality Road, Medium Quality Road, Low Quality Road, Foot Trail, and GIS Network Link (see Table 1 and Figure 6). Each feature was assigned a confidence value that captures the certainty that it exists and is assigned to the appropriate category. Where a high level of uncertainty existed about the features existence or where a feature is known to exist but could not be detected, the GIS Network Link type was used. All roads were assigned two speed attributes: 1) walking and 2) driving; however, based on field observations, vehicles are very rare within the study area. For this reason, walking time was the only attribute analyzed because walking is the primary mode of transportation.

Table 1 Road Type Definitions

Road Type	Definition
High Quality Road	Paved or dirt feature with wide lanes, sometimes containing multiple lanes
Medium Quality Road	An unpaved road with two lanes or width for two passing vehicles at full speed.
Low Quality Road	An unpaved, unimproved feature consisting of two tire tracks.
Foot Trail	Consists of dirt and is only wide enough for people or donkeys
GIS Network Link	Artificial to low confidence type that was created to improve the network.

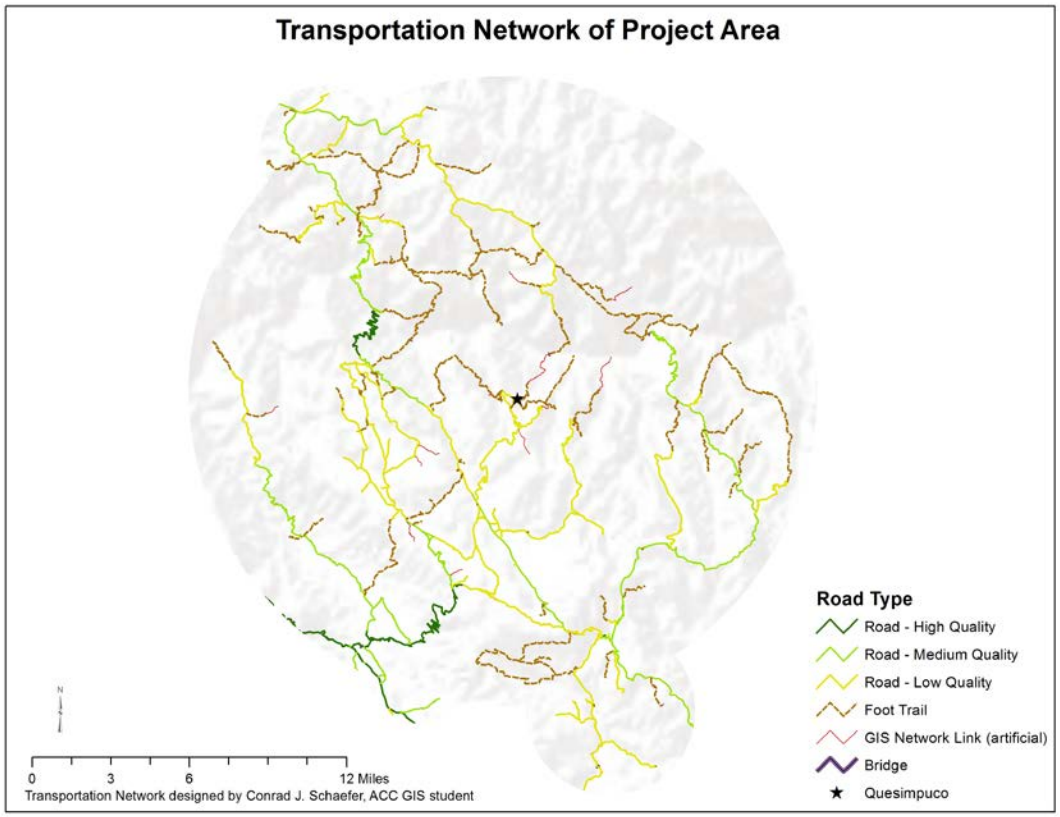

Figure 6 Transportation Network of Project Area

Village Analysis

Data are extremely difficult to obtain for the remote villages of Bolivia. As described previously, due to the remoteness of the area, the village name information is limited. For the villages, a point feature class was created that contains a village ID and a structure count estimate. A village name was assigned when known; otherwise, villages were assigned an identification number. Villages were classified into three categories based on the number of structures visible in satellite images. The number count of structures in each village were defined into three categories: "1-25", "26-50", and "51&up". A 1,000 ft. circular buffer feature class was created around each village center. The circles were used to standardize the count of structures in a village. The structure counts were used to estimate a proxy population value. From health surveys, we learned that sometimes there is a single person living in one house and sometimes multiple families in one house. To be able to perform calculations in the Network Analyst Extension, each category was assigned a single value (i.e. 13 for "1-25", 38 for "26-50", and 75 for "51&up".

The 2012 community level census data was recently made available from the INE in fall of 2014. Census data is often skewed by misrepresentation of the population data motivated by political interests and monetary gain of having a larger community (WHO, 2009 & CENATEC leaders during the 2014 trip to Chijmu). Structure count estimates and the 2012 population data were compared to determine if a correlation exists. Neither method is 100% reliable; however, determining if a linear correlation between the two datasets exists provides the overall network analysis with more validity.

Pearson's correlation between the two datasets was conducted to determine if a positive correlation exists.

Health Clinic Analysis

The Bolivian Health clinic information was difficult to obtain. The health facilities locations were gained through the use of Open Street Maps (OSM) and the Bolivian Ministry of Health and Sports Software Primary Health (SOAPS) website (SOAPS, 2011). One limitation is that the general public can enter clinic locations into OSM; for this reason, the source is not identifiable. In the OSM platform, the clinic sites are often not accurately placed in a village but instead on a nearby mountainside. The locations, as seen in Figure 7, were adjusted to the closest village center and the accuracy was confirmed using village names captured from topographic maps purchased from the Bolivian military and a list of clinic names obtained from the Bolivian Health Ministry website. Clinic names and village names were compared to test the accuracy.

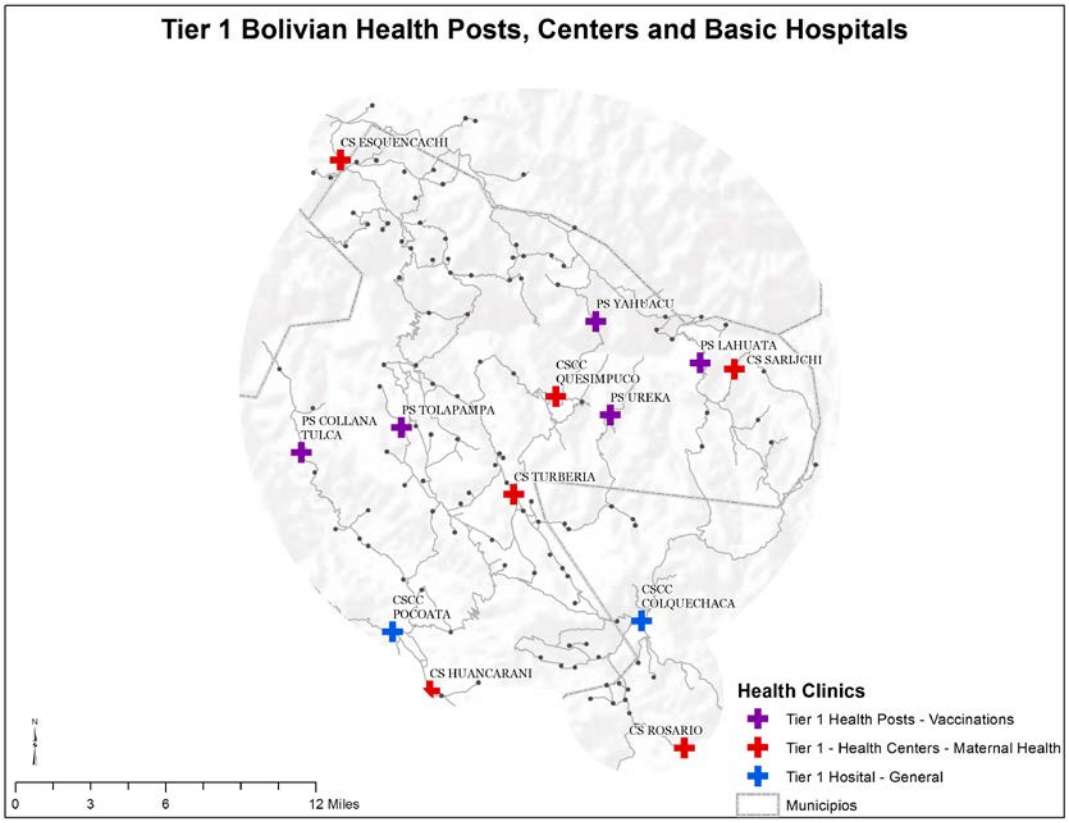

Figure 7 Health Posts, Centers and Basic Hospitals in the Study Area

Environmental Systems Research Institute (ESRI) ArcGIS Network Analyst

As described previously, existing tools built into the ESRI ArcGIS Network Analyst Extension were used for the primary analysis. The Closest Facility analysis was used to determine the closest existing health clinic (regardless of type) for all villages, the time it takes to travel to the nearest health center for maternal/child care and the time it takes to travel to the general hospital in Pocoata from each village. Time (minutes) was the impedance value used. The impedance value is the quantity of resistance required to travel a path in a network. Time was derived from the feature distance and the walking speed during the construction of the transportation analysis. The second method, The Location-Allocation/Maximize Coverage analysis, was used to determine the best location for a new health clinic where time (minutes) was again used as the impedance value. When running the analysis, a high impedance cutoff value (250 minutes) was used so that no villages were excluded from the analysis. There are 19 existing Bolivian clinics (8 health centers and 11 health posts) in the Pocoata Municipality); however 13 exist in the defined study area. In order for the software to choose a new location for a clinic, a set of candidate villages was assigned. Candidate villages are those villages in the “26-50” and “51&up” structure count categories and those that are within 20 meters of a road, not a trail. The rationale behind these criteria comes from an anticipated need to be able to drive resources to the clinic, that the clinic be in a larger sized village with a population that could be directly served, and that the village have substantial existing infrastructure. Finally, the Service Area tool in the

Network Analysis Extension was used to visualize and measure the accessibility of service near the established clinics.

Results

Distances from Villages to Clinics (2012 Quesimpuco and Futina)

During the summer of 2012, community members from 27 different villages visited the Futina and Quesimpuco Clinics. As seen in Figure 8, the results of the buffer analysis indicate that the locations of the clinics appear to be appropriately placed based on the 2012 clinic locations and the villages from where visitors traveled. However, the analysis was limited in that the distances provided between villages and clinic locations did not capture the actual time, path, distance and extremity of the patient's travel. The same information (excluding the Futina Clinic and villages) is presented in Figure 9 using the transportation network dataset. The transportation network allows the user to define the travel path from village to clinic, view the length in miles, calculate the minutes, and understand the diverse terrain. The length in miles to the Quesimpuco Clinic from the select villages ranged from 0.81 to 22.23 miles (M = 10.88, SD = 7.28, N=16) (Figure 9). One limitation to this network analysis is that the slope of the mountainous topography is not considered, and this element could further enhance the precision of the measurements for time and distance.

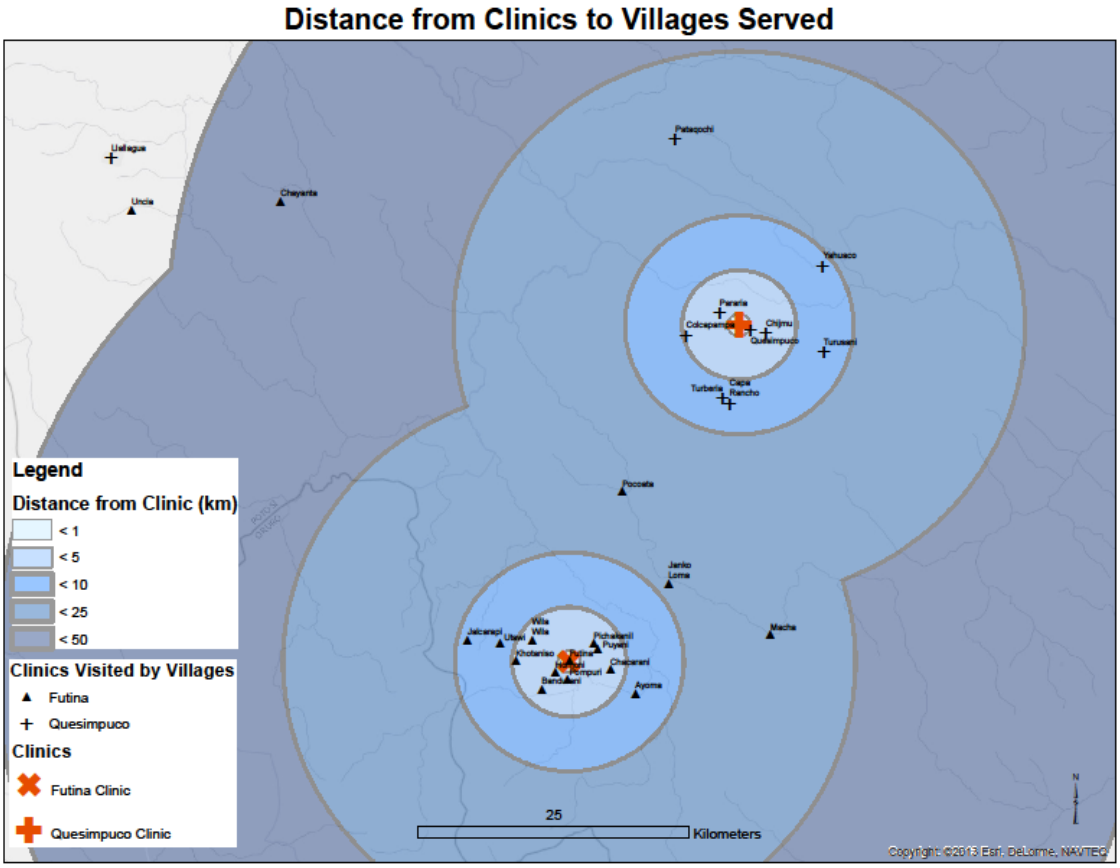

Figure 8 Buffer Analysis of Projecting the Distance from 2012 Clinics to Villages Served

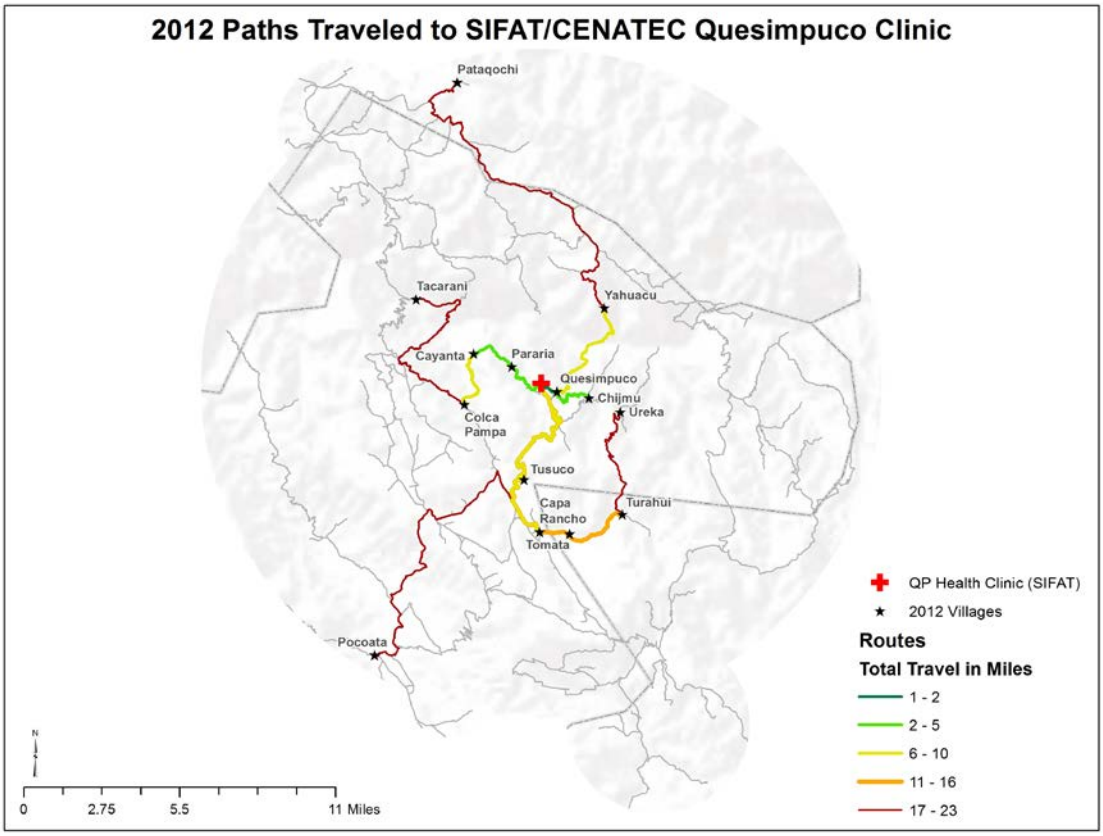

Figure 9 Map Projecting the Distance from 2012 Clinics to Villages Served Using a Transportation Network

Village Analysis

Based on the topographic maps purchased from the Bolivian Military Museum and from discussions with the community doctor and nurse in the field, there were a total of 131 identifiable villages in the study area (Figure 11). Population data was obtained from the 2012 INE Census for 52% of the sample. There was a positive correlation between the village structure count (M = 0.764, SD = 0.755) and village population (M = 271.79, SD = 561.97), r = 0.358, p = < .0046, n = 68 (Figure 10). The result is significant at α=0.05 the level.

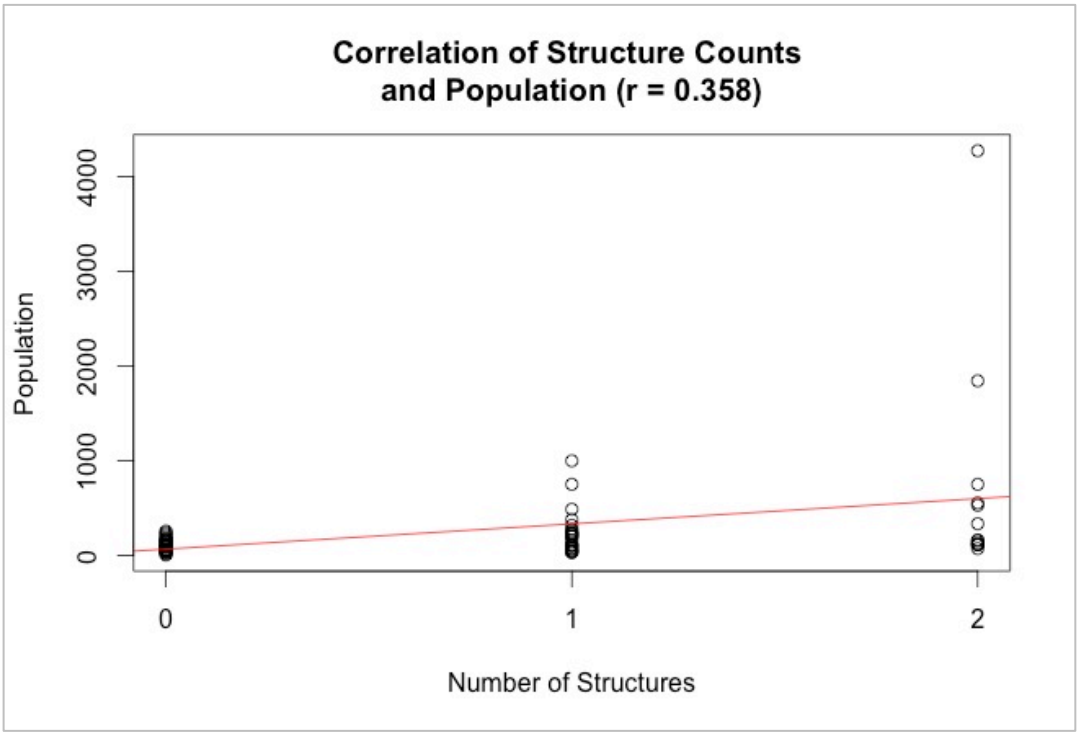

Figure 10 Correlation of Structure Count and 2012 Community Population Data

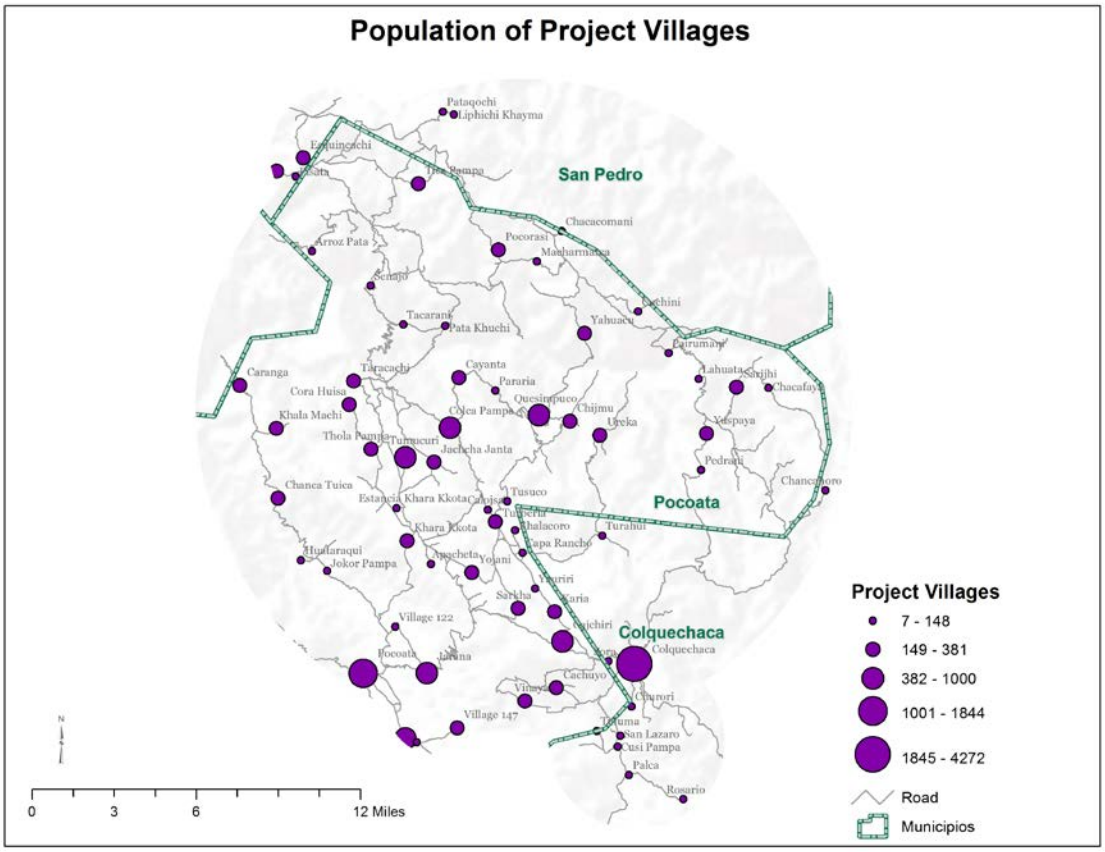

Figure 11 Population of Project Villages

(ESRI) ArcGIS Network Analyst Tool

The length in miles to the nearest Bolivian Health Clinic, regardless of type (Health Post, Health Center or General Hospital) from each village in the project area ranged from 0.01 to 11.24 miles (M = 4.54, SD = 2.74, N=131) (Figure 12). Each type of facility has different operating procedures, capacities, capabilities and waiting times; however, the differences could not be captured in this analysis. The point of the exercise was to gather information on how far a person must travel from each village to attempt to see a health care professional. The nearest Health Center (Maternal/Child Health) from each village ranged from 0.01 to 18.19 miles (M = 6.17, SD = 3.93, N=131) (Figure 13). Travel to the nearest basic hospital in Pocoata ranged from 0.12 to 41.06 miles (M = 21.96, SD = 9.85, N=131) from villages in the study area (Figure 14). The Colquechaca general hospital, located in the Colquechaca Municipality, is labeled in the maps and is just outside of the defined study area. Because it is adjacent to many of the Pocoata villages, the decision was made to include the hospital in the analysis. One limitation of the Closest Facility analysis is that it does not account for the population density of each village and the maximum capacity of each clinic.

The Location/Allocation Maximum Coverage Analysis chose the candidate village of Quehualluni as the new health clinic site (Figure 15). The new location village is near the Esquencachi health clinic. The Esquencachi health clinic served the greatest volume of the villages in the study area accounting for approximately 21%. The new clinic location reduces the number of villagers traveling to Esquencachi by 66%. With the proposed clinic, the mean travel distance decreases to approximately 4.02 miles

(SD = 2.81) from 4.5 miles. The max distance decreases from approximately 10.7 miles from 11.24 miles. Figures 16 and 17 indicate that the new clinic in Quehualluni reduces the total time to service by 2434.5 minutes (40.58 hours) in the northern portion of the study area.

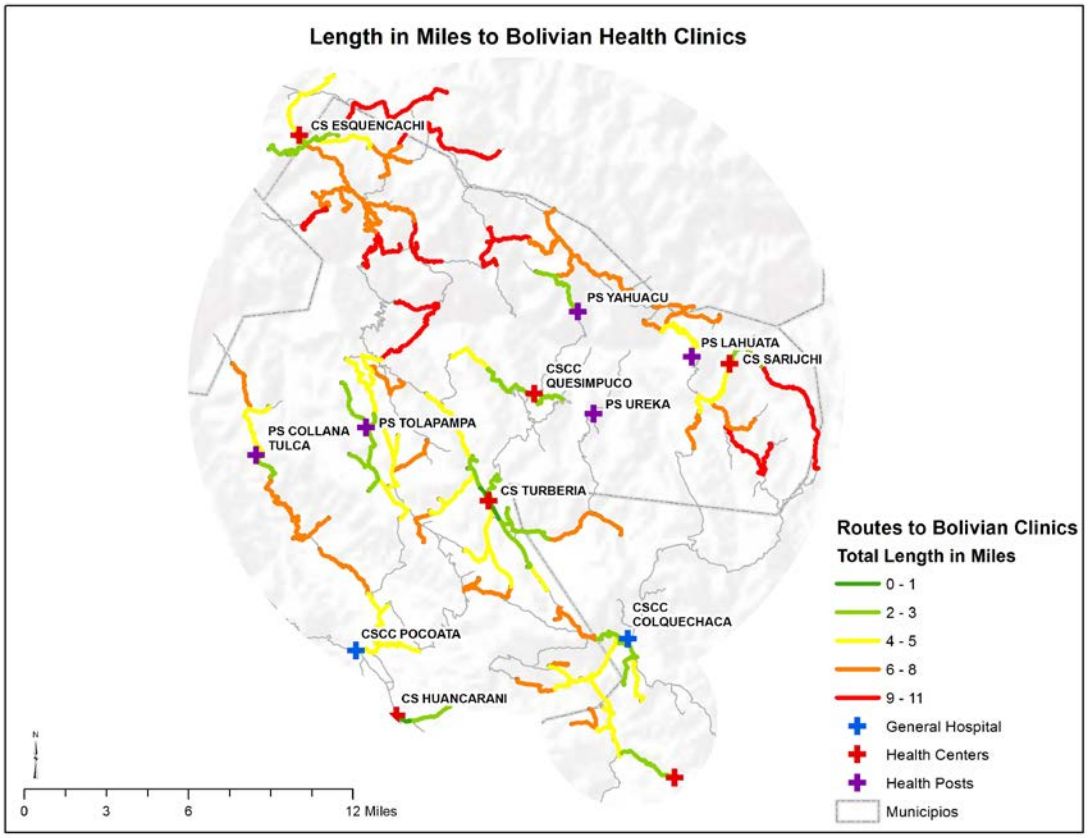

Figure 12 Length in Miles to Bolivian Health Clinics

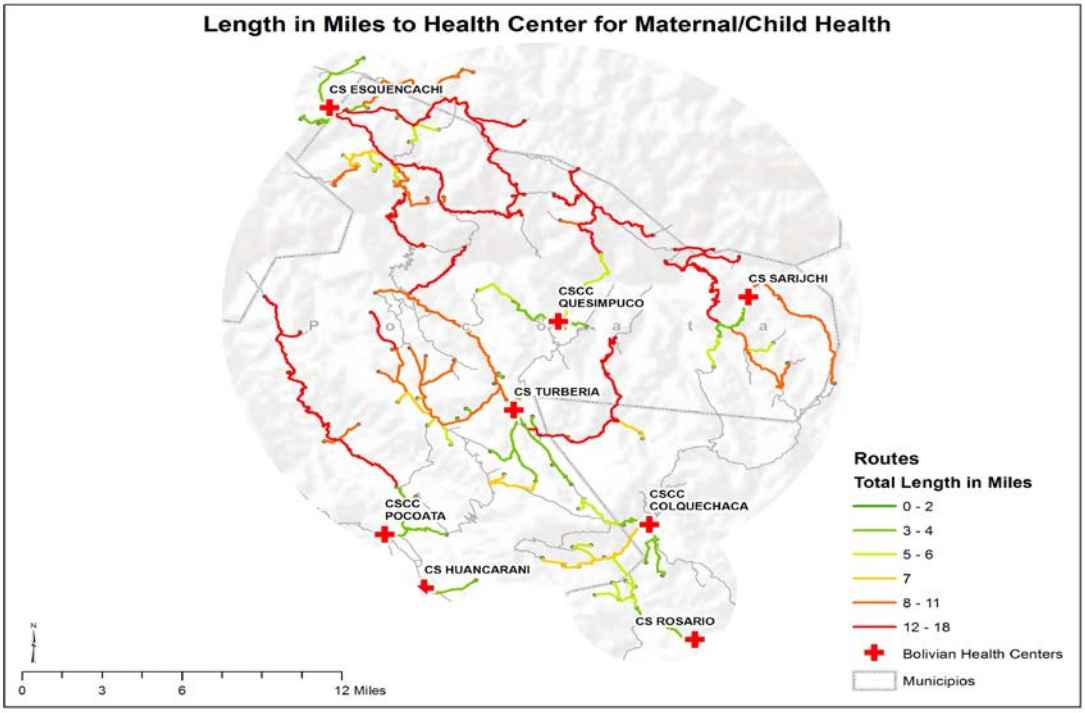

Figure 13 Length in Miles to Health Centers for Maternal and Child Health

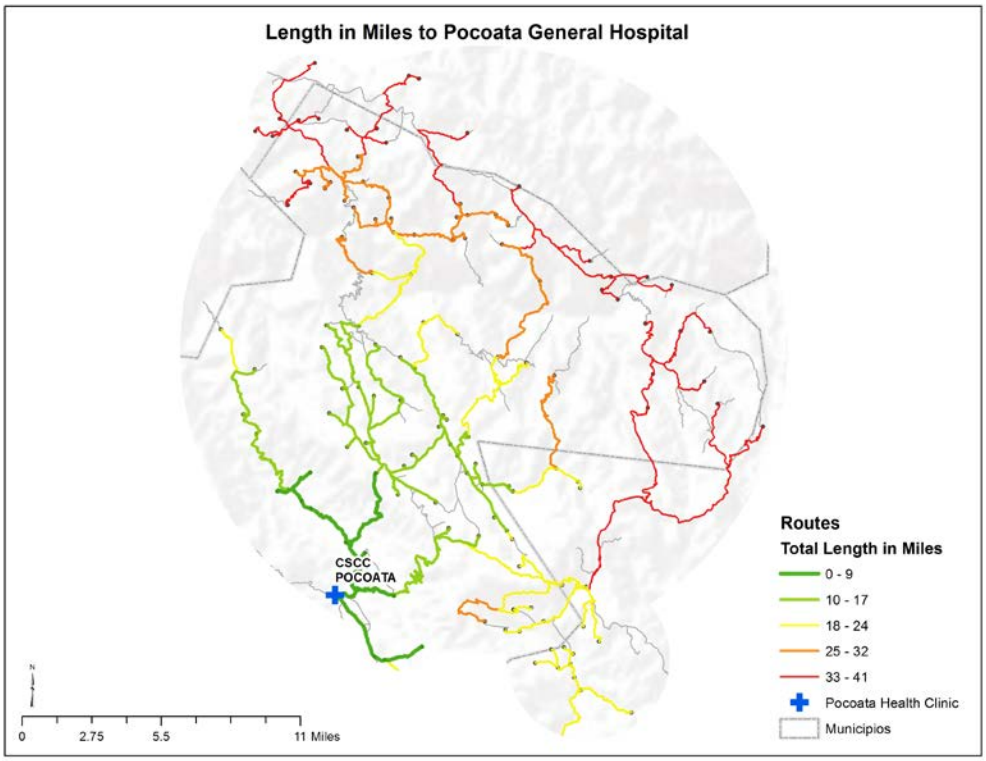

Figure 14 Length in Miles to Nearest General Hospital

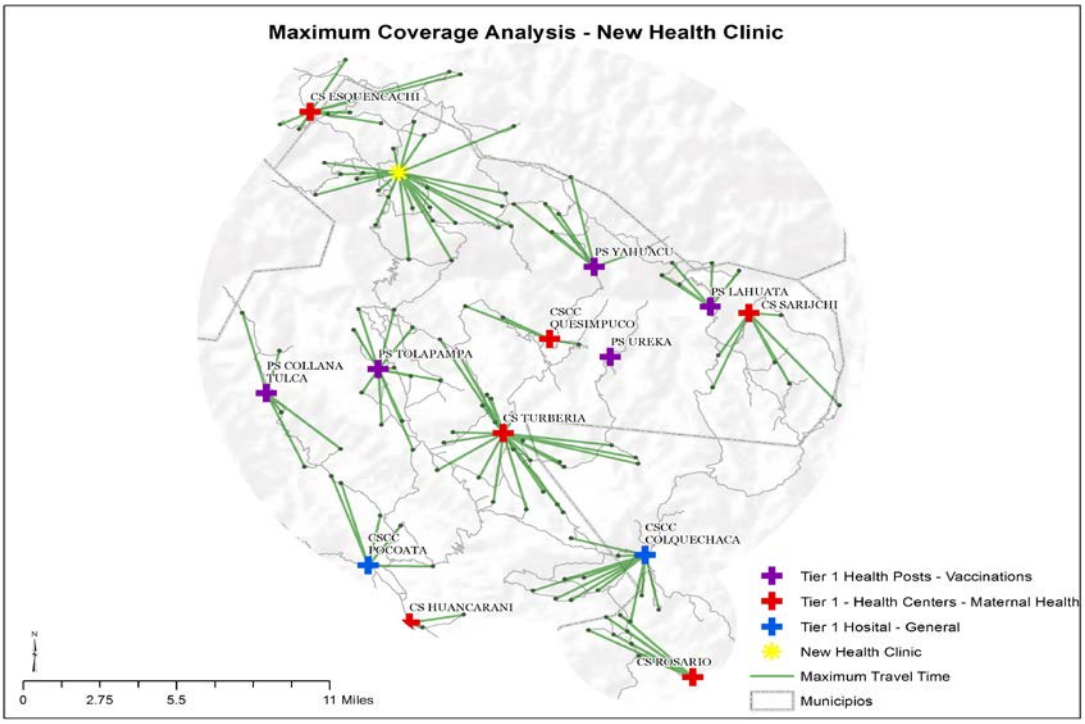

Figure 15 Maximum Coverage Analysis

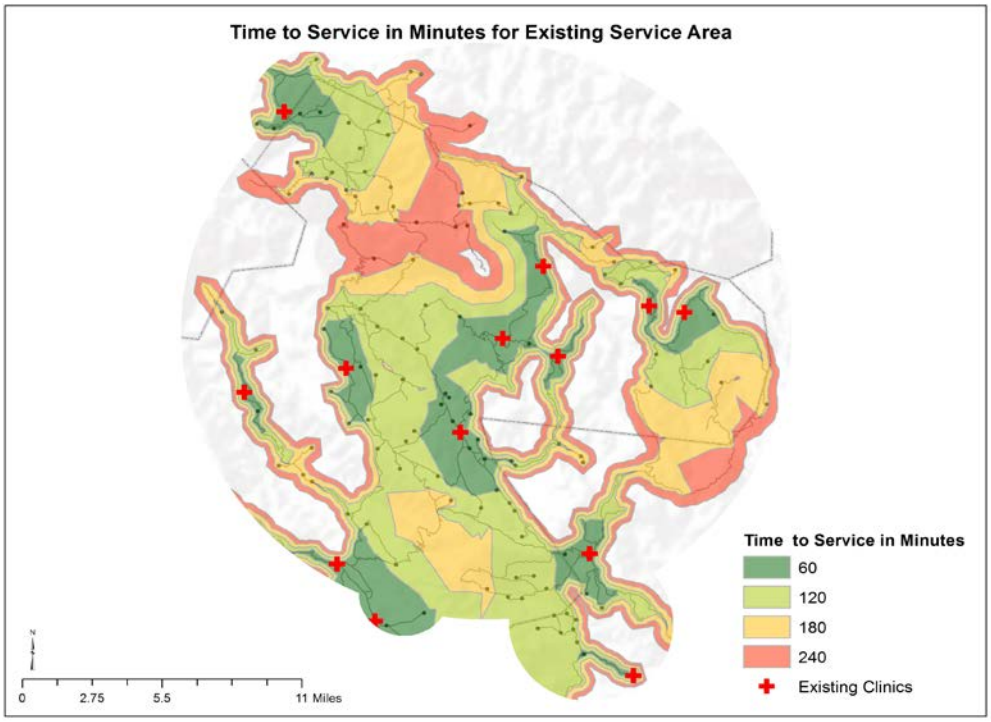

Figure 16 Time to Existing Services

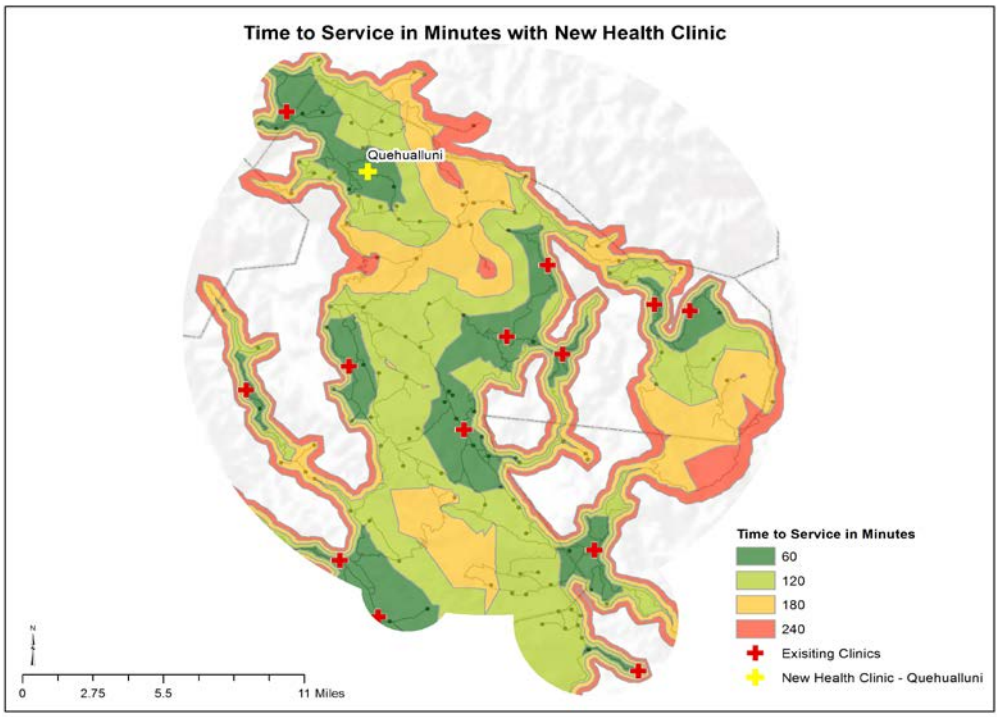

Figure 17 Time to Service with the New Clinic

Discussion

Using GIS for solving public health problems such as access to health care proves to be a valuable tool in assessing the needs of a defined service area in rural areas of developing countries. Existing distributions of access to primary care in the study area need improvement. The results from the Closest Facility analyses reveal a need for more clinics in the study area. The mean travel time to the closest clinic (regardless of the type) is estimated to be approximately 1.5 hours at 3 miles per hour (mph) and the average distance is approximately 5 miles. For the established health centers that are generally used for maternal and child health, the average travel time is 1.9 hours at 3 mph and the mean distance is approximately 6 miles. Research suggests that populations in poor, rural areas will use the closest health care facility regardless of services available (Tanser, 2006). This analysis suggests that more health centers that cater to maternal/child health may be necessary for the study area. For example, near the village of Quesimpuco, many individuals suggested that they knew the need to seek care was important; however, the distance was too great to travel over the rugged terrain while expecting or with young children (information obtained from community doctor during the 2014 trip to Chijmu). In addition, a new basic hospital in the study area is needed. The mean distance to the basic hospital in Pocoata is 22 miles from the villages in the study area. The analyses demonstrate that the population service volumes are not distributed equally among clinics. The Location-Allocation Maximize-Coverage and Service Area analyses proved also to be valuable. The new clinic in the village of

Quehaulluni reduces the number of villages traveling to other clinics in the area and reduces travel time and distance.

The GIS methods used for this analysis are simple techniques that can aid in optimizing access to health care and are generalizable to other rural areas of Bolivia. However, geographic data distinguishes geographic information from all other types of data. Spatial data are observations with precise locations and are the basis of GIS (Cromley and McLafferty, 2012). As described previously, data, especially geographic data, were extremely difficult to obtain for the rural study area. The use of global positioning systems (GPS), remote sensing, digitization and the use of topographic maps were the principal methods used for collecting the geographic data. Expertise, time, and funds are necessary; however, without the geographic data gained in this project, the analyses would not have been possible. The building of the transportation network for this study area was the first of its kind and was critical to the analyses. SIFAT/CENATEC and the Bolivian government can use this GIS platform to manage the flow of new information as it becomes available and can build upon the existing roads, foot trails and villages that are currently in place to make the platform more accurate.

Limitations

For this study, population data was available for 68 villages out of the 131 villages in the study area (52%). Part of the reason for the low percentage is that several of the villages were assigned a Village ID number instead of an actual name. Future efforts should work to gain the names of the remaining 63 villages so that the population

data can be obtained for these villages. In addition, although there was a slight positive correlation between the estimate village structure count and village population, efforts should be made to gain an actual count of each of the village structures. This can be accomplished through remote sensing; however, it will take time and expertise to gain an actual count. Using an actual count instead of an estimate of the village structures will increase the correlation and will enhance the accuracy of the study design.

Another limitation is the lack of information for the access and availability to well-trained medical workers. Many villagers often complain of not having the ability to see healthcare workers when needed. Future efforts can work to obtain information on whether facilities are accommodating the needs of the service population through gaining hours of operation, application of procedures and waiting times. Increasing the volume of local, trained healthcare workers could assist greatly in addition to adding a new clinic location.

Conclusions

GIS can be used as an effective tool for summarizing and visualizing geographical differences in availability and accessibility of health clinics in rural areas. This instrument can effectively assist governments and non-governmental organizations in solving critical public health problems such as access to healthcare. As seen in this analysis, more health clinics are needed to reduce existing gaps in service in the Chaupirana Valley of the Pocoata Municipality. Further, there are multiple opportunities for future research using this GIS platform, including, but not limited to, a detailed analysis of the current availability of healthcare workers. Finally, although availability

and accessibility are important components of the access equation, these aspects are only part of the spatial component of a healthcare system. Other aspects such as accommodation, affordability and acceptability need to be considered when designing the components of public health systems.

CHAPTER III

CROSS-SECTIONAL ANALYSIS OF THE BASIC LIVING CONDITIONS AND HEALTH PROBLEMS OF THE INDIGENOUS PEOPLE OF THE CHAUPIRANA VALLEY

Introduction

One obstacle to providing healthcare to rural Bolivia is a lack of knowledge of common health issues faced by its inhabitants. Spatially outlining the major health problems and complaints of indigenous inhabitants of select villages in the Chaupirana Valley using the most recent 2012 census data and recent health assessments will assist in focusing resources of SIFAT/CENATEC and will ultimately aid in identifying gaps in the Bolivian health care system. GIS provides an effective mechanism to outline diagnoses data and in mapping disease prevalence. In addition, GIS assists in creating a "spatial health information infrastructure" that is critical in determining intervention strategies to eliminate disease and adverse health outcomes (Boulos, 2005).

Background

Recently, great strides have been made in the improvement of the general healthcare system of Bolivia. With this progress, some rural areas have been left behind compared to the more densely populated areas. CENETEC does the majority of its work in the rural area of the Chaupirana Valley and has worked with international teams to assist with ideas to improve the general health of the people in this area for many years. The objective of this study is to outline the major health issues and complaints of

indigenous inhabitants from select villages in the Chaupirana Valley to provide a baseline for future efforts.

2012 Texas A&M Health Science Center (TAMHSC) Interprofessional Mission of Service Trip

This portion of the project uses data from TAMU Protocol IRB2013-0382 titled *International Interprofessional Service Learning Evaluation*, with Dr. Bree Watzak as the Principal Investigator. TAMHSC students and faculty from nursing, medicine, dentistry, public health and pharmacy participated in the program to experience the interprofessional nature of health care delivery that TAMHSC offered in conjunction with CENETEC and SIFAT. The trip took place from May 30th - June 9th, 2012, with objectives to assist in setting up clinics in two remote Bolivian communities (Quesimpuco and Futina) and conduct a cross-sectional analysis as a team to assess patients and collect community health assessments.

Recruitment for the community assessment was conducted through CENATEC who notified village leaders in advance of the arrival of the team. Leaders then relayed this information to the community members along with the consent to participate. Those who chose not to participate in the community health assessment, but wished to see the physician did so without penalty. Upon arriving at each of the two villages, the students and faculty established a clinic with a triage station, a pharmacy, and doctor and dental exam rooms. Public health students were responsible for triaging the patients each day and making sure that the public health assessment was completed for each patient. The public health assessment was created to provide insight on how the local citizens of

each village perceived their current public health needs in regards to access to health care, shelter, nutrition, access to potable water and education. Information on childhood mortality, vaccinations and record availability was also collected (Appendix A). Nursing students and faculty acquired basic vital signs, and patients then saw medical and dental providers for assessment and treatment. Patients received prescribed medications and vitamins and were counseled by pharmacy students. As a result, the medical team saw 492 patients, 245 public health assessment forms were translated using Google Translator, and results were compiled using Microsoft Excel 2010.

Limitations of data analysis include missing patient data forms (approximately ¼) and exclusion of data that could not be translated due to either illegible handwriting or lack of translation from Quechua to Spanish to English. It appears that approximately 50% responded to the questions on the public health questionnaire. However, families were asked to complete the form (not necessarily individual patients), resulting in a low response rate. In addition, the public health questionnaire was detailed and often held up lines to see medical professionals.

2012 Edward Via College of Osteopathic Medicine (VCOM) of South Carolina Trip

This portion of the project uses data from TAMU Protocol IRB2014-0629 titled *Public Health Analysis of Remote Quechuan Villages in the Chayanta Province of Bolivia: Data from South Carolina Student*s, with Dr. Regina Bentley as the Principal Investigator. In 2012, a group of medical students from the Edward Via College of Osteopathic Medicine (VCOM) in South Carolina was asked by CENATEC for ideas to improve the general health of the people in Chayanta Province. The objective of this

study was to outline the major health issues and complaints of indigenous inhabitants of select villages in the Chayanta River Valley. Teaming up with a local physician, clinic days were conducted in five different villages (Quesimpuco, Chijmu, Cayanta, Macha and Wilkarquchi) located within the region. Patients aged 18 to 100 years who received care during these clinics were invited to participate in an anonymous survey consisting of a socioeconomic and physical assessment portion. The physical assessment portion was broken into categories with yes/no questions pertaining to specific symptoms. The socioeconomic part included questions relating to diet, occupation, and education (Appendix A).

The objective of this study was to outline the prevalence of communicable and chronic diseases including, but not limited to dermatological conditions, upper respiratory infections, gastrointestinal illnesses, and hypertension in the indigenous inhabitants of the Chayanta River Valley. Participants consisted of adults 18 years or older who live in the selected villages and who freely volunteered to participate. Village leaders were notified in advance of the arrival date and then relayed this information to villagers. The informed consent process took place by the village leaders prior to the arrival of the team. Along with information on the survey, leaders communicated that there would be no penalty if individuals did not wish participate based upon any reason. Those who chose to participate were sent to surveyors in a triage-like setting. After the survey had been taken, participants were sent to health professionals who were present for unrelated evaluation. Those who chose to not participate in the survey, but wished to see the physician did so without penalty. The survey was administered in Spanish to

those who spoke Spanish. When individuals spoke only Quechua (indigenous language), translators were used in administration of surveys. Surveys were administered over a six-day period. Data was entered into a Microsoft Excel™ 2010 spreadsheet and stratified based on village, gender, and age group.

2014 Chijmu Trip

This portion of the project uses data from TAMU Protocol IRB2014-0394D *Public Health Analysis of Chijmu, Bolivia* with Dr. Regina Bentley as the Principal Investigator. Based on the results of the 2012 VCOM South Carolina data, it was determined that the village of Chijmu had the highest complaint rate of the majority of surveyed issues. Therefore, CENATEC suggested a follow-up visit to the community to verify health issues and to conduct an additional community health assessment using the same methodology as the 2012 VCOM South Carolina trip. Therefore, in 2014, a team from TAMHSC along with the local nurse, community doctor and translator visited Chijmu residents aged 18 to 100 years. Volunteers were again invited to participate in an anonymous survey consisting of a socioeconomic and physical assessment portion in 2014. The survey consisted of the same methods and forms that were used in 2012 by the VCOM South Carolina team. Surveys were assigned an accession number and dissociated from patient identity. The survey was administered in Spanish and was translated to Quechua when needed. Data was entered into a Microsoft Excel™ 2010 spreadsheet and basic summary statistics were applied.

Methods

Data Analysis of the Cross-Sectional Surveys

Survey data was analyzed using descriptive statistics and by computing measures of association. Due to small sample sizes, data were aggregated across villages prior to computing basic summary statistics (counts, means, medians, standard deviations, and proportions). The aggregate data was joined with the spatial data so that the information could be visualized using Geographic Information Systems (GIS). The prevalence of the top five health problems of the villages were displayed using ArcMap. Statistical analysis was completed using R version 3.1.0 (The R Foundation for Statistical Computing version "Spring Dance", Lawrence, Kansas) and STATA 13.1 (College Station, TX). Because infrastructure such as piped water to the village center and the exposure of smoke during cooking over open fire in the homes differs amongst villages, diagnoses of gastrointestinal illness (gastritis, parasites, dyspepsia etc.) and respiratory issues (cough, difficulty breathing, common cold) were chosen as the outcomes of interest. Odds ratios of the unadjusted associations between demographics and in-home smoke exposure and respiratory symptoms for the VCOM survey in 2012 and the Chijmu 2014 data were calculated. Similarly, odds ratios were also calculated for the unadjusted associations between demographics and use of public tap and gastrointestinal symptoms for the same datasets. Stratification was not performed due to the small sample size. Odds ratios for the *2012 TAMHSC Interprofessional Mission of Service Trip* data from the Quesimpuco and Futina Clinics were not calculated due to lack of exposure information.

Power analyses were performed using PS: Power and Sample Size Calculations Version 3.1.2 (Vanderbilt, 2014) for the analysis of the relationship between respiratory issues and smoke in the home for the VCOM 2012 dataset. The statistical power was calculated for respiratory issues at a 95% significance level, with a sample size (n) of 42, the probability of exposure among non-exposed being 0.52, and the ratio of exposed to non-exposed of 1.5, to be 0.17 at an odds ratio of 1.5. If the true odds ratio for disease in exposed subjects relative to unexposed subjects is 3, we will be able to reject the null hypothesis that this odds ratio equals 1 with the power of 0.73.

Similarly, the statistical power was calculated for gastrointestinal issues at a 95% significance level, with a sample size of 53, the probability of exposure among non-exposed being 0.43, and the ratio of exposed to non-exposed of 1.5, is 0.20 at an odds ratio of 1.5. The statistical power of the study increases as the association between the variables (OR) increases and power of 0.86 is achieved with the odds ratio of 3.0.

Table 2 Power Analysis

	Respiratory α= 0.5 p_o = 0 .52 n=42 m=1.5	Gastrointestinal α= 0.5 p_o = 0 .43 n=53 m=1.5
Odds Ratio	Power	Power
1.5	0.17	0.20
2.0	0.38	0.49
3.0	0.73	0.86

α = Type 1 error probability for a two-sided test
p_o = Probability of exposure in controls
n = sample size
m = ratio of cases and controls

Results

2012 TAMHSC Interprofessional Mission of Service Trip

Futina Clinic

Approximately 238 community members, aged infant to 90 (M=23.71; SD=25.95), in the region traveled from approximately 56 different villages (7 unknown) to the established clinic in Futina. Of the 56 villages, the latitude and longitude were obtained for 17 of the villages (30% of the total number of villages). Sixty percent (60.50 %) of the patients surveyed were female and 38.66% were male. Approximately 68% of those who visited the clinic were between the ages of 18 and 90. In total, diagnostic results from all villages indicated that the five top health diagnoses were: gastrointestinal illness (parasitic infection, gastritis, diarrhea, abdominal pain) (36.97%), osteo-arthritis (20.59%), cataracts and/or presbyopia (19.75%), back pain (16.81%) and head-ache (13.87%). Although not mentioned in the table as one of the five major diagnoses, 9 of the visitors presented signs of tuberculosis. The diagnostic count of all villages was summed then divided by the total number in the sample (N=238) to obtain the prevelance. Some villages only had 1 person receive care at the clinic; therefore, it was not reasonable to aggregate the data. In addition, due to the lack of exposure information, it was not feasible to calculate odds ratios.

Of the 238 villagers who visited the clinic, 99 (42%) completed the public health assessment (Table 3). Appoximately 50% of the surveyed population had never attended school, 54% indicated that they had experienced the death of 1-3 children, 50% stated that they had diarreha in the last month, and 80% had been vaccinated. Public health

assessments also indicated local concerns with proper housing, potable water and water supplies for animals, food security and education (Figure 18).

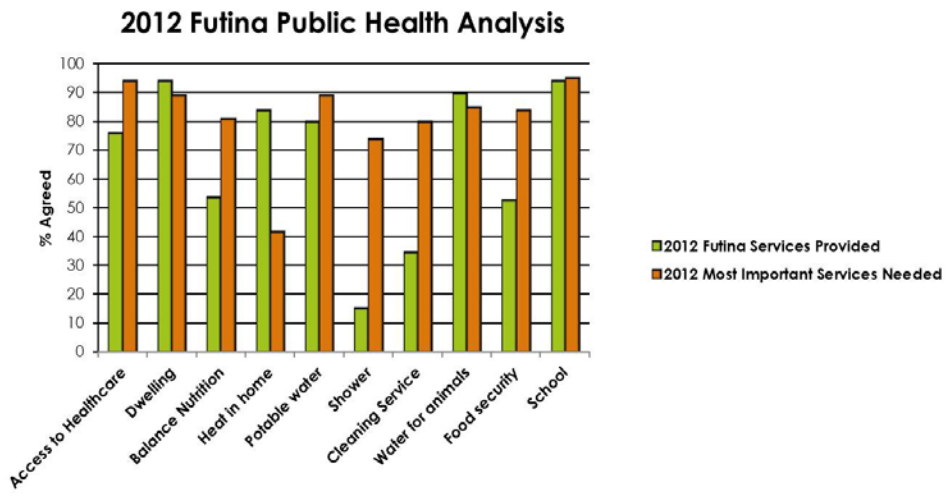

Figure 18 Public Health Assessment Results in Futina

Table 3 Characteristics of the Villagers Who Visited the Futina Clinic

Characteristics	**Categories**	**N=99**	**%**
Years of school	0	49	49.49%
	1 - 3	19	19.19%
	4+	28	28.28%
Number people living in home	1-3	20	20.20%
	4-6	48	48.48%
	7+	31	31.31%
Death of Children	0	42	42.42%
	1 - 3	53	53.54%
	4+	5	5.05%
Cause of Child's Death	Cholera	3	3.03%
	Cough	10	10.10%
	At birth	3	3.03%
	Diarrhea	8	8.08%
	Sick	11	11.11%
	Unknown	57	57.58%
Diarrhea in the Last Month	No	49	49.49%
	Yes	50	50.51%
Vaccinated	No	19	19.19%
	Yes	80	80.81%
Shot Record	No	27	27.27%
	Yes	53	53.54%

Quesimpuco Clinic

Approximately 164 community members, aged infant to 86 years old (M=30.01; SD=25.04), traveled from approximately 6 different villages to the established clinic in Quesimpuco. Forty percent (41.46 %) of the patients surveyed were female and 57.93% were male. Approximately 45% of those who visited the clinic were > 18 years old. In total, diagnostic results from all villages, the five top health complaints were: gastrointestinal illness (parasitic infection, gastritis, diarrhea, abdominal pain) (34.75%), dental problems (29.27%), osteo-arthritis (14.63%), cataracts and/or presbyopia (15.24%), and skin issues (12.80%) (Table 4). The diagnostic count of all villages was summed then divided by the total number in the sample (N=164) to obtain the prevelance. Some villages only had 1 person receive care at the clinic; therefore, it was not reasonable to aggregate the data. In addition, due to the lack of exposure information, it was not feasible to calculate odds ratios.

Of the 164 villagers who visited the clinic, 145 (88.41%) completed the public health assessment (Table 5). Appoximately 55% of the surveyed population had never attended school, 47% indicated that they had experienced the death of 1-6 children, 13% stated that they had diarrhea in the last month, and 44% had been vaccinated. Similar to Futina, public health assessments also indicated local concerns with proper housing, potable water and water supplies for animals, food security and education (Figure 19).

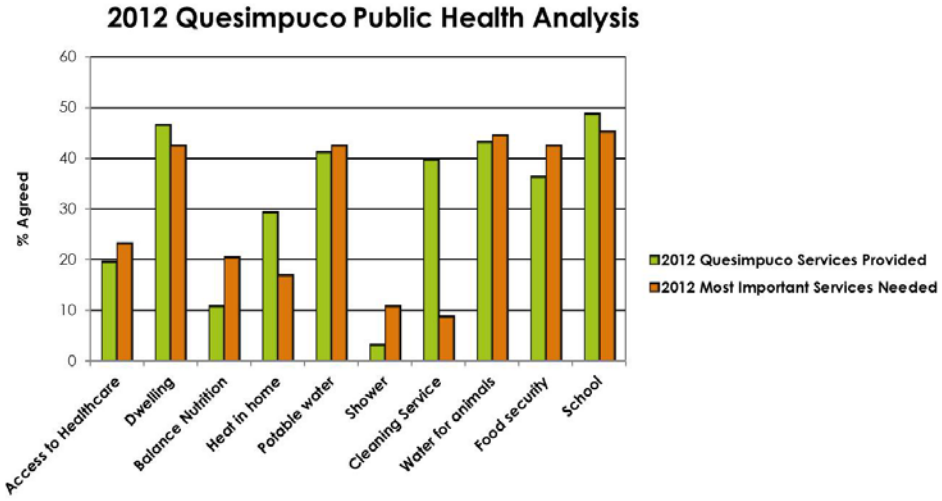

Figure 19 Public Health Assessment Results in Quesimpuco

Table 4 Diagnostic Data by Village for the Quesimpuco Clinic

Community	Visited	Gastro	%	Dental	%	Osteo-arthritis	%	Cataracts presbyopia	%	Skin	%
Chijmu	1	1	0.61	0	0	0	0	0	0	0	0
Quesimpuco	157	54	32.93	47	28.66	24	14.63	24	14.63	20	12.2
Thorawi	1	1	0.61	0	0	0	0	0	0	0	0
Turberia	1	0	0	0	0	0	0	0	0	1	0.61
Ureka	3	1	0.61	1	0.61	0	0	1	0.61	0	0
Yahuaco	1	0	0	0	0	0	0	0	0	0	0
Total	**164**	**57**		**48**		**24**		**25**		**21**	

Table 5 Characteristics of Quesimpuco Clinic Visitors

Characteristics	Categories	N=145	%
Years of school	0	80	55.17%
	1 - 3	25	17.24%
	4+	40	27.59%
Number people living in home	0	56	38.62%
	1-3	38	26.21%
	4-6	30	20.69%
	7+	21	14.48%
Death of Children	0	117	80.69%
	1 - 3	26	17.93%
	4+	2	1.38%
Cause of Child's Death	At birth	3	2.07%
	Diarrhea	8	5.52%
	Sick	3	2.07%
	Unknown	1	0.69%
Diarrhea in the Last Month	No	126	86.90%
	Yes	19	13.10%
Vaccinated	No	81	55.86%
	Yes	64	44.14%
Shot Record	No	13	8.97%
	Yes	51	35.17%

2012 VCOM South Carolina Trip

The VCOM South Carolina medical students surveyed one hundred sixty-nine (n=169) patients, aged 18-100 (M=52.65; SD=20.1), from the villages visited of Quesimpuco, Chijmu, Wilkarquchi, Macha and Cayanta. Sixty-six percent (66%) of patients surveyed were female and 32.1% were male. In total, survey results from all villages, the five top health complaints were: headache (59.28%), general weakness (52.10%), muscle or joint pain (50.30%), back pain (40.72%), and heartburn (34.73%). These results reflect the total population surveyed. Data was further broken down based upon village, gender, and age group (Figure 20, Figure 21, and Figure 22).

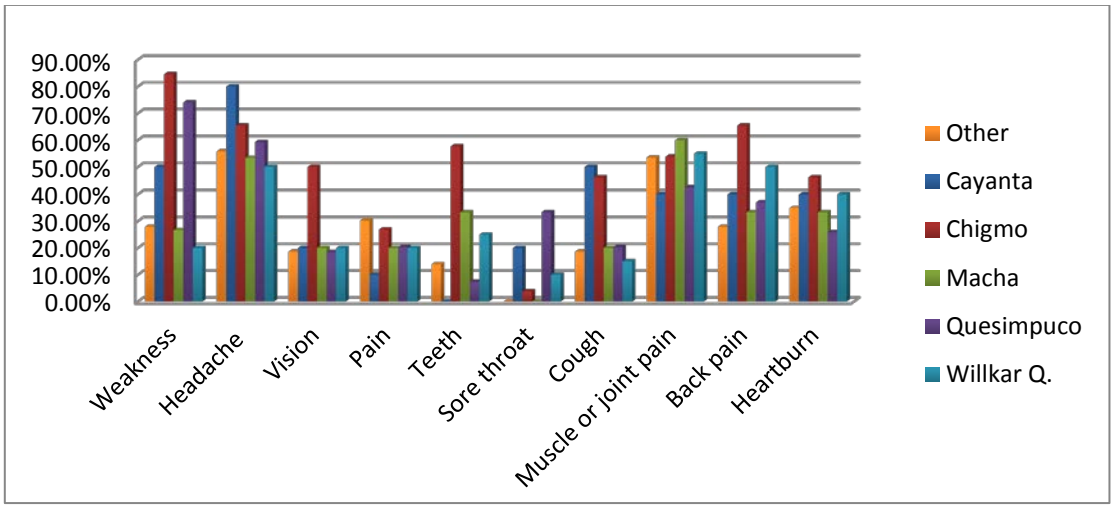

Figure 20 Percentage report of top ten health complaints by village.

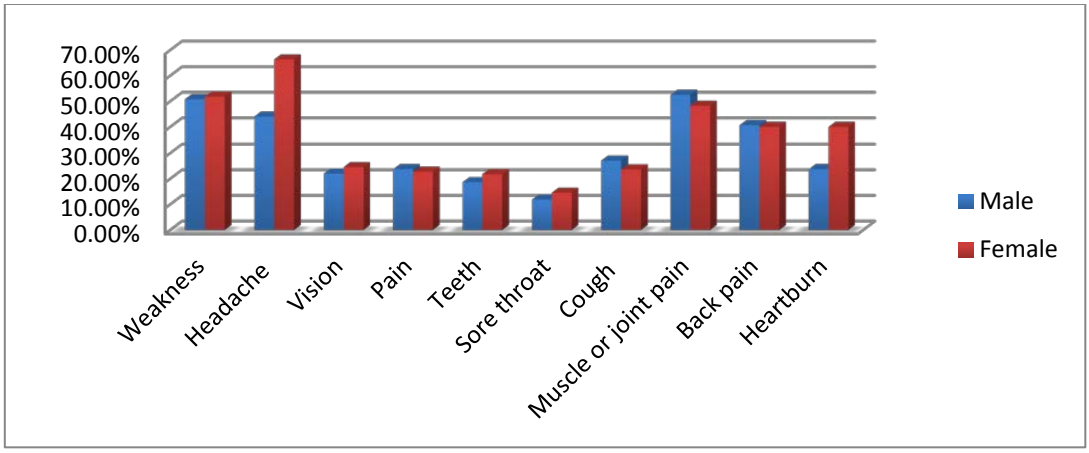

Figure 21 Percentage Report of Top Ten Health Complaints by Gender

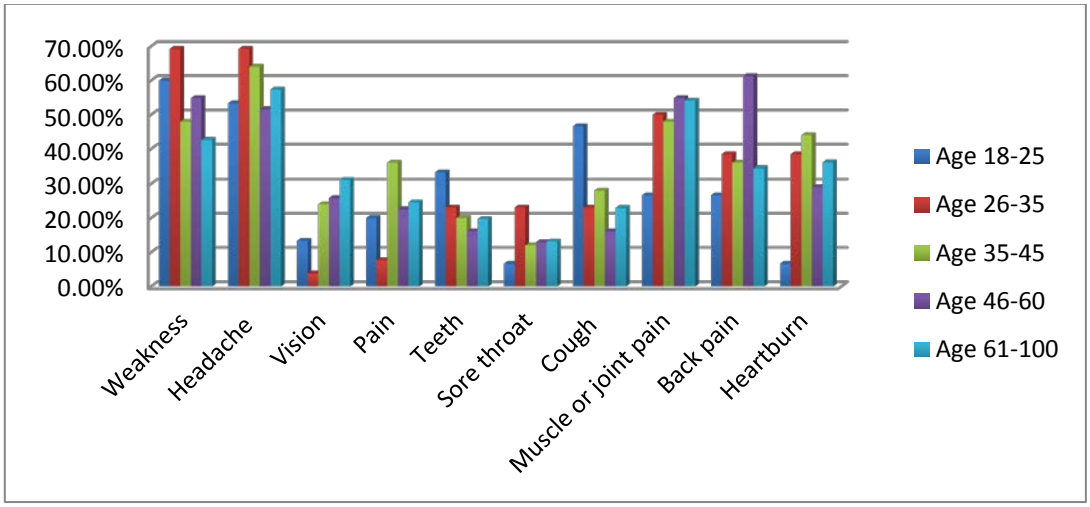

Figure 22 Percentage Report of Top Ten Health Complaints by Age Group

Data by Village

Quesimpuco

Fifty-four patients (N=54), aged 18-90 (M=48.53; SD=20.58), completed the socio-economic survey and were seen by the community doctor and medical-students. Fifty-nine percent (59%) of patients surveyed were female and 41% were male. According to the 2012 INE census data, there were 531 people living in the village of Quesimpuco in 2012, estimating a response rate of 10%. The five top health complaints were: musculoskeletal (61%), head (59%), gastrointestinal (44%), eyes (35%), and respiratory issues (29%) (Table 5).

Appoximately 28% of the surveyed population had attended at least 4 years of school, 24% claimed to use open fire as their method of cooking, 39% stated that their drinking water was piped into their homes, and 15% claimed to purify their water. Of those who claimed to purify/filter their drinking water only 3 used proper methods of purification (i.e. boiling longer than 5 minutes or chlorine). Nearly 13% claimed to dispose of feces outside (Table 6). Quesimpuco had one of the most varied diets of the villages visited. The majority of individuals claimed to regularly consume vegetables, fruit, grains, and starch. Only a small number surveyed claimed to have a steady protein source. When asked what the most important health issues were in Quesimpuco many answers were received. The two most common issues verbalized were stomach pain and diarrhea. The source of stomach pain is most likely varied, though many of those complaining of stomach pain presented with symptoms of gastro-esophageal reflux

disease and gastric ulcer. Both of these issues can be attributed to diet, lack of purified water, and genetic predisposition.

Table 6 Top 5 Health Problems in Quesimpuco

Community	N	Diagnosis	Number of Cases	% Of Population Surveyed
Quesimpuco	54	Musculoskeletal	33	61.11
		Head	32	59.26
		Gastrointestinal	24	44.44
		Eyes	19	35.19
		Respiratory	16	29.63

Table 7 Characteristics of Quesimpuco Clinic Visitors

Characteristics	Categories	N=54	%
Years of school	0	5	9.26
	1 to 3	10	18.52
	4+	15	27.78
Number people living in home	1 to 3	15	27.78
	4 to 6	9	16.67
	7+	5	9.26
Number of children	0 to 2	11	20.37
	3 to 4	7	12.96
	4+	9	16.67
Age at time of first child	12 to 15	2	3.70
	16-19	2	3.70
	20+	17	31.48
	Unknown	9	16.67
Method of cooking/heating home	Open fire	13	24.07
	Chimney Vent	10	18.52
	Gas or Enclosed	6	11.11
	Unknown	1	1.85
Hours/day spent over fire (smoke)	0-2	17	31.48
	3 to 4	8	14.81
	4+	2	3.70
Type of fuel used	Wood	24	44.44
	Other	6	11.11
Hours/day gathering fuel	0 to 2	14	25.93
	3 to 4	9	16.67
	4-6+	3	5.56
Water source for drinking	House	21	38.89
	Public	6	11.11
	River	1	1.85
	Unknown	2	3.70
Is drinking water purified	Yes	8	14.81
	No	17	31.48
How do you dispose of fecal matter	Outside	7	12.96
	Lavatory in House	4	7.41
	Public Latrine	2	3.70
	Unknown	4	7.41

Chijmu

Twenty-six patients (N=26), aged 18-70 (M=48.5; SD=17.02), completed the survey. Seventy-seven percent (77%) of patients surveyed were female and 23% were male. According to the INE, there were 204 people living in the village of Chijmu in 2012, estimating a response rate of 13%. The five top health complaints were: musculoskeletal (85%), gastrointestinal (81%), throat (73%), eyes (69%), and neurologic issues (62%) (Table 7). Chijmu had the highest complaint rate of the majority of surveyed issues out of all of the villages. Specific complaints of dental issues and back pain stand out most from the other villages surveyed. In addition, most people presented with signs of dehydration.

Appoximately 38% of the surveyed population had attended at least 4 years of school, 88% claimed to use open fire as their method of cooking, 92% stated that their drinking water was piped into their homes, and 11% claimed to purify their water. The three who claimed filtering water did not explain the method in which they filtered their drinking water. Nearly 88% claimed to dispose of feces outside (Table 8). There was evidence of possible intestinal helminthic infection seen in many of the school-aged children. The major sign seen was distended abdomens. These infections can easily be treated with anthelminthic medicine courses but have a high probability of returning without proper water filtering techniques. Many individuals surveyed complained also of constant, dry cough and painful breathing. This could possibly be attributed to exposure to smoke in the home for many hours. The diets in Chijmu were the least diverse of all

villages surveyed. Most common diets were reported to include potatoes, grain, corn, and wheat.

Table 8 Top 5 Diagnoses in Chijmu

Community	N	Diagnosis	Number of Cases	% Of Population Surveyed
Chijmu	26	Musculoskeletal	22	84.62
		Gastrointestinal	21	80.77
		Throat	19	73.08
		Eyes	18	69.23
		Neurologic	16	61.54

Table 9 Characteristics of Chijmu Population

Characteristics	Categories	N=26	%
Years of school	0	6	23.077
	1 to 3	9	34.615
	4+	10	38.462
Number people living in home	1 to 3	7	26.92
	4 to 6	12	46.15
	7+	6	23.08
Number of children	0 to 2	5	19.23
	3 to 4	10	38.46
	4+	10	38.46
Age at time of first child	12 to 15	2	7.69
	16-19	3	11.54
	20+	10	38.46
	Unknown	11	42.31
Method of cooking/heating home	Open fire	23	88.46
	Chimney Vent	2	7.69
	Unknown	1	3.85
Hours/day spent over fire (smoke)	0-2	22	84.62
	3 to 4	2	7.69
Type of fuel used	Wood	24	92.31
	Other	1	3.85
Hours/day gathering fuel	0 to 2	16	61.54
	3 to 4	7	26.92
	4-6+	1	3.85
Water source for drinking	House	24	92.31
	Public	1	3.85
Is drinking water purified	Yes	3	11.54
	No	21	80.77
How do you dispose of fecal matter	Outside	23	88.46
	Unknown	1	3.85

Wilkarquchi

Twenty patients (N=20), aged 18-90 (M=54; SD=20.50), completed the survey. Sixty percent (60%) of patients surveyed were female and 40% were male. According to the INE, there were 134 people living in the village of Wilkarquchi (WQ) (spelled Wilquir Cocki in the INE census data) in 2012, estimating a response rate of 15%. The five top health complaints were: musculoskeletal (60%), head (50%), gastrointestinal (40%), eyes (35%), and respiratory issues (35%). The main issues seen in WQ were similar to other villages (Table 9). As a whole, they had many complaints of back, dental, and muscle issues. The prevalence of gastrointestinal issues was comparable to other villages and similar measures of action are recommended for WQ. One additional concern was the prevalence of unintentional, self-inflicted middle ear damage. Many individuals presented with complaints of imbalance, problems hearing, itchy ears, headaches, and painful ears. On examination with an otoscope, the middle ears showed signs of previous trauma (chronically inflamed with previous bleeding, perforated tympanic membranes). When the patient history was taken pertaining to ears, all claimed to have used wooden sticks at some time to clean out their ears. Trauma from cleaning ears with sticks is thought to be the cause of the previous symptoms listed (imbalance, problems hearing, itchy ears, headaches, and painful ears).

Approximately 45% of the surveyed population had not attended school, 45% claimed to use open fire as their method of cooking, 50% stated that their drinking water was piped into their homes, and 20% claimed to purify their water. Of those who claimed to filter water, none could explain the method in which they filtered their

drinking water. Nearly 45% claimed to dispose of feces outside (Table 10). The most important health issue considered by the villagers in WQ was access to healthcare.

Table 10 Top 5 Health Problems in Wilkarquchi

Community	N	Diagnosis	Number of Cases	% Of Population Surveyed
Wilkarquchi	20	Muskoskeletal	12	60
		Eyes	7	35
		Head	10	50
		Respiratory	7	35
		Gastrointestinal	8	40

Table 11 Characteristics of Wilkarquchi Population

Characteristics	Categories	N=20	%
Years of school	0	9	45
	1 to 3	4	20
	4+	5	25
Number people living in home	1 to 3	8	40
	4 to 6	3	15
	7+	4	20
Number of children	0 to 2	2	10
	3 to 4	4	20
	4+	11	55
Age at time of first child	12 to 15	0	0
	16-19	5	25
	20+	8	40
	Unknown	4	20
Method of cooking/heating home	Open fire	9	45
	Chimney Vent	4	20
	Gas or Enclosed	4	20
	Unknown	3	15
Hours/day spent over fire (smoke)	0-2	12	60
	3 to 4	3	15
	4+	2	10
Type of fuel used	Wood	12	60
	Other	5	25
Hours/day gathering fuel	0 to 2	4	20
	3 to 4	6	30
	4-6+	7	35
Water source for drinking	House	11	55
	Public	6	30
	River	0	0
	Unknown	3	15
Is drinking water purified	Yes	4	20
	No	13	65
How do you dispose of fecal matter	Outside	9	45
	Public Latrine	8	40
	Unknown	3	15

Macha

Fifteen villagers (N=15) in Macha, aged 25-83 (M=55.67; SD=17.74), completed the survey. Seventy-three percent (73%) of the patients surveyed were female and 27% were male. According to the INE, there were 1,335 people living in the village of Macha in 2012, estimating a response rate of 2%. The low response rate may be attributed to the fact that there is an established health clinic in Macha and it is one of the larger villages in the area. The five top health complaints were: musculoskeletal (73 %), head (53%), eyes (47%), gastrointestinal (47%), and respiratory issues (20%) (Table 11).

Approximately 40% of the surveyed population had not attended school, 53% claimed to use gas or an enclosed stove as their method of cooking, 53% stated that their drinking water was piped into their homes, and 20% claimed to purify their water. Of those who claimed to filter water, none could explain the method in which they filtered their drinking water. Nearly 53% claimed to dispose of feces using their indoor lavatory (Table 12).

The main issues seen in Macha were very similar to other villages. However, Macha is a larger, more established village. The use of gas and enclosed stoves for cooking and the use of indoor lavatories indicate that this village is more advanced than the other villages in the study population. In addition, Macha has a weekly vegetable market available that offers a variety of food options for the residents. Further, Macha has an established Bolivian health center available for the residents; therefore, results

may have been biased due to the fact that those who participated in the survey may have been in dire need of medical attention.

Table 12 Top 5 Health Problems in Macha

Community	N	Diagnosis	Number of Cases	% Of Population Surveyed
Macha	15	Muskoskeletal	11	73.33
		Head	8	53.33
		Eyes	7	46.67
		Gastrointestinal	7	46.67
		Respiratory	3	20.00

Table 13 Characteristics of Macha

Characteristics	Categories	N=15	%
Years of school	0	6	40
	1 to 3	2	13
	4+	2	13
Number people living in home	1 to 3	3	20
	4 to 6	4	27
	7+	1	7
Number of children	0 to 2	1	7
	3 to 4	5	33
	4+	4	27
Age at time of first child	12 to 15	0	0
	16-19	2	13
	20+	5	33
	Unknown	3	20
Method of cooking/heating home	Open fire	2	13
	Chimney Vent	0	0
	Gas or Enclosed	8	53
	Unknown	5	33
Hours/day spent over fire (smoke)	0-2	7	47
	3 to 4	2	13
	4+	0	0
Type of fuel used	Wood	2	13
	Other	8	53
Hours/day gathering fuel	0 to 2	8	53
	3 to 4	1	7
	4-6+	1	7
Water source for drinking	House	8	53
	Public	2	13
	River	0	0
	Unknown	5	33
Is drinking water purified	Yes	3	20
	No	7	47
How do you dispose of fecal matter	Inside	8	53
	Outside	2	13
	Public Latrine	0	0
	Unknown	5	33

Cayanta

Ten villagers (N=10), aged 36-100 (M=71.88; SD=19.64), completed the survey. Seventy-percent (70%) of patients surveyed were female and 30% were male. According to the INE, there were 201 people living in the village of Cayanta in 2012, estimating a response rate of 5%. As seen in Table 13, the five top health complaints were: musculoskeletal (73%), head (53%), eyes (47%), gastrointestinal (47%), and respiratory issues (20%).

Appoximately 60% of the surveyed population had not attended school, 50% claimed to use open fire as their method of cooking, 40% stated that their drinking water was piped into their homes, and 10% claimed to purify their water. Of those who claimed to filter water, none could explain the method in which they filtered their drinking water. Nearly 30% claimed to dispose of feces outdoors (Table 14). Access to healthcare was the main complaint of the villagers.

Table 14 Top 5 Health Problems in Cayanta

Community	N	Diagnosis	Number of Complaints	% Of Population Surveyed
Cayanta	10	Muskoskeletal	5	50.00
		Head	8	80.00
		Eyes	2	20.00
		Gastrointestinal	6	60.00
		Respiratory	5	50.00

Table 15 Characteristics of Cayanta Population

Characteristics	Categories	N=10	%
Years of school	0	6	60
	1 to 3	2	20
	4+	0	0
Number people living in home	1 to 3	3	30
	4 to 6	3	30
	7+	2	20
Number of children	0 to 2	3	30
	3 to 4	0	0
	4+	5	50
Age at time of first child	12 to 15	0	0
	16-19	1	10
	20+	7	70
	Unknown	2	20
Method of cooking/heating home	Open fire	5	50
	Chimney Vent	3	30
	Gas or Enclosed	0	0
	Unknown	2	20
Hours/day spent over fire (smoke)	0-2	2	20
	3 to 4	4	40
	4+	0	0
Type of fuel used	Wood	8	80
	Other	2	20
Hours/day gathering fuel	0 to 2	4	40
	3 to 4	0	0
	4-6+	2	20
Water source for drinking	House	4	40
	Public	3	30
	River	0	0
	Unknown	3	30
Is drinking water purified	Yes	1	10
	No	4	40
How do you dispose of fecal matter	Inside	0	0
	Outside	3	30
	Public Latrine	1	10
	Unknown	6	60

Examination of In-Home Smoke Exposure and Respiratory Symptoms

To examine the association between exposure to smoke from cooking over an open fire in the home without a chimney and respiratory issues, those with and without exposure to smoke and those with and without respiratory issues were combined for all villages. There were a total of 28 cases with exposure to smoke and respiratory illness, 34 cases of exposure to smoke with no respiratory illness, 14 cases without exposure with respiratory issues, and 31 villagers without exposure to smoke or respiratory issues (see Table 15). These numbers yield a crude odds ratio of 1.82 with a non-statistically significant 95% confidence interval of 0.82 - 4.08. Results indicated that villagers with respiratory issues were nearly two times as likely to have open fire in the home as compared to those with a chimney vent. In addition, those living in the village of Chijmu were 1.6 times likely to have respiratory issues when compared to the other villages. However, these associations were not statistically significant.

Table 16 Unadjusted Associations Between Demographics and In-Home Smoke Exposure and Respiratory Symptoms for the VCOM Survey in 2012 (Chijmu, QP, WQ, Macha, Cayanta)

Variable	Respiratory Issues n (%) *	No Respiratory Issues n (%)*	OR and 95% CI	p-value
Smoke in home (open fire)				
Yes	28 (66.67)	34 (52.31)	1.82 (0.82-4.08)	0.14
No	14 (33.33)	31 (47.69)	1.00	
Age				
< 50	15 (37.5)	34 (44.16)	0.76 (0.35-1.66)	0.49
>50	25 (62.5)	43 (55.84)	1.00	
Gender				
Male	15 (35.71)	25 (38.46)	0.89 (0.40-1.9)	0.77
Female	27 (64.29)	40 (61.54)	1.00	
Education				
0 years	16 (38.10)	32 (48.48)	0.65 (0.30-1.43)	0.29
1-4+ years	26 (61.90)	34 (51.52)	1.00	
# of People Living in Home				
0-3	13 (32.5)	37 (56.92)	0.36 (0.16, 0.83)	0.02
4+	27 (67.5)	28 (43.08)	1.00	
# of Children				
0-2	8 (19.05)	13 (19.40)	0.98 (0.37-2.6)	0.96
3-4+	34 (80.95)	54 (80.60)	1.00	
Village				
Chijmu	16 (41.03)	10 (16.95)	1.60 (0.37, 6.96)	0.53
Quesimpuco	8 (20.51)	19 (32.20)	0.42 (0.09, 1.87)	0.26
Wiikar Q	7 (17.95)	13 (22.03)	0.54 (0.11, 2.56)	0.43
Macha	3 (7.69)	12 (20.34)	0.25 (0.04, 1.47)	0.13
Cayanta	5 (12.82)	5 (8.48)	1.00	

Examination of the Reporting of Gastrointestinal Issues and the Odds of Exposure to Drinking Water from the Public Tap

To examine the association of exposure of the use of the public tap for drinking water and gastrointestinal issues, those who use the public tap for drinking water, those who have water piped into the home and those with and without gastrointestinal issues were combined for all villages. There were a total of 11 cases with exposure to water from the public tap and a gastrointestinal diagnosis, 20 cases of exposure to the public tap water with no gastrointestinal issues, 42 cases without exposure with gastrointestinal issues, and 27 villagers without exposure to the public tap water or gastrointestinal issues (see Table 16). These numbers yield a crude odds ratio of 0.35 with a statistically significant 95% confidence interval of 0.52 – 0.85. Villagers with gastrointestinal issues were nearly three times as likely to live in Chijmu as compared to those in other villages

and 1.6 more likely to not disinfect their water. However, these associations were not statistically significant.

Table 17 Unadjusted Associations Between Demographics and Use of Public Tap and Gastrointestinal Symptoms for the VCOM Survey in 2012 (Chijmu, QP, Macha, Cayanta)

Variable	Gastrointestinal Issues n (%) *	No Gastrointestinal Issues n (%)*	OR and 95% CI	p-value
Water Source				
Pubic Tap	11 (20.75)	20 (42.55)	0.35 (0.15-0.85)	0.02
Piped in home	42 (79.25)	27 (57.45)	1.00	
Disinfect Water				
No	43 (84.31)	37 (77.08)	1.60 (0.58-4.39)	0.36
Yes	8 (15.69)	11 (22.92)	1.00	
Age				
< 50	27 (45.76)	22 (37.93)	1.38 (0.66-2.89)	0.39
> 50	32 (54.24)	36 (62.07)	1.00	
Gender				
Male	20 (31.25)	27 (44.26)	0.57 (0.28-1.9)	0.13
Female	44 (68.75)	34 (55.74)	1.00	
Education				
0 years	23 (40.35)	25 (49.02)	0.70 (0.33-1.51)	0.37
1-4+ years	34 (59.65)	26 (50.98)	1.00	
# of People Living in Home				
0-3	24 (44.44)	26 (50.98)	0.77 (0.36, 1.66)	0.50
4+	30 (55.56)	25 (49.02)	1.00	
# of Children				
0-2	9 (16.67)	12 (23.53)	0.65 (0.25-1.71)	0.38
3-4+	45 (83.33)	39 (76.47)	1.00	
Village				
Chijmu	21 (37.50)	5 (11.90)	2.80 (0.57, 13.83	0.21
Quesimpuco	14 (25.00)	13 (30.95)	0.72 (0.16, 3.13)	0.66
Wiikar Q	8 (14.29)	12 (28.57)	0.44 (0.10, 2.09)	0.31
Macha	7 (12.50)	8 (19.05)	0.58 (0.12, 2.95)	0.51
Cayanta	6 (10.71)	4 (9.53)	1.00	

2014 Chijmu Trip

During the 2014 Chijmu trip, twenty-seven (27) villagers, aged 18-100 (M=44.64; SD=23.25) were surveyed. According to the municipal mayor of Chijmu, in 2014 there were 55 families and 230 inhabitants living in the community, representing an 11.74% response rate. The five top health diagnoses among the villagers surveyed were: gastrointestinal (74.07%), respiratory (25.93%), back pain (22.22%), cataracts (7.41%), and skin (7.41%). These results reflect the total population surveyed (Table 17).

Appoximately 48% of the surveyed population had attended at least 4 years of school, 96% claimed to use open fire as their method of cooking and 37% stated that they had a chimney vent in the home. Nearly 78% stated that their drinking water was received from the public tap, and 75% did not purify their water. The five who claimed to filter the water did so by boiling. Ninety-three percent (93%) claimed to dispose of feces in the river (two responses were not given) (Table 18). Again, the most common diets were reported to include potatoes, grain, corn, and wheat with occasional protein intake. Similar to the other villages and the 2012 results, the responses indicate a need to address water, sanitation, and the use of open fire as a cooking method in the homes in the village of Chijmu.

Table 18 Top 5 Health Problems of Chijmu (2014)

Community	N	Diagnosis	Number of Cases	% Of Population Surveyed
Chijmu	27	Gastrointestinal	20	74.07
		Respiratory	7	25.93
		Back Pain	6	22.22
		Eyes	2	7.41
		Skin	2	7.41

Table 19 Characteristics of the Village of Chijmu (2014)

Characteristics	Categories	N=27	% Of Population Surveyed
Years of school	0	7	25.93
	1 - 3	7	25.93
	4+	13	48.15
Number people living in home	1-3	8	29.63
	4-6	9	33.33
	7+	10	37.04
Number of children	0-2	11	40.74
	3-4	5	18.52
	4+	11	40.74
Method of cooking/heating home	Open fire	26	96.30
	Stove	1	3.70
	Grill	0	0.00
Chimney	Yes	10	37.04
	No	17	62.96
Hours/day spent over fire (smoke)	0-2	17	62.96
	3-4	10	37.04
Type of fuel used	Wood	23	85.19
	Other	3	11.11
Hours/day gathering fuel	0-2	8	29.63
	3-4	11	40.74
	4-6+	7	25.93
Water source for drinking	House	4	14.81
	Public	21	77.78
	River	1	3.70
Is drinking water purified	Yes	7	25.93
	No	20	74.07
Boil Water	Yes	5	18.52
	No	21	77.78
How do you dispose of fecal matter	River	25	92.59
	Anywhere	0	0.00
Doctor Visits	0	4	14.81
	1-3	17	62.96
	4+	5	18.52

Examination of Exposure to Open Fire in the Home and the Odds of Respiratory Issues

To examine the association between exposure to smoke from cooking over an open fire in the home without a chimney and respiratory issues, those with and without exposure to smoke and those with and without respiratory issues were combined for the village of Chijmu. There were a total of 6 cases with exposure to smoke and respiratory illness, 1 case of exposure to smoke with no respiratory illness, 11 cases without exposure with respiratory issues, and 9 villagers without exposure to smoke or respiratory issues (see Table 19). These numbers yield a crude odds ratio of 4.66 with a non-statistically significant 95% confidence interval of 0.43 – 250.42. The large confidence interval suggests that the sample size is too small. Results indicated that villagers with respiratory issues were nearly five times as likely to have open fire in the home as compared to those with a chimney vent. However, these associations were not statistically significant.

Table 20 Unadjusted Associations Between Demographics and In-Home Smoke Exposure and Respiratory Symptoms for the Chijmu 2014 Survey.

Variable	Respiratory Issues n (%) *	No Respiratory Issues n (%)*	OR and 95% CI	p-value
Smoke in home (open fire)				
Yes	6 (86.00)	11 (55.00)	4.66 (0.43, 250.42)	0.20
No	1 (14.00)	9 (45.00)	1.00	
Education				
0 years	0 (0.00)	7 (33.00)	4.24 (0.52, +inf)	0.14
1-4+ years	7 (100.00)	14 (67.00)	1.00	
# of People Living in Home				
0-3	1 (14.29)	7 (33.00)	2.89 (0.26, 157.39)	0.63
4+	6 (85.71)	14 (67.00)	1.00	
# of Children				
0-2	4 (19.05)	7 (19.40)	0.39 (0.04-3.01)	0.38
3-4+	3 (80.95)	14 (80.60)	1.00	

Examination of the Reporting of Gastrointestinal Issues and the Odds of Exposure to Drinking Water from the Public Tap

To examine the association between exposure of the use of the public tap for drinking water and gastrointestinal issues, those who use the public tap for drinking water, those who have water piped into the home and those with and without gastrointestinal issues were combined for all villages. There were a total of 18 cases with exposure to water from the public tap and a gastrointestinal diagnosis, 6 cases of exposure to the public tap water with no gastrointestinal issues, 2 cases without exposure with gastrointestinal issues, and 2 villagers without exposure to the public tap water or gastrointestinal issues (see Table 20). These numbers yield a crude odds ratio of 2.9 with a non-statistically significant 95% confidence interval of 0.17 – 47.99. Again, the large confidence interval suggests that the sample size is too small.

Table 21 Unadjusted Associations Between Demographics and Public Tap Exposure and Gastrointestinal Symptoms for the Chijmu 2014 Survey.

Variable	Gastrointestinal Issues n (%) *	No Gastrointestinal Issues n (%)*	OR and 95% CI	p-value
Water Source				
Pubic Tap	18 (20.75)	6 (42.55)	2.9 (0.17-47.99)	0.55
Piped in home	2 (79.25)	2 (57.45)	1.00	
Disinfect Water				
No	15 (78.95)	5 (63.00)	0.45 (0.05-4.24)	0.63
Yes	4 (21.05)	3 (38.00)	1.00	
Education				
0 years	6 (30.00)	1 (12.50)	0.34 (0.01-3.83)	0.63
1-4+ years	14 (70.00)	7 (87.50)	1.00	
# of People Living in Home				
0-3	7 (35.00)	1 (12.50)	0.27 (0.01, 2.96)	0.37
4+	13 (65.00)	7 (87.50)	1.00	
# of Children				
0-2	7 (35.00)	4 (50.00)	1.8 (0.25-13.32)	0.67
3-4+	13 (65.00)	4 (50.00)	1.00	

Discussion

Despite the lack of healthcare in the country, in 2011, the immunization rate for DPT and measles was nearly 80% for children ages 12-23 months in Bolivia (World Bank, 2015). In 2012, 44% of the 145 patients at the Quesimpuco Clinic and 81% of the 99 Futina Clinic patients reported being vaccinated. The majority of the patients in Futina had a personal identification card that included medical records and this may have eliminated the possibility of recall bias.

The overall main medical problem identified at the Quesimpuco and Futina Clinics and in the villages visited was gastrointestinal upset (including parasitic infection, gastritis, diarrhea, abdominal pain) possibly due to contaminated water supplies (Figures 24, 25, 26). Lack of potable water leads to dehydration, and clean, accessible water is still an issue in the rural regions of Bolivia. In addition, musculoskeletal pain and back problems from the burden of carrying heavy items over the rugged terrain were also major medical concerns identified. The high elevation combined with intense sunlight and increased ultraviolet (UV) radiation found in the Andes also increases the prevalence of eye issues in the indigenous population. Further, many individuals surveyed complained of a constant dry cough and painful breathing.

Overall, Quesimpuco is taking the correct strides in focusing on education. The general health and well-being of villagers will continue to improve if efforts are made to address water purification and basic sanitation principles in the village. For Wilkarquchi, future efforts should also consist of water purification and sanitation education. In addition, measures should be taken to educate villagers on how to

properly clean their ears. This may seem a moot point; however, this issue seemed to impact many individuals and if this practice continues it will impair the livelihood and well-being of many people in the village. Results for the village of Chijmu indicate a need to address water, sanitation, and the use of open fire as a cooking method in the homes. For Macha and Cayanta, future efforts should consist of water purification and sanitation education as previously mentioned for the other villages.

Research indicates that approximately 1 billion people of the global population do not have access to an improved water source and must use unprotected wells, springs, canals, lakes or rivers for their water needs (IOM, 2009). In addition, nearly 2.5 billion people lack access to sanitation facilities (WHO, 2013). Diarrhea is the second leading cause of death among children under 5 in the world, accounting for 2.2 million deaths and approximately 4 billion cases of diarrhea worldwide each year. Frequent diarrhea can cause malnutrition in children and make other health problems worse (USAID, 2009). It is estimated that disease burden could be greatly reduced through improved water supply, sanitation, hygiene, and water resource management (IOM, 2009).

Figure 23 Images of Common Skin Issues

For the children in the region, data obtained through the community doctor suggest that the main complaints were cough, gastrointestinal issues, and skin lesions. The two former issues can be improved with education on personal hygiene and access to clean water. The image of the leg (above) was a common skin issue (Sarcoptosis or Scabies) found throughout the villages. Cleaning linens and clothes regularly with soap and water can prevent the spread of this type of infection. The two boys (above) present classic Staphylococcal infections (Figure 23). The infections, if left untreated, can lead to further complications such as pharyngitis and Rheumatic fever. Infections such as these can also easily be prevented through the improvement of personal hygiene.

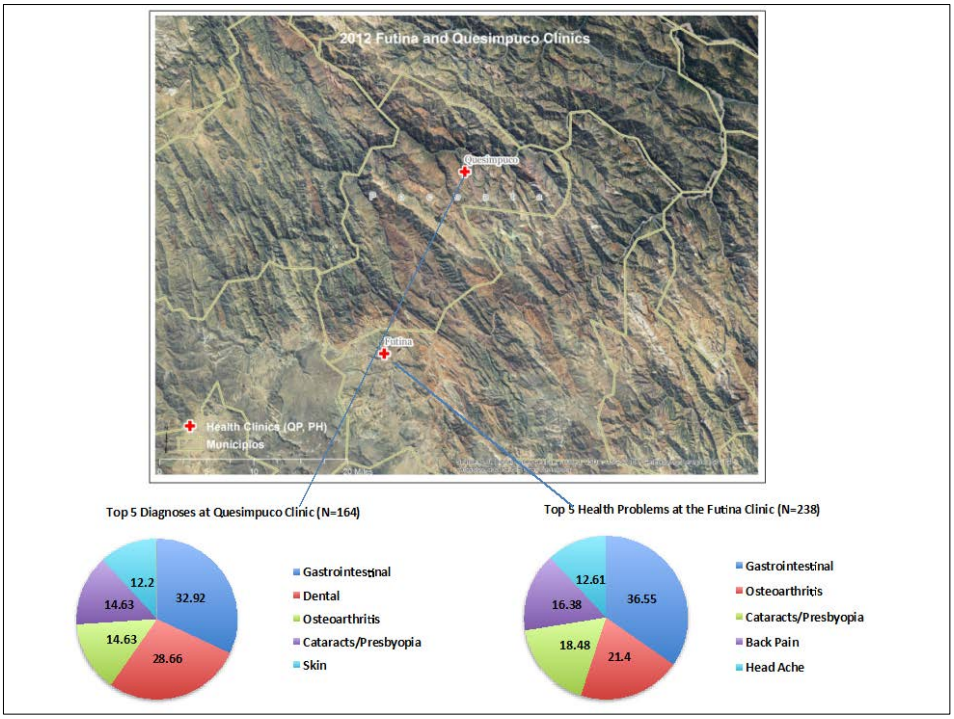

Figure 24 Top 5 Diagnoses at the 2012 Quesimpuco and Futina Clinics

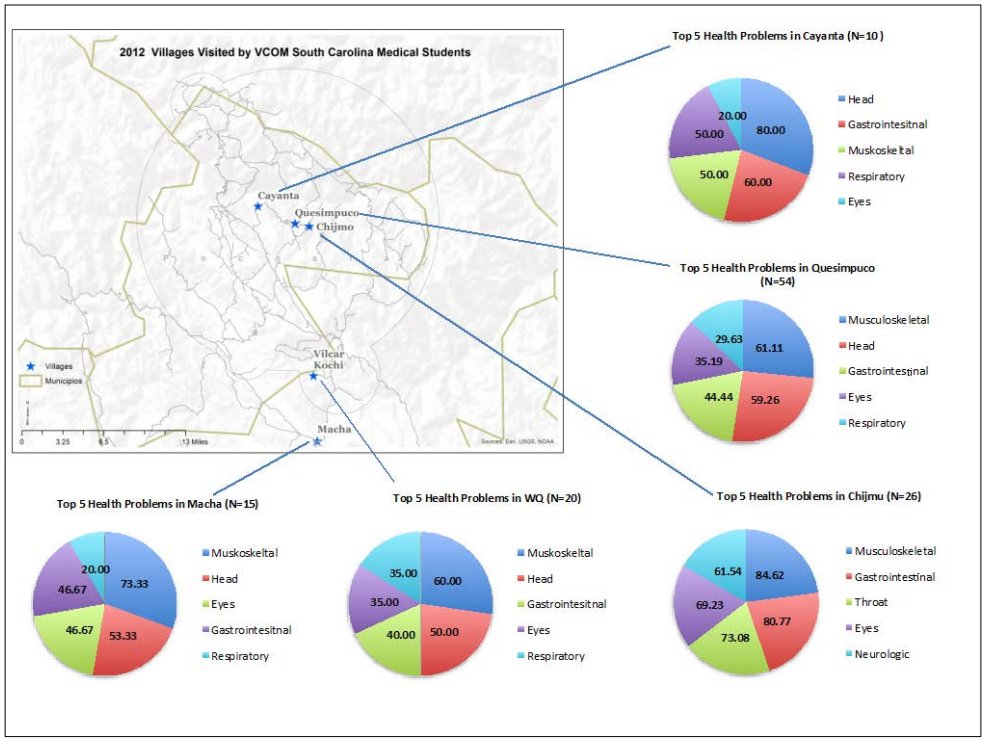

Figure 25 Top 5 Health Problems of Villages Visited by VCOM South Carolina Students

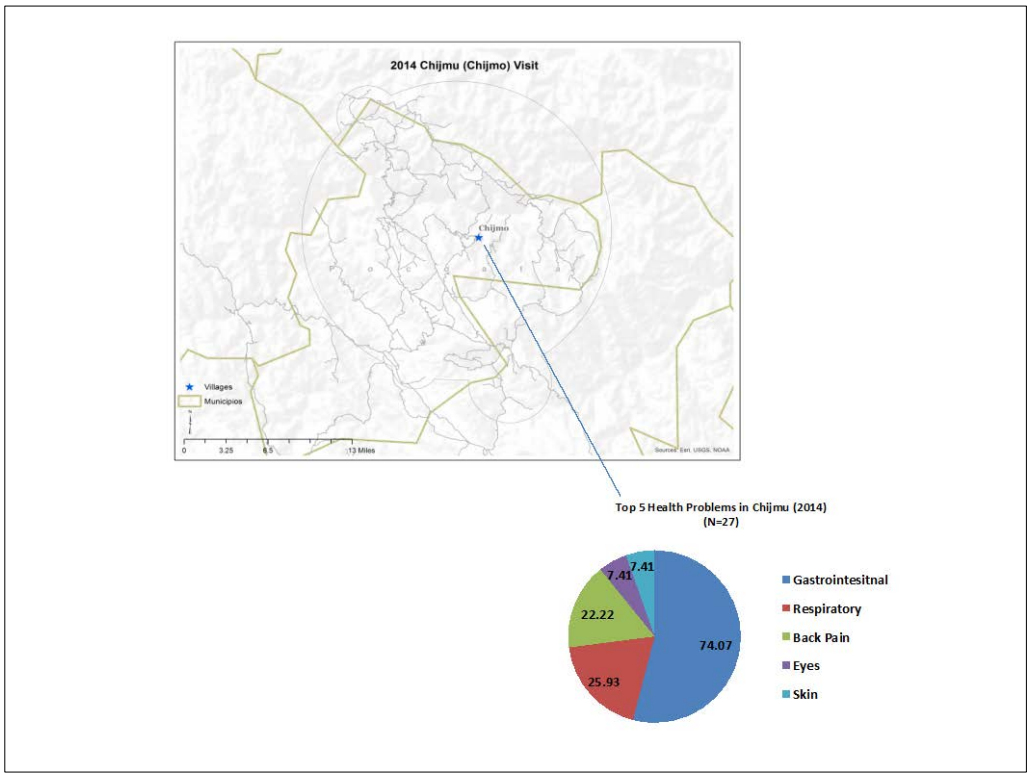

Figure 26 Top 5 Health Problems in Chijmu in 2014

CENATEC's work in the Chaupirana Valley began in Quesimpuco in 1995 and efforts have substantially improved the area to include a boarding school with permanent teachers for grades K-12, aqueduct preservation efforts, and training in appropriate technologies to address challenges in agriculture, sanitation and hygiene. For example, based on this analysis, many of the villagers claim to have water piped to a spout in their homes or use a public waterspout. Many measures can be taken to improve the health of the villagers in the Chaupirana valley; however, the most important preventative measures are providing training on disinfection techniques for clean water and personal hygiene. Many places around the world that have instilled proper hygiene techniques have seen vast improvements in the general health and well being of the overall population, especially in children. Based on the results of this research, many of the people living in the villages have chronic intestinal parasitic infection. Most of these infections may not present clinically but can have an affect on absorption of necessary nutrients. This in turn can affect the overall health of this population. Measures should be taken to ensure proper facilities for defecation; education on the importance of hand washing; and instructions and materials on how to purify drinking water should be made readily available.

In addition, wood was the most common reported fuel used for heating and cooking, and many communities in the area lack access to quality stoves to pipe smoke away from their homes. Many individuals surveyed complained of a constant dry cough and painful breathing. These health concerns may be attributed to exposure to smoke in the home. Exposure to particulate matter from wood burning fires has been associated

with increased respiratory issues, decreased lung function, premature deaths and other adverse problems. Emissions from wood burning stoves also include sulfur dioxides, nitrogen oxides, carbon monoxide, polycyclic aromatic hydrocarbons (PAHs), benzene, formaldehyde and dioxins (EPA, 2007). PAHs are of particular importance because of they are considered carcinogens, can affect the immune system, can produce reproductive and neurologic effects and may inhibit fetal development (ATSDR, 2009). In order to tackle common health problems identified by this research at the root, a culturally appropriate public health surveillance program that focuses on decreasing gastrointestinal and respiratory illness should be implemented.

Limitations

As mentioned previously, the limitations of this project include the lack of data available for the remote regions of Bolivia. Several village names that were collected on the public health assessment forms were excluded from the analysis due to the fact that geographic coordinates were not obtainable. Approximately 50% of the villagers responded to the questions on the public health questionnaire at the Quesimpuco and Futina Clinics. However, families were asked to complete the form (not necessarily individual patients), resulting in a low response rate. Furthermore, the public health questionnaire was detailed and often held up lines to see health care professionals. Limitations of data analysis include missing patient data forms (approximately ¼) and exclusion of data that could not be translated due to either illegible handwriting or lack of translation from Quechan to Spanish to English.

Overall, the sample size of the cross-sectional analyses was small especially when analyzing the village specific data, which limited the computation of stratified odds ratios. Future efforts should work to obtain a larger response rate from the village participants. In addition, surveys were only administered in specific villages and different survey instruments were used from year to year. In order to provide a complete analysis of the region, survey methods and instruments should be standardized and used throughout the region. For example, as seen in Table 21, there are discrepancies in the 2012 and 2014 Chijmu data for the number of people who claim to have chimney vents and water piped into the home. Although education of using chimney vents in the homes did occur in 2012 by CENATEC, results of the surveys should be verified using home visits. Further, it is important to note that the sample size is extremely small and the respondents were likely different from year to year thus limiting comparisons over time. In addition, in 2012, 24 villagers stated that they received drinking water in the home while 21 participants stated that they received their drinking water from the public spout in 2014. Again, results should be verified using home visits or by repeating the surveys. Standardizing survey methods and instruments, and clearly delineating collection instructions would assist in decreasing the likelihood of errors.

Table 22 Comparison of 2012 and 2014 Chijmu Data

Characteristics	Categories	2012 N=26	% 2012	2014 N=27	% 2014	% Change
Years of school	0	6	23.077	7	25.93	12.35
	1 to 3	9	34.615	7	25.93	-25.10
	4+	10	38.462	13	48.15	25.19
Number people living in home	1 to 3	7	26.92	8	29.63	10.05
	4 to 6	12	46.15	9	33.33	-27.78
	7+	6	23.08	10	37.04	60.49
Number of children	0 to 2	5	19.23	11	40.74	111.85
	3 to 4	10	38.46	5	18.52	-51.85
	4+	10	38.46	11	40.74	5.93
Age at time of first child	12 to 15	2	7.69	3	11.11	44.44
	16-19	3	11.54	6	22.22	92.59
	20+	10	38.46	12	44.44	15.56
	Unknown	11	42.31	3	11.11	-73.74
Method of cooking/heating home	Open fire	23	88.46	16	96.30	8.86
	Chimney Vent	**2**	7.69	**10**	37.03	**381.39**
	Unknown	1	3.85	1	3.70	-3.80
Hours/day spent over fire (smoke)	0-2	22	84.62	17	62.96	-25.59
	3 to 4	2	7.69	10	37.04	381.48
Type of fuel used	Wood	24	92.31	23	85.19	-7.72
	Other	1	3.85	3	11.11	188.89
Hours/day gathering fuel	0 to 2	16	61.54	8	29.63	-51.85
	3 to 4	7	26.92	11	40.74	51.32
	4-6+	1	3.85	7	25.93	574.07
Water source for drinking	House	**24**	92.31	**4**	14.81	**-83.95**
	Public	**1**	3.85	**21**	77.78	**1922.22**
Is drinking water purified	Yes	3	11.54	7	25.93	124.69
	No	21	80.77	20	74.07	-8.29
How do you dispose of fecal matter	Outside	23	88.46	25	92.59	4.67
	Unknown	1	3.85	0	0.00	-100.00

Conclusions

The recent cross-sectional surveys provided knowledge of the common health issues faced by village inhabitants of the Chaupirana Valley. Spatially outlining the major health problems and complaints of the indigenous inhabitants aids in focusing resources of SIFAT/CENATEC. In addition, using spatial data provides an effective mechanism to outline the prevalence of the diagnostic data. Many problems identified in the research are ubiquitous to the region and can be addressed similarly from village to village. Diarrhea is a common health issue across the globe. Many measures can be taken in prevention; however, the most important aspects are clean water and personal hygiene. Those places that have instilled proper hygiene and clean water programs have seen vast improvement in the general health and wellbeing of the overall population, especially in children. Providing clean, potable water to the villages will eliminate the source of many pathogens and measures should be taken in educating villages on how to purify their drinking water. The data from this study can be used as an initial outline in improving the lives of the indigenous population of the Chaupirana Valley.

CHAPTER IV

PUBLIC HEALTH SURVEILLANCE PROGRAM TO REDUCE MORBIDITY FROM DIARRHEAL DISEASE IN THE CHAYANTA VALLEY OF RURAL BOLIVIA

Introduction

Epidemiology surveillance, a monitoring and control process, plays a key role in assessing and monitoring the morbidity, mortality, determinants, distribution and prevalence of health outcomes in specific populations in hopes of preventing future harm (Frerichs, 1991). This aspect of public health is essential to identifying and prioritizing health problems and hazards in communities. With community-specific health needs identified, public health professionals and governments can allocate the appropriate workforce, training needs and resources. Further, because surveillance and monitoring provides continuous scrutiny, feedback and opportunities for change, it assists with the management of resources and organizational structure of health services in communities by helping to implement preventative programs to educate the public on community-specific health issues (Frerichs, 1991).

Background

Epidemiological surveillance of the microbiological quality of drinking water has helped to provide evidence linking exposure to disease. Certain pathogens such as hepatitis, giardiasis, cholera, typhoid, dysentery, guinea worm and schistosomiasis have been associated with the incidence and prevalence of infectious or parasitic diseases in populations (WHO, 2001). There is substantial epidemiologic evidence that suggests that improving water supply and sanitation can have a significant impact on human health.

According to the United Nations, nearly 35% of the world's population lives without basic sanitation and it is estimated that 1.8 billion people drink water contaminated with feces (Prüss-Üstün, Bos, Gore & Bartram, 2008). Eighty-eight percent (88%) of diarrheal morbidity and mortality among the young is attributed to lack of sanitation and clean water (WHO, 2014). Open defecation is thought to be a major cause of diarrhea and parasitic infection among children less than 5 years old (Patil, Salvatore, Briceno, Ganguly, Colford, & Gertler, 2014). Diarrhea is the second leading cause of death among children under 5 in the world, accounting for 2.2 million deaths and approximately 4 billion cases of diarrhea worldwide each year (IOM, 2009). Frequent diarrhea can lead to malnutrition in children and make other health problems worse. In addition, diarrhea is expensive in that it causes days missed from work and school and increases medical expenses (IOM, 2009). It is estimated that nearly 9% of the global disease burden could be reduced through improved water supply, water resource management, sanitation and hygiene (IOM, 2009). In Bolivia, as of 2012, less than fifty percent (50%) of the population reported using improved sanitation facilities. Further, only sixty-nine (69%) of the rural population reported having improved access to drinking water sources (INE, 2012). As of 2010, it was reported that less than 30% of wastewater in the country was treated and this is concentrated in urban areas (PAHO, 2013).

Reducing the number of preventable illnesses due to poor water quality and lack of sanitation requires an understanding of the magnitude of the problem in the targeted villages. Further, prevention efforts done by other organizations in similar situations help

provide a key to methods that have worked in the past. In addition, public health surveillance provides methods to understanding the magnitude of health problems in communities. The objective of this effort is to design a public health surveillance system in the remote areas of rural Bolivia so that village leaders and stakeholders can implement a plan to better understand the health of the population.

Methods

Surveillance System

In order to tackle common health problems identified from the recent cross-sectional analysis (parasites, anemia, respiratory infections etc.) at the root, a culturally appropriate epidemiologic surveillance program that focuses on diarrhea morbidity, basic sanitation and water purification was developed to assist SIFAT/CENTATEC and the local community doctor in setting up a desired Community Health Watch Group. The surveillance system for the villages near Quesimpuco (Chaupirana Valley) was designed using the World Health Organization's (WHO) *Communicable disease surveillance and response systems: Guide to monitoring and evaluating* (WHO, 2006). The WHO guide depicts eight core functions of surveillance systems**:** case detection, case registration, case confirmation, reporting, data analysis and interpretation, epidemic preparedness, response and control, and feedback from the systems to the data providers, stakeholders and decision-makers (WHO, 2006). The WHO Guide was developed for communicable disease and surveillance implementation of monitoring at the country level (WHO, 2006); therefore, the surveillance system that was developed for this research was limited to steps that only include pertinent information in order to create a

successful surveillance program at the village level (see Figure 27). Scarcity of resources and personnel are a primary concern and must be considered when developing a surveillance system in rural regions of developing countries. As pointed out by Frerichs (1991), a costly extensive surveillance system may cause more harm than good in developing countries (Frerichs, 1991).

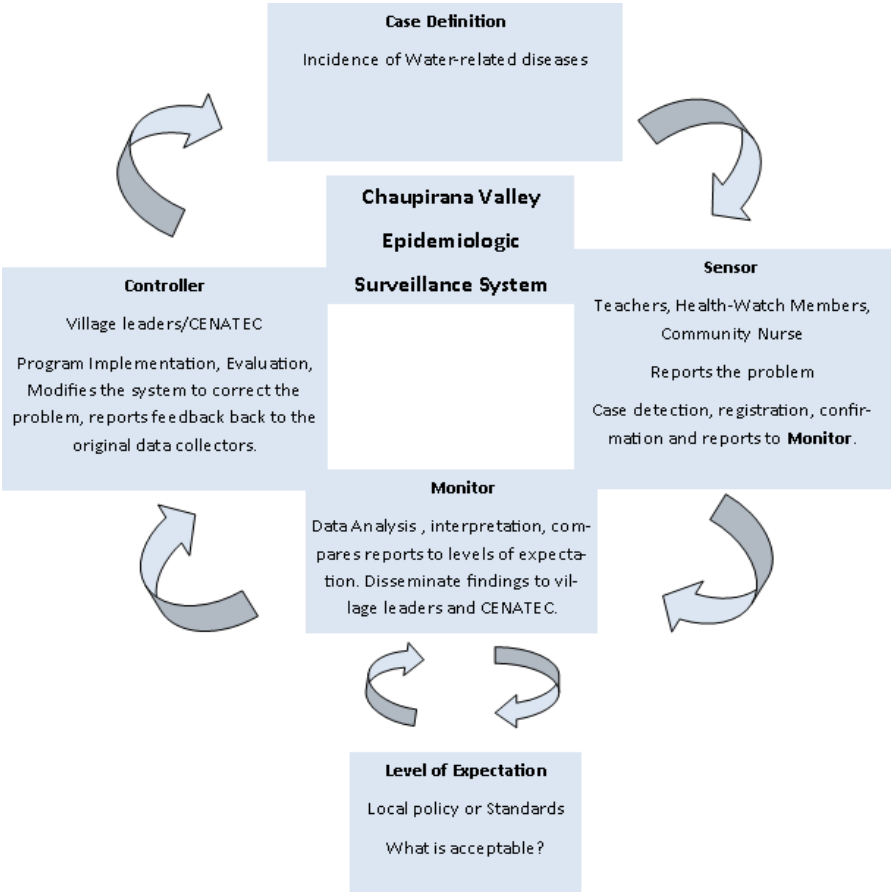

Figure 27 Steps of the Chaupirana Valley Epidemiologic Surveillance System. Adapted from Figure 1 of Frerichs, 1991.

For developing countries, Frerichs (1991) identifies four key essential components in a public health surveillance program similar to that of the WHO guidelines:

1. Sensor - The sensor is similar to WHO's case detection, registration, confirmation and reporting steps. The sensor is responsible for "identifying the state of health of a population under observation" and sending a signal to the monitor. The sensors at the village level may include teachers or a group of individuals trained to identify problems such as diarrheal incidence, water quality and hygiene issues in the community. Example data collection forms were developed as part of this research.
2. Monitor – The monitor is similar to the data analysis, interpretation and reporting steps in the WHO guidelines. The monitor is responsible for comparing the state of health with the expected, acceptable levels. The community doctor may play the role of the monitor at the village level. The monitor must be able to review the information sent in from the sensors, track problems successfully and report information to the controller(s).
3. Level of Expectation – The Level of Expectation is similar to the epidemic preparedness step in the WHO model. These are predetermined expectations or acceptable levels that are described in local policy or standards. If these standards do not exist, they are defined prior to the implementation of the surveillance program. If the monitor reports that the level of expectation is not met, a signal is sent to the controller.

4. Controller - The controller is similar to the control and feedback steps of the WHO Guidelines. The controller is a person or group that has the ability to correct problems to decrease disease in the population. Once a remedy has been applied and the level of expectation has been met, then no further action is required. However, if the level of expectation continues not be met, the feedback loop persists until the problem is corrected. The controller at the village level may be community leaders and/or CENATEC.

For this research, the structure of the surveillance system was developed in detail for each of the core functions to include standards and guidelines, coordination activities and recommended monitoring and evaluation strategies to ensure quality of the program. In addition, Epi Info, a data collection and statistical analysis software with GIS capabilities developed by the Center for Disease Control and Prevention (CDC), was used to develop a standard format and forms for the surveillance system (CDC, 2013). Data records were entered into EPI Info for the 2014 Chijmu villagers as an example of how the system can be used. The use of Epi Info will help to standardize data collection procedures for analysis and reporting purposes, easily produce disease counts amongst many variables such as age, gender and village, and to customize maps according to village-specific needs. Epi Info can also easily be used in areas with limited network connectivity. The use of Epi Info will allow for an area with a limited health infrastructure to keep records of health data from year to year (Frerichs, 1991).

Results

The ultimate goal of this community, water-quality and hygiene surveillance system is to assess the safety of the water distributed to the community and implement the use of hand-washing stations so that public health hazards are eliminated (WHO, 1997). Thus, water-quality and sanitation surveillance requires a structured framework that reflects the goal of eliminating harmful pathogens and distributes responsibilities to the participating community members and village leaders.

Sensor

The sensor at the village level will consist of lay people (such as teachers and willing individuals) who will be trained as Community Health Watch Investigators (CHWIs) to test the water supply, install and monitor hand washing stations, and report vital events occurring in their communities. The CHWIs will be responsible for collecting the data and sending information to the monitors (local community nurse and doctor) on a quarterly basis (every 3 months).

It is well known that feces contaminated water can produce parasitic infections and those who drink untreated water can become ill. Testing for microbiological contaminants is imperative to determine if the water supply is contaminated. Thus, to better understand and minimize risks of health effects caused by the consumption of contaminated water, it is important to identify the pathogen(s). Pathogens can consist of microorganisms that include bacteria, viruses and parasites. There is technically no safe level established for pathogens in drinking water. In order to quantify the magnitude of the problem, water quality indicators can be used to determine the extent of the

contamination. Water quality indicators include turbidity, total coliforms, fecal coliforms and E. coli, and fecal indicators. The use of indicators is often preferred to measurements of pathogenic organisms in the water due to the difficulties in detecting small numbers (EPA, 2013). The controller will be responsible for identifying the most appropriate technology for water-quality testing and training the sensors on how to use and record the results of all testing (see controller section for more information). The quantitative summary of water-quality indicators will be reported to the monitor by the sensor for evaluation purposes. The indicators will be entered into the Water Quality Survey Epi Info Form (Figure 28, form adapted from WHO, 1997) and used to evaluate the improvement of water-quality on a regular basis (WHO, 1997).

In addition, washing hands with soap at key times and treating water at the point-of-use are the most effective ways of improving the prevalence of illness from the consumption of contaminated water (USAID, 2005). The Sensors will also be responsible for conducting sanitary inspections and hygiene surveys using the standardized Sanitary Inspection Survey Epi Info Form (Figure 29). The inspection forms were designed and provided as a simple means of assessing hazards associated with hygiene and sanitation. These forms will be reviewed by the monitor for quality assurance and used to determine if action is needed.

Example of Community Water-Quality Survey Form

Community or Village

Date of Visit

Source Type (example: stream, river, ground)

System type:

open/closed

piped/unpiped

Population

Number of Households in Village

School?

Number of Public Taps (Standpipes)

School tap?

Number of house connections (taps)

Total Village Coverage = no. standpipes and taps x 100% / no. households

System Functioning

Water entering system on day of inspection?

School taps operating?

Public taps operating?

Supply all day?

Home taps operating?

Supply all year?

Water Quality

Thermotolerant (faecal) coliform count per 100ml

Inspector

Classification Risk Scheme for Faecal Coliforms in Water Supplies

0 per ml - Category A - In conformity with WHO Guidelines

1-10 per 100 ml - Category B - Low Risk

10-100 per 100 ml - Category C - Intermediate Risk

100-1000 per 100 ml - Category D - High Risk

> 1000 per 100 ml- Category E - Very High Risk

Figure 28 Water Quality Surveillance Form

Example of Sanitary Inspection Survey Form

Community or Village

Date of Visit

Source Type (private or public handwashing stations)

System type for Latrines

- public
- private

Population

Number of Households in Village

School?

Number of Handwashing Stations

School handwashing station?

Observation of Handwashing Activity?

School Latrines Available?

System Functioning of Sanitary Stations

Water in public system on day of inspection?

School handwashing stations operating?

Soap available on day of inspection?

Soap supply all day in schools?

Public Latrines operating?

School Latrines operating?

Risk Score for Sanitary Inspection

- 0 - No Observed Risk
- 1-3 - Low Risk
- 4-6 - Intermediate Risk
- 7-10 - High Risk

Observations or Comments

Inspector

Figure 29 Sanitary Surveillance Form

Monitor

The monitors at the village level will consist of the community nurse and doctor who will analyze the data from the sensors, gather and report diarrheal incidence and, report all results to the controller(s). The monitors will also provide feedback to the CHWIs during monthly meetings. The surveillance system is designed to regularly monitor water-quality data, sanitation and diarrheal disease trends, and to provide continuously updated information on the health of the villagers in the rural areas. Epi Info medical and socio-economic forms (Figures 31, 32, 33) were developed to provide a standard format for health data collection for the surveillance system. The use of Epi Info will help to standardize data collection procedures for analysis and reporting purposes, and easily produce disease counts and quantify health issues amongst the different villages. Epi Info allows users to easily build forms, enter and modify data, and search for records within a database. Simple statistics, tables, graphs, and maps are easily produced and saved within the database. The stored data can easily be shared with the controllers and saved for future data analysis (CDC, 2013).

Socio Economic Survey

Community | Date of Birth | Patient Number | Gender

1. What is your occupation/community role? Ex. Potatoe farmer/Water Mayor

2. How many years of school have you attended?

3. How many people live in your home?

4. How many children do you have?

5. How old were you when you had your first child?

6. Describe how you cook food/heat your home?

7. Chimney Vent

8. How many/hours/day do you spend near a fire (in smoke)?

9. How do you fuel the fire?

10. How many hours/day do you (or a family member) spend gathering fuel?

11. Where do you get your drinking water from?

12. Do you boil or purify your drinking water?

12a. If so, how do you purify?

13. How far do you have to travel to get water?

14. What is the most common method for disposing of fecal matter in your village?

15. Does your diet consist of:

Starches | Grains | Proteins | Vegetables | Fruit

16. How many times have you seen a doctor?

17. Have you been vaccinated?

18. What do you think is the number one health problem in your community?

Figure 30 Socio-economic Surveillance Form

Medical Form

Date | Patient Number | Age | Gender: Male / Female

Blood Pressure | Heart Rate | Temperature | Respiratory Rate | Weight (kg)

Height (cm) | Chief Complaints | Allergies

General Problems
- Weight loss or gain
- Fatigue
- Fever or Chills
- Weakness
- Trouble Sleeping

Head
- Headache
- Head Injury

Neck
- Lumps
- Swollen Glands
- Pain
- Stiffness

Eyes
- Vision
- Glasses or Contacts
- Pain
- Redness
- Blurry or double vision
- Flashing lights
- Specks
- Cataracts
- Glaucoma

Nose
- Stuffiness
- Disharge
- Itching
- Nosebleeds
- Sinus Pain

Throat
- Teeth
- Gums
- Bleeding
- Dentures
- Sore tongue
- Dry Mouth
- Sore throat
- Hoarseness
- Thrush

Ears
- Decreased Hearing
- Ringing in Ears (tinnitus)
- Earache
- Drainage

Neurologic
- Dizziness
- Fainting
- Seizures
- Weakness
- Numbness
- Tingling
- Tremor

Musculoskeletal
- Muscle or joint pain
- Stiffness
- Back Pain
- Redness of joints
- Swelling of joints
- Trauma

Respiratory
- Cough (dry or wet, productive)
- Sputum (color and amount)
- Coughing up blood (hemoptysis)
- Shortness of Breath (dyspnea)
- Wheezing
- Painful Breathing

Cardiovascular
- Chest pain or discomfort
- Tightness
- Palpitations
- Shortness of Breath with Activity
- Difficulty Breathing Lying Down
- Sudden awakening with SOB
- Swelling

Skin
- Rashes
- Lumps
- Itching
- Dryness
- Color Changes
- Hair and Nail Changes

Psychiatric
- Nervousness
- Memory Loss
- Depression
- Stress

Vascular
- Calf Pain (claudication)
- Leg Cramping

Doctor or Nurse Initials

Figure 31 Medical Surveillance Form

Medical Form (Continued)

Gastrointestinal

- [ ] Swallowing Difficulties
- [ ] Heartburn
- [ ] Change in appetite
- [ ] Nausea
- [ ] Change in bowel habits
- [ ] Rectal Bleeding
- [ ] Constipation
- [ ] Diarrhea
- [ ] Yellow eyes or skin

Urinary

- [ ] Frequent
- [ ] Urgency
- [ ] Burning or Pain
- [ ] Blood in urine
- [ ] Incontinence
- [ ] Change in urinary strength

Endocrine

- [ ] Heat or cold intolerance
- [ ] Sweating
- [ ] Frequent Urination (polyuria)
- [ ] Thirst (polydypsia)
- [ ] Change in appetite (polyphagia)

Genital Male

- [ ] Pain with Sex
- [ ] Hernia
- [ ] Penile discharge
- [ ] Sores
- [ ] Masses or pain
- [ ] Erectile dysfunction
- [ ] STDs

Gential Female

- [ ] Pain with sex
- [ ] Vaginal Dryness
- [ ] Hot Flashes
- [ ] Vaginal discharge
- [ ] Itching or rash
- [ ] STDs

Diagnosis

- [ ] Diarrhea
- [ ] Gastritis
- [ ] Stomach Pain
- [ ] Parasites
- [ ] Dehydration
- [ ] Cough
- [ ] Headache
- [ ] Sore Throat
- [ ] Fever
- [ ] Common Cold
- [ ] Back Pain
- [ ] Leg Pain
- [ ] Rash
- [ ] Sores
- [ ] Cataracts
- [ ] Presbyopia

Notes (Diagnoses)

Doctor/Nurse Electronic Signature

Today's Date

Figure 32 Medical Surveillance Form Continued

Level of Expectation

As mentioned previously, the goal of the community water-quality surveillance program is to assess the safety of the water distributed to the community so that public health hazards are eliminated. However, depending on the type of water supply available, surveillance structures and activities can drastically differ among countries, regions and communities (WHO, 1997). Scarcity of local resources and lack of background knowledge and personnel are primary concerns. Surveillance activities and expectations should be adapted to local conditions (Frerichs, 1991 & WHO 1997). According to the WHO, factors influencing surveillance activities include: water-supply systems size and type; available equipment; training of personnel; community participation; geographical and climatological conditions, and the communication and transport infrastructure (WHO, 1997). The controllers (village leaders and CENATEC) must work together to determine feasible expectations for the remote villages being served.

For example, the WHO guideline for drinking water is that *E. coli* and fecal coliform bacteria should not be detected in a 100-ml sample of water (WHO, 1997). This may be a difficult guideline to reach for developing countries. However, the WHO offers guidelines that represent progressive improvement of water supplies if *E. coli* is detected and cannot meet the initial guideline. For example, the use of a risk classification scheme for fecal coliform or *E. coli*, where 0 colony forming units (CFU)/100 mL is “in conformity with WHO guidelines”, 1-10 is “low risk”, 10-100 is “intermediate risk”, 100-1000 is “high risk”, and >1000 is “very high risk” is often used

as guideline for developing countries (WHO, 1997). Further, minimal level of analysis can easily include testing for indicators of feces pollution (thermotolerant (faecal) coliforms), turbidity, and chlorine residual and pH (if the water is disinfected with chlorine) (WHO, 1997).

Currently hand washing stations and public latrines do not exist in many of the villages in the Chaupirana Valley. For this reason, current standards for the sanitation and hygiene programs do not exist and should be defined prior to the implementation of the surveillance program.

Controller

The controller at the village level will consist of community leaders and CENATEC. The controller is responsible for correcting problems and decreasing disease in the population. Thus, the controller is ultimately accountable for the success of the surveillance system and must organize the system for progress.

For example, in order to minimize health effects, it is important to understand where residents are receiving their drinking water. Mapping out the sources of where people are receiving their water would be a useful tool to help with public health interventions and surveillance. In addition, pathogens in feces enter a water source through open defecation and improper disposal of wastes. Providing improved latrines and teaching the community on proper disposal methods of animal and human feces will help improve the problem (USAID, 2005). In addition, water pathogens are commonly spread through food or water that has been contaminated with human or animal feces. Teaching the public to wash hands before eating, properly wash fruits and vegetables

before consuming, and not putting soil and hands in the mouth would help improve the transport of water born disease. Further, improving access to safe drinking water at the community level would greatly minimize health effects from the consumption of contaminated water (USAID, 2005).

Ultimately, to be successful, water-quality, hygiene and sanitation surveillance must be well planned. The controller is responsible for securing the resources for the provision of equipment and training; determining the standard quality of the drinking-water supply; identifying sources of contamination; and securing involvement of communities in the surveillance process (Figure 33). In addition, the controller is responsible for developing and implementing community-based education in hygiene (WHO, 1997).

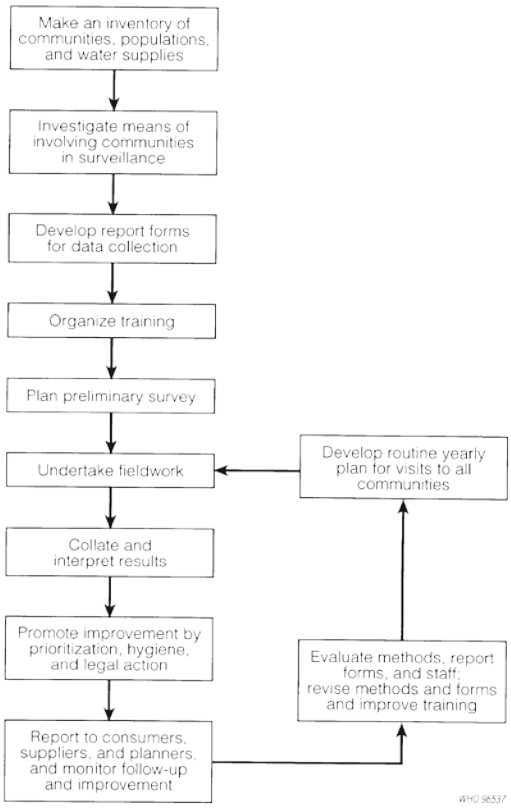

Figure 33 WHO's Sequence in Development of a Surveillance Program (WHO, 1997)

Discussion

Ensuring a safe, potable water supply alone is insufficient to ensure the health and well being of the indigenous people of Bolivia. Research suggests that there are many stages in the collection, storage, food handling, and disposal of excreta, which can contaminate a water supply with pathogens from feces. Washing hands with soap at key times and treating water at the point-of-use are the most effective ways of improving the prevalence of illness from the consumption of contaminated water (USAID, 2005). Using filters made from ceramic clay and sand, chlorination, solar disinfection and boiling water are all successful treatment methods useful for removing parasites from the water supply (EPA, 2013). Water should also be stored in covered, clean containers. Providing disinfection materials to the communities is essential to the success of the public health surveillance program. Communities should also be educated on the prevention and treatment of diarrheal disease. Education should include the risks of dehydration and the importance of consuming clean, purified water during sickness.

Research also indicates that hand washing with soap is one of the most effective and inexpensive ways to prevent diarrheal diseases and could reduce the incidence of diarrhea by nearly half and deaths from acute respiratory infection by a fourth (Zhang, 2013). However, according to available literature, the practice of hand washing is difficult to promote and includes significant challenges of transforming knowledge into behavioral change. Unfortunately, hand washing with soap remains low with rates reported as low as 5–15 % (Scott et. al, 2003). Assuring availability and affordability of hand washing supplies and infrastructure is also a major limitation to the promotion of

correct hand washing practices (Zhang, 2013). According to the USAID, the challenge is to transform the abstract idea of washing hands with soap into an automatic behavior performed at each social-ecological level. Turning the practice of hand washing to an ingrained habit could cut deaths from diarrhea by almost half and deaths from acute respiratory infections by one-fourth (USAID, 2005).

In addition, open defecation is thought to be a major cause of diarrhea and parasitic infection among children under 5 years old (Patil et al, 2014). Poor sanitation and hygiene account for 7% of deaths in undeveloped countries (Sarah & Graham, 2014). Improved access and use to sanitation facilities, which are defined as facilities that prevent human feces from re-entering the environment, can reduce open defecation practices. However, few studies have been conducted in rural areas of low-income countries and networked sewerage is challenging to achieve and expensive.

Limitations

For this surveillance system, challenges may arise in gathering resources for and training personnel in the use of water quality testing equipment. As described previously, to be successful, the controller should secure the resources for the provision of equipment and training. This aspect of the surveillance system may take time to develop and patience should be executed before implementing a rushed plan. In addition, in order to use the Epi Info forms designed for this surveillance system, small electronic devices such as tablets or IPads should be purchased for the CHWIs to enter data in the field. Further, future efforts should work to translate the forms to Spanish. This can easily be accomplished through the translation database in Epi Info 7.

Conclusions

Epidemiology surveillance of water-quality, sanitation and hygeine plays a key role in assessing and monitoring the morbidity of diarrheal disease. With community-specific health needs identified by sensors and monitors, controllers can allocate the appropriate workforce, training needs and resources to ensure progress in community health initiatives. Further, the use of EpiInfo can assist with the management of data and organizational structure of health data in the remote villages of Bolivia. Ensuring a safe, potable water supply, proper hygiene infrastructure such as hand washing stations, and latrines can greatly improve the lives of the indigenous people of the Chayanta River Valley.

CHAPTER V

CONCLUSIONS

The core functions of public health are to assess community health, promote policies that are evidenced based, and assure availability and access to health services. This research focused on the assessment portion of the core functions by aiming to monitor the environmental and health status of the indigenous people in the Chayanta of rural Bolivia. The purpose of this dissertation was to examine approaches to improve knowledge of critical healthcare barriers and issues in the defined study area. The results of this research can ultimately help inform, educate and empower SIFAT/CENATEC and village leaders to partner to develop policies and plans that support the use of the developed public health surveillance program for the Chaupirana Valley. In addition, the GIS platform that was developed to document access to healthcare and mapping disease distributions in the region focused efforts on eliminating risks, assisting with community health, and improving health services in the area. Chapter II presented methods to identify gaps in access to healthcare based on distances between rural villages and established Bolivian clinics in the Chaupirana Valley. Chapter III defined the needs of the rural, indigenous people of the Chaupirana Valley through cross-sectional assessments of basic living conditions and health problems. Disease patterns were identified to assist in focusing resources of stakeholders. Chapter IV developed a public health surveillance program to reduce morbidity related to water-borne disease in the Chaupirana Valley and so that village leaders and stakeholders can better understand the health of the population.

Lessons Learned

Chapter II focused on the use of GIS in solving critical public health problems such as access to healthcare. The length in miles to the nearest Bolivian Health Clinic, regardless of type (Health Post, Health Center or General Hospital) from each village in the project area ranged from 0.01 to 11.24 miles. The nearest Health Center (Maternal/Child Health) from each village ranged from 0.01 to 18.19 miles. The Closest Facility and Location-Allocation analysis tools in the Network Analyst Extension of ArcGIS effectively contributed to determining an optimal location for a new clinic in the village Quehualluni. These tools were effective in modeling paths from villages to the nearest health clinics in order to identify gaps in service in the Pocoata Municipality of Bolivia. GIS can be used as an effective tool for summarizing and visualizing geographical differences in availability and accessibility of health clinics in rural areas. This instrument can effectively assist governments and non-governmental organizations in solving critical public health problems such as access to healthcare.

Chapter III presented a summary of common health issues faced by the inhabitants of select villages of the Chaupirana Valley. Again, GIS proved to be an effective mechanism to outline diagnostic data and in mapping disease prevalence. This research provides a spatial health information infrastructure that can be used by village leaders and CENATEC in determining intervention strategies to eliminate disease and common adverse health outcomes. Many problems identified in the research are ubiquitous to the region and can be addressed similarly from village to village. The main medical problems identified in the villages visited were gastrointestinal illness (parasitic

infection, gastritis, diarrhea, abdominal pain), musculoskeletal pain and back problems an increased prevalence of eye issues, and respiratory illness. Many measures can be taken in prevention; however, the most important aspects are clean water and personal hygiene. As described previously, the data from this study can be used as an initial outline in improving the lives of the indigenous population of the Chaupirana Valley.

Chapter IV presented the outline of an epidemiology surveillance program that can be used in the remote regions of the Chayanta province. Public health surveillance is essential to identifying and prioritizing health problems and hazards in communities. Further, because surveillance and monitoring provides continuous scrutiny, feedback and opportunities for change, it assists with the management of resources and organizational structure of health services. With community-specific health needs identified by sensors and monitors, controllers can allocate the appropriate workforce, training needs and resources to ensure progress in community health initiatives. Further, the use of EpiInfo can assist with the management of data and organizational structure of health data in the remote villages of Bolivia. Ensuring a safe, potable water supply and proper hygiene infrastructure can greatly enhance the lives of the indigenous people of the Chayanta River Valley.

Limitations

As described previously, the limitations of this project include the lack of data available for the remote regions of Bolivia. Research challenges in Bolivia are related to cultural barriers, harsh topography, and lack of access and allocation of resources from governments. In rural Bolivia in particular, there is limited health infrastructure that also limits records of historical data. Therefore, it is often difficult to collect diagnostic data or provide follow-up care to determine if needs are being met, whether treatment is effective, if medicine is being taken as directed, or determine whether public health programs are effective. In addition, in Quesimpuco, due in part to the boarding school, children often migrate in and out of the villages and are lost to follow-up. Further, tribal affiliations of adjacent villages are often political and often disagree about the amount of supplies delivered by the Bolivian Government to each village. Many roads to small villages are often not navigable by vehicle and present limitations in providing supplies and resources. Further, several village names that were collected on the public health assessment forms were excluded from this analysis due to the fact that geographic coordinates were not obtainable.

Future Directions

CENATEC's work in the Chaupirana Valley has substantially improved the area on many levels. Although there is still work to be done, the most important focus should be on preventative measures to provide training on clean water and personal hygiene. Based on the results of this research, many of the people living in the villages have a chronic intestinal parasitic infection and this can affect the overall health of this

population. Measures should be taken to ensure proper facilities for defecation, materials and education on the importance of hand washing should be nurtured in the villages, and instructions and materials on how to purify drinking water should be made readily available.

Another issue is access and availability to well-trained medical workers. In many instances, individuals knew they needed to seek care but the distance was too great to travel. Increasing the volume of local, trained healthcare workers could help significantly in addition to possibly adding a new clinic location. In conclusion, implementing the tailored public health surveillance program and providing basic healthcare and education that is sustainable in the remote and underserved communities can play a critical role in future programs and can continue to foster community capacity and improve the quality of life of the indigenous people of Bolivia.

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APPENDIX

2012 Quesimpuco and Futina Public Health Assessment

Cuestionario Familiar y de Salud Pública

Bolivia, 2012

FECHA Date_____ COMUNIDAD Community_____

Datos familiars Family Data

- Nombre del jefe de familia Head of family_____
- Nombre de la esposa Wife's name_____
- Cuántas personas en el núcleo familiar How many members in the nuclear family_____

NOMBRE Name	EDAD Age	SEXO Gender	LUGAR DE NACIMIENTO Birth Place	ATENCION HOY

- Alguno de los hijos ha muerto en su niñez Has any of your children died in childhood

EDAD EN LA QUE MURIO Age when he/she died	CAUSA, SI SE CONOCE Reason of death

- El padre o la madre de alguno de los hijos a muerto? Has either parent died?
    - De qué murió Reason of death_____
    - Hace cuánto tiempo murió_How long ago did he/she died? _____
    - Cuando alguien de la familia se enferma, a dónde lo llevan a curarse? When there is an illness or an emergency, where do you go for assistance? _____

- En el mes pasado, alguien de su familia se ha enfermado? Has anyone in your family been sick over the last month? _____

- De qué se enfermó What did she/he had_____

- En las últimas dos semanas algún(a) niña(o) ha tenido diarrea? Has anyone of your children had diarrhea in the last two weeks?_____
- Los niños de su familia han sido vacunados? Have the children in your family bee vaccinated? _____ Dónde? Where?_____
  - Tiene el registro de vacunas de sus hijos al día? Are your children vaccination record up to date?_____
- Ha asistido a la escuela/colegio? Have you attended school?____ Hasta qué curso estudio? What was the highest grade you completed?_____
- Algún miembro de su familia ha tendio algún accidente en el último año? Has any member of your family had an accident over the last year? _____
  - Cómo fue el accidente? What kind of accident? _____

Cuales de las siguientes servicios se provee en su comunidad. Which of the following services are provided in your community?	De la lista siguiente cuales crees que son mas importantes. From the list below which services are more important to you?
____Acceso al cuidado médico/hospital Access to medical care ____Vivienda Housing ____Nutrición balanceada Nutrition ____Humo en la casa Smoke in the house ____Agua limpia/potable Drinking water ____Duchas Showers ____Servicio Sanitario Latrines/bathrooms ____Agua para la chakra Water for the farms ____Seguridad alimentaria Food security ____Escuela/Colegio School facilities	____Acceso al cuidado médico/hospital ____Vivienda ____Nutrición balanceada ____Humo en la casa ____Agua limpia/potable ____Duchas ____Servicio Sanitario ____Agua para la chakra ____Seguridad alimentaria ____Escuela/Colegio

2012 South Carolina and 2014 Chijmu Assessment

Name: _____

Date: _____ DOB: _____

BP: _____ HR: _____ Temp: _____ RR: _____

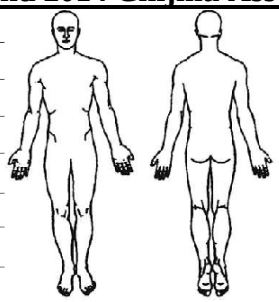
PMH: _____

_____

Cheif Complaints: _____

_____

_____



Weight (lbs): _____ Allergies: _____

General-
- ☐ Weight loss or gain
- ☐ Fatigue
- ☐ Fever or chills
- ☐ Weakness
- ☐ Trouble sleeping

Head-
- ☐ Headache
- ☐ Head injury

Eyes-
- ☐ Vision
- ☐ Glasses or contacts
- ☐ Pain
- ☐ Redness
- ☐ Blurry or double vision
- ☐ Flashing lights
- ☐ Specks
- ☐ Glaucoma
- ☐ Cataracts

Nose-
- ☐ Stuffiness
- ☐ Discharge
- ☐ Itching
- ☐ Nosebleeds
- ☐ Sinus pain

Throat-
- ☐ Teeth
- ☐ Gums
- ☐ Bleeding
- ☐ Dentures
- ☐ Sore tongue
- ☐ Dry mouth
- ☐ Sore throat
- ☐ Hoarseness
- ☐ Thrush
- ☐ Non-healing sores

Ears-
- ☐ Decreased hearing
- ☐ Ringing in ears (tinnitus)
- ☐ Earache
- ☐ Drainage

Respiratory-
- ☐ Cough (dry or wet, productive)
- ☐ Sputum (color and amount)
- ☐ Coughing up blood (hemoptysis)
- ☐ Shortness of breath (dyspnea)
- ☐ Wheezing
- ☐ Painful breathing

Cardiovascular-
- ☐ Chest pain or discomfort
- ☐ Tightness
- ☐ Palpitations
- ☐ Shortness of breath with activity (dyspnea)
- ☐ Difficulty breathing lying down (orthopnea)
- ☐ Sudden awakening from sleep with shortness of breath (Paroxysmal Nocturnal Dyspnea)
- ☐ Swelling (edema)

Neck-
- ☐ Lumps
- ☐ Swollen glands
- ☐ Pain
- ☐ Stiffness

Skin- (See Diagram)
- ☐ Rashes
- ☐ Lumps
- ☐ Itching
- ☐ Dryness
- ☐ Color changes
- ☐ Hair and nail changes

Musculoskeletal-
- ☐ Muscle or joint pain
- ☐ Stiffness
- ☐ Back pain
- ☐ Redness of joints
- ☐ Swelling of joints
- ☐ Trauma

Vascular-
- ☐ Calf pain with (Claudication)
- ☐ Leg cramping

Breasts-
- ☐ Lumps
- ☐ Pain
- ☐ Discharge
- ☐ Self-exams
- ☐ Breast-feeding

Gastrointestinal-
- ☐ Swallowing difficulties
- ☐ Heartburn
- ☐ Change in appetite
- ☐ Nausea
- ☐ Change in bowel habits
- ☐ Rectal bleeding
- ☐ Constipation
- ☐ Diarrhea
- ☐ Yellow eyes or skin

Urinary-
- ☐ Frequency
- ☐ Urgency
- ☐ Burning or pain
- ☐ Blood in urine (hematuria)
- ☐ Incontinence
- ☐ Change in urinary strength

Endocrine-
- ☐ Heat or cold intolerance
- ☐ Sweating
- ☐ Frequent urination (polyuria)
- ☐ Thirst (polydypsia)
- ☐ Change in appetite (polyphagia)

Genital Male-
- ☐ Pain with sex
- ☐ Hernia
- ☐ Penile discharge
- ☐ Sores
- ☐ Masses or pain
- ☐ Erectile dysfunction
- ☐ STD's

Genital Female-
- ☐ Pain with sex
- ☐ Vaginal dryness
- ☐ Hot flashes
- ☐ Vaginal discharge
- ☐ Itching or rash
- ☐ STD's

Neurologic-
- ☐ Dizziness
- ☐ Fainting
- ☐ Seizures
- ☐ Weakness
- ☐ Numbness
- ☐ Tingling
- ☐ Tremor

Psychiatric-
- ☐ Nervousness
- ☐ Depression
- ☐ Memory loss
- ☐ Stress

Notes: _____

_____

_____

_____

_____

_____ _____

Medical Student Signature/Date Physician Signature/ Date

Socio Economic Survey

DOB: **Patient #:**

1 What is your occupation/community role? Ex. Potato farmer/Water Mayor

2 How many years of school have you attended?

0 1-3 4+

3 How many people live in your home?

1-3 4-6 7+

4 How many children do you have?

0-2 3-4 4+

5 How old were you when you had your first child?

12-15 16-18 20+

6 Descrive how you cook food/heat your home?

Open fire:	inside	outside
Enclosed stove:	inside	outside
Grill:	inside	outside
Chimney/Vent:	Yes	No

7 How many hours/day do you spend near a fire (in smoke)?

0-2 3-4 4-6+

8 What do you use to fuel your fire?

wood other

9 How many hours/day do you (or your family member) spend gathering fuel?

0-2 3-4 4-6+

10 Where do you get water fo Drinking Bathing