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SECONDARY ANALYSIS OF DATA DERIVED FROM AN ONGOING HEALTH-RELATED GLOBAL ENDEAVOR IN NICARAGUA INCORPORATING THREE POPULATION ASSESSMENT PROCEDURES

A Chapter Style Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Public Health in Community Health Education

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ABSTRACT

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Health outreach experiences provided services to populations with limited resources, but some have noted that such experiences can be harmful to the target population if partnerships and sustainability are not core components. This analytic longitudinal ecological epidemiologic study used secondary data derived from an ongoing partnership between The Rainbow Network, Global Partners-Nicaragua, and residents of villages in the Matagalpa region of Nicaragua. The purpose this retrospective study was to determine the distribution of disease, risk factors related to disease, and protective factors related to disease within the populations of four villages who were involved in assessments to identify health needs and assets. Among the results of this study, investigators found that potential asthma among children was lower in El Paraiso where stoves were located outside the home; nearly half of all adult participants were overweight or obese with women more frequently being overweight or obese; and children in El Paraiso were more likely to be severely underweight or obese. Investigators recommended that grant funding be sought to move stoves outside the homes; nutritional and physical activity education be considered for women and children; and additional studies be conducted to examine the causes of nutritional imbalances in women and children.

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CHAPTER I

INTRODUCTION

Short-term medical outreach experiences have been a popular process used to address health disparities that exist in populations due to differences in wealth and health capacities. Typically, persons or populations with excess health capacities – to include trained healthcare professionals, technologies, expertise, or money – would collaborate with a target population that has limited health capacities in an effort to improve the well-being of the target population. Health outreach experiences, particularly international medical outreach, has expanded in recent years perhaps due, in part, to the increasing ease and affordability of both travel and communications (Martiniuk, Manouchehrian, Negin, & Zwi, 2012).

At its core, medical outreach is built upon the notion of mutual beneficence to all parties involved, meaning everyone derives some sort of benefit from the experience. Healthcare professionals who partake in medical outreach experiences benefit in several ways. For instance, physicians-in-training who participated in such medical outreach experiences were more likely than their peers who did not participate in such experiences to care for patients on public assistance, change career paths from a sub-specialty to general practice, and have favorable views of the healthcare systems in developing countries (Gupta, Wells, Horwitz, Bia, & Barry, 1999; Thompson, Huntington, Hunt, Pinsky, & Brodie, 2003; Miller, Corey, & Lallinger, 1995). International medical outreach experiences reminded some physicians about the importance of fundamental necessities of life that wealthy societies often took for granted and renewed health care workers' vigor for their professions (Bryden, 2007). The target population which received health care profited from this arrangement, as well. In addition to medical care that the target populations received (care that the populations may not ordinarily have received due to accessibility and/or affordability issues), some individuals preferred to have personal interactions with health care professionals from wealthy areas rather than monetary donations because the personal nature of health care delivery provided hope that future assistance would continue (Buchman, 2007).

While some have noted the benefits of medical outreach, others in the past two decades have raised concerns regarding the negative impacts of short-term medical outreach experiences (Montgomery, 1993; Bezruchka, 2000; Bishop & Litch, 2000; Roberts, 2006). Some have argued that short-term medical outreach may negatively impact the target population as this temporary work may be viewed as self-serving, ineffective, or costly (Mongomery, 1993; Suchdev et al., 2007; Jesus, 2010). Providing health care for short and intermittent periods of time, often providing treatment options for diseases that have already progressed to a point where patients are showing signs or symptoms of disease, contradicts the notion of sustained efforts to prevent diseases from developing or progressing. This has led critics to label these short-term medical outreach experiences as "medical tourism" - "short-term overseas work in poor countries by clinical people from rich countries" (Bezruchka, 2000, p. 77). In the past two decades, there has been increased interest in medical outreach ethics in response to these growing concerns of the risk of "negative impacts" (Montgomery, 1993, p. 3) and even "harm"

(DeCamp, 2007) that these endeavors may have caused to the target population (DeCamp, 2011; Suchdev et al., 2007; Emanuel, Wendler, Killen, & Grady, 2004).

The new emphasis on increased inclusion of ethical considerations in the planning of medical outreach was similar to previous success in integrating ethics into international health research. The ethical considerations that surrounded international medical research were earnestly addressed before the ethical considerations of international medical outreach. As a result, DeCamp (2007, 2011) noted that there was a rift between the rigorous ethical standards required for international human subject research and the lack of unified ethical standards for international medical outreach. Additionally, DeCamp (2011, p. 92) stated that "global health is inherently an ethical enterprise," meaning that ethics was intrinsically interwoven into the very essence of global medical outreach and therefore outreach organizers must have ensured that their actions truly benefited the target population. The increased consideration for moral guidance in conducting medical outreach suggested the need for a clear paradigm in which ethical considerations were incorporated throughout the planning, implementation, and evaluation process of international medical outreach.

Some have already developed guiding ethical principles that were intended to protect target populations of global medical outreach. These guiding principles were markedly similar to related principles developed for global research, highlighting the connectedness between research and practice. From their work in El Salvador, one group outlined seven guiding principles for a sustainable short-term medical mission project: 1) Mission, 2) Collaboration, 3) Education, 4) Service, 5) Teamwork, 6) Sustainability, and 7) Evaluation (Suchdev et al., 2007). DeCamp (2011) noted the similarity between these principles and those that guided global medical research. He therefore modified and simplified the base built by Suchdev et al. (2007) to incorporate aspects of global medical research resulting in eight guiding principles: 1) Create a statement of purpose: toward global health equity through an expression of mutual caring, 2) Establish a collaborative partnership, 3) Ensure fairness in site selection, 4) Commit to benefits of social value, 5) Educate the local community and team members, 6) Build the capacities of local infrastructure, 7) Evaluate outcomes, and 8) Engage in frequent ethical review.

Key elements of both Suchdev et al. (2007) and DeCamp's (2011) guidelines included developing partnerships to effectively serve the target population and evaluating the effectiveness of that service. A meta-analysis by Martiniuk et al. (2012) reviewed literature over the past 25 years surrounding short-term medical outreach found that many articles related to these experiences center around descriptive accounts of individuals' experiences rather than quantitatively evaluating the effectiveness of such outreach. A separate group who found a similar lack in quantitative analysis regarding the quality of short-term medical missions sought to create a comprehensive, 360 degree evaluation of the impacts and effectiveness of short-term medical outreach (Maki, Qualls, White, Kleefield, & Crone, 2008).

This study examined a novel model used to both plan interventions and evaluate the effectiveness of the interventions that will take place on an international medical outreach experience. This evolving model coincided well with recommendations to incorporate ethical considerations into medical outreach. Gundersen Health System’s Global Partners Program, in collaboration with The Rainbow Network and health practitioners in four villages within the Matagalpa region of Nicaragua, created a comprehensive trivalent assessment process that consisted of 1) A health assessment that identified physical characteristics, lifestyle behaviors, and physical health indicators through a brief health history and physical examination, 2) A public health assessment that noted 24-hour dietary recall and community observations through key informant interviews and observations by volunteers, and 3) A literacy assessment that rated an individual's ability to read as a rough estimate of participants' education level. The goal of this trivalent assessment was to identify health needs, collaborate with partners to create tailored interventions that can be sustained within the capacities of local communities, and ultimately evaluate the effectiveness of such efforts through continual assessments. The purpose of this retrospective data analysis for an analytic longitudinal ecological epidemiologic study was to determine the distribution of disease, risk factors related to disease, and protective factors related to disease within the populations of four villages who were involved in assessments to identify health needs and assets, and to come up with an analytical model for future data analysis purposes. Given the exploratory nature of this study, six research questions were developed to appropriately address this purpose.

Research Questions

RQ1: What are the risk factors related to diseases or injuries?

RQ2: What are the protective factors that protect one from diseases or injuries?

RQ3: What is the relationship between an individual's literacy level and his or her lifestyle behaviors?

RQ4: What is the relationship between an individual's literacy and his or her physical indicators of health?

RQ5: How do the prevalence of disease, risk factors, and protective factors compare:

- Comparisons among the villages?
- Comparisons between the villages and Nicaragua?
- Comparisons between the villages and Central America?

RQ6: What is an appropriate analytic model for the review of the data collected by the three assessment procedures?

Delimitations

This study was delimited to individuals who resided in the four villages in the Matagalpa region of Nicaragua on the date each assessment took place. All assessment questions were pre-determined based on likely health issues the community faced. Therefore, the assessment did not identify all indices of disease within the communities, but rather it used previously linked risk/protective factors and efficiently identified the most pressing health concerns. Changes to the future assessments may occur based on the perceived needs of the communities. Additionally, the assessment procedures used within the four villages in the Matagalpa region of northern Nicaragua evolved over time. This meant that the available data for each village varied, distinctions that will be noted in Chapters 3 and 4. Some of the collected data was not analyzed in this study because it did not align with the research questions contained in this study (e.g., previous pregnancies and child deaths, assistance during delivery, child head circumference, vision, and the like).

Analysis of contraception use was delimited to sexually active female participants of childbearing age. Investigators interpreted “childbearing age” to be between the ages of 15 and 50. While data were collected regarding contraception use from some males in Santa Celia, assessment administrators questioned the validity of this data due to inconsistencies among males who seemed unsure whether they should answer the question on behalf of their partner's contraception practices. Therefore, investigators of this study delimited contraception use analysis to females only in an effort to maintain validity. Analysis of contraception use was further delimited to sexually active participants in a specified age range (15-50) in order to accurately reflect contraception use among the population that was at a higher risk for contracting sexually transmitted diseases and most likely to bear children.

Limitations

The validity of data obtained from some questions in the assessments may have been limited by differences in language and culture between the target population and many of the volunteers conducting the assessments. Despite efforts made to accommodate the language and cultural differences, some understanding may still have been lost in translation as indicated by anecdotal accounts from Global Partners-Nicaragua volunteers. As an example, determining the age of participants was more difficult than initially assumed due to differences between cultures in reporting the date of birth. Meticulous record-keeping of the date of birth was not as common in the rural Nicaraguan villages as it was in the United States where the assessments were developed. Therefore, the age of some individuals was estimated to the nearest year rather than a precise date of birth. However, many younger participants knew their date of birth and data collectors required younger individuals to be estimated to the month if younger than four years or number of days if younger than five weeks. This slight variability in the reported age from the actual age was deemed acceptable by the leaders of the experience. Assessors still held younger participants to high standards in reporting age since it may have affected the child's expected height and weight based on standard growth charts. Conversely, older participants were grouped into larger cohorts and slight deviations between reported age and actual age were of less concern.

Some data were collected based on participant self-report that could be skewed by difficulties in translation or cultural differences in the acceptability of a behavior or physical characteristic. Cultural differences became apparent when female participants were asked whether they smoked cigarettes. Some of the leaders of the experience noted that women felt offended by the question indicating a social stigma associated with women who smoke. Therefore, a seemingly simple question in the United States might have been a sensitive, and therefore complex, question in Nicaragua. If such questions were not framed and asked with care they could have resulted in under-reporting.

Some data required the subjective analysis of trained physicians to identify certain signs within participants. While physicians were often trained to observe and note similar abnormalities, slight variability in noting and recording signs was inevitable.

Some participants did not fast before the health assessment which may have inflated the reported fasting blood glucose level. Typically, participants who did not fast before the health assessment were asked to fast the following morning and return for an accurate fasting blood glucose measure. It was likely, though, that some participants did not fast before the health assessment and data were still recorded thus inflating the reported fasting blood glucose level.

Investigators categorized participants based on their body mass index (BMI). These BMI categories tended to be good indicators of disease and morbidity. There was no accurate international standard cutoff points for these categories since populations differ in both BMI and morbidity associated with BMI ranges. However, investigators used BMI cutoff points that were typically used to categorize adults in all areas of the world despite these regional differences in BMI interpretation. While investigators recognized the limitations inherent in this process, they were not familiar with any Nicaraguan-specific BMI interpretations among adult or child populations. There appeared to be less consensus on how to interpret BMI among children (see Denney-Wilson, Booth, & Baur, 2003; Cole, Bellizzi, Flegal, & Dietz, 2000; Inokuchi, Matsuo, Takayama, & Hasegawa, 2009; Goon, Toriola, & Shaw, 2010; El-Ghaziri, Boodai, Young, & Reilly, 2011; Wijnhoven et al., 2013). Therefore, investigators used cutoff points that they felt would most accurately reflect potential morbidity in the sample population, even if such connections had not been previously confirmed.

Assumptions

It was assumed participants of this trivalent assessment process answered all questions honestly and to the best of their abilities. It was assumed that few language barriers existed and that no barrier – cultural or language – significantly hindered the reporting of any single question on the assessment. Furthermore, it was assumed that all physicians reported participants' signs and symptoms of diseases in a manner that was acceptable among medical professionals.

Definitions

Beneficence

An obligation of researchers who interact with human subjects to 1) do no harm and 2) maximize possible benefits and minimize possible harms (The National Commission, 1979).

Body Mass Index (BMI)

General indication of a person's body habitus. BMI = weight (kg) ÷ [height (m)]^2 (Myers, 2009, p. 236).

Brief Pediatric Asthma Screening Plus (BPAS+)

A validated (in both English and Spanish) assessment tool used to screen children for potential symptoms of asthma **(**Berry, Quinn, Wolf, Mosnaim, & Shalowitz, 2005).

Critical Hypertension

Either a systolic pressure higher than 180 mmHg or a diastolic pressure higher than 110 mmHg (American Heart Association [AHA], 2012)

Endemic Disease

"Disease that is occurring regularly in a defined population" (Jekel, Katz, Elmore, & Wild, 2007, p. 385)

Health Outreach Experience

There are many definitions with broad meanings that could be encompassed under this definition. For the purposes of this study, health outreach experience included any planned activities in which trained health professionals assisted with the health needs of a target population that had limited access to quality health care. While most applications of such health outreach experiences were international, note that this definition included health outreach experiences that were intended to improve the health of populations within a country's own borders as well. Such experiences could last anywhere from one visit to several years and could involve multiple short-duration visits on a continual schedule. The most common type of health outreach experience, and the experience examined in this study, was the short-term ongoing international health partnership. This model of care involved a sponsor organization from an area of abundant health resources continually sending health resources – such as health workers and technologies – to a target community for short periods of time to assist in an ongoing relationship.

Healthy Weight (Children and Teens 2-19)

For the purposes of this study, overweight children were between one standard deviation below (non-inclusive) and one standard deviation above (non-inclusive) the World Health Organization's international reference for children of similar age and sex (see Appendix D, Appendix E, Appendix F, and Appendix G).

Hypertension

Either a systolic pressure of 140 mmHg or greater, or a diastolic pressure of 90 mmHg or greater (AHA, 2012)

Hypotension

Either a systolic blood pressure below 90 mmHg or a diastolic blood pressure below 60 mmHg (AHA, 2012)

Mutual Beneficence

The notion that health care providers ensure beneficence to health care recipients and vice versa

Normal Blood Pressure

Both a systolic pressure from 90 mmHg up to120 mmHg and a diastolic pressure from 60 mmHg up to 80 mmHg (AHA, 2012)

Normal Weight (Adult Age 19 and Older)

BMI from 18.5 up to 25 (World Health Organization [WHO], 2013)

Obese (Adults Age 19 and Older)

BMI greater than 30 (WHO, 2013)

Obese (Children and Teens 2-19)

For the purposes of this study, obese children were two or more standard deviations above the World Health Organization's international reference for children of similar age and sex (see Appendix D, Appendix E, Appendix F, and Appendix G).

Overweight (Adults age 19 and Older)

BMI from 25 up to 30 (WHO, 2013)

Overweight (Children and Teens 2-19)

For the purposes of this study, overweight children were between one standard deviation (inclusive) and two standard deviations (non-inclusive) above the World Health Organization's international reference for children of similar age and sex (see Appendix D, Appendix E, Appendix F, and Appendix G).

Prehypertension

Either a systolic pressure from 120 mmHg up to 140 mmHg or a diastolic pressure from 80 mmHg up to 90 mmHg (AHA, 2012)

Protective Factor

"Protective factors have the reverse effect [when compared to risk factors]; they enhance the likelihood of positive outcomes and lessen the likelihood of negative consequences from exposure to risk" (Jessor, Turbin, & Costa, 1998, p. 195).

Risk Factor

"A characteristic that, if present and active, increases the probability of a particular disease in a group of persons who have the factor compared with an otherwise similar group of persons who do not. A risk factor is neither a necessary cause nor a sufficient cause of the disease" (Jekel et al., 2007, p. 391).

Severely Underweight (Children and Teens 2-19)

For the purposes of this study, severely underweight children were two or more standard deviations below the World Health Organization's international reference for children of similar age and sex (see Appendix D, Appendix E, Appendix F, and Appendix G).

Trivalent Assessment

The assessment process used to collect data for this study was considered a trivalent assessment because it was comprised of three components: 1) health, 2) literacy, and 3) public health.

Type I Error

"Error that occurs when data lead one to conclude that something is true when it is not true" (Jekel et al., 2007, p. 393).

Type II Error

"Error that occurs when data lead one to conclude that something is false when it is true" (Jekel et al., 2007, p. 393).

Underweight (Adults Age 19 and Older)

BMI below 18.5 (WHO, 2013)

Underweight (Children and Teens 2-19)

For the purposes of this study, underweight children were between one standard deviation (inclusive) and two standard deviations (non-inclusive) below the World Health Organization's international reference for children of similar age and sex (see Appendix D, Appendix E, Appendix F, and Appendix G).

CHAPTER II

REVIEW OF LITERATURE

Introduction

This chapter was divided into three sections. First, some contextual information gave the reader an understanding of the partnerships that developed to serve people living in rural regions of Nicaragua. Next, a brief justification showed the benefit of conducting assessments, particularly health, literacy, and public health assessments. Finally, an in-depth review of literature identified risk factors related to disease or injury and protective factors that protect one from disease or injury and provided rationale for including specific questions on the three assessments.

History of Global Partners-Nicaragua and The Rainbow Network Partnership

The recent partnership between Gundersen Health System's Global Partners-Nicaragua and The Rainbow Network can trace its roots to the establishment of The Rainbow Network in 1995 (The Rainbow Netowork, "History," n.d.) as a non-profit, non-governmental organization believing that the call to serve neighbors extends beyond political borders (The Rainbow Network, "Why help?", n.d.).

The Rainbow Network's mission was to "share in the love of God by partnering with Nicaragua's poorest people in healthcare, education, economic development, and housing" (The Rainbow Network, "Core beliefs," n.d.). At the time of this study, The Rainbow Network had a sustainable presence offering services in healthcare, education, economic development, and housing in 102 communities in seven Nicaraguan regions.

An essential component of The Rainbow Network approach involved leadership development with community organization and citizen participation at the core of each program (The Rainbow Network, "Our approach," n.d.). Private donations from the United States primarily supported the efforts of The Rainbow Network. Additionally, many individuals from church groups in the United States volunteered their time to assist in the programs that The Rainbow Network ran in Nicaragua. Many people in the community of La Crosse, Wisconsin supported The Rainbow Network through either monetary donations or volunteered time including two individuals who served on The Rainbow Network's Board of Directors.

This pre-developed relationship between the La Crosse community and The Rainbow Network helped develop collaboration between The Rainbow Network and Gundersen Health System's charitable health outreach division Global Partners. Gundersen Health System, an integrated health center based in La Crosse that served a large area of western Wisconsin and southeastern Minnesota, created Global Partners in 2008 to "develop long-term, sustainable relationships and community-to-community partnerships that expand beyond [Gundersen Health System's] typical borders" (Gundersen Health System, n.d.). In this partnership, The Rainbow Network provided sustainable projects in healthcare and education for rural Nicaraguan residents by employing Nicaraguan physicians, nurses, and teachers. Global Partners offered an interdisciplinary team of health workers and educators to assist in building health and education capacities that could improve the quality of life for rural Nicaraguan residents in the region surrounding Matagalpa.

Dr. Paul Klas, co-director of Global Partners-Nicaragua, noted that its teams of volunteers would try to build upon existing capacities and avoid being “another medical brigade group” from an affluent country that provided restorative care during intermittent visits (Klas, P., 2010). In keeping with this mindset, the leaders of Global Partners-Nicaragua sought to conduct a community health assessment for two purposes. First, a community health assessment would help identify health needs and assets that could assist in program planning. Second, a consistent community health assessment could serve as an evaluation of the effectiveness of the efforts of Global Partners and The Rainbow Network. Overall, the collaboration between The Rainbow Network and Global Partners-Nicaragua embodied the spirit of the Center for Disease Control and Prevention’s Center for Global Health model of creating partnerships that expand upon existing infrastructure and public health services (Centers for Disease Control and Prevention [CDC], 2012).

Liz Arnold, director of Gundersen Health System’s Global Partners Program, presented an overview of the work and accomplishments being done with its three global partners –Matagalpa region, Nicaragua; Pine Ridge, South Dakota; and Tanzania – at community events in La Crosse, Wisconsin. The information presented at one of these events was relayed to Dr. Gary Gilmore, director of the Community Health Education and Public Health departments at the University of Wisconsin-La Crosse (UW-L). Dr. Gary Gilmore contacted Liz Arnold to see if these global partnerships had already incorporated a community health perspective. Several members of Global Partners were quite receptive to this connectivity between the medical expertise that Gundersen Health System’s Global Partners offered and the community health expertise that UW-L offered.

Dr. Judy Klevan, co-director of Global Partners-Nicaragua, was one of these members, and she contacted Dr. Gary Gilmore to incorporate community health perspectives into the planning stages of the aforementioned health assessment that was being developed. In Gilmore (2012, pp. 39-41) a community assessment model was presented based upon the array of variables that needed to be assessed.

In these planning stages, it was decided to keep two separate processes, one for a health assessment and one for a community assessment. Later in the planning stages, Sheila Riley spearheaded an effort to add a third process to assess the literacy among the target population. Assessing the literacy of participants fit well with The Rainbow Network's goal of educating rural populations in Nicaragua, and the information gathered from such a literacy assessment could be used to help further understand a potential social determinant of health. The combined expertise from these institutions, and the trivalent assessment process that evolved, ensured that Global Partners-Nicaragua and The Rainbow Network maintained a holistic view of health in the areas they served. And indeed, a comprehensive program such as this assessment process that drew from several unique, yet related fields aligned with the recommendations of the Institute of Medicine (2002, 2012) to build interdisciplinary partnerships that more adequately assure the health of communities by drawing from the strengths of each interdisciplinary unit.

Community-Based Assessments and their Value

Public health has long been concerned about an environment's influence on a community's health. The earliest public health initiatives were often concerned with providing a sanitary environment that was less likely to breed infectious and communicable diseases, thus eliminating the source of disease rather than treating disease. John Snow's infamous intervention of removing the handle from the Broad Street water pump to prevent the spread of Cholera in a London community can be seen as an early instance of considering the social ecological influence on community health. This concept that societies affect a community's health has been expanded upon to the current definition of social determinants of health that we know today. A community assessment can help identify these social determinants of health to aid in preventing disease rather than reacting to its onset.

Risk Factors and Protective Factors Related to Disease

Certain behaviors and environments have been identified as risk/protective factors associated with disease causation and prevention. These risk/protective factors could relate to communicable diseases or chronic diseases. Figure 1 shows a graphical depiction of the 19 leading risk factors affiliated with global mortality, as identified by the World Health Organization (WHO, 2009). The six risk leading factors of attributable global mortality – high blood pressure, tobacco use, high blood glucose, physical inactivity, overweight and obesity, and high cholesterol – were previously identified as risk factors for chronic diseases including heart disease, strokes, lung cancer, chronic obstructive pulmonary disorder, emphysema, type 2 diabetes, and osteoporosis among others (WHO, 2009). Conversely, risk factors such as limited supplies of safe water, substandard sanitation, or lack of hygiene were more commonly affiliated with communicable diseases.

Figure 1 also identifies which attributable factors for global mortality tend to affect high income countries, middles income countries, and low income countries. It was quite apparent that while risk factors affiliated with chronic diseases affect countries at all income levels, risk factors affiliated with communicable diseases or diseases that result from nutrition deficits tended to disproportionately affect low income countries. Therefore, WHO (2009) noted that individuals in developing countries, such as Nicaragua, faced a double burden. Individuals in lower income countries were at risk for chronic, non-communicable conditions that afflict all countries, and individuals in lower income countries were also at a greater risk for developing communicable diseases.

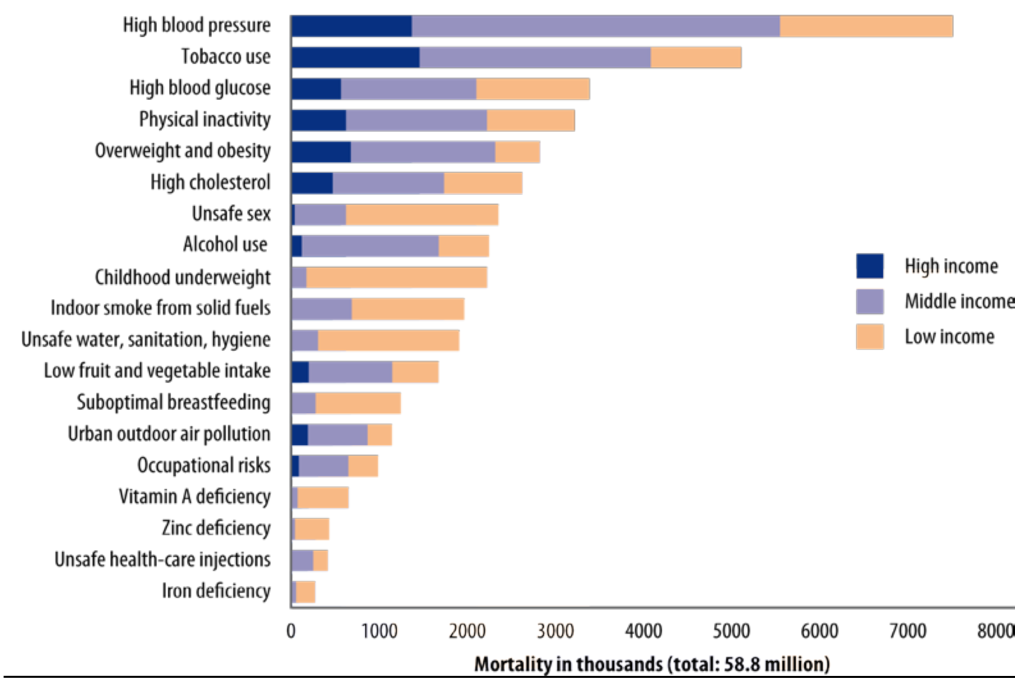

Figure 1. Deaths attributed to 19 leading risk factors, by country income level, 2004 (WHO, 2009).

It appeared that global health organizations such as the WHO emphasized the growing need to monitor a community's diet and physical activity. The *Global strategy on diet, physical activity, and health* (WHO, 2004) noted "For non-communicable diseases, the most important risks included high blood pressure, high concentrations of cholesterol in the blood, inadequate intake of fruit and vegetables, overweight or obesity, physical inactivity, and tobacco use. Five of these risk factors are closely related to diet and physical activity," (p. 2). The diseases discussed in this WHO report were seen as a growing trend in developing countries where an inadequate balance of nutrients was as much of a concern as food scarcity.

How can one know if a community has food-related issues such as food scarcity or improper nutrient balance? An effective method of assessing a community's dietary habits known as the twenty-four-hour dietary recall has existed since the mid 1900's. According to Witschi (1990), "The 24-hour recall, pioneered by Burke (1947), McHenry (1939), and Kruse and colleagues (1940), is the most widely used dietary assessment method" (p. 52). Investigators were able to gain insights into the eating habits of a community by asking individuals within that community to list all the foods eaten within the past day and the times that foods were eaten. Investigators then looked for trends in food consumption behaviors within the community. The flexibility of this tool allowed patterns to emerge that could suggest the causes of different consumption behaviors.

Another factor protecting the health of infants appeared to be exclusive breastfeeding for six months. Indeed, this was the recommendation of the World Health Organization (2011). This recommendation was based on empirical evidence that showed better health outcomes for infants who exclusively breastfed for six months than those who exclusively breastfed for three to four months before switching to combined breast feeding and solid foods (Kramer, 2012). Exclusive breastfeeding for six months appeared to protect infants from gastrointestinal infection and assisted the mother in returning to a normal weight after the birth and delays the return of menstrual periods.

Living Conditions

In addition to behaviors, certain environments have been identified as risk factors related to disease. For instance, detrimental health effects arose in populations using biomass such as wood or coal as an energy source for heat and food preparation, particularly if the smoke was not ventilated properly. Some evidence indicated that indoor stoves increased the risk for conditions such as chronic obstructive pulmonary disorder (COPD), asthma, tuberculosis, low birth weight, and cancers including lung cancer among others (WHO, 2002; Mishra, 2003). While there appeared to be a link between the use of biomass-fueled stoves and negative health outcomes such as COPD and asthma, this link is not as strong as the evidence linking coal-fueled stoves as a risk factor for either these same health conditions or lung cancer (Kurmi, Lam, & Ayres, 2012). In this study, Kurmi et al. (2012) noted that while the evidence linking biomass-fueled stoves to negative health conditions is not as strong as it is for coal-fueled stoves, it is safe to assume that both fuel sources are risk factors for COPD, asthma, tuberculosis, low birth weight, and cancers. These risk factors may be reduced by improving the air quality within a home. Torres-Dosal et al. (2008) noted that blood biomarkers affiliated with inhaling smoke from biomass stoves was significantly reduced by installing chimneys that ventilated the smoke from the stove directly outside the home, replacing soot-covered walls, and covering dirt floors with cement so that particulates such as soot could be easily removed from the floor.

In addition to helping improve air quality, replacing dirt floors with hard floors has been shown to be a protective factor against the spread of communicable diseases. One cross-sectional study that followed a project in Mexico aimed at replacing dirt floors with concrete found improved health effects among those with cement floors (Cattaneo, Galiani, Gertler, Martinez, & Titiunik, 2007). This study compared the health of matched populations located in separate cities and states but within the same metropolitan area – an area that straddled the state border. At the time of this study, one state – serving as the intervention group – implemented the *Piso Firme*, or “firm floor”, program while the other state – serving as the control group – did not. The matched populations living in the same metropolitan area but different states offered a good source of comparison for the outcomes of *Piso Firme*. One of the most startling improvements was that parasitic infections were reduced by 78 percent. Additionally, diarrhea, a common symptom of viral, bacterial, and parasitic infections, was reduced by 49 percent, and anemia was reduced by 81 percent. Catteneo et al. (2007) noted that their results indicated a potential for substantial cost savings by investing in hard floors to prevent infection by communicable diseases rather than investing in medicines to treat infections. Mental health among those with hard floors was also enhanced as self-reported quality of life improved due, in part, to reductions in depression and perceived stress.

While dirt floors may serve as a vehicle for transmitting communicable diseases, insects and animals can serve as vectors for transmitting these diseases. Mosquitoes are perhaps the most notorious vector since they transmit diseases such as yellow fever, dengue fever, and malaria – three communicable diseases that continue to affect millions of people around the globe (McKenzie, Pinger, & Kotecki, 2008, p 102). Ticks and other mites can also act as vectors transmitting diseases such as Rocky Mountain Spotted Fever. Ticks and mites can be found on larger animals and transmitted to humans who live in close proximity to animals such as livestock or domesticated pets. In addition to the potential of animals transmitting mites and their related diseases to humans, animal fecal matter is another vehicle of communicable disease transmission. Humans living in close proximity to animals have a greater risk of coming into contact with animal fecal matter that may contain zoonoses that could potentially harm humans. Some have noted that financial assistance from wealthy countries often resulted in broad, global goals focused on controlling or eradicating specific high profile diseases – such as AIDS or malaria – while neglecting endemic diseases that are often caused by zoonoses transmitted by animals (Maudlin, Eisler, & Welburn, 2009). Maudlin et al. (2009) continue by noting that many communities around the globe may have benefited more from specific measures to help them interact with the animals in their environment in a manner that reduced communicable diseases perhaps even to the point where these diseases were no longer considered endemic.

Social Connectedness

In addition to behaviors and environments that directly influenced our health, some have noted that behaviors and environments may also indirectly influence our health, particularly by improving mental well-being. In a cross-sectional study, Heritage, Wilkinson, Grimaud, & Pickett (2008) found that individuals in France with more social ties scored higher in self-reported health than those with fewer social ties. Additionally, individuals with lower income tended to have lower self-reported health and were more likely to receive no phone calls, have no friends, not be a member of a community group, and live alone. This implies that social connectedness is a protective factor for maintaining positive mental health; a protective factor that is less likely to be found among poorer, more isolated individuals.

Literacy Assessments

Upon considering all of the risk factors and protective factors identified in the previous section, one may view them as independent from one another. But social determinants of health often linked these risk factors and protective factors. Social determinants of health may be thought of as the economic and social conditions that may influence a person's choices or environment and thereby influence his or her health. Many of these social determinants of health – such as early childhood development, housing, food security, and employment – have been related to income and education. Since income tended to rise with higher educational attainment, many efforts to improve the health of populations included some aspect of improving education.

Higher educational attainment has been consistently correlated to better health (Cutler & Lleras-Muney, 2006; Gakidou, Cowling, Lozano, & Murray, 2010). However, some questioned whether higher educational attainment directly caused better health outcomes for two reasons. First, it was unknown whether people in poor health had difficulty achieving success in school, in which case a person's health would determine his or her success in educational attainment, or if a person's success in education provided knowledge and skills that allowed that individual to behave in a manner that was better for his or her health (Cutler & Lleras-Muney, 2006). Second, many noted that good health was also correlated to higher income and questioned whether education was directly impacting better health outcomes or if higher income had the stronger impact on positive health and education merely allowed individuals to attain higher incomes. Many studies that often rely on cross-sectional designs did provide some indication that education was independently linked to health (Gakidou et al., 2010), but stronger evidence that education itself impacts health regardless of income emerged when a cohort design was used (Lynch, 2003). This indicated that increased education was directly associated with better health. Therefore, it appeared that higher education caused better health outcomes both by directly influencing health through unknown mechanisms and by increasing the income a person received for their work allowing him or her to pay for resources and services that benefit health.

But the question arises, “What constitutes better education?” Is it the number of years a person spends formally studying in a school setting? Or is it the level of knowledge and skills a person has as a result of schooling? How can one measure educational attainment rather than merely the number of years a person spent in school? IQ tests are often cited as a means to rank an individual’s intelligence. But IQ tests are time-consuming and not relevant for this assessment process. Some have noted that literacy levels may be a good starting point for indicating educational attainment in developing countries. In fact, two separate articles reviewed scholarly studies and came to the same conclusion that literacy is correlated with better health (Ad Hoc, 1999; Dewalt, Berkman, Sheridan, Lohr, & Pignone, 2004).

Not only does the educational attainment of an individual affect his or her health, the education of a child’s parents also appeared to influence infant mortality (Chou, Liu, Grossman, & Joyce, 2010), with particular emphasis to the educational attainment of the infant’s mother (Caldwell, 1979; Bicego & Boerma, 1993; Malwade Basu & Sephenson, 2005; Boyle et al., 2006). One study noted that the relationship between higher maternal education and reduced infant mortality held for all forty-two developing countries studied, though the strength of the relationship varied greatly depending upon the political, social, and environmental influences of each country (Boyle et al., 2006). Malwade Basu and Sephenson (2005) proposed that maternal empowerment and autonomy among educated women may cause the offspring of educated women to have lower child mortality rates. Additionally, in low and middle-income countries, a mother's stature – her natural height – has been associated with health outcomes in her child such as mortality and underweight (Ozaltin, Hill, & Subramanian, 2010).

Health Literacy

Beginning in the 1980s and 1990s a new approach to the link between education and health outcomes emerged; health literacy. Health literacy has many varying definitions. The American Medical Association defined health literacy as, "a constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the health care environment" (Health literacy, 1999). Conversely, Zaarcadoolas, Pleasant, & Greer (2005) define health literacy as "the wide range of skills, and competencies that people develop to seek out, comprehend, evaluate and use health information and concepts to make informed choices, reduce health risks and increase quality of life." One can clearly see a divide between the medical and community definitions of health literacy, a point brought out by Pleasant and Kuruvilla (2008). While the more narrow medical definition of health literacy might be beneficial in certain settings, the broader community definition of Zaarcodoolas et al. (2005) encompassed the medical definition while allowing more flexibility in its application to settings outside of clinics. Zaarcodoolas et al. (2005) described four domains that comprised health literacy: 1) fundamental literacy, 2) science literacy, 3) civic literacy, and 4) cultural literacy. However, it appeared that this concept of health literacy was still a concept with limited abilities to assess the health literacy of populations. Investigators were unaware of any validated tool that incorporated these four domains into a health literacy assessment.

CHAPTER III

METHODS

The purpose of this retrospective data analysis for an analytic longitudinal ecological epidemiologic study was to determine the distribution of disease, risk factors related to disease, and protective factors that protect one from disease within the populations of four villages who were involved in assessments to identify health needs and assets, and to come up with an analytical model for future data analysis purposes. Given the exploratory nature of this study, six research questions appropriately addressed this purpose.

RQ1: What are the risk factors related to diseases or injuries?

RQ2: What are the protective factors that protect one from diseases or injuries?

RQ3: What is the relationship between an individual's literacy level and his or her lifestyle behaviors?

RQ4: What is the relationship between an individual's literacy and his or her physical indicators of health?

RQ5: How do the prevalence of disease, risk factors, and protective factors compare:

- Among the villages?
- Comparisons between the villages and Nicaragua?
- Comparisons between the villages and Central America?

RQ6: What is an appropriate analytic model for the review of the data collected by the three assessment procedures?

Summary of Data Collection

Gundersen Health System's Institutional Review Board granted approval to gather data from human subjects by performing a comprehensive trivalent assessment process that included a health assessment, literacy assessment, and public health assessment. This approval allowed health teams affiliated with Global Partners-Nicaragua to collect general health-related population data based on several variables with specific research objectives to be identified in future studies. For logistical purposes, the leaders of the experience chose to combine the health and literacy assessment procedures into a single process that was conducted on two consecutive days in order to accommodate the volume of participants. Then, the public health assessment process was conducted on the subsequent day or two following the health and literacy assessment.

Health and Literacy Assessment Process

Dr. Judy Klevan, Co-Director of Global Partners-Nicaragua and a pediatrician at Gundersen Health System; Dr. Paul Klas, Co-Director of Global Partners-Nicaragua and a family medicine physician at Gundersen Health System; and Dr. Mark Nigogosyan, a radiologist at Gundersen Health System developed the health assessment. Sheila Riley, a Global Partners-Nicaragua volunteer, developed the literacy assessment. A cooperative team comprised of both volunteers from Global Partners-Nicaragua and the local The Rainbow Network medical staff conducted the assessments because of the large number of volunteers and trained health care providers needed to conduct the health and literacy assessment at any village. The Rainbow Network medical staff informed village leaders of the dates, times, and procedures planned for the assessments in order to recruit participants from the target population. Global Partners-Nicaragua and The Rainbow Network allowed residents to easily access the health and literacy assessments by conducting them in public locations. Participants received a free, limited physical examination through the course of the assessment, and physicians referred participants for additional care, as necessary.

Residents in each village provided voluntary consent for themselves and their children before participating in the health and literacy assessments. To ensure participants understood the voluntary nature of participating in the study, a Spanish version of the consent form was both presented to potential participants and read aloud before asking for a signature. After receiving voluntary consent, all participants provided demographic information at the first station, and then visited each of the remaining seven stations in any order so as to reduce wait times: 1) Height and weight, 2) Lab, 3) Blood pressure, 4) Dental, 5) Vision, 6) Physical exam, and 7) Literacy assessment.

Demographic Information

Participants provided their date of birth, sex, occupation, and marital/family status. Children indicated their grade level if they attended school.

Height and Weight

Volunteers measured participants' height using a stadiometer and weight using a digital scale. Children under two years old had their length measured supine. Volunteers also measured the head circumference of children under two years old.

Lab Station

All adult and child participants underwent a finger stick blood test to measure the proportion of hemoglobin in the blood. Volunteers asked participants with hemoglobin lower than 10 grams per deciliter to repeat the test. Each adult participant underwent a finger stick to ascertain a fasting blood glucose level using a glucometer. Participants with abnormal glucose levels repeated the test. If the participant did not fast, he or she returned the next day for a fasting glucose test.

Blood Pressure

Volunteers trained to use a stethoscope and sphygmomanometer measured participants' blood pressure in the brachial artery. Participants with an elevated blood pressure rested and repeated the measurement (elevated meant systolic pressure greater than 140 mmHg or diastolic pressure greater than 90 mmHg).

Dental

A dentist examined participants to determine the number of decayed teeth, missing teeth, filled teeth, and present teeth. Each child also received a fluoride treatment to prevent future decay.

Vision

A Snellen eye chart tested visual acuity in Santa Celia, but later iterations of the health assessment did not include this test. Thereafter, the literacy assessment station tested close-cropped vision and offered corrective lenses to participants who benefited from them.

Physical Examination

A physician from Global Partners-Nicaragua or The Rainbow Network saw each of the participants for a limited physical examination. The physician used a stethoscope to listen for abnormalities in the heart and lungs, manually checked for abdominal distension among children, asked adults about tobacco and alcohol use, asked adult women about pregnancy history and contraception practices, determined whether children were born at home or in a clinic, determined the level of training of those assisted mothers during delivery, and screened for potential asthma among children.

Literacy Assessment

Volunteers asked participants about the number of years they attended school, whether they participated in adult learning courses, and whether they had access to reading materials at home. The participants' vision was tested and glasses were given to participants who had difficulty seeing objects close to them in order to eliminate inability to see the page as a factor affecting one's literacy level. The literacy assessment tested participants' abilities to read and understand written symbols, Spanish words, and Spanish sentences in the following manner:

Level 0. Participants viewed letters and numbers. If they correctly identified two of the three letters or numbers then they proceeded to Level 1. If not, then they scored "0".

Level 1. Participants viewed a sentence and attempted to identify the image that corresponded to the sentence. If they correctly matched a sentence to its corresponding image, they proceeded to Level 2. If not, they scored "0".

Level 2. Participants read a paragraph and responded to oral questions about the content of what they read. If participants correctly answered two of the three questions, they proceeded to Level 3. If not, they scored “1”.

Level 3. Participants again read a paragraph, but this time responded to written questions regarding the content of the paragraph. If they correctly answered two of the three questions, they scored “3”. If not, they scored “2”.

Sex and Age Considerations

The health assessment differed for participants based on sex and age. Adult women were asked questions about pregnancy and contraception that men were not asked. Similarly, adults and children underwent slightly different tests. Volunteers only measured blood pressure and glucose levels among adults. Conversely, only children partook in the Brief Pediatric Asthma Screening Plus (BPAS+) questions (see Appendix A to view the BPAS+ tool).

Visiting clinicians and assistants also found it difficult to ascertain a specific birth date for some participants due to limited record keeping. These clinicians and assistants attempted to identify the exact date of birth for children younger than two months, at least the exact month and year of birth for children under two years of age, and at least the exact year of birth for all other participants.

Changes in Health and Literacy Assessment Tools

Tests and questions in the health and literacy assessments changed over time. Later iterations of the health assessment eliminated some questions due to a reduced likelihood of occurrence among the participants. For instance, few people reported lice or scabies during the first assessment at Santa Celia. Therefore, these questions were eliminated from subsequent health assessments to streamline the process. Similarly, assessment administrators eliminated the questions pertaining to alcohol due to limited alcohol use among participants.

At times, assessment administrators and some volunteers added new tests or questions. For instance, after the first assessment conducted in Santa Celia physicians tested for abdominal distension among children, participants indicated how frequently they smoked, and participants answered whether they had reading materials at home.

In addition to changes in the questions asked during the health assessment, the processes and tools used to collect data changed, as well. In Santa Celia, the data collection process did not combine the health and literacy assessments. Instead the literacy assessment occurred on the day following the health assessment. Consequently, some individuals in Santa Celia who participated in the health assessment did not participate in the literacy assessment, and vice versa. Subsequently assessments in the remaining three villages involved the literacy assessment at a station occurring concurrently with the health assessment, and therefore very few individuals chose to forgo either assessment. Clinicians and assistants used paper forms as the tool to collect information about each participant in both Santa Celia and El Paraiso. The data were later entered into a computer database. Conversely, in both Santa Marta and La Grecia the clinicians and assistants used iPads to input participant information directly into a program specifically designed for these health and literacy assessments by Mariah Borgschatz, then a student at the University of Wisconsin La Crosse studying computer science. This program stored all of the data directly into a database and ensured that all portions of these health and literacy assessments were answered completely and consistently.

Public Health Assessment Process

Dr. Gary Gilmore, Professor and Director of the Graduate Community Health/Public Health Program at the University of Wisconsin-La Crosse developed the preliminary draft of the public health assessment process, which had subsequent input by the lead members. Public health professionals, nurses, and other medical and non-medical volunteers from Global Partners-Nicaragua and The Rainbow Network traveled door-to-door to conduct the public health assessment on the day following the health and literacy assessments. These volunteer assessors visited all dwelling units within an assessed village giving all inhabitants the opportunity to participate in the assessment. Assessors orally reminded each inhabitant willing to participate in the public health assessment that their participation was voluntary, that no services would be denied for their refusal or acceptance to participate, and that all information gathered during the assessment would remain confidential. Upon the participants' oral voluntary consent to continue with the assessment, assessors interviewed the respondent and observed his or her indoor and outdoor household environment.

Twenty-four-hour Dietary Recall

As a part of the public health assessment, the respondents recalled all of the foods they ate within the last twenty-four hours. Participants noted the time they consumed food or beverage and the ingredients contained within the food. Participants also provided information about the food they gave to infants. Assessors asked participants questions pertaining to food preparation, storage, and availability. See Appendix B for a sample of the Twenty-four hour dietary recall portion of the public health assessment.

Community Observations

In addition to the twenty-four-hour dietary recall, assessors also asked participants about their communal life and observed certain environmental conditions in and around the home. These questions and observations focused on issues including water availability and purification, housing, education, social connectedness, other sanitation concerns, the presence and conditions of walls and floors, the quality of indoor air, the presence of animals inside or outside the home, and any further information regarding the physical environment near the home that the observer felt may influence the health of the home's inhabitants. Additionally, assessors noted observations pertaining to each community's infrastructure including electricity, cell phone availability, community latrines, possible sources of contamination or injury inducers, clinics, schools, grocery stores, churches and community meeting centers, work buildings and employment opportunities, daycare centers, playgrounds and parks, community transportation access, and other assets including, but not limited to, community gardens. See Appendix C for a sample of the community portion of the public health assessment.

Overview of Data Analyses

The University of Wisconsin-La Crosse Institutional Review Board governing human subject research approved the methods of this study before data analysis began. Investigators used IBM SPSS Statistics Version 20.0 to perform all data analyses. The six research questions guided the data analysis process in this study. Investigators split the data analyses into four phases that each depended upon the results of earlier analyses:

1) Descriptive Analyses, 2) Inferential Analyses, 3) Expert Review, and 4) Additional Analyses.

Phase 1: Descriptive Analyses

Investigators conducted descriptive statistical procedures on each included variable for the health and literacy portions of the trivalent assessment in the first phase of analysis. The data for the four villages remained separated at this phase to allow for differences among the villages to emerge. Frequency counts and the percentage of the population with a particular trait, habit, or behavior served as the primary descriptive analysis for nominal and ordinal level data. Means and standard deviations served as the primary descriptive analysis for interval and ordinal level data. Investigators scanned data from qualitative variables contained in the health and literacy assessments – many of which were comments to supplement quantitative data collection – to ensure data validity, but investigators did not analyze these data with statistical procedures. In addition to the aforementioned descriptive analysis techniques, investigators created an age distribution chart for each village. Investigators examined qualitative data from the public health assessment at this point as well to provide potential insights into observed differences among villages. Investigators noted any differences among villages that merited additional statistical analyses and examined qualitative data from the public health assessment that might provide insight into these observed differences.

Phase 2: Inferential Analyses

In the second phase of analysis, investigators used inferential statistical procedures to evaluate 1) Relationships between variables of interest and both sex and age, 2) Intra-village relationships between literacy variables as well as variables that were risk/protective factors related to disease, 3) Inter-village relationships pertaining to literacy variables as well as variables that were risk/protective factors related to disease, and 4) Relationships between the villages and broader Central America pertaining to literacy variables as well as variables that were risk/protective factors related to disease. The results of Phase 1 and the investigators' experiences and knowledge pertaining to population health governed the selection of dependent variables in each Phase 2 analysis. This method of utilizing the results from Phase 1 to guide the analysis conducted in Phase 2 reduced the likelihood of data mining - searching for all possible statistically significant relationships between variables regardless of their value.

Investigators used consistent methods while conducting inferential analyses. All statistical analyses testing for significant differences used an alpha value of .05. Investigation of relationships between data from two nominal or ordinal level variables used Pearson's Chi-square test of independence, with Yates' continuity correction used for all 2x2 analyses. When cell counts fell below five observations, Fisher's Exact Test was used. Investigations of relationships involving interval or ratio level data that met all of the criteria for parametric statistical procedures used Student's independent samples t-tests, one-way between-groups ANOVA, and two-way between-groups ANOVA statistical procedures. At times, Levene's test for homogeneity of variances indicated that variances differed between groups, thus violating one of the assumptions of parametric statistical analysis. If Levene's test indicated unequal variances between groups when conducting a Student's independent samples t-test, then investigators used Welch's independent sample t-test to correct for this difference in variances. If Levene's test indicated unequal variances between groups when conducting a one-way or two-way between-groups ANOVA, then investigators used the Brown-Forsythe correction for unequal variances. Tukey's HSD post-hoc method determined the alignment of the significant relationships found during both one-way and two-way ANOVAs. Investigators preferred a moderate post-hoc test such as Tukey’s HSD in order to achieve some significant results while maintaining rigor in the test’s ability to control Type I error. If early analyses indicated that age or sex influenced a particular dependent variable, then a two-way between-groups ANOVA was typically utilized instead of a one-way between-groups ANOVA to consider the effect of extraneous variables.

Phase 3: Expert Review

Upon completing the first two phases of data analysis, investigators convened to consider the need or benefit of additional analysis based on observations that emerged from the results of Phase 1 and Phase 2 as well as experience in both academia and medical practice, particularly the anecdotal indications of the three authors who were also involved in the data collection process in Nicaragua.

Phase 4: Additional Analyses

Upon convening, the investigators felt no additional analyses were warranted for this study.

CHAPTER IV

RESULTS

The actual assessment tools used by Global Partners supplied extensive information through participant self-report and health examinations by professionals. This study included much of the collected information, though some information was not used or was not available due to three considerations: 1) This study excluded data that could not easily be categorized or quantified due to ambiguous, incomplete, or limited responses, 2) Data that were available for one village may not have been available in other villages due to slightly modified assessment questions and processes, and 3) Assessment questions that required examinations by health professionals could not be completed for certain villages if that person was not readily available when the assessment was done. Table 1 provides a visual depiction of the data that were included in this study. Note that the villages are listed from left to right in the chronological order that assessments were conducted: Santa Celia, followed by El Paraiso, then Santa Marta, and finally La Grecia. This convention of listing the villages in chronological order from left to right in tables and top to bottom in lists was used throughout this study. One can clearly see that examinations for abdominal distension as well as questions regarding the frequency of tobacco use and availability of reading materials at home were added to the assessment processes in later iterations. Questions regarding alcohol use were discontinued after the assessment in Santa Celia, and dental examination data were unavailable in La Grecia as no dentist was present during that assessment.

Table 1. Comparison of availability of data in four villages in the Matagalpa region, Nicaragua, 2011 – 2012.

	Village			
	Santa Celia	El Paraiso	Santa Marta	La Grecia
Health Assessment Related				
Abdominal Distension		x	x	x
Age	x	x	x	x
Sex	x	x	x	x
Alcohol use	x			
Alcohol problem	x			
Asthma (previously diagnosed)*	x	x	x	x
Blood pressure (diastolic)	x	x	x	x
Blood pressure (systolic)	x	x	x	x
BMI (20 and older)	x	x	x	x
BMI z-score (younger than 20)	x	x	x	x
Contraception	x	x	x	x
Contraception available	x	x	x	x
Contraception desired	x	x	x	x
Contraception type	x	x	x	x
Diarrhea		x	x	x
Glucose (mg/dL)	x	x	x	x
Hemoglobin (g/dL)	x	x	x	x
Teeth decayed	x	x	x	
Teeth filled	x	x	x	
Teeth missing	x	x	x	
Tobacco smoking	x	x	x	x
Tobacco smoking frequency		x	x	x
Trouble breathing (cold)*	x	x	x	x
Trouble breathing (night cough)*	x	x	x	x
Trouble breathing (persistent cough)*	x	x	x	x
Trouble breathing (wheeze self report)*	x	x	x	x
Trouble breathing (wheeze physician exam)	x	x	x	x

Table 1. Comparison of availability of data in four villages in the Matagalpa region, Nicaragua, 2011 – 2012, continued.

Literacy Assessment Related				
Age	x	x	x	x
Sex	x	x	x	x
Literacy level	x	x	x	x
Reading materials at home		x	x	x
Public Health Assessment Related				
24-hour dietary recall	x	x	x	
Access to food	x	x	x	
Breastfeeding	x		x	
Cooking methods and location	x	x	x	
Dental hygiene		x		
Sanitation	x	x	x	
Water quality	x	x	x	x

*Denotes a variable that was derived from the BPAS+

Map

Participants in this study resided in four villages in the Matagalpa region of Nicaragua. The Matagalpa region is shaded on the map of Nicaragua displayed in Figure 2. The four villages assessed in this study were located just east of the city of Matagalpa in more rural mountainous regions.

Figure 2. Map of Nicaragua with the Matagalpa region shaded (TUBS, 2011).

Demographics

Santa Celia

A health, literacy, and public health assessment occurred in November 2011. One hundred eighty-one people participated in the health assessment comprised of 34 male children, 52 female children, 37 male adults, and 58 female adults. The mean age of adult participants in the health assessment was 39 years (*SD* = 19) with participants ranging in age from16-100 years. The mean age of child participants (younger than 16) in the health assessment was 8 years (*SD* = 4).

El Paraiso

A health, literacy, and public health assessment occurred in April 2012. One hundred sixty-six people participated in the health assessment comprised of 29 male children, 31 female children, 41 male adults, and 65 female adults. The mean age of adult participants in the health assessment was 40 years (*SD* = 17) with participants ranging in age from16-85 years. The mean age of child participants in the health assessment was 9 years (*SD* = 4).

Santa Marta

A health, literacy, and public health assessment occurred in April 2012. Two hundred eighty-six people participated in the health assessment comprised of 72 male children, 64 female children, 41 male adults, and 109 female adults. The mean age of adult participants in the health assessment was 34 years (*SD* = 15) with participants ranging in age from16-94 years. The mean age of child participants in the health assessment was 7 years (*SD* = 5).

La Grecia

A health, literacy, and public health assessment occurred in July 2012. Two hundred thirty-three people participated in the health assessment comprised of 52 male children, 61 female children, 39 male adults, and 81 female adults. The mean age of adult participants in the health assessment was 36 years (*SD* = 16) with participants ranging in age from16-86 years. The mean age of child participants in the health assessment was 8 years (*SD* = 5).

The following research questions guided the data analysis resulting in the following findings:

RQ1: What Are the Risk Factors Related to Diseases or Injuries?

Air Quality

The Brief Pediatric Asthma Screening Plus (BPAS+) developed by Berry et al. (2005) allowed investigators to report the number of children previously diagnosed with asthma and the number of children who potentially have asthma but have not yet been diagnosed. Additionally, the community observations section of the public health assessment allowed investigators to identify potential sources of airborne particulates.

Santa Celia. Twenty-two (29.7%) of the child respondents were previously diagnosed with asthma. Among those not previously diagnosed with asthma or who did not indicate whether they were previously diagnosed with asthma, 29 (58.0%) scored one or greater on the asthma screening questions, indicating that they showed symptoms of asthma and further evaluation was recommended.

The community observations portion of the public health assessment noted that most homes were made of wood with dirt floors. Food was typically cooked on a wood-fired stove inside the house.

El Paraiso. Thirteen (21.3%) of the mostly child respondents were previously diagnosed with asthma. Note that six respondents between the age of 16 and 19 were included in the sample. Among those not previously diagnosed with asthma or who did not indicate whether they were previously diagnosed with asthma, 11 (20.8%) scored one or greater on the asthma screening questions, indicating that they showed symptoms of asthma and further evaluation was recommended.

The community observations portion of the public health assessment noted that most homes were made of brick with cement floors and had a separate structure behind the house that was used to cook food using a wood fire. A few wooden homes with dirt floors cooked food with wood fires in one room of the house. However, the residents of these wooden homes will soon move to newer, concrete houses that contain a separate structure behind the house for cooking.

Santa Marta. Twenty-nine (23.4%) of the child respondents were previously diagnosed with asthma. Among those not previously diagnosed with asthma or who did not indicate whether they were previously diagnosed with asthma, 58 (61.1%) scored one or greater on the asthma screening questions, indicating that they showed symptoms of asthma and further evaluation was recommended.

The community observations portion of the public health assessment noted that most homes were made of wood with dirt floors. Food was typically cooked in the house with a wood stove, and the houses smelled of smoke.

La Grecia. Sixteen (14.5%) of the child respondents were previously diagnosed with asthma. Among those not previously diagnosed with asthma or who did not indicate whether they were previously diagnosed with asthma, 45 (47.9%) scored one or greater on the asthma screening questions, indicating that they showed symptoms of asthma and further evaluation was recommended.

Alcohol Use

During the health assessment, participants from Santa Celia were asked if they drank alcohol and if alcohol use was a problem for them. During the public health assessment, key informants from Santa Celia were asked if alcohol was used in their community and whether alcohol use caused community problems. Participants from El

Paraiso, Santa Marta, and La Grecia were not asked if they drank alcohol, nor were they asked if they had a drinking problem (See Table 1).

Santa Celia. Six people (6.5%) drank alcohol. None of the female respondents drank alcohol while six (16.2%) males drank alcohol. None of the respondents reported having a drinking problem. Interviews from the public health assessment implied that alcohol use was more common than the health assessment data indicated, particularly when men received their pay check. These interviews also indicated that alcohol was stigmatized in the community due, in part, to religious virtues.

Body Mass Index (BMI)

The BMI of all health assessment participants was calculated using measured weight, measured height, and the following formula:

$$\text{BMI} = \text{weight (kg)} \div [\text{height (m)}^2]$$

(Meyers, 2009, p. 236)

Since weight and height vary during periods of growth, the manner in which the calculated BMI value was interpreted differed between children and adults in accordance with standard practices. While the rest of this study defined children as those under the age of 16 (in accordance with the cultural norms of Nicaragua), for the purposes of interpreting BMI, "children" referred to participants between the ages of 2 and 19 when periods of growth greatly affected a child's height and weight.

Standard categories identified whether adults were underweight, normal weight, overweight, or obese. Table 2 shows the number of participants 19 and older included in each BMI category regardless of sex or age, and Figure 2 displays four panels – one for each assessed village – that illustrate the proportion of participants aligned with the aforementioned BMI categories, grouped by sex.

Table 2. Body Mass Index category ranges and the number of participants 19 and older in each category during a particular health assessment; Matagalpa region of Nicaragua, 2011 – 2012 (WHO, 2013).

Category	BMI Range	Number	Age Range
Underweight	Less than 18.5	8	19-84
Normal	18.5 up to 25	200	19-100
Overweight	25 up to 30	141	20-73
Obese	30 or greater	57	21-78

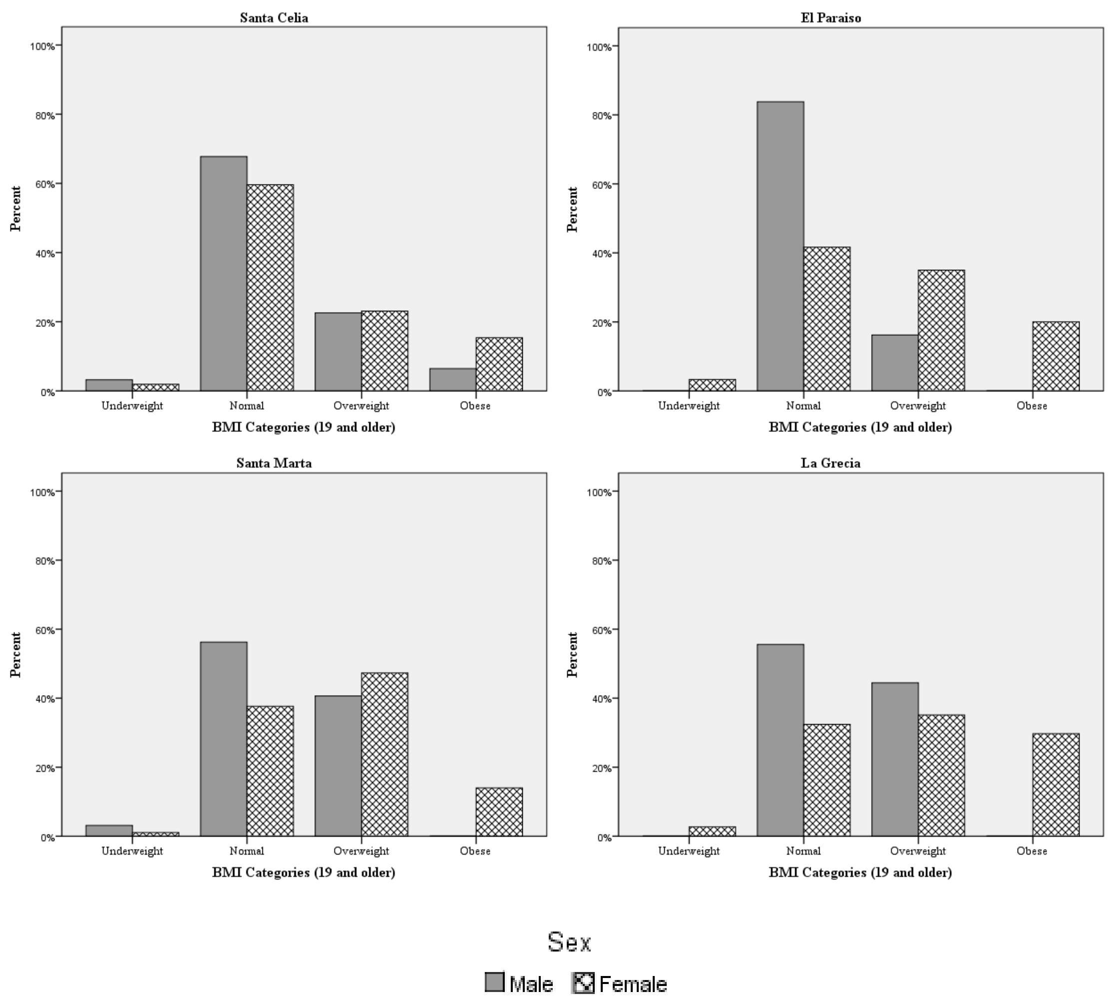

Figure 3. Percent of participants 19 and older in each BMI category separated by sex; Four villages in the Matagalpa region of Nicaragua, 2011-2012.

Figure 3 displays parity in BMI categorization between men and women in Santa Celia, but in the other three villages women tended to populate the “Overweight” or “Obese” categories more frequently.

As previously mentioned, the BMI of children was calculated in the same manner as adults. However, interpretations of the resulting BMI differed for children. Rather than grouping the participants into categories defined by static cut points, a z-score was calculated for each participants age 2-19. These sex and age dependent z-scores were calculated using the following formula:

$$Z = \frac{(X/M)^{L}-1}{LS}$$

X = calculated BMI

M = median value

L = power in the Box-Cox transformation

S = the generalized coefficient of variation

(CDC, 2009)

The tables in Appendix D, Appendix E, Appendix F, and Appendix G allowed investigators to determine the appropriate M, L, and S values for each participant. These tables were a combination of the World Health Organization's (WHO) table for interpreting BMI scores for children aged 2-5 (WHO, "Child growth standards," n.d.) and the WHO's table for interpreting BMI scores for children aged 5-19 (WHO, "Growth reference 5-19 years," n.d.). As with adults, children were grouped into categories based on their BMI (see the "Limitations" subsection in Chapter 1 for a discussion about categorizing BMI). Table 3 shows the number of participants aged 2-19 included in each BMI category, and Figure 3 displays four panels – one for each assessed village – that illustrate the proportion of participants aged 2-19 aligned with the aforementioned BMI categories. Note that the prevalence of "Severely Underweight" and "Obese" were more frequently observed in El Paraiso.

Table 3. Body Mass Index category ranges and the number of participants age 2-19 in each category during a particular health assessment; Matagalpa region of Nicaragua, 2011 – 2012.

Category	BMI z-score Range	Number	Age Range
Severely Underweight	z-score of -2 or less	9	2-17
Underweight	z-score of -1 up to -2	24	5-18
Healthy weight	z-score between -1 and 1	293	2-18
Overweight	z-score of 1 up to 2	55	2-18
Obese	z-score of 2 or greater	16	2-18

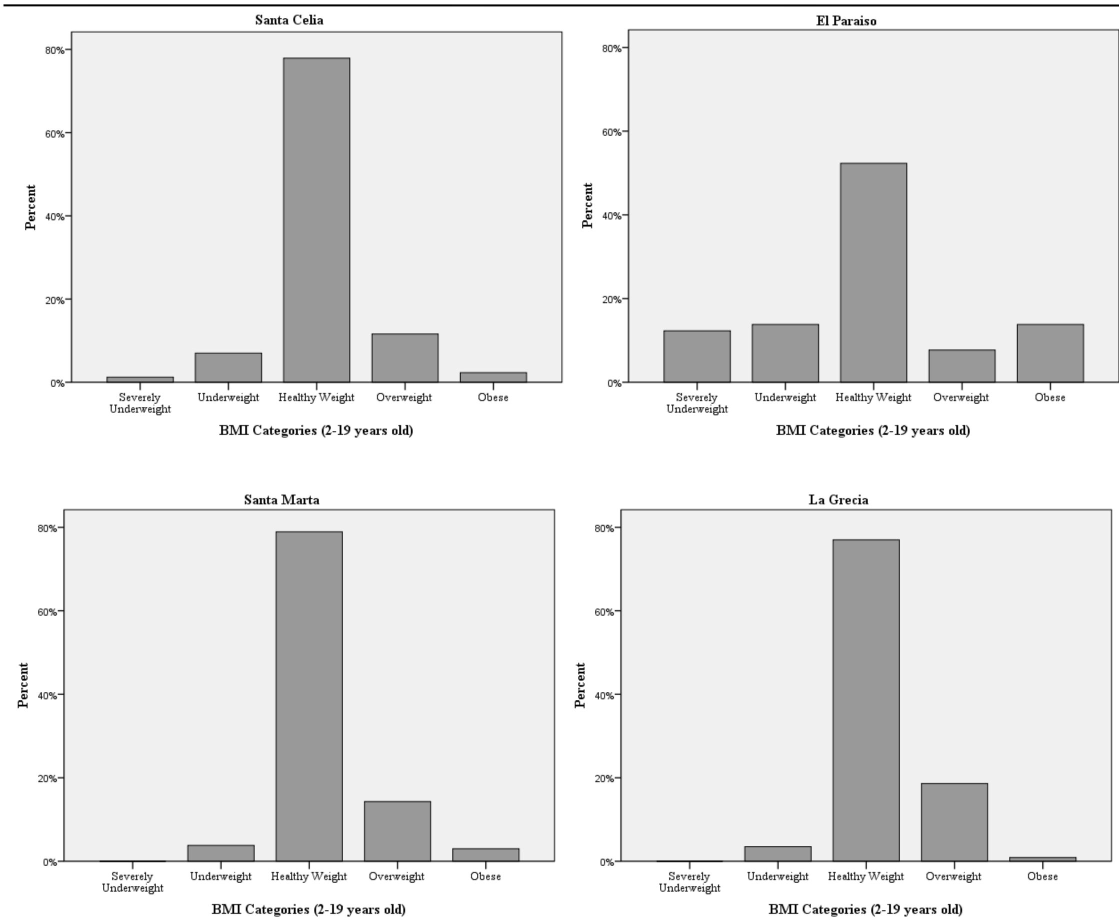

Figure 4. Percent of participants age 2-19 in each BMI category; Four villages in the Matagalpa region of Nicaragua, 2011-2012.

Santa Celia. Among participants 19 and older, 65 (38.5%) were underweight, 70 (41.4%) were normal, 23 (13.6%) were overweight, and 11 (6.5%) were obese. Only two of the 11 obese participants were men. Student's independent-samples t-test indicated that there was no significant difference in mean BMI values for males 19 and older (M = 23.6, SD = 4.29) and females 19 and older (M = 25.1, SD = 4.58; t (81) = -1.41, p = .16, two-tailed). A Pearson product-moment correlation coefficient found no significant correlation between age and BMI among participants 19 and older (r = -.20, n = 83, p = .08).

Among participants age 2-19, one (1.2%) was severely underweight, six (7.0%) were underweight, 67 (77.9%) were healthy weight, 10 (11.6%) were overweight, and two (2.3%) were obese. Student's independent-samples t-test indicated no significant difference in mean BMI z-scores for males between age 2-19 (M = .21, SD = .55) and females between age 2-19 (M = .15, SD = 1.2; t (84) = .28, p = .78, two-tailed).

El Paraiso. Among participants 19 and older, 53 (32.3%) were underweight, 70 (42.7%) were normal, 27 (16.5%) were overweight, and 14 (8.5%) were obese. None of the obese participants were men. Welch's independent-samples t-test indicated that there was a significant difference in mean BMI values for males 19 and older (M = 22.8, SD = 2.34) and females 19 and older (M = 25.9, SD = 5.61; t (85.78) = -3.79, p = .00, two-tailed). A Pearson product-moment correlation coefficient found no significant correlation between age and BMI (r = .12, n = 97, p = .24).

Among participants age 2-19, eight (12.3%) were severely underweight, nine (13.8%) were underweight, 34 (52.3%) were healthy weight, five (7.7%) were overweight, and nine (13.8%) were obese. Student's independent-samples t-test indicated no significant difference in BMI z-scores for males between age 2-19 (*M* = -.40, *SD* = 1.5) and females between age 2-19 (*M* = .41, *SD* = 2.0; *t* (63) = -1.83, *p* = .07, two-tailed).

Santa Marta. Among participants 19 and older, 84 (32.6%) were underweight, 99 (38.4%) were normal, 62 (24.0%) were overweight, and 13 (5.0%) were obese. None of the obese participants were men. Student's independent-samples t-test indicated a significant difference in mean BMI values for males 19 and older (*M* = 24.3, *SD* = 3.16) and females 19 and older (*M* = 26.0, *SD* = 3.88; *t* (123) = -2.23, *p* = .03, two-tailed). A Pearson product-moment correlation coefficient found no significant correlation between age and BMI (*r* = .10, *n* = 125, *p* = .25).

Among participants age 2-19, none were severely underweight, five (3.8%) were underweight, 105 (78.9%) were healthy weight, 19 (14.3%) were overweight, and four (3.0%) were obese. Student's independent-samples t-test indicated no significant difference in BMI z-scores for males (*M* = .24, *SD* = .83) and females (*M* = .25, *SD* = .82; *t* (131) = -.09, *p* = .93, two-tailed).

La Grecia. Among participants 19 and older, 70 (32.7%) were underweight, 84 (39.3%) were normal, 38 (17.8%) were overweight, and 22 (10.3%) were obese. None of the obese participants were men. Welch's independent-samples t-test indicated a significant difference in mean BMI values for males (*M* = 24.4, *SD* = 2.55) and females (*M* = 27.0, *SD* = 5.16; *t* (90) = -3.39, *p* = .00, two-tailed). A Pearson product-moment correlation coefficient found no significant correlation between age and BMI (*r* = -.13, *n* = 101, *p* = .21).

Among participants age 2-19, none were severely underweight, four (3.5%) were underweight, 87 (77.0%) were healthy weight, 21 (18.6%) were overweight, and one (0.9%) was obese. A Student's independent-samples t-test indicated no significant difference in BMI z-scores for males between age 2-19 (*M* = .37, *SD* = .88) and females between age 2-19 (*M* = .37, *SD* = .68; *t* (111) = .01, *p* = .99, two-tailed).

Decayed, Missing, Filled Teeth (DMFT)

Dentists examined participants in all villages except La Grecia and noted the number of participants' teeth that were decayed, missing, or filled. Adding these three numbers together created what was known as DMFT, a common oral health surveillance tool.

DMFT = Decayed teeth + Missing teeth + Filled teeth

(Fischer, Treister, & Pinto, 2012, p 98)

Investigators assumed that a normal mouth contained 28 teeth. No distinction was made between adults and children unless specified.

Santa Celia. Student's independent-samples t-test indicated no significant difference in the mean DMFT for males (*M* = 10.72, *SD* = 8.33) and females (*M* = 11.29, *SD* = 9.10; *t* (179) = -.43, *p* = .67, two-tailed). A Pearson product-moment correlation coefficient found a highly significant, positive correlation between age and DMFT (*r* = .74, *n* = 181, *p* = .00) indicating that older age was associated with higher DMFT.

El Paraiso. Welch's independent-samples t-test indicated no significant difference in mean DMFT for males (*M* = 10.91, *SD* = 6.83) and females (*M* = 11.22, *SD* = 8.80; *t* (160.48) = -.25, *p* = .80, two-tailed). A Pearson product-moment correlation coefficient found a highly significant, positive correlation between age and DMFT (r = .67, n = 163, p = .00) indicating that older age was associated with higher DMFT.

The community observations portion of the public health assessment noted that oral hygiene was poor in El Paraiso with a large portion of the population having decayed teeth. Children appeared to have some knowledge of proper oral hygiene, though it was unclear whether toothbrushes were readily available.

Santa Marta. Welch's independent-samples t-test indicated a significant difference in mean DMFT for males (M = 10.65, SD = 4.50) and females (M = 12.54, SD = 7.08; t (257.78) = -2.62, p = .01, two-tailed). A Pearson product-moment correlation coefficient found a highly significant, positive correlation between age and DMFT (r = .54, n = 260, p = .00) indicating that older age was associated with higher DMFT. Note that Santa Marta was the only village to have a significant difference in DMFT between males and females while age was positively correlated to DMFT in all three villages. Investigators split the sample in Santa Marta into four age groups (0-19, 20-39, 40-59, 60+) and looked at differences between males and females in each age group. No age group had a significant difference in DMFT between males and females implying that women in Santa Marta tended to be older than men and therefore more likely to have a higher DMFT.

La Grecia. No dentist collected dental data in La Grecia.

Fasting Blood Glucose

The primary purpose for collecting fasting blood glucose samples from adult participants was to determine the prevalence of hyperglycemia typically associated with Type 2 Diabetes. Investigators categorized participants into “Normal”, “Diabetic”, and

“Severe Diabetic” roughly in-line with the standards of the American Diabetes Association (ADA) (n.d.). Note that anyone in this study with a fasting blood glucose less than 126 mg/dL was considered “Normal” whereas the ADA considered anyone with a fasting blood glucose of 100-125 mg/dL to be “Prediabetic.” This slightly conservative approach of not including the category “Prediabetic” was done to reduce the influence of the limitation that some reported fasting blood glucose levels were likely inflated due to some participants who did not fast before the test (See Chapter 1 “Limitations” for further discussion on this topic). Table 4 shows the number of adult participants included in each of these three categories, and Figure 4 displays four panels – one for each assessed village – that illustrate the proportion of participants aligned with the aforementioned fasting blood glucose categories for participants. One can clearly see from both the table and figure that the prevalence of hyperglycemia was low in all four villages.

Table 4. Fasting blood glucose category ranges and the number of adult participants in each category during a particular health assessment; Matagalpa region of Nicaragua, 2011 – 2012 (ADA, n.d.).

Category	Fasting Blood Glucose Range (mg/dL)	Number	Age Range
Normal	Less than 126	418	15-86
Diabetic	126 up to 200	35	17-94
Severe Diabetic	200 or greater	3	35-70

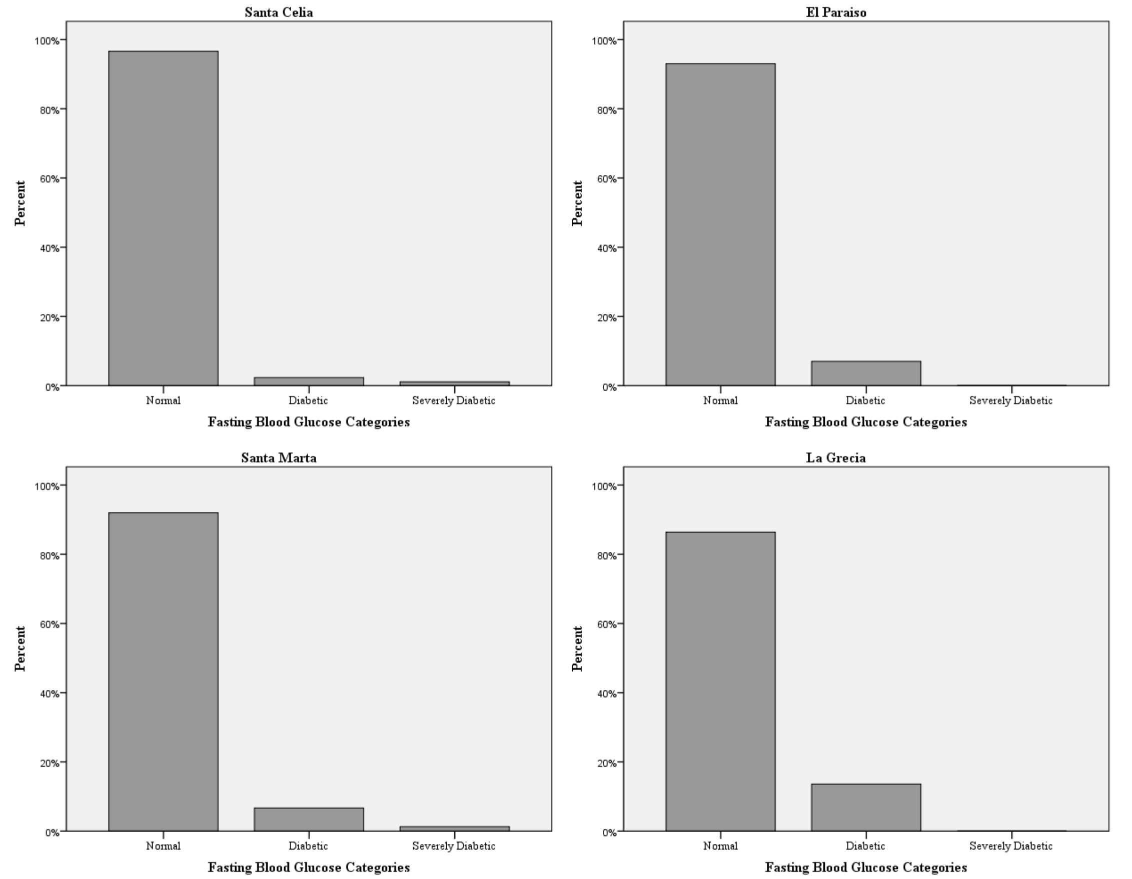

Figure 5. Percent of adult participants in each fasting blood glucose category; Four villages in the Matagalpa region of Nicaragua, 2011-2012.

Santa Celia. Among adult participants, 85 (96.6%) were normal, two (2.3%) were diabetic, and one (1.1%) was severely diabetic. Student's independent-samples t-test indicated no significant difference in mean glucose levels between males (M = 98, SD = 31) and females (M = 90, SD = 12; t (86) = 1.78, p = .08, two-tailed). A Pearson product-moment correlation coefficient found a significant, positive correlation between age and mean glucose level (r = .24, n = 88, p = .03) indicating that older age is associated with higher glucose levels.

El Paraiso. Among adult participants, 93 (93.0%) were normal, seven (7.0%) were diabetic, and none were severely diabetic Student's independent-samples t-test indicated no significant difference in mean glucose levels between males (*M* = 101, *SD* = 15) and females (*M* = 99, *SD* = 19; *t* (98) = .60, *p* = .55, two-tailed). A Pearson product-moment correlation coefficient found no significant correlation between age and mean glucose level (*r* = .19, *n* = 100, *p* = .07).

Santa Marta. Among adult participants, 138 (92.0%) were normal, 10 (6.7%) were diabetic, and two (1.3%) were severely diabetic Student's independent-samples t-test indicated no significant difference in mean glucose levels between males (*M* = 98, *SD* = 31) and females (*M* = 94, *SD* = 26; *t* (148) = .67, *p* = .50, two-tailed). A Pearson product-moment correlation coefficient found a highly significant, positive correlation between age and mean glucose level (*r* = .41, *n* = 150, *p* = .00) indicating that older age is associated with higher glucose levels.

La Grecia. Among adult participants, 102 (86.4%) were normal, 16 (13.6%) were diabetic, and none were severely diabetic. Student's independent-samples t-test indicated a significant difference in mean glucose levels between males (*M* = 106, *SD* = 19) and females (*M* = 98, *SD* = 19; *t* (116) = 2.09, *p* = .04, two-tailed). A Pearson product-moment correlation coefficient found a significant, positive correlation between age and mean glucose level (*r* = .21, *n* = 118, *p* = .02) indicating that older age is associated with higher glucose levels.

Nutrition and Physical Activity

Nutrition and physical activity contribute to the health and well-being of individuals in complex manners. Therefore, investigators examined several variables relating to nutrition and physical activity. First, investigators analyzed serum hemoglobin levels of participants from all four villages combined to observe the prevalence of anemia – a condition that can be caused by poor nutrition. Then investigators examined the community observations portion of the public health assessment for an indication of the physical activity levels for all four villages combined. Finally, investigators inspected the 24-hour dietary recall from key informants in each village to provide an idea of the eating habits of each assessed village.

The primary purpose for collecting blood serum hemoglobin samples from participants was to determine the prevalence of anemia as an indicator of nutritional deficiencies, though one must keep in mind that there are many causes of anemia beyond solely nutritional deficiencies. For the purposes of this study, anyone with a serum hemoglobin less than 10 g/dL was considered "Anemic" while participants with serum hemoglobin of 10 g/dL or greater were considered "Normal." Investigators split the sample into four age groups (under 2, 2-14, 15-49, 50+) and examined sexes independently. Splitting the sample into these age ranges and examining sexes independently was considered prudent since anemia in children might be due to nutritional deficiencies that could affect growth, women of childbearing age might have anemia due to menorrhea, and anemia in post-middle age adults might be a sign of chronic diseases. While investigators were interested to see if any notable patterns emerged in any age group or sex, they were primarily observing children of both sexes under the age 2, children of both sexes age 2-14, women of childbearing age (15-50), and elderly adults of both sexes. Table 5 displays the frequencies of anemia for each age group and sex. Chi-square tests for independence using Fischer's Exact Test for low cell counts indicated no differences in the prevalence of anemia between sexes in any age group. However, Chi-square tests for independence using Fischer’s Exact Test indicated that children under two had a higher prevalence of anemia than any other age group.

Table 5. Cross tabulation of anemia among four age groups, separated by sex; Matagalpa region, Nicaragua, 2011-2012.

			Age							
	Overall		Under 2		2-14		15-50		50+	
Hemoglobin Category	M	F	M	F	M	F	M	F	M	F
Anemic	8 (2)	7 (1)	5 (19)	4 (18)	2 (1)	2 (1)	1 (1)	0 (0)	0 (0)	1 (2)
Normal	333 (98)	511 (99)	21 (81)	18 (82)	147 (99)	172 (99)	130 (99)	261 (100)	35 (100)	60 (98)
Total	341 (100)	518 (100)	26 (100)	22 (100)	149 (100)	174 (100)	131 (100)	261 (100)	35 (100)	61 (100)

A Pearson product-moment correlation found a significant, negative correlation between age and hemoglobin in male adults (r = -.17, n = 155, p = .04) and no significant correlation between age and female adults (r = -.03, n = 311, p = .58) indicating that older age is significantly associated with lower serum hemoglobin values in male adults only.

The community observations portion of the public health assessment offered little information regarding the physical activity level among residents of the four villages. Males tended to receive regular physical activity in their employment, particularly on coffee plantations. Additionally, male children tended to play more active games than female children.

Santa Celia. According to the 24-hour dietary recall portion of the public health assessment, residents did not always eat three meals per day, and several participants mentioned that they had skipped meals because they could not always afford food. Most meals consisted of rice, beans, corn, and tortillas. Occasionally eggs were available for those who owned chickens, and rarely chicken meat was also available. Vegetable and fruit consumption were infrequent as residents could not plant their own gardens since they did not own the homes and produce typically had to be ascertained from neighboring villages. During the picking season, coffee plantation workers were given three meals per day consisting primarily of rice, beans, and tortillas. The Rainbow Network also provided free noon meals to children under 12 years of age. Two families noted that they ate chicken, pork, or beef on a weekly basis. These two families had two parents working for the plantation who may have taken advantage of the free meals provided by the plantation and saved money for the meat.

El Paraiso. According to the 24-hour dietary recall portion of the public health assessment, residents ate primarily rice and beans supplemented with occasional eggs and rarely chicken meat. Residents did not own their homes and therefore could not plant gardens. Participants consumed fruits and vegetables only on occasion with some participants eating plantains or bananas from trees adjacent to the plantation. New houses being built on land leased from the plantation would give residents the opportunity to plant gardens. The people who will reside in these houses were excited to have a garden, though few planned to plant fruits or vegetables.

Besides water, residents drank coffee, tang, and soda. Children drank milk when families could afford it, and all children who attended school were provided lunch year-round by The Rainbow Network.

Santa Marta. According to the 24-hour dietary recall portion of the public health assessment, residents ate three meals per day with a diet consisting primarily of rice, beans, and tortillas supplemented with eggs occasionally and chicken meat rarely. Residents owned their homes and were able to plant gardens if they chose. Some residents did have gardens where they planted fruits and vegetables such as bananas, oranges, avocado, chayote (squash), and yuca. There were also three commissaries that sold limited varieties of produce.

Besides water, residents drank coffee, tang, soda, and juice. Children drank milk when families could afford it, which was rare. One family reported buying powdered milk for children. All children who attended school were provided lunch by The Rainbow Network while school was in session.

La Grecia. No dietary recall information was available.

Sanitation

Santa Celia. Two families typically shared one latrine and kept this latrine clean. The plantation owned the latrines, though, so they were often in disrepair. There was a larger community latrine for migrant workers that tended to be dirtier and nearly full. A few chickens and dogs were observed roaming the village. Residents did not cage chickens because they were unsure if the plantation owner allowed animals.

El Paraiso. Latrines were shared by one to six families with cleaning performed by all who use them. There was no mention of latrines being dirty or malfunctioning. With the exception of chickens, there were few animals in the areas surrounding the houses. The chickens were not contained in coops and were left to roam free. Most homes were built of bricks with cement floors. The few homes that were made of wood and had dirt floors were being replaced with brick houses with cement floors.

Santa Marta. Each family tended to have their own latrine behind their house. These latrines were cleaned with bleach and water, and only a few were reported to be full or unusable. Chickens roamed freely, and a few families owned pigs, goats, sheep, or cows. Most homes were built of wood with dirt floors and smelled of smoke.

La Grecia. No information regarding sanitation in La Grecia was available.

Smoking Tobacco

Few participants smoked in any of the four villages. The limited number of respondents who smoked hindered statistical analyses that were split by village. Therefore, analyses were conducted without splitting the data. A Chi-Square test for independence (with Yates' continuity correction) for all four villages combined indicated a significant difference between sex and smoking status, $\chi^2 = 88.42$, $p = .00$. A Chi-

Square test for independence for all four villages combined indicated no significant difference between four age groups (0-19, 20-39, 40-59, 60+) and smoking status, χ^2 = 1.43, p = .70.

Santa Celia. Twelve (12.9%) respondents smoked cigarettes. None of the female respondents smoked cigarettes while 12 (32.4%) males did. The Santa Celia health assessment did not ask participants how frequently they smoked.

El Paraiso. Fifteen (16.3%) respondents smoked cigarettes. None of the female respondents smoked cigarettes while 15 (45.5%) males did. Two males reported smoking less than one half of a pack of cigarettes per day and one male reported smoking one pack of cigarettes per day.

Santa Marta. Fifteen (10.3%) respondents smoked cigarettes. One (0.9%) female respondent smoked cigarettes while 14 (35.0%) males did. Eleven males and one female reported smoking less than one half of a pack of cigarettes per day, two males reported smoking one half of a pack of cigarettes per day, and one male reported smoking one pack of cigarettes per day.

La Grecia. Eleven (10.1%) respondents smoked cigarettes. Three (4.1%) female respondents smoked cigarettes while eight (22.2%) males did. Four males and three females reported smoking less than one half of a pack of cigarettes per day, two males reported smoking one half of a pack of cigarettes per day, and two males reported smoking one pack of cigarettes per day.

Water Quality

Santa Celia. Almost all residents drank out of an untreated public water source with a limited number of access point locations. Some residents used a nearby stream for cooking, bathing, and laundry due to long lines at the communal access points. It was unclear whether animals also drank and bathed in this stream. Chlorine packets supplied by The Rainbow Network were used infrequently due to a shortage of those chlorine packets. Abdominal distension was not examined among children in Santa Celia, nor were children asked if they had diarrhea.

El Paraiso. Water for El Paraiso came from a spring located higher on the mountain. Pipes gravity fed water to the village, and spigots behind each house provided individual homes access to this water. The residents reported the water was clean, though it was not treated. The Rainbow Network educated residents on proper drinking water treatment. Fifty-eight children and seven adults – all younger than twenty – were examined for abdominal distension. Twenty-six (40.0%) of the 65 participants examined showed signs of abdominal distension. Forty children and two adults – all younger than twenty – were asked if they had diarrhea. Eight (19.0%) of the 42 respondents had diarrhea.

Santa Marta. Water for Santa Marta came from a secure cistern built by the Care Foundation that brought water from Santa Celia to Santa Marta. The Rainbow Network treated the water in the cistern, though some participants reported adding chlorine if they could not taste it. Each home had a spigot behind their house to use for cooking, bathing, and washing clothes. Twenty-two (17.7%) of the 124 children examined showed signs of abdominal distension. Fifteen (28.3%) of 53 child respondents had diarrhea.

La Grecia. Water for La Grecia came from a secure cistern built by the Care Foundation. The Rainbow Network treated the water with chlorine at the source and provided additional chlorine packets. Six (5.5%) of the 110 children examined showed signs of abdominal distension. Seventeen (36.2%) of 47 child respondents had diarrhea.

Table 6 displays frequencies, percentages, means, and standard deviations for all health assessment variables analyzed in this study. This table lists a snapshot of all results from both RQ1 and RQ2 in one, easily accessible table.

Table 6. Descriptive characteristics of selected variables from a health assessment conducted in four villages, Matagalpa region, Nicaragua, 2011-2012.

	Community										
	Overall		Santa Celia		El Paraiso		Santa Marta		La Grecia		
Attribute	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	*p*
Total (health assessment)	866	100%	181	21%	166	19%	286	33%	233	27)	
Age											
0-19	467	54%	100	55%	70	42%	165	58%	132	57%	
20-39	223	26%	42	23%	52	31%	70	25%	59	25%	$.00^{\#}$
40-59	121	14%	25	14%	25	15%	42	15%	29	12%	
60+	55	6%	14	8%	19	11%	9	3%	13	6%	
Sex											
Male	345	40%	71	40%	70	42%	113	40%	91	39%	$.92^{*}$
Female	521	60%	110	61%	96	58%	173	61%	142	61%	
Abdominal distension	54	18%	NA	NA	26	40%	22	18%	6	6%	$.00^{*}$
Alcohol use	6	7%	6	7%	NA	NA	NA	NA	NA	NA	^
BPAS+											
Previously diagnosed asthma	80	22%	22	30%	13	21%	29	23%	16	15%	$.10^{*}$
Potential asthma	143	49%	29	58%	11	21%	58	61%	45	48%	$.00^{*}$
Blood pressure [*n* (mean in mmHg, standard deviation)]											
Diastolic	455 (75, 11)		94 (80, 7.2)		100 (77, 9.6)		144 (73, 12)		117 (70, 9.8)		$.00^{\#}$
Systolic	455 (124, 16)		94 (125, 14)		100 (128, 17)		144 (121, 16)		117 (123, 18)		$.01^{\#}$
Blood pressure categories											
Hypotension	22	5%	0	0%	3	3%	11	8%	8	7%	
Normal	167	37%	26	28%	26	26%	64	44%	51	44%	$.00^{*a}$
Prehypertension	179	39%	48	51%	44	44%	49	34%	38	34%	
Hypertension	87	19%	20	21%	27	27%	20	14%	20	14%	
BMI 19 and older [*n* (mean in kg/m^2, standard deviation)]	406 (25.3, 4.5)		83 (24.5, 4.5)		97 (24.7, 4.9)		125 (25.6, 3.8)		101 (26.3, 4.7)		$.03^{\#}$
BMI categories (19 and older)											
Underweight	8	2%	2	2%	2	2%	2	2%	2	2%	
Normal weight	200	49%	52	63%	56	58%	53	42%	39	39%)	$.00^{*b}$
Overweight	141	35%	19	23%	27	28%	57	46%	38	38%	
Obese	57	14%	10	12%	12	12%	13	10%	22	22%	

Table 6. Descriptive characteristics of selected variables from a health assessment conducted in four villages, Matagalpa region, Nicaragua, 2011-2012, continued.

BMI z-score aged 2-19 [*n* (mean, standard deviation)]	397 (.23, 1.1)		86 (.18, 1.0)		65 (.04, 1.8)		133 (.25, .82)		113 (.37, .77)		.35[#]
BMI categories (2-19)											
Severely underweight	9	2%	1	1%	8	12%	0	0%	0	0%	
Underweight	24	6%	6	7%	9	14%	5	4%	4	4%	
Normal weight	293	74%	67	78%	34	52%	105	79%	87	77%	.00[*c]
Overweight	55	14%	10	12%	5	8%	19	14%	21	19%	
Obese	16	4%	2	2%	9	14%	4	3%	1	1%	
Contraception use	117	60%	16	36%	27	64%	34	68%	40	69%	.00[*]
Contraception type											
Depo-Provera	85	70%	15	75%	16	59%	30	88%	24	60%	
BCP	10	8%	3	15%	5	19%	1	3%	1	3%	
Sterilization	20	17%	2	10%	3	11%	2	6%	13	33%	^
IUD	4	3%	0	0%	3	11%	1	3%	0	0%	
Condom	2	2%	0	0%	0	0%	0	0%	2	5%	
Diarrhea	40	28%	NA	NA	8	19%	15	28%	17	36%	.20[*]
Tobacco use	53	12%	12	13%	15	16%	15	10%	11	10%	.48[*]
DMFT [*n* (mean, standard deviation)]	604 (11.4, 8)		181 (11.1, 9)		163 (11.1, 8)		260 (11.8, 6)		NA	NA	.55[#]
Fasting blood glucose [*n* (mean in mg/dL, standard deviation)]	456 (97, 23)		88 (93, 22)		100 (100, 17)		150 (95, 28)		118 (100, 19)		.04[#]
Fasting blood glucose categories											
Normal	418	92%	85	97%	93	93%	138	92%	102	86%	
Diabetic	35	8%	2	2%	7	7%	10	7%	16	14%	.06[*d]
Severe Diabetic	3	1%	1	1%	0	0%	2	1%	0	0%	
Hemoglobin [*n* (mean in g/dL, standard deviation)]	859 (13.3, 2)		181 (12.9, 2)		164 (13.8, 2)		284 (13.2, 2)		230 (13.4, 2)		.00[#]

[*]Indicates a *p*-value calculated using a Chi-square test for independence
[#]Indicates a *p*-value calculated using a one-way between-groups ANOVA (with Brown-Forsythe correction as appropriate)
[^]Indicates that too few cases were available to conduct a Chi-square test of independence
[a]Indicates that “Hypotension” was added to “Normal” due to low cell counts in “Hypotension”
[b]Indicates that “Underweight” was added to “Normal” due to low cell counts in “Underweight”
[c]Indicates that “Severe underweight” was added to “Underweight” and “Obese” was added to “Overweight” due to low cell counts in both “Severe underweight” and “Obese”
[d]Indicates that “Severe diabetic” was added to “Diabetic” due to low cell counts in “Severe diabetic”

Summary

In order to address the research question that dealt with risk factors for disease, the following key findings emerged:

- Potential asthma rates among previously undiagnosed children were lowest in El Paraiso, a village where the houses, owned by the plantation, contained brick walls, cement floors, and a wood-fired stove in a separate structure behind the home. Conversely, houses in the other three villages – Santa Celia, El Paraiso, and La Grecia – with higher rates of potential asthma among previously undiagnosed children contained wooden walls, dirt floors, and a wood-fired stove located inside the house.
- Santa Celia was the only village where participants were asked about alcohol use. Alcohol use was uncommon in Santa Celia, particularly among women. Those who drank alcohol did not report having problems in their daily life because of alcohol use. The limited consumption of alcohol led the administrators of the health assessment to discontinue these questions in later iterations. However, key informant interviews in the public health assessment indicated that community members believed alcohol was consumed more often than the health assessment data would lead one to believe and felt that some community problems were instigated or exacerbated by alcohol consumption.
- Smoking tobacco use was not common in any village, particularly among women. Those women who did smoke tended to smoke less frequently than men.
- Adult women had significantly higher BMI values than adult males in all villages except Santa Celia despite similar diets between the sexes. This difference in BMI between sexes was not observed among children. Visual inspection of Figure 2 and

Figure 3 appeared to indicate that the prevalence of underweight, overweight, and obese participants differed among the villages. Physical activity information from the public health assessment seemed to indicate that male children played more active games than female children and adult men worked more physically demanding jobs than women. This difference in physical activity might account for some of the differences seen in adult BMI values between sexes. Intriguingly, no correlation was observed between age and BMI.

- Participants in Santa Marta consumed more fruits and vegetables than participants in Santa Celia or El Paraiso. Personal gardens were also more common in Santa Marta – a village where houses were owned by residents – than in Santa Celia or El Paraiso – villages where houses were owned by a plantation.
- As expected, DMFT increased with age, but the high mean DMFT in all villages indicated a need for improved dental hygiene and care to prevent caries.
- Glucose levels generally increased with age – except in El Paraiso. Glucose levels generally did not differ between sexes – except in La Grecia where men had significantly higher glucose levels than females. Few participants from any village were labeled "Diabetic," though from visual inspection of Figure 4 it appeared that La Grecia had a higher prevalence of diabetes than Santa Celia.
- Latrines appeared to be cleanest in Santa Marta where each family typically had its own latrine. Latrines in Santa Celia were owned by the plantation and a few were kept in disrepair. Observers did not see coops for chickens or pens for livestock in any village. Key informants in Santa Celia indicated that they were unsure whether the plantation allowed residents to own chickens, so residents tended to avoid coops

to keep chickens they perhaps were not supposed to have.

- El Paraiso – the only village examined that did not treat water at its source – had the highest rate of abdominal distension – an indicator of parasitic infections. But it also had the lowest rate of diarrhea among children.

RQ2: What are the Protective Factors that Protect One from Diseases or Injuries?

Blood Pressure

As with BMI, adult participants were separated into categories based on blood pressure ranges presented in Table 7. Some participants had diastolic and systolic blood pressure that placed them in different categories. If participants had either a diastolic pressure lower than 60 mmHg or a systolic pressure lower than 90 mmHg, then they were included in the "Hypotension" category. For all other cases, participants were included in whichever category was farthest from "Normal".

Table 7. Blood pressure category ranges and the number of adults in each category during a particular health assessment; Matagalpa region of Nicaragua, 2011 – 2012(AHA, 2012).

Category	Diastolic BP Range (mmHg)	Systolic BP Range (mmHg)	Number	Age Range
Hypotension	Lower than 60	Lower than 90	22	16-54
Normal	60 up to 80	90 up to 120	167	15-81
Prehypertension	80 up to 90	120 up to 140	179	16-94
Hypertension	90 or greater	140 or greater	87	20-100

Figure 6 displays four panels – one for each assessed village – that illustrate the proportion of participants that align with the aforementioned blood pressure categories, grouped by sex. Note that the majority of participants in Santa Celia, Santa Marta, and La Greacia appeared to be in the "Normal" or "Prehypertension" categories with little discernible difference between the sexes. Participants from El Paraiso appeared to have fewer people in the “Normal” category and more people in the “Hypertension” category than the other three villages.

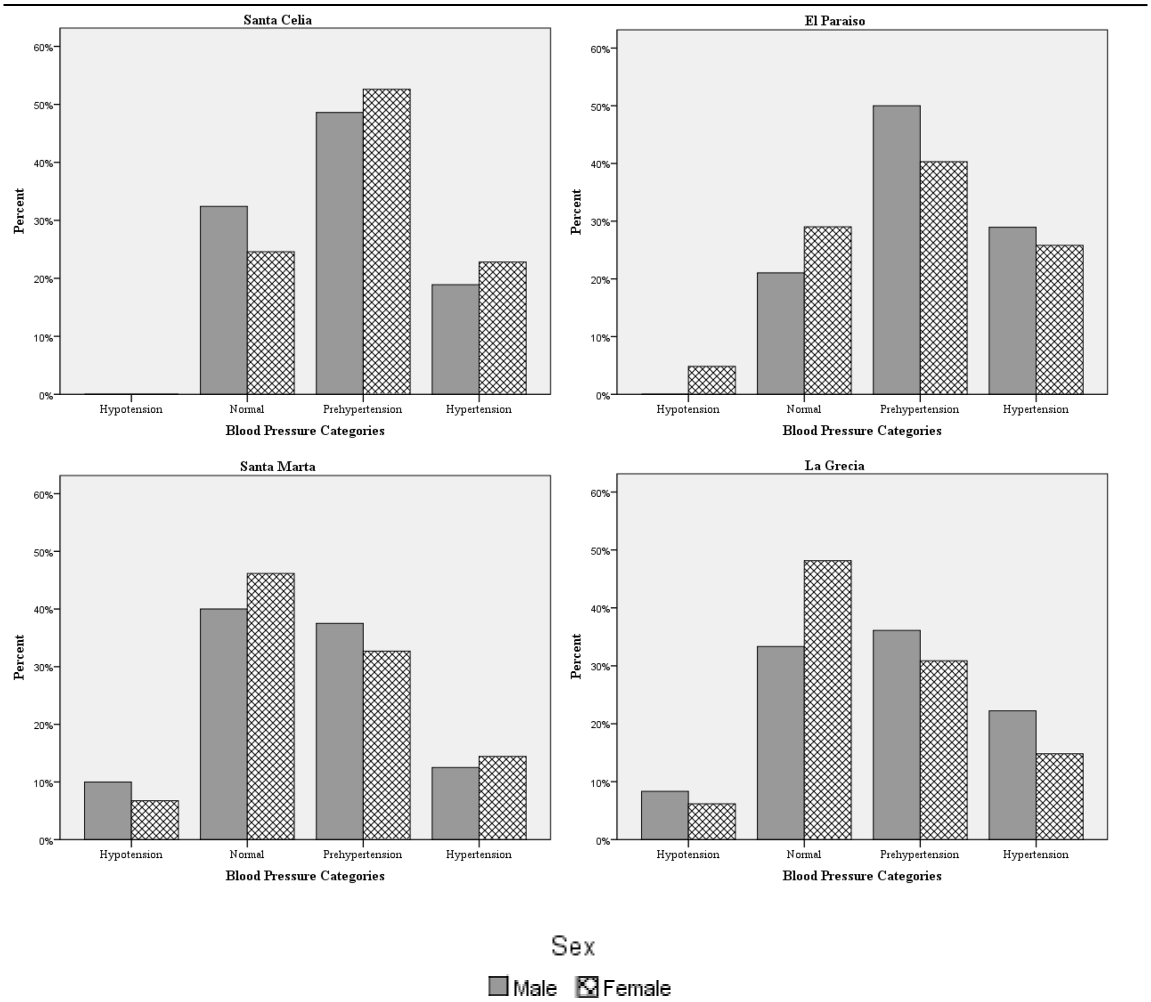

Figure 6. Percent of participants in each blood pressure category separated by sex; Four villages in Matagalpa region, 2011-2012.

Santa Celia. Among adult participants, none were hypotensive, 26 (27.7%) were normal, 48 (51.1%) were normal, and 20 (21.3%) were hypertensive. The mean diastolic blood pressure was 80 mmHg with a standard deviation of 7.2 mmHg. A Pearson product-moment correlation found no significant correlation between age and diastolic blood pressure (r = .02, n = 94, p = .86). The mean systolic blood pressure was 125 mmHg with a standard deviation of 14 mmHg. A Pearson product-moment correlation signify found a highly significant, positive correlation between age and systolic blood pressure (r = .43, n = 94, p = .00) indicating that older age is significantly associated with elevated systolic blood pressure.

El Paraiso. Among adult participants, 3 (3.0%) were hypotensive, 26 (26.0%) were normal, 44 (44.0%) were normal, and 27 (27.0%) were hypertensive. The mean diastolic blood pressure was 77 mmHg with a standard deviation of 9.6 mmHg. A Pearson product-moment correlation found a highly significant, positive correlation between age and diastolic blood pressure (r = .36, n = 100, p = .00) indicating that older age is significantly associated with higher diastolic blood pressure. The mean systolic blood pressure was 128 mmHg with a standard deviation of 17 mmHg. A Pearson product-moment correlation found a highly significant, positive correlation between age and systolic blood pressure (r = .55, n = 100, p = .00) indicating that older age is significantly associated with elevated systolic blood pressure.

Santa Marta. Among adult participants, 11 (7.6%) were hypotensive, 64 (44.4%) were normal, 49 (34.0%) were normal, and 20 (13.9%) were hypertensive. The mean diastolic blood pressure was 73 mmHg with a standard deviation of 12 mmHg. A Pearson product-moment correlation found a highly significant, positive correlation between age and diastolic blood pressure (r = .50, n = 144, p = .00) indicating that older age is significantly associated with higher diastolic blood pressure. A Pearson product-moment correlation found a highly significant, positive correlation between age and systolic blood pressure (r = .44, n = 144, p = .00) indicating that older age is significantly associated with elevated systolic blood pressure.

La Grecia. Among adult participants, 8 (6.8%) were hypotensive, 51 (43.6%) were normal, 38 (32.5%) were normal, and 20 (17.1%) were hypertensive. The mean diastolic blood pressure of adults was 70 mmHg with a standard deviation of 9.8 mmHg. A Pearson product-moment correlation found a highly significant, positive correlation between age and systolic blood pressure (r = .52, n = 117, p = .00) indicating that older age is significantly associated with higher diastolic blood pressure. The mean systolic blood pressure was 123 mmHg with a standard deviation of 18 mmHg. A Pearson product-moment correlation found a highly significant, positive correlation between age and systolic blood pressure (r = .66, n = 117, p = .00) indicating that older age is significantly associated with elevated systolic blood pressure.

Breastfeeding

Information from the public health assessment regarding breastfeeding was limited. However, this assessment did note that children in Santa Celia generally breastfed for one or two years after birth. Additionally, summaries of key informant interviews noted that some children in Santa Marta breastfed until the age of three.

Contraception Use

Recall that analysis of contraception use was delimited to females of childbearing age, interpreted to be age 15 up to 50. A Chi-square test for independence for all four villages combined indicated a significant difference between the five age groups (15-21, 22-28, 29-35, 36-42, 43-49) and contraception use, $\chi^2 = 11.51$, p = .02. No post-hoc tests were available to interpret the direction of the relationship between contraception use and age, but the frequencies of contraception use in each of the four age groups can be observed in Table 8. It appeared quite clear that contraception use increased with age until participants reached early to mid-thirties, and then contraception use declined with age. Given the high teenage pregnancy rate in Nicaragua (Lion, Prata, & Stewart, 2009) investigators were particularly interested in contraception use among youngest age group (15-21). This age group had the lowest rate of contraception use among sexually active females.

Table 8. Crosstabulation of contraception use among four age groups; Matagalpa region, Nicaragua, 2011-2012.

Contraception Use	Overall	Age				
		15-21	22-28	29-35	36-42	43-49
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
No	77 (39.7)	20 (58.8)	19 (38.0)	16 (27.1)	10 (34.5)	12 (54.5)
Yes	117 (60.3)	14 (41.2)	31 (62.0)	43 (72.9)	19 (65.5)	10 (45.5)
Total	194 (100)	34 (100)	50 (100)	59 (100)	29 (100)	22 (100)

Santa Celia. Sixteen (36.4%) sexually active female respondents of childbearing age used contraceptive devices. The preferred method of birth control among 20 sexually active female respondents of childbearing age was a Depo-Provera shot (75.0%), followed by sterilization (10.0%), and finally birth control pills (15.0%).

Among sexually active female respondents of childbearing age who did not use contraception, 16 (66.7%) desired to do so, and 11 of these 16 participants indicated that contraception was not available.

El Paraiso. Twenty-seven (64.3%) sexually active female respondents of childbearing age used contraceptive devices. The preferred method of birth control among 27 sexually active female respondents of childbearing age was a Depo-Provera shot (59.3%), followed by sterilization (18.5%), and finally both birth control pills (11.1%) intrauterine devices (11.1%).

Among sexually active female respondents of childbearing age who did not use contraception, five (55.6%) desired to do so, and two of three indicated that contraception was not available (two participants did not answer whether contraception was available).

Santa Marta. Thirty-four (68.0%) sexually active female respondents of childbearing age used contraceptive devices. The preferred method of birth control among 34 sexually active female respondents of childbearing age was a Depo-Provera shot (88.2%), followed by sterilization (5.9%), and finally both birth control pills (2.9%) and intrauterine devices (2.9%).

Among sexually active female respondents of childbearing age who did not use contraception, seven (50.0%) desired to do so, and five of these seven indicated that contraception was not available.

La Grecia. Forty (69.0%) sexually active female respondents of childbearing age used contraceptive devices. None of the eight female children who answered this question used contraceptive devices. The preferred method of birth control among 40 respondents was a Depo-Provera shot (60.0%), followed by sterilization (32.5%), then condoms (5.0%), and finally birth control pills (2.5%).

Among sexually active female respondents of childbearing age who did not use contraception, 11 (68.8%) desired to do so, and seven of these 11 participants indicated that contraception was not available.

Table 9 is an excerpt of Table 6 that displays the frequency, percentage, mean, and standard deviation of health assessment variables identified by investigators as protective factors from disease.

Table 9. Excerpt from Table 6 displaying protective factors from disease from a health assessment conducted in four villages, Matagalpa region, Nicaragua, 2011-2012.

	Community										
	Overall		Santa Celia		El Paraiso		Santa Marta		La Grecia		
Attribute	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%	*p*
Total (health assessment)	866	100%	181	21%	166	19%	286	33%	233	27)	
Age											
0-19	467	54%	100	55%	70	42%	165	58%	132	57%	
20-39	223	26%	42	23%	52	31%	70	25%	59	25%	.00[#]
40-59	121	14%	25	14%	25	15%	42	15%	29	12%	
60+	55	6%	14	8%	19	11%	9	3%	13	6%	
Sex											
Male	345	40%	71	40%	70	42%	113	40%	91	39%	.92[*]
Female	521	60%	110	61%	96	58%	173	61%	142	61%	
Blood pressure [*n* (mean in mmHg, standard deviation)]											
Diastolic	455 (75, 11)		94 (80, 7.2)		100 (77, 9.6)		144 (73, 12)		117 (70, 9.8)		.00[#]
Systolic	455 (124, 16)		94 (125, 14)		100 (128, 17)		144 (121, 16)		117 (123, 18)		.01[#]
Blood pressure categories											
Hypotension	22	5%	0	0%	3	3%	11	8%	8	7%	
Normal	167	37%	26	28%	26	26%	64	44%	51	44%	.00[*a]
Prehypertension	179	39%	48	51%	44	44%	49	34%	38	34%	
Hypertension	87	19%	20	21%	27	27%	20	14%	20	14%	
Contraception use	117	60%	16	36%	27	64%	34	68%	40	69%	.00[*]
Contraception type											
Depo-Provera	85	70%	15	75%	16	59%	30	88%	24	60%	
BCP	10	8%	3	15%	5	19%	1	3%	1	3%	
Sterilization	20	17%	2	10%	3	11%	2	6%	13	33%	^
IUD	4	3%	0	0%	3	11%	1	3%	0	0%	
Condom	2	2%	0	0%	0	0%	0	0%	2	5%	

[*]Indicates a *p*-value calculated using a Chi-square test for independence
[#]Indicates a *p*-value calculated using a one-way between-groups ANOVA (with Brown-Forsythe correction as appropriate)
[^]Indicates that too few cases were available to conduct a Chi-square test of independence
[a]Indicates that “Hypotension” was added to “Normal” due to low cell counts in “Hypotension”

Summary

In order to address the research question that dealt with protective factors from disease, the following key findings emerged:

- As expected, both systolic and diastolic blood pressure tended to increase with age in all four villages – Santa Celia, El Paraiso, Santa Marta, and La Grecia. There was consistency across all villages with most participants being in the category of "Normal" or "Prehypertension." The prevalence of "Hypertension" was greatest in El Paraiso (27%) while the other three villages – Santa Celia, Santa Marta, and La Grecia – were all similar and slightly lower (14-21%).
- Contraception use among sexually active females of childbearing age tended to increase with age up until the mid-30's; thereafter, use appeared to gradually decline until age 50. There appeared to be differences in contraception use among the villages, particularly with low contraception use in Santa Celia. The highly preferred method of contraception in all four villages was a Depo-Provera shot. Sterilization and birth control pills were used at roughly similar rates, though both were used much less frequently than Depo-Provera shots. Condoms were rarely used. The preferred methods of contraception – Depo-Provera shots, sterilization, and birth control pills – can effectively limit pregnancy, though they do little, if anything, to prevent the spread of sexually transmitted diseases.
- In three of the villages – El Paraiso, Santa Marta, La Grecia – women who did not use contraception rarely desired to do so. Santa Celia saw a higher prevalence of women who did not use contraception yet desired to do so. In all four villages, a large portion of women who did not use contraception yet desired to do so indicated that

contraception was not available, though the sample size was small.

RQ3: What is the Relationship between an Individual's Literacy and His or Her Lifestyle Behaviors?

Descriptive Characteristics of Literacy Assessment Participants

Santa Celia. Eighty-two people participated in the literacy assessment comprised of 37 male adults, 45 female adults, and no children. The mean age of participants in the literacy assessment was 39 years (*SD* = 17) with participants ranging in age from 16-80 years. Fifty-five people who participated in the literacy assessment also participated in some portion of the health assessment.

El Paraiso. One hundred people participated in the literacy assessment comprised of 38 male adults, 60 female adults, two adult participants of unidentified sex, and no children. The mean age of participants in the literacy assessment was 41 years (*SD* = 17) with participants ranging in age from 17-85 years. Ninety-eight people who participated in the literacy assessment also participated in some portion of the health assessment.

Santa Marta. One hundred forty-nine people participated in the literacy assessment comprised of 39 male adults, 105 female adults, two male children, and three female children. The mean age of participants in the literacy assessment was 33 (*SD* = 15) with participants ranging in age from 15-94 years. All 149 people who participated in the literacy assessment also participated in some portion of the health assessment.

La Grecia. One hundred seventeen people participated in the literacy assessment comprised of 79 female adults, 35 male adults, three participants of unidentified sex, and no children. The mean age of participants in the literacy assessment was 37 years (*SD* =

16) with participants ranging in age from 16 to 86. One hundred and fourteen people who participated in the literacy assessment also participated in some portion of the health assessment.

Many of the literacy assessment descriptive characteristics for each village can be seen in Table 10. Note that all four variables in that table (age, sex, literacy, and reading materials at home) differed significantly between the villages when compared using a one-way between-groups ANOVA or a Chi-square test for independence. Also, since both age and sex differed significantly between villages, they may act as confounding variables in some inter-village literacy assessment analyses where variables of interest were shown to be related to either age or sex.

Table 10. Descriptive characteristics of selected variables from a literacy assessment conducted in four villages, Matagalpa region, Nicaragua, 2011-2012.

	Community					
	Overall	Santa Celia	El Paraiso	Santa Marta	La Grecia	
Attribute	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	*p*
Total (literacy assessment)	448 (100)	82 (18.3)	100 (22.3)	149 (33.3)	117 (26.1)	
Age						
0-19	60 (13.4)	10 (12.2)	3 (3.0)	32 (21.5)	15 (12.8)	
20-39	214 (47.8)	37 (45.1)	52 (52.0)	68 (45.6)	57 (48.7)	
40-59	118 (26.3)	24 (29.3)	25 (25.0)	40 (26.8)	29 (24.8)	.00
60+	52 (11.6)	11 (13.4)	19 (19.0)	9 (6.0)	13 (11.1)	
Unknown	4 (0.9)	0 (0)	1 (1.0)	0 (0)	3 (2.6)	
Sex						
Male	151 (33.7)	37 (45.1)	38 (38.0)	41 (27.5)	35 (29.9)	
Female	292 (65.2)	45 (54.9)	60 (60.0)	108 (72.5)	79 (67.5)	.03
Unknown	5 (1.1)	0 (0)	2 (2.0)	0 (0)	3 (2.6)	
Literacy level						
Illiterate	147 (32.8)	43 (52.4)	41 (41.0)	40 (26.8)	23 (19.7)	.00
Some Literacy Skills	301 (67.2)	39 (47.6)	59 (59.0)	109 (73.2)	94 (80.3)	
Reading materials at home	143 (39.1)	NA	30 (30.0)	36 (24.2)	77 (65.8)	.00

A Chi-square test for independence (with Yates' correction for continuity) among literacy assessment participants from all four villages combined indicated no significant difference between the literacy of males and females, $\chi^2 = 2.40$, $p = .12$. A Chi-square test for independence indicated a significant difference in literacy among four age groups (0-19, 20-39, 40-59, 60+), $\chi^2 = 47.02$, $p = .00$. While no post-hoc test was available to test which age groups differed significantly from others, Table 11 clearly shows that younger age groups tended to have better reading comprehension skills than older age groups.

Table 11. Cross tabulation of literacy among four age groups; Matagalpa region, Nicaragua, 2011-2012.

Literacy level	Overall	Age			
		0-19	20-39	40-59	60+
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Illiterate	147 (33.1)	7 (11.7)	57 (26.6)	48 (40.7)	35 (67.3)
Some literacy skills	297 (66.9)	53 (88.3)	157 (73.4)	70 (59.3)	17 (32.7)
Total	444 (100)	60 (100)	214 (100)	118 (100)	52 (100)

Alcohol Use

Due to a limited number of respondents who drank alcohol (four), statistical analyses could not be conducted to examine relationships between literacy and alcohol use.

Contraception Use

Recall that contraception questions were delimited to sexually active women of childbearing age (15-50). A Chi-Square test for independence for all four villages combined indicated no significant difference between literacy and contraception use, $\chi^2 =$

.08, p = .78. Since age was previously shown to be related to both literacy and contraception use, investigators split the file according to five age groups (15-21, 22-28, 29-35, 36-42, 43-49) and found that literacy was still not significantly related to contraception use in any age group.

Reading Material at Home

A Chi-square test for independence (with Yates' continuity correction) for all four villages combined indicated a significant difference between access to reading material at home and literacy, $\chi^2 = 9.73$, $p = .00$, with access to reading material at home being associated with higher literacy levels. A Chi-square test for independence indicated no significant difference in access to reading material among four age groups (0-19, 20-39, 40-59, 60+), $\chi^2 = 2.42$, $p = .49$, suggesting that age did not act as a cofactor influencing the relationships between access to reading material at home and literacy.

Smoking Tobacco

A Chi-Square test for independence (with Yates' continuity correction) for all four villages combined indicated no significant difference between literacy and smoking tobacco use, $\chi^2 = 1.29$, $p = .26$.

Summary

In order to address the research question that dealt with protective factors from disease, the following key findings emerged:

- Literacy was related to age with younger age groups tending to be more literate. Literacy was not related to sex.
- In the three villages where participants were asked whether they had reading materials at home – El Paraiso, Santa Marta, and La Grecia – literacy levels were

higher among participants who had access to reading materials at home. While literacy was related to age, access to reading materials at home was not. Therefore, it was unlikely that age was a confounding variable in the significant relationship between access to reading materials at home and literacy.

- The relatively homogeneous behaviors related to limited alcohol and smoking tobacco use made it difficult to accurately analyze the relationship between literacy levels and these lifestyle behaviors. No relationships between literacy level and alcohol or smoking tobacco use were observed. Recall that only participants in Santa Celia were asked questions regarding alcohol use (See Table 1).
- Use of contraceptive devices among sexually active females of childbearing age was not related to literacy even when controlling for age.
- No relationships were observed between literacy level and lifestyle behaviors, though this may have been caused by limited responses and could be revisited in the future when more data become available.

RQ4: What is the Relationship between an Individual's Literacy and His or Her Physical Indicators of Health?

Body Mass Index (BMI)

Student's independent-samples t-test indicated no significant difference in mean BMI between participants 19 years of age or older with some literacy skills ($M = 25.7$, $SD = 4.37$) and illiterate participants ($M = 24.9$, $SD = 4.28$; $t\,(361) = -1.67$, $p = .10$, two-tailed). Since BMI for participants 19 years of age or older was previously shown to vary by sex, the data were split and independent samples t-tests were conducted for each sex. Welch's independent-samples t-test indicated a significant difference in BMI between males with some literacy skills (*M* = 24.3, *SD* = 3.51) and illiterate males (*M* = 23.1, *SD* = 2.19; *t* (89.95) = -2.19, *p* = .03, two-tailed). Student's independent-samples t-test indicated no significant difference in mean BMI between females with some literacy skills (*M* = 26.4, *SD* = 4.60) and illiterate females (*M* = 25.5, *SD* = 4.64; *t* (249) = -1.44, *p* = .15, two-tailed).

Investigators examined relationships between literacy and BMI categories for participants 19 and older. Due to low frequencies for the category "Underweight," participants in this category were combined into the category "Normal" to enhance statistical analysis procedures. A Chi-square test for independence indicated no significant difference between literacy and categorization of BMI among adults, χ^2 = 1.89, *p* = .39.

Since participants age 2-19 rarely partook in the literacy assessment, investigators chose not to analyze the relationship between literacy level and BMI among children and teens.

Blood Pressure

A Chi-Square test for independence for all four villages combined indicated a significant difference between literacy and blood pressure categories, χ^2 = 17.27, *p* = .00. Since both literacy and blood pressure were previously shown to be related to age, investigators split the data into four age groups (0-19, 20-39, 40-59, 60+) and attempted to conduct a Chi-square for each age group. However, limited cell counts hindered this process. Upon visually inspecting the frequencies for each category, though, it appeared that age was the primary variable accounting for differences in blood pressure categories, and there was little difference in the blood pressure categories between the illiterate and those with some literacy skills.

Decayed, Missing, Filled Teeth (DMFT)

Since older age was previously associated with both higher DMFT and lower literacy level scores, a two-way between-groups ANOVA indicated that there was no significant difference in mean DMFT between the illiterate and those with some literacy skills: $F(1, 277) = .12$, $p = .67$.

Fasting Blood Glucose

Student's independent-samples t-test indicated no significant difference in mean fasting blood glucose between participants with some literacy skills ($M = 96$, $SD = 22$) and illiterate participants ($M = 100$, $SD = 24$; $t(407) = 1.65$, $p = .10$, two-tailed).

Hemoglobin

Statistical analysis examining the relationship between participants with anemia and literacy was not considered prudent since only one literacy assessment participant was anemic.

Summary

In order to address the research question that dealt with relationships between literacy level and physical indicators of health, the following key findings emerged:

- Once previously determined relationships were accounted for, only one physical indicator of health – BMI among males – was related to literacy.

RQ5: How Do the Prevalence of Disease, Risk Factors, and Protective Factors Compare?

Among the Villages

For all nominal and ordinal level dependent variables, Chi-square tests for independence indicated whether a significant difference existed among villages. For some interval and ratio level dependent variables, investigators first examined differences among villages using one-way between-groups ANOVAs with Brown-Forsythe correction for unequal variances as necessary. Then, investigators performed two-way between-groups ANOVAs to reduce Type II error if previous analyses showed that age or sex was related to the dependent variable in question. Investigators continued to examine the main effect statistic of interest in a two-way between-groups ANOVA even if Levene's test indicated unequal variances between groups. This was considered prudent due to the robust nature of ANOVA tests with larger sample sizes and the lack of non-parametric alternatives. In cases where interval or ratio level data were categorized in previous analyses, Chi-square tests for independence were conducted to examine differences in each category's frequency among the villages. This was done to provide a more clinically useful interpretation of the data.

Abdominal distension. A Chi-square test for independence indicated a significant difference between village of residence and abdominal distension among children, $\chi^2 = 32.96$, $p = .00$. No post-hoc test was available, though individual Chi-square tests between all villages indicated that the frequency of abdominal distension among children in El Paraiso was significantly higher than the frequency of abdominal distension among children in both Santa Marta and La Grecia. Additionally, the frequency of abdominal distension among children in Santa Marta was significantly higher than the frequency of abdominal distension in La Grecia.

Asthma. A Chi-square test for independence indicated no significant difference between village of residence and previously diagnosed asthma among children, $\chi^2 = 6.11$, $p = .11$. However, a Chi-square test for independence indicated a significant difference between village of residence and signs of potential asthma among children not previously diagnosed with asthma, $\chi^2 = 25.69$, $p = .00$. No post-hoc test was available, though individual Chi-square tests between all villages indicated that the frequency of potential asthma among children in El Paraiso was significantly lower than the frequency of potential asthma among children in all three other villages. No differences in potential asthma were observed between other villages.

Blood pressure. Investigators examined differences in blood pressure categories among the villages for a more clinically useful interpretation of the data. Due to low frequencies for the category "Hypotension," participants in this category were combined into the category "Normal" to enhance statistical analysis procedures. A Chi-square test for independence indicated a significant difference between village of residence and categorization of blood pressure, $\chi^2 = 26.28$, $p = .00$. No post-hoc test was available, but examination of the crosstabulations appeared to indicate that Santa Celia and El Paraiso had a lower prevalence of "Normal" and higher prevalence of either "Prehypertension" or "Hypertension" when compared to both Santa Marta and La Grecia. The sample was split by age to account for a previously determined relationship between age and blood pressure. While investigators could not use a Chi-square test of independence due to low cell counts, examination of the frequencies in the table tended to support the notion that

Santa Celia and El Paraiso had a lower prevalence of "Normal" and a higher prevalence of either "Prehypertension" or "Hypertension" than both Santa Marta and La Grecia.

BMI. Investigators examined differences in BMI categories for participants 19 and older among the villages for a more clinically useful interpretation of the data. Due to low frequencies for the category "Underweight," participants in this category were combined into the category "Normal" to enhance statistical analysis procedures. A Chi-square test for independence indicated a significant difference between village of residence and categorization of BMI among adults, $\chi^2 = 23.09$, $p = .00$. No post-hoc test was available, but examination of the crosstabulations appeared to indicate that Santa Marta and La Grecia had a lower prevalence of "Normal" and higher prevalence of either "Overweight" or "Obese" when compared to both Santa Celia and El Paraiso. The prevalence of obesity in La Grecia (21.8%) appeared much higher than the prevalence of obesity in the other three villages (ranging from 10.4-12.4%). Since BMI of participants 19 and older was previously shown to be related to sex, the sample was split by sex and Chi-square tests of independence confirmed that BMI categories were significantly different among the villages. Examination of the crosstabulations table revealed that the same pattern described above – Santa Marta and La Grecia having a lower prevalence of "Normal" and higher prevalence of either "Overweight" or "Obese" – existed for both males and females.

Investigators also examined differences in BMI categories for participants age 2-19 among the villages. Due to low frequencies for the categories "Severely underweight" and "Obese," participants who were "Severely underweight" and "Underweight" were combined into one category and participants who were "Obese" and "Overweight" were combined into one category to enhance statistical analysis procedures. A Chi-square test for independence indicated a significant difference between village of residence and BMI categorization among children and teens, $\chi^2 = 37.62$, $p = .00$. No post-hoc test was available, but examination of the crosstabulations appeared to indicate that El Paraiso had both the highest prevalence of underweight (26.2%) and the highest prevalence of overweight/obesity (21.5%). The remaining three villages displayed parity in low prevalence of underweight. However, overweight/obesity varied among the three villages (Santa Celia 14.0%, Santa Marta 17.3%, La Grecia 19.5%).

Contraception. A Chi-square test for independence indicated a significant difference between village of residence and contraception use among sexually active females of childbearing age, $\chi^2 = 13.87$, $p = .00$. No post-hoc test was available, though individual Chi-square tests, with Yates' correction for continuity, between all villages indicated that the frequency of contraception use in Santa Celia was significantly lower than the frequency of contraception use in all other villages. No differences in contraception use were observed between other villages.

Diarrhea. A Chi-square test for independence indicated no significant difference between village of residence and diarrhea among children, $\chi^2 = 3.21$, $p = .20$.

DMFT. A one-way between-groups ANOVA, with Brown-Forsythe correction for unequal variances between groups, indicated that there was no significant difference in DMFT among the three villages: $F (2, 478.5) = .61$, $p = .55$.

Since DMFT was previously shown to be positively correlated with age, a two-way between-groups ANOVA more thoroughly explored the impact that both village of residence and age had on DMFT. According to the village of residence main effect statistics, there was a significant difference in DMFT for the three villages of residence (there was no dental data for La Grecia): F (2,592) = 3.91, $p = .013$. However, post-hoc comparisons using the Tukey HSD test indicated no significant differences among the villages of residence. Therefore, at this time there was no difference in DMFT among the four villages.

Investigators also examined differences among villages in the mean number of decayed, missing, and filled teeth individually to explore differences in treatment options available in each village. A one-way between-groups ANOVA, with Brown-Forsythe correction for unequal variances when necessary, indicated no significant differences between village of residence and either mean decayed teeth (F (2, 601) = 2.28, $p = .10$) or mean missing teeth (F (2, 601) = .01, $p = .99$). However, there was a significant difference between village of residence and mean filled teeth: F (2, 601) = 6.10, $p = .002$. Post-hoc comparisons using Tukey's HSD test indicated that the number of filled teeth in Santa Celia (*M* = .08, *SD* = .61) differed significantly from the number of teeth filled in El Paraiso (*M* = .53, *SD* = 1.26).

Fasting blood glucose. Investigators examined differences in fasting blood glucose level categories among the villages for a more clinically useful interpretation of the data. Due to low frequencies for the category "Severe Diabetic," participants in this category were combined into the category "Diabetic" to enhance statistical analysis procedures essentially creating a dichotomy labeling participants as either "Normal" or "Diabetic." A Chi-square test for independence indicated no significant difference between village of residence and categorization as "Diabetic", $\chi^2 = 7.27$, $p = .06$. Since investigators previously determined that fasting blood glucose generally increased with age, the sample was split into four age groups (0-19, 20-39, 40-59, 60+) and a Chi-square test for independence was conducted for each age group. Limited cell counts called to question the validity of the test, but it did not appear that splitting the sample by age would have affected the results.

Hemoglobin. A Chi-square test for independence examining the relationship between village of residence and anemia could not be performed due to low cell counts. Examination of the crosstabulation frequencies appeared to indicate relative parity among the villages, though it was interesting to note that El Paraiso had no cases of anemia. The frequency and prevalence of anemia in the other three villages was: Santa Celia 4 (2.2%), Santa Marta 7 (2.5%), La Grecia 4 (1.7%).

Literacy. A Chi-square test for independence indicated a significant difference between village of residence and literacy, $\chi^2 = 28.96$, $p = .00$. The frequencies of literacy in each of the four villages can be observed in Table 12.

Table 12. Crosstabulation of literacy levels among four villages; Matagalpa region, Nicaragua, 2011-2012.

		Village			
Literacy	Overall	Santa Celia	El Paraiso	Santa Marta	La Grecia
Illiterate	147 (32.8%)	43 (52.4%)	41 (41.0%)	40 (26.8%)	23 (19.7%)
Some Literacy Skills	301 (67.2%)	39 (47.6%)	59 (59.0%)	109 (73.2%)	94 (80.3%)
Total	448 (100%)	82 (100%)	100 (100%)	149 (100%)	117 (100%)

It appeared that La Grecia had the highest literacy levels, followed by Santa Marta, then El Paraiso, and finally Santa Celia. When Chi-square tests for independence (with Yates' continuity correction) were conducted between each village separately, there was a significant difference between the literacy of Santa Celia and both Santa Marta and La Grecia. Similarly, there was a significant difference between the literacy of El Paraiso and both Santa Marta and La Grecia. However, there was no difference in literacy between either Santa Celia and El Paraiso or Santa Marta and La Grecia. These results tended to indicate that there were two levels of literacy among the villages with Santa Celia and El Paraiso being on a lower tier of literacy than Santa Marta and La Grecia.

However, it was unclear whether these differences were affected by different age demographics in the four villages. The samples were split into four age groups and a Chi-square test for independence between village of residence and literacy level was conducted for each age group. Low counts in certain cells called to question the validity of the test, but observing the crosstabulations of frequencies appeared to confirm that the aforementioned two tiers in literacy among villages were consistent across all age groups.

Reading material at home. Recall that information regarding access to reading material at home were collected in three villages – El Paraiso, Santa Marta, and La Grecia (see Table 1). A Chi-square test for independence indicated a significant difference between village of residence and reading material at home, $\chi^2 = 52.20$, $p = .00$. No post-hoc test was available, though individual Chi-square tests, with Yates' correction for continuity, between all three villages indicated that prevalence of reading material at home was significantly higher in La Grecia than either El Paraiso or Santa Marta. No differences in the prevalence of reading material at home were observed between El Paraiso and Santa Marta.

Smoking tobacco. A Chi-square test for independence indicated no significant difference between village of residence and smoking tobacco use, $\chi^2 = 2.47$, $p = .48$.

Comparisons between the Villages and Nicaragua

Air quality. Many people in the four assessed villages used wood stoves in or near their home for cooking meals, a practice that has been linked to respiratory diseases and discomfort among children. To the investigators' knowledge, no other studies used the BPAS+ in Nicaragua to generate results that could be directly compared to this study. However, one study found that 15 (17.0%) of children in Managua had asthma and 12.5% had other respiratory conditions (Allen, Meadows-Oliver, & Ryan-Krause, 2008). Another study that examined the rates of asthma among children aged 13-14 in Latin America found that 15.2% of children in Managua, Nicaragua were previously diagnosed with asthma, 13.8% wheezed, and 3.8% had a sleep disturbance from wheezing more than one time per week (Mallol et al., 2010). The findings in both of these studies regarding asthma rates among Nicaraguan children were lower than the 80 (21.6%) children previously diagnosed with asthma and 143 (49.0%) displaying potential signs or symptoms of asthma in this study. Investigators are uncertain if participants of this study genuinely had a higher prevalence of asthma and asthma-related symptoms compared to the rest of Nicaragua or if the difference is mainly attributed to the rural vs. urban settings since Managua was the target population of both comparable studies.

Alcohol. Reliable information regarding alcohol use in Nicaragua was difficult to find. A study by Laux et al. (2012) found that 47.7% (n = 647) of participants had drank alcohol at some point in their life. This was much higher than the 6.5% (n = 6) of participants from this study who drank alcohol, though it should be noted that the questions asked of participants were quite different. Laux et al. (2012) noted that males were much more likely to drink alcohol than women, a result that was also found in this study.

BMI. According to the WHO Global Database on BMI, 3.7% of females were underweight, 44.5% of females were normal weight, 32.0% of females were overweight, and 19.6% of females were obese in Nicaragua in 2005 ("WHO Global database," n.d.). By comparison, among participants aged 19 and older, 2.2% of females were underweight, 41.2% of females were normal weight, 36.9% of females were overweight, and 19.8% of females were obese. The proportion of female participants aged 19 and older who were in the overweight and obese BMI categories was slightly higher than the proportion of Nicaraguan females in the overweight and obese BMI categories according to the WHO Global Database on BMI. Similarly, the proportion of female participants aged 19 and older who were in the underweight and normal BMI categories was slightly lower than the proportion of Nicaraguan females in the underweight and normal BMI categories according to the WHO Global Database on BMI. However, statistical analysis to determine whether these differences were significant could not be performed due to an unknown distribution of the WHO Global Database on BMI data. Additionally, this database did not offer data for the proportion of Nicaraguan males in each BMI category nor did it offer information regarding BMI z-scores for children.

A separate source, the Central Intelligence Agency (CIA) World Factbook, listed obesity for Nicaraguan adults to be 22.2% (Central Intelligence Agency, 2013). By comparison, the obesity rate among participants of this study aged 19 and older was lower at 16.0%. Again, statistical analysis could not be performed due to unknown distribution in the CIA World Factbook obesity data.

Blood pressure. One study examined blood pressure among other risk factors related to disease in six, mostly rural Nicaraguan communities in the Matagalpa region and farther west (Laux et al., 2012). Participants of Laux et al. (2012) had a significantly lower mean diastolic blood pressure (*M* = 73.2, *SD* = 10.0) than participants of this study (*M* = 74.5, *SD* = 10.5; *t* (1,808) = 2.31, *p* < .05, two-tailed). Participants of Laux et al. (2012) also had a significantly lower mean systolic blood pressure (*M* = 119.7, *SD* = 16.0) than participants of this study (*M* = 123.9, *SD* = 16.3; *t* (1,808) = 4.78, *p* < .05, two-tailed).

Contraception use. One study found that the pre-marital contraception rate among single women aged 15-24 was 14.1 per 100 woman years in Nicaragua (Ali & Cleland, 2005). Contraception use among women aged 15-24 in this study was 50.9% (n = 28).

DMFT. One older study examined differences in DMFT among Nicaraguan populations seeking dental treatment and those not seeking dental treatment (Smith & Lang, 1993). Participants from this study were compared to participants who did not seek dental treatment in Smith and Lang's study (1993). Smith and Lang (1993) split the sample into three age groups to examine DMFT, 12-17 (*M* = 6.2, *SD* = 2.9), 18-34 (*M* = 11.4, *SD* = 4.9), and 35-64 (*M* = 14.6, *SD* = 5.8). Comparatively, DMFT results from this study when split into similar age groups were as follows; 12-17 (*M* = 8.8, *SD* = 4.0), 18-34 (*M* = 11.9, *SD* = 5.1), and 35-64 (*M* = 17.4, *SD* = 8.5). The data from this study were split into similar age groups and independent samples t-tests were conducted to examine differences in DMFT among the two study sample populations; 12-17 *t* (136) = 4.34, *p* < .01, two-tailed; 18-34 *t* (200) = .61, *p* > .05, two-tailed; 35-64 *t* (149) = 2.16, *p* < .05, two-tailed. These analyses indicated that participants of this study in the age groups 12-17 and 35-64 had higher mean DMFT than participants in Smith & Lang (1993). Due to the length of time that elapsed between the two studies, it was unclear if this increase in DMFT among participants in this study indicated that these four villages had higher DMFT than other areas of Nicaragua, if DMFT was higher among the four rural villages when compared to an urban location, or if DMFT in Nicaragua has risen over time.

Literacy. According to the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Institute for Statistics (UIS), the literacy rate for adults (15+) in Nicaragua in 2005 was 78.0% (78.1% among males and 77.9% among females) (United Nations Educational, n.d.). Comparing these percentages to the frequencies of adult (15+) participants who scored "1" or higher on the literacy assessment analyzed in this study, one can see that the literacy rate of 66.9% (72.2% among males, 64.4% among females) in the four assessed villages was lower than the UIS literacy rate for adults in Nicaragua and contained more disparity between sexes.

Additionally, literacy the rate among youth (15-24) in Nicaragua in 2005 was 87.0% (85.2% among males and 88.8% among females) (United Nations Educational, n.d.). Comparing these percentages to the frequencies of youth (15-24) participants who scored "1" or higher on the literacy assessment analyzed in this study, one can see that the literacy rate of 88.0% (83.3% among males, 90.9% among females) in the four assessed villages was similar to, and slightly higher than, the UIS literacy rate for youth in Nicaragua.

Independent samples t-tests could not be conducted to examine whether these differences in mean literacy rates were significantly different since the standard deviations of the mean literacy rates reported by the UIS were unknown.

Smoking tobacco use. Reliable information regarding smoking tobacco use in Nicaragua was difficult to find. The study by Laux et al. (2012) found that 31.3% (n = 424) of participants had smoked at some point in their life. This was much higher than the 12.0% (n = 53) of participants from this study who smoked, though it should be noted that the questions asked of participants were quite different. Laux et al. (2012) noted that males were much more likely to smoke tobacco than women, a result that was also found in this study.

Comparisons between the Villages and Central America

Air quality. A study that examined the rates of respiratory problems among children in Latin America found that 13.6% of children were previously diagnosed with asthma, 15.9% of children wheezed, and 2.6% of children had sleep disturbances to due wheezing at least once per week (Mallol et al., 2010). The rates of asthma varied between the countries, though this variation was not related to socioeconomic status indicating that the causes of asthma may contain complex social and cultural interactions. Comparatively, in this study 21.7% of children were previously diagnosed with asthma and 37.7% of children wheezed (including children previously diagnosed with asthma). Using the Mallol et al. (2010) study as a comparison, it appeared that children in this study had higher rates of asthma and wheezing than in other communities in Central America.

Alcohol use. One study that examined alcohol and tobacco use in seven urban areas in Latin America among adults aged 60 and older found that 30.4% of participants drank alcohol at least sometimes (Kim, De La Rosa, Rice, & Delva, 2007). It would appear that the 6.5% of males who drank alcohol in Santa Celia had a much lower use rate than the rest of Nicaragua. However, investigators caution coming to such a conclusion since it appeared that respondents self-reported use did not match the concerns of participants brought to light during the public health assessment. This schism between low self-reported alcohol use in the health assessment and higher reported community use in the public health assessment may have been attributable to social stigmas surrounding alcohol use.

Literacy. The UIS literacy rate for adults (15+) in the Central American region in 2011 was 91.5% (92.2% among males and 90.9% among females) (United Nations Educational, n.d.). Comparing these percentages to the frequencies of adult (15+) participants in this study with some literacy skills (a literacy assessment score of “1” or higher), one can see that the literacy rate of 66.9% (72.2% among males, 64.4% among females) in the four assessed villages was lower than the UIS literacy rate for adults in the Central American region and contained more disparity between sexes.

Additionally, the literacy rate among youth (15-24) in the Central American region in 2011 was 97.1% (96.8% among males and 97.3% among females) (United Nations Educational, n.d.). Comparing these percentages to the frequencies of youth (15-24) participants in this study with some literacy skills (a literacy assessment score of “1” or higher), one can see that the literacy rate of 88.0% (83.3% among males, 90.9% among females) in the four assessed villages was similar to, and slightly higher than, the UIS literacy rate for youth in Nicaragua.

Independent samples t-tests could not be conducted to examine whether these differences in mean literacy rates were significantly different since the standard deviations of the mean literacy rates reported by the UIS were unknown.

Smoking tobacco use. According to a Gallup poll (Naurath & Jones, 2007), 12% of the people in Central America smoke tobacco. This rate was identical to the 12.0% of people (all males) who smoked in Santa Celia. Another study that examined seven Latin America cities found that current smokers was slightly higher at 16.3%, though this study was performed in urban areas and had significant variation by country (Kim et al., 2007).

Summary

In order to address the research question that dealt with differences among the villages, between the villages and Nicaragua, and between the villages and Central America, the following key findings emerged:

- Abdominal distension rates differed significantly among children in all three villages where data were collected – El Paraiso, Santa Marta, and La Grecia – with children in El Paraiso having the highest rate of abdominal distension, followed by Santa Marta, and then children in La Grecia having the lowest rate of abdominal distension. While rates of abdominal distension differed among villages, the prevalence of diarrhea among children did not.
- The frequency of diagnosed asthma did not differ significantly among the villages, though potential asthma among children not previously diagnosed with asthma was significantly lower in El Paraiso where most of the houses had brick walls, concrete floors, and a stove located behind the home rather than inside the home.
- Blood pressure categorizations differed significantly among the villages with Santa Celia and El Paraiso generally having a higher prevalence of prehypertension or hypertension than Santa Marta and La Grecia. This trend appeared to continue even

when the sample was split by age to account for previously determined relationships between age and blood pressure.

- BMI categorizations for participants aged 19 and older differed significantly among villages. While all villages displayed a low prevalence of underweight, Santa Marta and La Grecia tended to have a higher prevalence of overweight and obesity than Santa Celia and El Paraiso. This relationship held when sex was considered. BMI categorizations for participants age 2-19 also differed significantly among villages. "Severe underweight" was low in all villages except El Paraiso. El Paraiso also had the highest prevalence of "Obese."
- Mean DMFT did not differ significantly among villages. However, the mean number of filled teeth in Santa Celia was significantly lower than in El Paraiso perhaps speaking to limited access or the ability to afford dental care in Santa Celia.
- Categorization as "Diabetic" did not differ significantly among villages. This held true even when the sample was split by age to account for a previously determined relationship between fasting blood glucose and age.
- Limited cases of anemia made it difficult to determine whether differences among villages existed. It was interesting to note that El Paraiso had no instances of anemia.
- Contraception use among sexually active females of childbearing age was significantly lower in Santa Celia than in the other three villages.
- There appeared to be two tiers of literacy among the villages with Santa Marta and La Grecia having significantly higher literacy rates than El Paraiso and Santa Celia. This notion of two tiers of literacy continued when the file was split into four age groups to account for a previously determined relationship between age and literacy.

- There was no significant difference among villages for smoking tobacco use among adults.
- Investigators questioned most inferences that may be made when comparing these four villages to the rest of Nicaragua due to limited timely studies with similar methods. Two exceptions were made when participants of this study were seen to have higher blood pressures than those of Laux et al. (2012) and participants in this study had higher rates of childhood asthma than those of Allen, Meadows-Oliver, and Ryan-Krause (2008).
- While the results from many variables in this study appeared to align closely with other observations made in Nicaragua, these four villages tended to fare worse on health and literacy metrics than other areas of Central America.

RQ6: What is an Appropriate Analytic Model for the Review of the Data Collected by the Three Assessment Procedures?

While analyzing the information from this data set, investigators kept in mind the notion of beneficence and attempted to assist in the greatest social benefit to the target population. In order to assist future investigators using data derived from the trivalent assessment developed by Global Partners-Nicaragua and The Rainbow Network, investigators presented the four steps that helped guide this study; 1) Develop research questions, 2) Ensure that appropriate descriptive analyses have been conducted, 3) Consider the appropriateness of inferential analyses, 4) As needed, incorporate the most appropriate type of statistical test (e.g., parametric vs. non-parametric). Note that these four steps are similar to, yet distinct from, the phases described in Chapter 3. While the phases described solely the data analysis methodology, these four steps described the process that built the foundation of the entire study.

Step 1: Develop Research Questions

The six research questions (RQs) were central to this study. These RQs framed the purpose of this study which helped guide the review of literature and created a structured data analysis process from which conclusions and recommendations emanated.

Step 2: Ensure that Descriptive Analyses have been Conducted

By first conducting descriptive analyses, investigators gained a better understanding of the data. The results from these descriptive analyses were crucial references when considering the appropriateness of inferential analyses and statistical procedures.

Step 3: Consider the Appropriateness of Inferential Analyses

Investigators considered inferential analyses only after observing the results from the descriptive analyses. One of the most common first steps in inferential analyses was to consider the confounding effects of age or sex. This helped strengthen further inferential analyses since confounding variables were accounted for. Additionally, the research questions in this study were ordered in a manner to help investigators identify confounding variables early in the study so that they could be included in analyses later in the study when appropriate.

Step 4: Consider Appropriate Statistical Analysis Procedures

While the first three steps were sequential in nature – investigators first developed research questions, then conducted descriptive analyses, and finally considered inferential analyses – choosing appropriate statistical analysis procedures was really incorporated into both steps two and three. When conducting descriptive analyses on a variable of interest, investigators considered the level of data for each variable before conducting the appropriate statistical procedure. Frequencies were ascertained for nominal and ordinal level data while the mean, median, mode, and range were observed for all interval and ratio level data. Then, before choosing an appropriate inferential statistical procedure, investigators determined whether a parametric or non-parametric test was appropriate. While they have greater power than non-parametric tests and many times are the preferred statistical procedures, parametric tests rely on certain assumptions. In order to use a parametric statistical procedure, five assumptions were made: 1) The data was interval or ratio level data, 2) The data came from a random sample 3), Observations were independent of one another, 4) Populations from which data were taken were normally distributed, and 5) Groups within a variable had homogeneity (equal) variances. Investigators in this study asked questions such as, "What level of data do I have?" "Is the distribution normal?" "Do groups that I intend to examine have equal variances?" There were some instances when investigators proceeded with parametric tests despite a violation of an assumption. As noted throughout this study, the assumption that groups had homogeneous variances was frequently violated. But SPSS offered alternative tests that maintained most of the power of parametric tests while accounting for unequal variances between groups. Additionally, there were times when a non-parametric test was not available and investigators used a parametric test that was quite robust with large sample sizes (e.g., two-way between-groups ANOVA). But generally, if the assumptions for parametric tests were violated, then non-parametric alternative tests were performed in an effort to err on the side of caution.

Discussion

Air Quality

Previously diagnosed asthma rates among child participants in this study were higher than in other studies that examined asthma rates in Nicaragua (Allen, Meadows-Oliver, & Ryan-Krause, 2008; Mallol et al., 2010). However, the city of Managua served as the Nicaraguan sample population in both of these studies, and the differences seen between the villages and Nicaragua may have been due to the rural population this study examined versus the urban population examined by both Allen, Meadows-Oliver, and Ryan-Krause (2008) and Mallol et al. (2010). Still, the large difference between the previously diagnosed asthma rates seen in this study compared to lower asthma rates in Managua indicated that improvements could potentially be achieved in this study's target population.

Not only were many children previously diagnosed with asthma, but many children previously undiagnosed with asthma showed potential symptoms of asthma according to the BPAS+. While children in El Paraiso had similar rates of asthma when compared to children in the other three villages, significantly fewer children in El Paraiso reported symptoms often affiliated with asthma. The public health assessment also indicated that houses in El Paraiso smelled less of smoke than houses in Santa Celia and Santa Marta. This might have been due to differences in the building materials of homes (most houses in El Paraiso were made of brick with cement floors while many houses in Santa Celia and Santa Marta – the two other villages where information regarding housing materials was available – were made of wood with dirt floors) or the location of the stove (the stove was located behind most homes in El Paraiso while homes in Santa Celia and Santa Marta contained a stove in the same area as the living quarters).

Alcohol Use

Only adult health assessment participants in Santa Celia were asked if they used alcohol and whether they believed they had a problem with alcohol. Only a few respondents, all males, indicated that they drank alcohol, and none of those respondents believed they had a problem with alcohol. These results appeared to conflict with the key informants for Santa Celia's public health assessment who indicated that alcohol was regularly consumed by some in the community, particularly following payday, and that safety concerns arose when some individuals consumed too much alcohol. Such inconsistencies may be due to social or religious taboos surrounding alcohol use that make people uncomfortable talking about it. Or perhaps the health assessment participants answered the questions honestly but interpreted the questions differently than the survey creators. Whatever the reason for the inconsistency, this provides an example of the value that may be derived from the flexible nature of key informant interviews (Gilmore, 2012).

Anemia

The prevalence of anemia was low in all villages, and appeared to be most prevalent in those younger than two. However, it was unknown whether this was due to true anemia among youth or a broad definition of anemia (less than 10 g/dL for all participants).

Blood Pressure

The prevalence of hypertension was relatively low in all four villages. There was a difference in the prevalence of hypertension among villages with El Paraiso having the highest prevalence of hypertension (27%) followed by Santa Celia, Santa Marta, and La Grecia having a prevalence of 21%, 14% and 14% respectively. These differences among villages appeared to remain when age, a variable previously determined to be related to blood pressure, was considered. While both the systolic and diastolic blood pressure of participants in this study differed significantly from a similar rural Nicaraguan sample in Laux et al. (2012), it could not be determined whether participants in this study had a higher prevalence of hypertension, a more clinically useful metric.

Body Mass Index (BMI)

Nearly half of all adults age 19 and older were overweight or obese. Women tended to more commonly be overweight or obese (57%) than men (32%). The one exception was observed in Santa Celia where there was no significant difference in BMI between adult men and women. Participants in Santa Marta and La Grecia displayed a significantly higher prevalence of overweight and obesity among adults than Santa Celia and El Paraiso. This relationship among villages remained when sex was considered as a confounding variable.

Only El Paraiso showed high rates of underweight and severe underweight among children age 2-19. El Paraiso also had the highest prevalence of obesity among children age 2-19. The remaining three villages – Santa Celia, Santa Marta, and La Grecia – tended to show parity in the low prevalence of underweight/severe underweight and overweight/obesity among children age 2-19.

Breastfeeding

Information regarding breastfeeding practices was limited but tended to indicate that children breastfed for one to three years.

Contraception Use

Contraception use among sexually active females of childbearing age was significantly lower in Santa Celia than the other three villages. Contraception use increased with age until the mid-30's at which point contraception use then declined with age. In all three villages, the preferred method of contraception was a Depo-Provera shot, followed by sterilization and birth control, then intrauterine devices, and condoms were rarely used. There were more women in Santa Celia who did not use contraception yet desired to do so, and in all villages women who did not use contraception yet desired to do so tended to indicate that contraception was not available.

Dental Hygiene

Decayed, missing, filled teeth (DMFT) did not differ significantly among the three villages where dental data were available – Santa Celia, El Paraiso, Santa Marta. However, Santa Celia had a lower prevalence of filled teeth compared to El Paraiso, perhaps speaking to a lack of access to, or inability to afford dental care. The public health assessment offered limited information regarding dental hygiene practices.

Diabetes

The prevalence of diabetes was low and did not differ among villages.

Literacy

Literacy varied by age with younger participants tending to be more literate than older participants. There also appeared to be two tiers of literacy among villages with

Santa Marta and La Grecia having more literate participants than Santa Celia and El Paraiso, even when age was considered as a confounding variable. Participants who had reading materials at home had a higher prevalence of literacy than those without reading materials at home. Literacy was generally not related to either lifestyle behaviors or physical indicators of health.

Nutrition and Physical Activity

The dietary habits of participants from the three villages where 24-hour dietary recall data were available - Santa Celia, El Paraiso, and La Grecia - were similar and consisted of rice, beans, and tortillas as staple foods with eggs, chicken, fruits, and vegetables consumed when available and pork or beef reserved for special occasions. Fruit and vegetable consumption was more common and frequent in Santa Marta - a village where personal gardens were more common perhaps due to the fact that residents, rather than a plantation, owned the homes. The public health assessment noted that village residents tended to be physically active, particularly male field workers and male children. Participants felt they had enough physical activity during work and generally did not value physical activity outside of employment.

Sanitation

All three villages where sanitation was assessed – Santa Celia, El Paraiso, and Santa Marta – used latrines and had free-roaming animals. The latrines appeared cleanest in Santa Marta perhaps due to the fact that only one or two families owned and shared the latrine. Santa Celia tended to have latrines that were more frequently full and kept in disrepair perhaps due to the many people who shared the latrines and the fact that the plantation owned them.

Water Quality

Among the three villages where physicians examined children for abdominal distension –El Paraiso, Santa Marta, La Grecia – prevalence was highest in El Paraiso, the only village of the three where water was not treated at its source. Prevalence did not differ among the three villages where self-report indicated whether child participants had diarrhea – El Paraiso, Santa Marta, La Grecia.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study examined data derived from a trivalent assessment process conducted in four rural Nicaraguan villages to identify health needs and assets. Investigators primarily examined risk factors related to disease and protective factors that protect one from disease by exploring relationships among the four villages where data were collected. This study served as an early investigation in a continuing global partnership between Global Partners-Nicaragua, The Rainbow Network, and residents of rural villages located in the Matagalpa region of Nicaragua. The results from this study were intended to guide interventions that could provide the greatest benefits to the health and well-being of rural Nicaraguan residents, and serve as a benchmark from which future investigators might evaluate the effectiveness of interventions.

Conclusions

The conclusions below emerged from the study findings.

Conclusion 1: Children living in homes with brick, walls, cement floors, and wood-fired stoves located behind the home had fewer respiratory issues.

While previously diagnosed asthma did not differ among villages, El Paraiso had significantly lower potential signs of asthma among children than villages with wooden walls, dirt floors, and wood-fired stoves located inside the home. This difference in potential signs of asthma might be due to differences in particulate levels due to a home's building materials and its stove location.

Conclusion 2: Alcohol and smoking tobacco use were rare among participants, particularly women, but limited data might have hindered the results.

While it was encouraging to see limited use of alcohol and smoking tobacco, future investigations must continue to examine these variables due to these activities' previously established links to a host of chronic conditions.

Conclusion 3: Roughly half of the adult participants were overweight or obese, and women were significantly more likely to be overweight or obese in all villages except Santa Celia.

Additionally, Santa Marta and La Grecia had a higher prevalence of both overweight and obesity. Dietary habits did not appear to differ much between sexes or villages. Physical activity appeared to differ between sexes with males receiving more physical activity from a young age. This difference in physical activity may account for some of the difference in BMI between sexes. Neither dietary habits nor physical activity appeared to differ between villages. Therefore, the differences in observed BMI among villages might be due to variables not considered by this study such as socioeconomic factors.

Conclusion 4: El Paraiso had a higher prevalence of both underweight and overweight among children age 2-19.

While the other three villages had relative parity in the distribution of BMI categories with most children in the "Healthy Weight" category, El Paraiso was markedly different as one can see from Figure 3.

Conclusion 5: Fruit and vegetable consumption was more common and frequent in Santa Marta - a village where personal gardens were more common perhaps due to the fact that residents, rather than a plantation, owned the homes.

Despite the higher consumption of fruits and vegetables in Santa Marta, residents of this village tended to have a higher BMI perhaps speaking to the complex interactions involved in caloric balance.

Conclusion 6: Dental outcomes did not vary between villages, but access to care might have. While the number of decayed, missing, or filled teeth was similar among villages, it appeared that residents of Santa Celia might have had limited access, or limited means to afford dental care as evidenced by their lower prevalence of filled teeth.

Conclusion 7: The prevalence of hyperglycemia, an indication of Type 2 Diabetes, was low in all villages.

Conclusion 8: The prevalence of abdominal distension among children in El Paraiso was significantly higher than Santa Marta or La Grecia – the two other villages where data were available.

There are several causes of abdominal distension among children including parasitic infections. The water supply was untreated in El Paraiso and treated in both Santa Marta and La Grecia making parasitic infections a potential factor in the increased abdominal distension. Diarrhea – another indicator of infection – did not differ among those three villages, and in fact El Paraiso had the *lowest* prevalence of diarrhea among children. It was also interesting to note that children in El Paraiso had the greatest variability in BMI categorization (refer to Conclusion 4 or Figure 3). Since abdominal distension is a cue for parasitic diseases at best, investigators were unsure if the increased abdominal distension among children in El Paraiso was a result of untreated water.

Conclusion 9: The prevalence of hypertension among participants in this study was relatively low.

Of note, while adults in Santa Marta and La Grecia tended to have more overweight and obese adult participants, they also had a lower prevalence of hypertension. Conversely, while Santa Celia and El Paraiso tended to have fewer overweight and obese adult participants, they also had a higher prevalence of hypertension.

Conclusion 10: The prevalence of contraception use among sexually active females of childbearing age increased with age until the middle 30's before declining again with the lowest level of use being in Santa Celia.

Contraception was used primarily to prevent pregnancy rather than protection against sexually transmitted diseases as was evident in the preferred contraception methods.

Conclusion 11: Young participants tended to be more literate than older participants in all four villages - perhaps a sign that recent educational efforts were effective.

Additionally, those with access to reading materials at home tended to have higher rates of literacy. While this study does not provide causal evidence, it would seem that reading materials at home improve literacy. Literacy also differed significantly among villages with Santa Celia and El Paraiso having a lower rate of literacy than Santa Marta and La Grecia across four age groups. However, a participant's literacy tended not to be related to lifestyle behaviors or physical indicators of health.

Conclusion 12: The four step analytic model used in this study helped guide investigations throughout this study.

Recommendations

The recommendations below emerged from the Conclusions and the collective study insights.

Interventions

Upon examining the results of this study, the following recommendations emerged for interventions to be conducted in the Matagalpa region of Nicaragua:

Encourage new building techniques and stove location. It appeared that respiratory conditions among children worsened as the amount of particulates in the air increased. It might be expensive to alter building designs and stove locations, but there might be grant funding available for such an endeavor. Global Partners-Nicaragua and The Rainbow Network can help villages seek such grant funding.

Encourage water treatment in El Paraiso and Santa Celia. Abdominal distension rates were highest in El Paraiso perhaps due to contaminated water. While the cause of the increased abdominal distension in El Paraiso was unknown, untreated water is a known risk factor for disease. Interventions might include providing filters, chlorine packs, and education on how to treat the water in the home or Global Partners-Nicaragua and The Rainbow Network might again seek funds to develop a sustainable method of treating the water at its source.

Develop a nutrition education program for children in El Paraiso. El Paraiso had the highest prevalence of both underweight and overweight/obesity among children. An educational intervention directed at this specific group might help bring more children into the "Healthy Weight" category and the program could be piloted in El Paraiso for implementation elsewhere.

Develop a nutrition and physical activity education program for adult women. Women had a higher prevalence of overweight and obesity in all villages except Santa Celia. Similar to a nutritional program for children in El Paraiso, a nutritional and physical activity educational intervention targeted specifically toward women in El Paraiso, Santa Marta, and La Grecia might help some of the women reduce their BMI to a healthier range.

Further Data Collection and Studies

Alcohol use, smoking tobacco use, dental hygiene, breastfeeding, and social connectivity. Investigators recommend that data continue to be collected for alcohol and smoking tobacco use because of these behaviors' known connection to diseases. Additionally, investigators recommend that thorough information regarding dental hygiene, breastfeeding, and social connectivity be gathered during the public health assessment in order to further investigate these risk/protective factors.

Study pregnancy. Contraception use was limited among teens. It would be interesting to observe whether that low contraception use correlated to pregnancies and whether such pregnancies were planned or unplanned. Additionally, due to the limited use of condoms, it might be of value to examine the prevalence of STDs in the villages if such tests are cost-effective.

Study BMI and blood pressure. It was interesting to note that the villages that had higher BMI among adults had lower blood pressures. So residents of villages tended to be protected against weight issues related to BMI but at risk to do high blood pressure or vice versa.

Health literacy. Literacy did not appear to be related to lifestyle behaviors or physical indicators of health. While the literacy assessment had value of its own in assessing the literacy of participants to give a guide of education levels, it might be beneficial to include a health literacy portion to the literacy assessment.

Analytic model for future studies. Future investigators who also conduct studies based on data derived from the trivalent assessment procedure might consider using a method similar to this study's four step model in order to ensure beneficence to the target population. However, not all studies will necessary conduct inferential analyses, and therefore future investigators might consider a three step model consisting of: 1) Develop research questions, 2) Ensure that descriptive analyses have been conducted, and 3) Consider other appropriate analyses (e.g., inferential analyses) and the parameters/assumptions that underlie such tests.

By using this model as a base, future investigators would create consistency in the investigations involving the trivalent assessment. In turn, this would help create consistency in the interventions of Global Partners-Nicaragua and The Rainbow Network as well consistency in the evaluation of these interventions. Goals of such consistency might be particularly important in volunteer organizations where turnover tends to be high.

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APPENDIX A

BRIEF PEDIATRIC ASTHMA SCREENING PLUS (BPAS+) TOOL

ENGLISH VERSION

1. Has a doctor or nurse EVER told you that your child has asthma? □ NO □ YES

> ***If YES, do not calculate asthma score. → "previous diagnosis of asthma."***
>
> ***If NO, calculate asthma score below.***

2. Does your child EVER:

a. wheeze (have whistling in the chest)?	0 NO	1 YES
b. have a cough that will not go away?	0 NO	1 YES
c. cough at night when the child does not have a cold?	0 NO	1 YES
d. have breathing problems when the air temperature changes?	0 NO	1 YES

Add 2 (a, b, c, d) to get asthma score:

> **Score of 1 or more → *"shows symptoms of asthma; evaluate further"***

SPANISH VERSION

1. ¿ALGUNA VEZ le ha dicho un médico o enfermero que su niño tiene asma? 0 NO 1 SÍ
2. ¿Ha tenido su niño EN ALGÚN MOMENTO:

a. respiración sibilante (silbido en el pecho)?	0 NO	1 SÍ
b. tos que no se cura?	0 NO	1 SÍ
c. tos durante la noche cuando no tiene un resfriado?	0 NO	1 SÍ
d. problemas para respirar cuando cambia la temperatura del aire?	0 NO	1 SÍ

Figure 1. English and Spanish versions of the asthma portion of the Brief Pediatric Asthma Screen Plus.

APPENDIX B

SAMPLE TWENTY-FOUR-HOUR DIETARY RECALL

Family Nutrition Assessment, La Gracia, San Ramon District, Nicaragua, July 9-12, 2012

Date
Home
Head of Household (Male or Female?)
Interviewee
Interviewer
Interpreter
Recorder
Observer

24 HOUR RECALL

Time 1
Food/Beverages 1
Ingredients 1
Prep. Methods 1
Other Considerations 1

Time 2
Food/Beverages 2
Ingredients 2
Prep. Methods 2
Other Considerations 2

Time 3
Food/Beverages 3
Ingredients 3
Prep. Methods 3
Other Considerations 3

Time 4
Food/Beverages 4
Ingredients 4
Prep. Methods 4
Other Considerations 4

Time 5
Food/Beverages 5
Ingredients 5
Prep. Methods 5
Other Considerations 5

Time 6
Food/Beverages 6
Ingredients 6
Prep. Methods 6
Other Considerations 6

Time 7
Food/Beverages 7

Ingredients 7
Prep. Methods 7
Other Considerations 7

Time 8
Food/Beverages 8
Ingredients 8
Prep. Methods 8
Other Considerations 8

INDIVIDUALS LIVING AT HOME

Male or Female 1
Age1

Male or Female 2
Age2

Male or Female 3
Age3

Male or Female 4
Age4

Male or Female 5
Age5

Male or Female 6
Age6

Male or Female 7
Age7

Male or Female 8
Age8

Male or Female 9
Age9

Male or Female 10
Age10

CURRENT INFANT FEEDING PRACTICE
Are you currently breastfeeding?
Do you give anything other than breast milk to the baby?

FORMULA FEEDING
Age started formula?
Where do you get your formula?
How do you prepare your formula?

FIRST SOLID FOODS
Age of first solid food?
What other drinks are given?
What age begin finger foods/self-feeding?
What age wean from breast?
What age wean from bottle?
Does the child sleep with the bottle?

YOUTH
How many meals/week are eaten away from home?
Where are they eaten?
What does the child(ren) usually drink?

DENTAL
Does anyone in the house not eat some foods because of mouth pain?
Age of individuals
What foods cannot be eaten?

FOOD SOURCE
List where you get your food and how often (e.g. local market, 1x/wk)

FOOD PREP/STORAGE
Who usually prepares the food for you and your family?
If all of the food from a meal is not eaten, what is done with the remaining food?
Observation-- Where is food prepared? (e.g., outside kitchen, cooked in home?

FOOD PREFERENCES
What foods would you like you or your family to eat more often?
What are the barriers to you/your family eating these foods?
Are there foods that your family used to eat that you and your family are no longer eating? Why?
Is gardening a plot of land or in containers something that you might be interested in and able to care for in the future?
Comments

APPENDIX C

SAMPLE OF COMMUNITY PORTION OF PUBLIC HEALTH ASSESSMENT

Family & Community Needs and Assets Assessment, La Gracia, San Ramon District, Nicaragua, July 9-12, 2012

Date> Click here to enter date.
Time> Click here to enter time.
Home> Home
Interviewee> Interviewee's Name.
Interviewer> Interviewer's Name
Interpreter> Interpreter's Name
Recorder> Recorder's Name
Observer> Observer's Name

I. Family Information>

1. How many of your family members live with you in your home? > Click here to enter text.

2. Do other families live with you? > Click here to enter text.

    3. How many other families/people? > Click here to enter text.

4. Do you own or rent your home? > Click here to enter text.

5. How long has your family lived in this home? > Click here to enter text.

6. How long has your family lived in the community? > Click here to enter text.

7. Do you have electricity? > Click here to enter text.

    8. How often do you have it each day? > Click here to enter text.

9. Do you have a family garden? > Click here to enter text.

    10. If yes, where is it? > Click here to enter text.

11. What are your sources of food for your family? > Click here to enter text.

12. What is your source of drinking and cooking water? > Click here to enter text.

13. Do you purify your water regularly for drinking and cooking? > Click here to enter text.

    14. If yes, how do you do so? > Click here to enter text.

15. Do you have your own family latrine or do you use a community latrine? > Click here to enter text.

16. Do you have animals or birds that you keep in or near your home? > Click here to enter text.

    17. If yes, what type and how many? > Click here to enter text.

18. What are the sources of family income? > Click here to enter text.

19. What was the amount of family income (all sources) during the past year (in Cordobas; $1 = 23.555 C$) ? > Click here to enter text.

20. What sources of communication do you have (e.g., cell phones, radio, TV)? > Click here to enter text.

21. Do/did all of your eligible children go to grade school? > Click here to enter text.

    22. If no, please explain why> Click here to enter text.

23. Do/did any of your eligible children go to high school (scholarship)? > Click here to enter text.

    24. If yes, who are they? > Click here to enter text.

27. What skills would you like to teach or show others? > Click here to enter text.

28. Which community groups do you participate in? > Click here to enter text.

29. What community groups have helped you and your family in the past? > Click here to enter text.

30. How have they helped you?> Click here to enter text.

31. Do you have books, magazines, and other reading material here at home? > Click here to enter text.

32. If so, what reading materials? > Click here to enter text.

33. Do you go to a specific church? > Click here to enter text.

34. If yes, which one? > Click here to enter text.

35. Do you think it is important to go church? > Click here to enter text.

36. Why? > Click here to enter text.

37. How often do you travel elsewhere? > Click here to enter text.

38. To where & why? > Click here to enter text.

39. How do you travel? > Click here to enter text.

Observations in and around home>

40. Floor /wall composition and condition> Click here to enter text.

41. Indoor air quality> Click here to enter text.

42. Animals inside/outside home> Click here to enter text.

43. Other (water filter in use; food storage; reading material; radio; TV; appliances; electrical circuits)> Click here to enter text.

II. Environmental/Community Commentary and Observations>
Information Source—<u>Key Informants (KI)</u> <u>Observation (OBS)</u> <u>Other (O)</u> >

44. Community leaders> Click here to enter text.

45. Electricity> Click here to enter text.

46. Cell phone availability/use> Click here to enter text.

47. Community water source> Click here to enter text.

48. Water distribution system(s)> Click here to enter text.

49. Community latrines> Click here to enter text.

50. Possible air, land, water contaminants/injury inducers (e.g., unsafe foot bridges)> Click here to enter text.

51. Clinic> Click here to enter text.

52. School(s)> Click here to enter text.

53. Grocery> Click here to enter text.

56. **Day care center(s)>** Click here to enter text.

57. **Playgrounds and parks>** Click here to enter text.

58. **Community member transportation access and use (e.g., road system, bus, other motor vehicles, bicycles)>** Click here to enter text.

59. **Other assets/issues (e.g., community garden)>** Click here to enter text.

APPENDIX D

BMI FOR AGE: BOYS AGE 2-5 Z-SCORES

Month	L	M	S	SD3neg	SD2neg	SD1neg	SD0	SD1	SD2	SD3
24	-0.6187	16.0189	0.07785	12.9	13.8	14.8	16.0	17.3	18.9	20.6
25	-0.5840	15.9800	0.07792	12.8	13.8	14.8	16.0	17.3	18.8	20.5
26	-0.5497	15.9414	0.07800	12.8	13.7	14.8	15.9	17.3	18.8	20.5
27	-0.5166	15.9036	0.07808	12.7	13.7	14.7	15.9	17.2	18.7	20.4
28	-0.4850	15.8667	0.07818	12.7	13.6	14.7	15.9	17.2	18.7	20.4
29	-0.4552	15.8306	0.07829	12.7	13.6	14.7	15.8	17.1	18.6	20.3
30	-0.4274	15.7953	0.07841	12.6	13.6	14.6	15.8	17.1	18.6	20.2
31	-0.4016	15.7606	0.07854	12.6	13.5	14.6	15.8	17.1	18.5	20.2
32	-0.3782	15.7267	0.07867	12.5	13.5	14.6	15.7	17.0	18.5	20.1
33	-0.3572	15.6934	0.07882	12.5	13.5	14.5	15.7	17.0	18.5	20.1
34	-0.3388	15.6610	0.07897	12.5	13.4	14.5	15.7	17.0	18.4	20.0
35	-0.3231	15.6294	0.07914	12.4	13.4	14.5	15.6	16.9	18.4	20.0
36	-0.3101	15.5988	0.07931	12.4	13.4	14.4	15.6	16.9	18.4	20.0
37	-0.3000	15.5693	0.07950	12.4	13.3	14.4	15.6	16.9	18.3	19.9
38	-0.2927	15.5410	0.07969	12.3	13.3	14.4	15.5	16.8	18.3	19.9
39	-0.2884	15.5140	0.07990	12.3	13.3	14.3	15.5	16.8	18.3	19.9
40	-0.2869	15.4885	0.08012	12.3	13.2	14.3	15.5	16.8	18.2	19.9
41	-0.2881	15.4645	0.08036	12.2	13.2	14.3	15.5	16.8	18.2	19.9
42	-0.2919	15.4420	0.08061	12.2	13.2	14.3	15.4	16.8	18.2	19.8
43	-0.2981	15.4210	0.08087	12.2	13.2	14.2	15.4	16.7	18.2	19.8
44	-0.3067	15.4013	0.08115	12.2	13.1	14.2	15.4	16.7	18.2	19.8
45	-0.3174	15.3827	0.08144	12.2	13.1	14.2	15.4	16.7	18.2	19.8
46	-0.3303	15.3652	0.08174	12.1	13.1	14.2	15.4	16.7	18.2	19.8
47	-0.3452	15.3485	0.08205	12.1	13.1	14.2	15.3	16.7	18.2	19.9
48	-0.3622	15.3326	0.08238	12.1	13.1	14.1	15.3	16.7	18.2	19.9
49	-0.3811	15.3174	0.08272	12.1	13.0	14.1	15.3	16.7	18.2	19.9
50	-0.4019	15.3029	0.08307	12.1	13.0	14.1	15.3	16.7	18.2	19.9
51	-0.4245	15.2891	0.08343	12.1	13.0	14.1	15.3	16.6	18.2	19.9
52	-0.4488	15.2759	0.08380	12.0	13.0	14.1	15.3	16.6	18.2	19.9
53	-0.4747	15.2633	0.08418	12.0	13.0	14.1	15.3	16.6	18.2	20.0
54	-0.5019	15.2514	0.08457	12.0	13.0	14.0	15.3	16.6	18.2	20.0
55	-0.5303	15.2400	0.08496	12.0	13.0	14.0	15.2	16.6	18.2	20.0
56	-0.5599	15.2291	0.08536	12.0	12.9	14.0	15.2	16.6	18.2	20.1
57	-0.5905	15.2188	0.08577	12.0	12.9	14.0	15.2	16.6	18.2	20.1
58	-0.6223	15.2091	0.08617	12.0	12.9	14.0	15.2	16.6	18.3	20.2
59	-0.6552	15.2000	0.08659	12.0	12.9	14.0	15.2	16.6	18.3	20.2
60	-0.6892	15.1916	0.08700	12.0	12.9	14.0	15.2	16.6	18.3	20.3

APPENDIX E

BMI FOR AGE: GIRLS AGE 2-5 Z-SCORES

Month	L	M	S	SD3neg	SD2neg	SD1neg	SD0	SD1	SD2	SD3
24	-0.5684	15.6881	0.08454	12.4	13.3	14.4	15.7	17.1	18.7	20.6
25	-0.5684	15.6590	0.08452	12.4	13.3	14.4	15.7	17.1	18.7	20.6
26	-0.5684	15.6308	0.08449	12.3	13.3	14.4	15.6	17.0	18.7	20.6
27	-0.5684	15.6037	0.08446	12.3	13.3	14.4	15.6	17.0	18.6	20.5
28	-0.5684	15.5777	0.08444	12.3	13.3	14.3	15.6	17.0	18.6	20.5
29	-0.5684	15.5523	0.08443	12.3	13.2	14.3	15.6	17.0	18.6	20.4
30	-0.5684	15.5276	0.08444	12.3	13.2	14.3	15.5	16.9	18.5	20.4
31	-0.5684	15.5034	0.08448	12.2	13.2	14.3	15.5	16.9	18.5	20.4
32	-0.5684	15.4798	0.08455	12.2	13.2	14.3	15.5	16.9	18.5	20.4
33	-0.5684	15.4572	0.08467	12.2	13.1	14.2	15.5	16.9	18.5	20.3
34	-0.5684	15.4356	0.08484	12.2	13.1	14.2	15.4	16.8	18.5	20.3
35	-0.5684	15.4155	0.08506	12.1	13.1	14.2	15.4	16.8	18.4	20.3
36	-0.5684	15.3968	0.08535	12.1	13.1	14.2	15.4	16.8	18.4	20.3
37	-0.5684	15.3796	0.08569	12.1	13.1	14.1	15.4	16.8	18.4	20.3
38	-0.5684	15.3638	0.08609	12.1	13.0	14.1	15.4	16.8	18.4	20.3
39	-0.5684	15.3493	0.08654	12.0	13.0	14.1	15.3	16.8	18.4	20.3
40	-0.5684	15.3358	0.08704	12.0	13.0	14.1	15.3	16.8	18.4	20.3
41	-0.5684	15.3233	0.08757	12.0	13.0	14.1	15.3	16.8	18.4	20.4
42	-0.5684	15.3116	0.08813	12.0	12.9	14.0	15.3	16.8	18.4	20.4
43	-0.5684	15.3007	0.08872	11.9	12.9	14.0	15.3	16.8	18.4	20.4
44	-0.5684	15.2905	0.08931	11.9	12.9	14.0	15.3	16.8	18.5	20.4
45	-0.5684	15.2814	0.08991	11.9	12.9	14.0	15.3	16.8	18.5	20.5
46	-0.5684	15.2732	0.09051	11.9	12.9	14.0	15.3	16.8	18.5	20.5
47	-0.5684	15.2661	0.09110	11.8	12.8	14.0	15.3	16.8	18.5	20.5
48	-0.5684	15.2602	0.09168	11.8	12.8	14.0	15.3	16.8	18.5	20.6
49	-0.5684	15.2556	0.09227	11.8	12.8	13.9	15.3	16.8	18.5	20.6
50	-0.5684	15.2523	0.09286	11.8	12.8	13.9	15.3	16.8	18.6	20.7
51	-0.5684	15.2503	0.09345	11.8	12.8	13.9	15.3	16.8	18.6	20.7
52	-0.5684	15.2496	0.09403	11.7	12.8	13.9	15.2	16.8	18.6	20.7
53	-0.5684	15.2502	0.09460	11.7	12.7	13.9	15.3	16.8	18.6	20.8
54	-0.5684	15.2519	0.09515	11.7	12.7	13.9	15.3	16.8	18.7	20.8
55	-0.5684	15.2544	0.09568	11.7	12.7	13.9	15.3	16.8	18.7	20.9
56	-0.5684	15.2575	0.09618	11.7	12.7	13.9	15.3	16.8	18.7	20.9
57	-0.5684	15.2612	0.09665	11.7	12.7	13.9	15.3	16.9	18.7	21.0
58	-0.5684	15.2653	0.09709	11.7	12.7	13.9	15.3	16.9	18.8	21.0
59	-0.5684	15.2698	0.09750	11.6	12.7	13.9	15.3	16.9	18.8	21.0
60	-0.5684	15.2747	0.09789	11.6	12.7	13.9	15.3	16.9	18.8	21.1

APPENDIX F

BMI FOR AGE: BOYS AGE 5-19 Z-SCORES

BMI-for-age BOYS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
5: 1	61	-0.7387	15.2641	0.08390	12.1	13.0	14.1	15.3	16.6	18.3	20.2
5: 2	62	-0.7621	15.2616	0.08414	12.1	13.0	14.1	15.3	16.6	18.3	20.2
5: 3	63	-0.7856	15.2604	0.08439	12.1	13.0	14.1	15.3	16.7	18.3	20.2
5: 4	64	-0.8089	15.2605	0.08464	12.1	13.0	14.1	15.3	16.7	18.3	20.3
5: 5	65	-0.8322	15.2619	0.08490	12.1	13.0	14.1	15.3	16.7	18.3	20.3
5: 6	66	-0.8554	15.2645	0.08516	12.1	13.0	14.1	15.3	16.7	18.4	20.4
5: 7	67	-0.8785	15.2684	0.08543	12.1	13.0	14.1	15.3	16.7	18.4	20.4
5: 8	68	-0.9015	15.2737	0.08570	12.1	13.0	14.1	15.3	16.7	18.4	20.5
5: 9	69	-0.9243	15.2801	0.08597	12.1	13.0	14.1	15.3	16.7	18.4	20.5
5:10	70	-0.9471	15.2877	0.08625	12.1	13.0	14.1	15.3	16.7	18.5	20.6
5:11	71	-0.9697	15.2965	0.08653	12.1	13.0	14.1	15.3	16.7	18.5	20.6
6: 0	72	-0.9921	15.3062	0.08682	12.1	13.0	14.1	15.3	16.8	18.5	20.7
6: 1	73	-1.0144	15.3169	0.08711	12.1	13.0	14.1	15.3	16.8	18.6	20.8
6: 2	74	-1.0365	15.3285	0.08741	12.2	13.1	14.1	15.3	16.8	18.6	20.8
6: 3	75	-1.0584	15.3408	0.08771	12.2	13.1	14.1	15.3	16.8	18.6	20.9
6: 4	76	-1.0801	15.3540	0.08802	12.2	13.1	14.1	15.4	16.8	18.7	21.0
6: 5	77	-1.1017	15.3679	0.08833	12.2	13.1	14.1	15.4	16.9	18.7	21.0
6: 6	78	-1.1230	15.3825	0.08865	12.2	13.1	14.1	15.4	16.9	18.7	21.1
6: 7	79	-1.1441	15.3978	0.08898	12.2	13.1	14.1	15.4	16.9	18.8	21.2
6: 8	80	-1.1649	15.4137	0.08931	12.2	13.1	14.2	15.4	16.9	18.8	21.3
6: 9	81	-1.1856	15.4302	0.08964	12.2	13.1	14.2	15.4	17.0	18.9	21.3
6:10	82	-1.2060	15.4473	0.08998	12.2	13.1	14.2	15.4	17.0	18.9	21.4
6:11	83	-1.2261	15.4650	0.09033	12.2	13.1	14.2	15.5	17.0	19.0	21.5
7: 0	84	-1.2460	15.4832	0.09068	12.3	13.1	14.2	15.5	17.0	19.0	21.6
7: 1	85	-1.2656	15.5019	0.09103	12.3	13.2	14.2	15.5	17.1	19.1	21.7
7: 2	86	-1.2849	15.5210	0.09139	12.3	13.2	14.2	15.5	17.1	19.1	21.8

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
7: 3	87	-1.3040	15.5407	0.09176	12.3	13.2	14.3	15.5	17.1	19.2	21.9
7: 4	88	-1.3228	15.5608	0.09213	12.3	13.2	14.3	15.6	17.2	19.2	22.0
7: 5	89	-1.3414	15.5814	0.09251	12.3	13.2	14.3	15.6	17.2	19.3	22.0
7: 6	90	-1.3596	15.6023	0.09289	12.3	13.2	14.3	15.6	17.2	19.3	22.1
7: 7	91	-1.3776	15.6237	0.09327	12.3	13.2	14.3	15.6	17.3	19.4	22.2
7: 8	92	-1.3953	15.6455	0.09366	12.3	13.2	14.3	15.6	17.3	19.4	22.4
7: 9	93	-1.4126	15.6677	0.09406	12.4	13.3	14.3	15.7	17.3	19.5	22.5
7:10	94	-1.4297	15.6903	0.09445	12.4	13.3	14.4	15.7	17.4	19.6	22.6
7:11	95	-1.4464	15.7133	0.09486	12.4	13.3	14.4	15.7	17.4	19.6	22.7
8: 0	96	-1.4629	15.7368	0.09526	12.4	13.3	14.4	15.7	17.4	19.7	22.8
8: 1	97	-1.4790	15.7606	0.09567	12.4	13.3	14.4	15.8	17.5	19.7	22.9
8: 2	98	-1.4947	15.7848	0.09609	12.4	13.3	14.4	15.8	17.5	19.8	23.0
8: 3	99	-1.5101	15.8094	0.09651	12.4	13.3	14.4	15.8	17.5	19.9	23.1
8: 4	100	-1.5252	15.8344	0.09693	12.4	13.4	14.5	15.8	17.6	19.9	23.3
8: 5	101	-1.5399	15.8597	0.09735	12.5	13.4	14.5	15.9	17.6	20.0	23.4
8: 6	102	-1.5542	15.8855	0.09778	12.5	13.4	14.5	15.9	17.7	20.1	23.5
8: 7	103	-1.5681	15.9116	0.09821	12.5	13.4	14.5	15.9	17.7	20.1	23.6
8: 8	104	-1.5817	15.9381	0.09864	12.5	13.4	14.5	15.9	17.7	20.2	23.8
8: 9	105	-1.5948	15.9651	0.09907	12.5	13.4	14.6	16.0	17.8	20.3	23.9
8:10	106	-1.6076	15.9925	0.09951	12.5	13.5	14.6	16.0	17.8	20.3	24.0
8:11	107	-1.6199	16.0205	0.09994	12.5	13.5	14.6	16.0	17.9	20.4	24.2
9: 0	108	-1.6318	16.0490	0.10038	12.6	13.5	14.6	16.0	17.9	20.5	24.3
9: 1	109	-1.6433	16.0781	0.10082	12.6	13.5	14.6	16.1	18.0	20.5	24.4
9: 2	110	-1.6544	16.1078	0.10126	12.6	13.5	14.7	16.1	18.0	20.6	24.6
9: 3	111	-1.6651	16.1381	0.10170	12.6	13.5	14.7	16.1	18.0	20.7	24.7

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (z-scores)

					Z-scores (BMI in kg/m^2)						
Year: Month	**Month**	**L**	**M**	**S**	**-3 SD**	**-2 SD**	**-1 SD**	**Median**	**1 SD**	**2 SD**	**3 SD**
9: 4	112	-1.6753	16.1692	0.10214	12.6	13.6	14.7	16.2	18.1	20.8	24.9
9: 5	113	-1.6851	16.2009	0.10259	12.6	13.6	14.7	16.2	18.1	20.8	25.0
9: 6	114	-1.6944	16.2333	0.10303	12.7	13.6	14.8	16.2	18.2	20.9	25.1
9: 7	115	-1.7032	16.2665	0.10347	12.7	13.6	14.8	16.3	18.2	21.0	25.3
9: 8	116	-1.7116	16.3004	0.10391	12.7	13.6	14.8	16.3	18.3	21.1	25.5
9: 9	117	-1.7196	16.3351	0.10435	12.7	13.7	14.8	16.3	18.3	21.2	25.6
9:10	118	-1.7271	16.3704	0.10478	12.7	13.7	14.9	16.4	18.4	21.2	25.8
9:11	119	-1.7341	16.4065	0.10522	12.8	13.7	14.9	16.4	18.4	21.3	25.9
10: 0	120	-1.7407	16.4433	0.10566	12.8	13.7	14.9	16.4	18.5	21.4	26.1
10: 1	121	-1.7468	16.4807	0.10609	12.8	13.8	15.0	16.5	18.5	21.5	26.2
10: 2	122	-1.7525	16.5189	0.10652	12.8	13.8	15.0	16.5	18.6	21.6	26.4
10: 3	123	-1.7578	16.5578	0.10695	12.8	13.8	15.0	16.6	18.6	21.7	26.6
10: 4	124	-1.7626	16.5974	0.10738	12.9	13.8	15.0	16.6	18.7	21.7	26.7
10: 5	125	-1.7670	16.6376	0.10780	12.9	13.9	15.1	16.6	18.8	21.8	26.9
10: 6	126	-1.7710	16.6786	0.10823	12.9	13.9	15.1	16.7	18.8	21.9	27.0
10: 7	127	-1.7745	16.7203	0.10865	12.9	13.9	15.1	16.7	18.9	22.0	27.2
10: 8	128	-1.7777	16.7628	0.10906	13.0	13.9	15.2	16.8	18.9	22.1	27.4
10: 9	129	-1.7804	16.8059	0.10948	13.0	14.0	15.2	16.8	19.0	22.2	27.5
10:10	130	-1.7828	16.8497	0.10989	13.0	14.0	15.2	16.9	19.0	22.3	27.7
10:11	131	-1.7847	16.8941	0.11030	13.0	14.0	15.3	16.9	19.1	22.4	27.9
11: 0	132	-1.7862	16.9392	0.11070	13.1	14.1	15.3	16.9	19.2	22.5	28.0
11: 1	133	-1.7873	16.9850	0.11110	13.1	14.1	15.3	17.0	19.2	22.5	28.2
11: 2	134	-1.7881	17.0314	0.11150	13.1	14.1	15.4	17.0	19.3	22.6	28.4
11: 3	135	-1.7884	17.0784	0.11189	13.1	14.1	15.4	17.1	19.3	22.7	28.5

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²)						
					-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
11: 4	136	-1.7884	17.1262	0.11228	13.2	14.2	15.5	17.1	19.4	22.8	28.7
11: 5	137	-1.7880	17.1746	0.11266	13.2	14.2	15.5	17.2	19.5	22.9	28.8
11: 6	138	-1.7873	17.2236	0.11304	13.2	14.2	15.5	17.2	19.5	23.0	29.0
11: 7	139	-1.7861	17.2734	0.11342	13.2	14.3	15.6	17.3	19.6	23.1	29.2
11: 8	140	-1.7846	17.3240	0.11379	13.3	14.3	15.6	17.3	19.7	23.2	29.3
11: 9	141	-1.7828	17.3752	0.11415	13.3	14.3	15.7	17.4	19.7	23.3	29.5
11:10	142	-1.7806	17.4272	0.11451	13.3	14.4	15.7	17.4	19.8	23.4	29.6
11:11	143	-1.7780	17.4799	0.11487	13.4	14.4	15.7	17.5	19.9	23.5	29.8
12: 0	144	-1.7751	17.5334	0.11522	13.4	14.5	15.8	17.5	19.9	23.6	30.0
12: 1	145	-1.7719	17.5877	0.11556	13.4	14.5	15.8	17.6	20.0	23.7	30.1
12: 2	146	-1.7684	17.6427	0.11590	13.5	14.5	15.9	17.6	20.1	23.8	30.3
12: 3	147	-1.7645	17.6985	0.11623	13.5	14.6	15.9	17.7	20.2	23.9	30.4
12: 4	148	-1.7604	17.7551	0.11656	13.5	14.6	16.0	17.8	20.2	24.0	30.6
12: 5	149	-1.7559	17.8124	0.11688	13.6	14.6	16.0	17.8	20.3	24.1	30.7
12: 6	150	-1.7511	17.8704	0.11720	13.6	14.7	16.1	17.9	20.4	24.2	30.9
12: 7	151	-1.7461	17.9292	0.11751	13.6	14.7	16.1	17.9	20.4	24.3	31.0
12: 8	152	-1.7408	17.9887	0.11781	13.7	14.8	16.2	18.0	20.5	24.4	31.1
12: 9	153	-1.7352	18.0488	0.11811	13.7	14.8	16.2	18.0	20.6	24.5	31.3
12:10	154	-1.7293	18.1096	0.11841	13.7	14.8	16.3	18.1	20.7	24.6	31.4
12:11	155	-1.7232	18.1710	0.11869	13.8	14.9	16.3	18.2	20.8	24.7	31.6
13: 0	156	-1.7168	18.2330	0.11898	13.8	14.9	16.4	18.2	20.8	24.8	31.7
13: 1	157	-1.7102	18.2955	0.11925	13.8	15.0	16.4	18.3	20.9	24.9	31.8
13: 2	158	-1.7033	18.3586	0.11952	13.9	15.0	16.5	18.4	21.0	25.0	31.9
13: 3	159	-1.6962	18.4221	0.11979	13.9	15.1	16.5	18.4	21.1	25.1	32.1

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (z-scores)

					Z-scores (BMI in kg/m²)						
Year: Month	Month	L	M	S	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
13: 4	160	-1.6888	18.4860	0.12005	14.0	15.1	16.6	18.5	21.1	25.2	32.2
13: 5	161	-1.6811	18.5502	0.12030	14.0	15.2	16.6	18.6	21.2	25.2	32.3
13: 6	162	-1.6732	18.6148	0.12055	14.0	15.2	16.7	18.6	21.3	25.3	32.4
13: 7	163	-1.6651	18.6795	0.12079	14.1	15.2	16.7	18.7	21.4	25.4	32.6
13: 8	164	-1.6568	18.7445	0.12102	14.1	15.3	16.8	18.7	21.5	25.5	32.7
13: 9	165	-1.6482	18.8095	0.12125	14.1	15.3	16.8	18.8	21.5	25.6	32.8
13:10	166	-1.6394	18.8746	0.12148	14.2	15.4	16.9	18.9	21.6	25.7	32.9
13:11	167	-1.6304	18.9398	0.12170	14.2	15.4	17.0	18.9	21.7	25.8	33.0
14: 0	168	-1.6211	19.0050	0.12191	14.3	15.5	17.0	19.0	21.8	25.9	33.1
14: 1	169	-1.6116	19.0701	0.12212	14.3	15.5	17.1	19.1	21.8	26.0	33.2
14: 2	170	-1.6020	19.1351	0.12233	14.3	15.6	17.1	19.1	21.9	26.1	33.3
14: 3	171	-1.5921	19.2000	0.12253	14.4	15.6	17.2	19.2	22.0	26.2	33.4
14: 4	172	-1.5821	19.2648	0.12272	14.4	15.7	17.2	19.3	22.1	26.3	33.5
14: 5	173	-1.5719	19.3294	0.12291	14.5	15.7	17.3	19.3	22.2	26.4	33.5
14: 6	174	-1.5615	19.3937	0.12310	14.5	15.7	17.3	19.4	22.2	26.5	33.6
14: 7	175	-1.5510	19.4578	0.12328	14.5	15.8	17.4	19.5	22.3	26.5	33.7
14: 8	176	-1.5403	19.5217	0.12346	14.6	15.8	17.4	19.5	22.4	26.6	33.8
14: 9	177	-1.5294	19.5853	0.12363	14.6	15.9	17.5	19.6	22.5	26.7	33.9
14:10	178	-1.5185	19.6486	0.12380	14.6	15.9	17.5	19.6	22.5	26.8	33.9
14:11	179	-1.5074	19.7117	0.12396	14.7	16.0	17.6	19.7	22.6	26.9	34.0
15: 0	180	-1.4961	19.7744	0.12412	14.7	16.0	17.6	19.8	22.7	27.0	34.1
15: 1	181	-1.4848	19.8367	0.12428	14.7	16.1	17.7	19.8	22.8	27.1	34.1
15: 2	182	-1.4733	19.8987	0.12443	14.8	16.1	17.8	19.9	22.8	27.1	34.2
15: 3	183	-1.4617	19.9603	0.12458	14.8	16.1	17.8	20.0	22.9	27.2	34.3

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (z-scores)

					Z-scores (BMI in kg/m²)						
Year: Month	Month	L	M	S	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
15: 4	184	-1.4500	20.0215	0.12473	14.8	16.2	17.9	20.0	23.0	27.3	34.3
15: 5	185	-1.4382	20.0823	0.12487	14.9	16.2	17.9	20.1	23.0	27.4	34.4
15: 6	186	-1.4263	20.1427	0.12501	14.9	16.3	18.0	20.1	23.1	27.4	34.5
15: 7	187	-1.4143	20.2026	0.12514	15.0	16.3	18.0	20.2	23.2	27.5	34.5
15: 8	188	-1.4022	20.2621	0.12528	15.0	16.3	18.1	20.3	23.3	27.6	34.6
15: 9	189	-1.3900	20.3211	0.12541	15.0	16.4	18.1	20.3	23.3	27.7	34.6
15:10	190	-1.3777	20.3796	0.12554	15.0	16.4	18.2	20.4	23.4	27.7	34.7
15:11	191	-1.3653	20.4376	0.12567	15.1	16.5	18.2	20.4	23.5	27.8	34.7
16: 0	192	-1.3529	20.4951	0.12579	15.1	16.5	18.2	20.5	23.5	27.9	34.8
16: 1	193	-1.3403	20.5521	0.12591	15.1	16.5	18.3	20.6	23.6	27.9	34.8
16: 2	194	-1.3277	20.6085	0.12603	15.2	16.6	18.3	20.6	23.7	28.0	34.8
16: 3	195	-1.3149	20.6644	0.12615	15.2	16.6	18.4	20.7	23.7	28.1	34.9
16: 4	196	-1.3021	20.7197	0.12627	15.2	16.7	18.4	20.7	23.8	28.1	34.9
16: 5	197	-1.2892	20.7745	0.12638	15.3	16.7	18.5	20.8	23.8	28.2	35.0
16: 6	198	-1.2762	20.8287	0.12650	15.3	16.7	18.5	20.8	23.9	28.3	35.0
16: 7	199	-1.2631	20.8824	0.12661	15.3	16.8	18.6	20.9	24.0	28.3	35.0
16: 8	200	-1.2499	20.9355	0.12672	15.3	16.8	18.6	20.9	24.0	28.4	35.1
16: 9	201	-1.2366	20.9881	0.12683	15.4	16.8	18.7	21.0	24.1	28.5	35.1
16:10	202	-1.2233	21.0400	0.12694	15.4	16.9	18.7	21.0	24.2	28.5	35.1
16:11	203	-1.2098	21.0914	0.12704	15.4	16.9	18.7	21.1	24.2	28.6	35.2
17: 0	204	-1.1962	21.1423	0.12715	15.4	16.9	18.8	21.1	24.3	28.6	35.2
17: 1	205	-1.1826	21.1925	0.12726	15.5	17.0	18.8	21.2	24.3	28.7	35.2
17: 2	206	-1.1688	21.2423	0.12736	15.5	17.0	18.9	21.2	24.4	28.7	35.2
17: 3	207	-1.1550	21.2914	0.12746	15.5	17.0	18.9	21.3	24.4	28.8	35.3

2007 WHO Reference

BMI-for-age BOYS

5 to 19 years (z-scores)

					Z-scores (BMI in kg/m²)						
Year: Month	Month	L	M	S	-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
17: 4	208	-1.1410	21.3400	0.12756	15.5	17.1	18.9	21.3	24.5	28.9	35.3
17: 5	209	-1.1270	21.3880	0.12767	15.6	17.1	19.0	21.4	24.5	28.9	35.3
17: 6	210	-1.1129	21.4354	0.12777	15.6	17.1	19.0	21.4	24.6	29.0	35.3
17: 7	211	-1.0986	21.4822	0.12787	15.6	17.1	19.1	21.5	24.7	29.0	35.4
17: 8	212	-1.0843	21.5285	0.12797	15.6	17.2	19.1	21.5	24.7	29.1	35.4
17: 9	213	-1.0699	21.5742	0.12807	15.6	17.2	19.1	21.6	24.8	29.1	35.4
17:10	214	-1.0553	21.6193	0.12816	15.7	17.2	19.2	21.6	24.8	29.2	35.4
17:11	215	-1.0407	21.6638	0.12826	15.7	17.3	19.2	21.7	24.9	29.2	35.4
18: 0	216	-1.0260	21.7077	0.12836	15.7	17.3	19.2	21.7	24.9	29.2	35.4
18: 1	217	-1.0112	21.7510	0.12845	15.7	17.3	19.3	21.8	25.0	29.3	35.4
18: 2	218	-0.9962	21.7937	0.12855	15.7	17.3	19.3	21.8	25.0	29.3	35.5
18: 3	219	-0.9812	21.8358	0.12864	15.7	17.4	19.3	21.8	25.1	29.4	35.5
18: 4	220	-0.9661	21.8773	0.12874	15.8	17.4	19.4	21.9	25.1	29.4	35.5
18: 5	221	-0.9509	21.9182	0.12883	15.8	17.4	19.4	21.9	25.1	29.5	35.5
18: 6	222	-0.9356	21.9585	0.12893	15.8	17.4	19.4	22.0	25.2	29.5	35.5
18: 7	223	-0.9202	21.9982	0.12902	15.8	17.5	19.5	22.0	25.2	29.5	35.5
18: 8	224	-0.9048	22.0374	0.12911	15.8	17.5	19.5	22.0	25.3	29.6	35.5
18: 9	225	-0.8892	22.0760	0.12920	15.8	17.5	19.5	22.1	25.3	29.6	35.5
18:10	226	-0.8735	22.1140	0.12930	15.8	17.5	19.6	22.1	25.4	29.6	35.5
18:11	227	-0.8578	22.1514	0.12939	15.8	17.5	19.6	22.2	25.4	29.7	35.5
19: 0	228	-0.8419	22.1883	0.12948	15.9	17.6	19.6	22.2	25.4	29.7	35.5

2007 WHO Reference

APPENDIX G

BMI FOR AGE: GIRLS AGE 5-19 Z-SCORES

BMI-for-age GIRLS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²)						
					-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
5: 1	61	-0.8886	15.2441	0.09692	11.8	12.7	13.9	15.2	16.9	18.9	21.3
5: 2	62	-0.9068	15.2434	0.09738	11.8	12.7	13.9	15.2	16.9	18.9	21.4
5: 3	63	-0.9248	15.2433	0.09783	11.8	12.7	13.9	15.2	16.9	18.9	21.5
5: 4	64	-0.9427	15.2438	0.09829	11.8	12.7	13.9	15.2	16.9	18.9	21.5
5: 5	65	-0.9605	15.2448	0.09875	11.7	12.7	13.9	15.2	16.9	19.0	21.6
5: 6	66	-0.9780	15.2464	0.09920	11.7	12.7	13.9	15.2	16.9	19.0	21.7
5: 7	67	-0.9954	15.2487	0.09966	11.7	12.7	13.9	15.2	16.9	19.0	21.7
5: 8	68	-1.0126	15.2516	0.10012	11.7	12.7	13.9	15.3	17.0	19.1	21.8
5: 9	69	-1.0296	15.2551	0.10058	11.7	12.7	13.9	15.3	17.0	19.1	21.9
5:10	70	-1.0464	15.2592	0.10104	11.7	12.7	13.9	15.3	17.0	19.1	22.0
5:11	71	-1.0630	15.2641	0.10149	11.7	12.7	13.9	15.3	17.0	19.2	22.1
6: 0	72	-1.0794	15.2697	0.10195	11.7	12.7	13.9	15.3	17.0	19.2	22.1
6: 1	73	-1.0956	15.2760	0.10241	11.7	12.7	13.9	15.3	17.0	19.3	22.2
6: 2	74	-1.1115	15.2831	0.10287	11.7	12.7	13.9	15.3	17.0	19.3	22.3
6: 3	75	-1.1272	15.2911	0.10333	11.7	12.7	13.9	15.3	17.1	19.3	22.4
6: 4	76	-1.1427	15.2998	0.10379	11.7	12.7	13.9	15.3	17.1	19.4	22.5
6: 5	77	-1.1579	15.3095	0.10425	11.7	12.7	13.9	15.3	17.1	19.4	22.6
6: 6	78	-1.1728	15.3200	0.10471	11.7	12.7	13.9	15.3	17.1	19.5	22.7
6: 7	79	-1.1875	15.3314	0.10517	11.7	12.7	13.9	15.3	17.2	19.5	22.8
6: 8	80	-1.2019	15.3439	0.10562	11.7	12.7	13.9	15.3	17.2	19.6	22.9
6: 9	81	-1.2160	15.3572	0.10608	11.7	12.7	13.9	15.4	17.2	19.6	23.0
6:10	82	-1.2298	15.3717	0.10654	11.7	12.7	13.9	15.4	17.2	19.7	23.1
6:11	83	-1.2433	15.3871	0.10700	11.7	12.7	13.9	15.4	17.3	19.7	23.2
7: 0	84	-1.2565	15.4036	0.10746	11.8	12.7	13.9	15.4	17.3	19.8	23.3
7: 1	85	-1.2693	15.4211	0.10792	11.8	12.7	13.9	15.4	17.3	19.8	23.4
7: 2	86	-1.2819	15.4397	0.10837	11.8	12.8	14.0	15.4	17.4	19.9	23.5

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)

World Health Organization

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
7: 3	87	-1.2941	15.4593	0.10883	11.8	12.8	14.0	15.5	17.4	20.0	23.6
7: 4	88	-1.3060	15.4798	0.10929	11.8	12.8	14.0	15.5	17.4	20.0	23.7
7: 5	89	-1.3175	15.5014	0.10974	11.8	12.8	14.0	15.5	17.5	20.1	23.9
7: 6	90	-1.3287	15.5240	0.11020	11.8	12.8	14.0	15.5	17.5	20.1	24.0
7: 7	91	-1.3395	15.5476	0.11065	11.8	12.8	14.0	15.5	17.5	20.2	24.1
7: 8	92	-1.3499	15.5723	0.11110	11.8	12.8	14.0	15.6	17.6	20.3	24.2
7: 9	93	-1.3600	15.5979	0.11156	11.8	12.8	14.1	15.6	17.6	20.3	24.4
7:10	94	-1.3697	15.6246	0.11201	11.9	12.9	14.1	15.6	17.6	20.4	24.5
7:11	95	-1.3790	15.6523	0.11246	11.9	12.9	14.1	15.7	17.7	20.5	24.6
8: 0	96	-1.3880	15.6810	0.11291	11.9	12.9	14.1	15.7	17.7	20.6	24.8
8: 1	97	-1.3966	15.7107	0.11335	11.9	12.9	14.1	15.7	17.8	20.6	24.9
8: 2	98	-1.4047	15.7415	0.11380	11.9	12.9	14.2	15.7	17.8	20.7	25.1
8: 3	99	-1.4125	15.7732	0.11424	11.9	12.9	14.2	15.8	17.9	20.8	25.2
8: 4	100	-1.4199	15.8058	0.11469	11.9	13.0	14.2	15.8	17.9	20.9	25.3
8: 5	101	-1.4270	15.8394	0.11513	12.0	13.0	14.2	15.8	18.0	20.9	25.5
8: 6	102	-1.4336	15.8738	0.11557	12.0	13.0	14.3	15.9	18.0	21.0	25.6
8: 7	103	-1.4398	15.9090	0.11601	12.0	13.0	14.3	15.9	18.1	21.1	25.8
8: 8	104	-1.4456	15.9451	0.11644	12.0	13.0	14.3	15.9	18.1	21.2	25.9
8: 9	105	-1.4511	15.9818	0.11688	12.0	13.1	14.3	16.0	18.2	21.3	26.1
8:10	106	-1.4561	16.0194	0.11731	12.1	13.1	14.4	16.0	18.2	21.3	26.2
8:11	107	-1.4607	16.0575	0.11774	12.1	13.1	14.4	16.1	18.3	21.4	26.4
9: 0	108	-1.4650	16.0964	0.11816	12.1	13.1	14.4	16.1	18.3	21.5	26.5
9: 1	109	-1.4688	16.1358	0.11859	12.1	13.2	14.5	16.1	18.4	21.6	26.7
9: 2	110	-1.4723	16.1759	0.11901	12.1	13.2	14.5	16.2	18.4	21.7	26.8
9: 3	111	-1.4753	16.2166	0.11943	12.2	13.2	14.5	16.2	18.5	21.8	27.0

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)

					Z-scores (BMI in kg/m²)						
Year: Month	**Month**	**L**	**M**	**S**	**-3 SD**	**-2 SD**	**-1 SD**	**Median**	**1 SD**	**2 SD**	**3 SD**
9: 4	**112**	-1.4780	16.2580	0.11985	12.2	13.2	14.6	16.3	18.6	21.9	27.2
9: 5	**113**	-1.4803	16.2999	0.12026	12.2	13.3	14.6	16.3	18.6	21.9	27.3
9: 6	**114**	-1.4823	16.3425	0.12067	12.2	13.3	14.6	16.3	18.7	22.0	27.5
9: 7	**115**	-1.4838	16.3858	0.12108	12.3	13.3	14.7	16.4	18.7	22.1	27.6
9: 8	**116**	-1.4850	16.4298	0.12148	12.3	13.4	14.7	16.4	18.8	22.2	27.8
9: 9	**117**	-1.4859	16.4746	0.12188	12.3	13.4	14.7	16.5	18.8	22.3	27.9
9:10	**118**	-1.4864	16.5200	0.12228	12.3	13.4	14.8	16.5	18.9	22.4	28.1
9:11	**119**	-1.4866	16.5663	0.12268	12.4	13.4	14.8	16.6	19.0	22.5	28.2
10: 0	**120**	-1.4864	16.6133	0.12307	12.4	13.5	14.8	16.6	19.0	22.6	28.4
10: 1	**121**	-1.4859	16.6612	0.12346	12.4	13.5	14.9	16.7	19.1	22.7	28.5
10: 2	**122**	-1.4851	16.7100	0.12384	12.4	13.5	14.9	16.7	19.2	22.8	28.7
10: 3	**123**	-1.4839	16.7595	0.12422	12.5	13.6	15.0	16.8	19.2	22.8	28.8
10: 4	**124**	-1.4825	16.8100	0.12460	12.5	13.6	15.0	16.8	19.3	22.9	29.0
10: 5	**125**	-1.4807	16.8614	0.12497	12.5	13.6	15.0	16.9	19.4	23.0	29.1
10: 6	**126**	-1.4787	16.9136	0.12534	12.5	13.7	15.1	16.9	19.4	23.1	29.3
10: 7	**127**	-1.4763	16.9667	0.12571	12.6	13.7	15.1	17.0	19.5	23.2	29.4
10: 8	**128**	-1.4737	17.0208	0.12607	12.6	13.7	15.2	17.0	19.6	23.3	29.6
10: 9	**129**	-1.4708	17.0757	0.12643	12.6	13.8	15.2	17.1	19.6	23.4	29.7
10:10	**130**	-1.4677	17.1316	0.12678	12.7	13.8	15.3	17.1	19.7	23.5	29.9
10:11	**131**	-1.4642	17.1883	0.12713	12.7	13.8	15.3	17.2	19.8	23.6	30.0
11: 0	**132**	-1.4606	17.2459	0.12748	12.7	13.9	15.3	17.2	19.9	23.7	30.2
11: 1	**133**	-1.4567	17.3044	0.12782	12.8	13.9	15.4	17.3	19.9	23.8	30.3
11: 2	**134**	-1.4526	17.3637	0.12816	12.8	14.0	15.4	17.4	20.0	23.9	30.5
11: 3	**135**	-1.4482	17.4238	0.12849	12.8	14.0	15.5	17.4	20.1	24.0	30.6

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)

					Z-scores (BMI in kg/m²)						
Year: Month	**Month**	**L**	**M**	**S**	**-3 SD**	**-2 SD**	**-1 SD**	**Median**	**1 SD**	**2 SD**	**3 SD**
11: 4	136	-1.4436	17.4847	0.12882	12.9	14.0	15.5	17.5	20.2	24.1	30.8
11: 5	137	-1.4389	17.5464	0.12914	12.9	14.1	15.6	17.5	20.2	24.2	30.9
11: 6	138	-1.4339	17.6088	0.12946	12.9	14.1	15.6	17.6	20.3	24.3	31.1
11: 7	139	-1.4288	17.6719	0.12978	13.0	14.2	15.7	17.7	20.4	24.4	31.2
11: 8	140	-1.4235	17.7357	0.13009	13.0	14.2	15.7	17.7	20.5	24.5	31.4
11: 9	141	-1.4180	17.8001	0.13040	13.0	14.3	15.8	17.8	20.6	24.7	31.5
11:10	142	-1.4123	17.8651	0.13070	13.1	14.3	15.8	17.9	20.6	24.8	31.6
11:11	143	-1.4065	17.9306	0.13099	13.1	14.3	15.9	17.9	20.7	24.9	31.8
12: 0	144	-1.4006	17.9966	0.13129	13.2	14.4	16.0	18.0	20.8	25.0	31.9
12: 1	145	-1.3945	18.0630	0.13158	13.2	14.4	16.0	18.1	20.9	25.1	32.0
12: 2	146	-1.3883	18.1297	0.13186	13.2	14.5	16.1	18.1	21.0	25.2	32.2
12: 3	147	-1.3819	18.1967	0.13214	13.3	14.5	16.1	18.2	21.1	25.3	32.3
12: 4	148	-1.3755	18.2639	0.13241	13.3	14.6	16.2	18.3	21.1	25.4	32.4
12: 5	149	-1.3689	18.3312	0.13268	13.3	14.6	16.2	18.3	21.2	25.5	32.6
12: 6	150	-1.3621	18.3986	0.13295	13.4	14.7	16.3	18.4	21.3	25.6	32.7
12: 7	151	-1.3553	18.4660	0.13321	13.4	14.7	16.3	18.5	21.4	25.7	32.8
12: 8	152	-1.3483	18.5333	0.13347	13.5	14.8	16.4	18.5	21.5	25.8	33.0
12: 9	153	-1.3413	18.6006	0.13372	13.5	14.8	16.4	18.6	21.6	25.9	33.1
12:10	154	-1.3341	18.6677	0.13397	13.5	14.8	16.5	18.7	21.6	26.0	33.2
12:11	155	-1.3269	18.7346	0.13421	13.6	14.9	16.6	18.7	21.7	26.1	33.3
13: 0	156	-1.3195	18.8012	0.13445	13.6	14.9	16.6	18.8	21.8	26.2	33.4
13: 1	157	-1.3121	18.8675	0.13469	13.6	15.0	16.7	18.9	21.9	26.3	33.6
13: 2	158	-1.3046	18.9335	0.13492	13.7	15.0	16.7	18.9	22.0	26.4	33.7
13: 3	159	-1.2970	18.9991	0.13514	13.7	15.1	16.8	19.0	22.0	26.5	33.8

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
13: 4	160	-1.2894	19.0642	0.13537	13.8	15.1	16.8	19.1	22.1	26.6	33.9
13: 5	161	-1.2816	19.1289	0.13559	13.8	15.2	16.9	19.1	22.2	26.7	34.0
13: 6	162	-1.2739	19.1931	0.13580	13.8	15.2	16.9	19.2	22.3	26.8	34.1
13: 7	163	-1.2661	19.2567	0.13601	13.9	15.2	17.0	19.3	22.4	26.9	34.2
13: 8	164	-1.2583	19.3197	0.13622	13.9	15.3	17.0	19.3	22.4	27.0	34.3
13: 9	165	-1.2504	19.3820	0.13642	13.9	15.3	17.1	19.4	22.5	27.1	34.4
13:10	166	-1.2425	19.4437	0.13662	14.0	15.4	17.1	19.4	22.6	27.1	34.5
13:11	167	-1.2345	19.5045	0.13681	14.0	15.4	17.2	19.5	22.7	27.2	34.6
14: 0	168	-1.2266	19.5647	0.13700	14.0	15.4	17.2	19.6	22.7	27.3	34.7
14: 1	169	-1.2186	19.6240	0.13719	14.1	15.5	17.3	19.6	22.8	27.4	34.7
14: 2	170	-1.2107	19.6824	0.13738	14.1	15.5	17.3	19.7	22.9	27.5	34.8
14: 3	171	-1.2027	19.7400	0.13756	14.1	15.6	17.4	19.7	22.9	27.6	34.9
14: 4	172	-1.1947	19.7966	0.13774	14.1	15.6	17.4	19.8	23.0	27.7	35.0
14: 5	173	-1.1867	19.8523	0.13791	14.2	15.6	17.5	19.9	23.1	27.7	35.1
14: 6	174	-1.1788	19.9070	0.13808	14.2	15.7	17.5	19.9	23.1	27.8	35.1
14: 7	175	-1.1708	19.9607	0.13825	14.2	15.7	17.6	20.0	23.2	27.9	35.2
14: 8	176	-1.1629	20.0133	0.13841	14.3	15.7	17.6	20.0	23.3	28.0	35.3
14: 9	177	-1.1549	20.0648	0.13858	14.3	15.8	17.6	20.1	23.3	28.0	35.4
14:10	178	-1.1470	20.1152	0.13873	14.3	15.8	17.7	20.1	23.4	28.1	35.4
14:11	179	-1.1390	20.1644	0.13889	14.3	15.8	17.7	20.2	23.5	28.2	35.5
15: 0	180	-1.1311	20.2125	0.13904	14.4	15.9	17.8	20.2	23.5	28.2	35.5
15: 1	181	-1.1232	20.2595	0.13920	14.4	15.9	17.8	20.3	23.6	28.3	35.6
15: 2	182	-1.1153	20.3053	0.13934	14.4	15.9	17.8	20.3	23.6	28.4	35.7
15: 3	183	-1.1074	20.3499	0.13949	14.4	16.0	17.9	20.4	23.7	28.4	35.7

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²) -3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
15: 4	184	-1.0996	20.3934	0.13963	14.5	16.0	17.9	20.4	23.7	28.5	35.8
15: 5	185	-1.0917	20.4357	0.13977	14.5	16.0	17.9	20.4	23.8	28.5	35.8
15: 6	186	-1.0838	20.4769	0.13991	14.5	16.0	18.0	20.5	23.8	28.6	35.8
15: 7	187	-1.0760	20.5170	0.14005	14.5	16.1	18.0	20.5	23.9	28.6	35.9
15: 8	188	-1.0681	20.5560	0.14018	14.5	16.1	18.0	20.6	23.9	28.7	35.9
15: 9	189	-1.0603	20.5938	0.14031	14.5	16.1	18.1	20.6	24.0	28.7	36.0
15:10	190	-1.0525	20.6306	0.14044	14.6	16.1	18.1	20.6	24.0	28.8	36.0
15:11	191	-1.0447	20.6663	0.14057	14.6	16.2	18.1	20.7	24.1	28.8	36.0
16: 0	192	-1.0368	20.7008	0.14070	14.6	16.2	18.2	20.7	24.1	28.9	36.1
16: 1	193	-1.0290	20.7344	0.14082	14.6	16.2	18.2	20.7	24.1	28.9	36.1
16: 2	194	-1.0212	20.7668	0.14094	14.6	16.2	18.2	20.8	24.2	29.0	36.1
16: 3	195	-1.0134	20.7982	0.14106	14.6	16.2	18.2	20.8	24.2	29.0	36.1
16: 4	196	-1.0055	20.8286	0.14118	14.6	16.2	18.3	20.8	24.3	29.0	36.2
16: 5	197	-0.9977	20.8580	0.14130	14.6	16.3	18.3	20.9	24.3	29.1	36.2
16: 6	198	-0.9898	20.8863	0.14142	14.7	16.3	18.3	20.9	24.3	29.1	36.2
16: 7	199	-0.9819	20.9137	0.14153	14.7	16.3	18.3	20.9	24.4	29.1	36.2
16: 8	200	-0.9740	20.9401	0.14164	14.7	16.3	18.3	20.9	24.4	29.2	36.2
16: 9	201	-0.9661	20.9656	0.14176	14.7	16.3	18.4	21.0	24.4	29.2	36.3
16:10	202	-0.9582	20.9901	0.14187	14.7	16.3	18.4	21.0	24.4	29.2	36.3
16:11	203	-0.9503	21.0138	0.14198	14.7	16.3	18.4	21.0	24.5	29.3	36.3
17: 0	204	-0.9423	21.0367	0.14208	14.7	16.4	18.4	21.0	24.5	29.3	36.3
17: 1	205	-0.9344	21.0587	0.14219	14.7	16.4	18.4	21.1	24.5	29.3	36.3
17: 2	206	-0.9264	21.0801	0.14230	14.7	16.4	18.4	21.1	24.6	29.3	36.3
17: 3	207	-0.9184	21.1007	0.14240	14.7	16.4	18.5	21.1	24.6	29.4	36.3

2007 WHO Reference

BMI-for-age GIRLS

5 to 19 years (z-scores)

Year: Month	Month	L	M	S	Z-scores (BMI in kg/m²)						
					-3 SD	-2 SD	-1 SD	Median	1 SD	2 SD	3 SD
17: 4	208	-0.9104	21.1206	0.14250	14.7	16.4	18.5	21.1	24.6	29.4	36.3
17: 5	209	-0.9024	21.1399	0.14261	14.7	16.4	18.5	21.1	24.6	29.4	36.3
17: 6	210	-0.8944	21.1586	0.14271	14.7	16.4	18.5	21.2	24.6	29.4	36.3
17: 7	211	-0.8863	21.1768	0.14281	14.7	16.4	18.5	21.2	24.7	29.4	36.3
17: 8	212	-0.8783	21.1944	0.14291	14.7	16.4	18.5	21.2	24.7	29.5	36.3
17: 9	213	-0.8703	21.2116	0.14301	14.7	16.4	18.5	21.2	24.7	29.5	36.3
17:10	214	-0.8623	21.2282	0.14311	14.7	16.4	18.5	21.2	24.7	29.5	36.3
17:11	215	-0.8542	21.2444	0.14320	14.7	16.4	18.6	21.2	24.8	29.5	36.3
18: 0	216	-0.8462	21.2603	0.14330	14.7	16.4	18.6	21.3	24.8	29.5	36.3
18: 1	217	-0.8382	21.2757	0.14340	14.7	16.5	18.6	21.3	24.8	29.5	36.3
18: 2	218	-0.8301	21.2908	0.14349	14.7	16.5	18.6	21.3	24.8	29.6	36.3
18: 3	219	-0.8221	21.3055	0.14359	14.7	16.5	18.6	21.3	24.8	29.6	36.3
18: 4	220	-0.8140	21.3200	0.14368	14.7	16.5	18.6	21.3	24.8	29.6	36.3
18: 5	221	-0.8060	21.3341	0.14377	14.7	16.5	18.6	21.3	24.9	29.6	36.2
18: 6	222	-0.7980	21.3480	0.14386	14.7	16.5	18.6	21.3	24.9	29.6	36.2
18: 7	223	-0.7899	21.3617	0.14396	14.7	16.5	18.6	21.4	24.9	29.6	36.2
18: 8	224	-0.7819	21.3752	0.14405	14.7	16.5	18.6	21.4	24.9	29.6	36.2
18: 9	225	-0.7738	21.3884	0.14414	14.7	16.5	18.7	21.4	24.9	29.6	36.2
18:10	226	-0.7658	21.4014	0.14423	14.7	16.5	18.7	21.4	24.9	29.6	36.2
18:11	227	-0.7577	21.4143	0.14432	14.7	16.5	18.7	21.4	25.0	29.7	36.2
19: 0	228	-0.7496	21.4269	0.14441	14.7	16.5	18.7	21.4	25.0	29.7	36.2

2007 WHO Reference