

RISK FACTORS OF *HELICOBACTER PYLORI* FOR HISPANICS LIVING IN SOUTHERN ARIZONA

by

Taylor Simmons

Copyright © Taylor Simmons 2024

A Thesis Submitted to the Faculty of the

MEL & ENID ZUCKERMAN COLLEGE OF PUBLIC HEALTH

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE IN ENVIRONMENTAL HEALTH SCIENCES

In the Graduate College

THE UNIVERSITY OF ARIZONA

2024

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Master's Committee, we certify that we have read the thesis prepared by: Taylor Simmons

titled: Risk Factors of *Helicobacter pylori* for Hispanics Living in Southern Arizona

and recommend that it be accepted as fulfilling the thesis requirement for the Master's Degree.



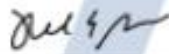
Marc Verhougstraete

Date: June 17, 2024



Paloma Beamer

Date: June 17, 2024



Heidi E. Brown

Date: June 17, 2024

Final approval and acceptance of this thesis is contingent upon the candidate's submission of the final copies of the thesis to the Graduate College.

I hereby certify that I have read this thesis prepared under my direction and recommend that it be accepted as fulfilling the Master's requirement.



Marc Verhougstraete
Thesis committee chair
Community, Environment, and Policy Department

Date: June 17, 2024

ACKNOWLEDGMENTS

I would first like to thank Marc for believing in me and finding promise in my few skills. He went above and beyond to push and coach me professionally and academically with what seemed like never-ending patience. I wouldn't be the person I am today without his support, mentorship, and kindness.

In terms of this project, I am thankful for the generous support from the Southwest Environmental Health Sciences Center that funded not only my time and efforts, but those of integral team members, like Estefania. This project would not have taken flight if it wasn't for her enthusiasm, attention to detail, and passion. I hope that this funding or other secured funding sources can sustain her continuation of the project. I'm so grateful to have met and worked with her.

I'd also like to thank my spouse, Adam, for his emotional support, understanding, and love demonstrated through countless meals, loads of laundry, and grocery runs. I promise the "I'm almost done" phrases will apply soon! I'd also like to thank my pops for the guaranteed pep talks. Sorry I couldn't be a marine biologist, but EHS is pretty cool, too (see below). And lastly, I'd like to thank Zoe for always being ready to run, listen, and break into tears or bread with me.

Table of Contents

List of Figures	6
List of Tables	7
List of Acronyms	8
Abstract	10
Introduction	11
Climate Change Influencing Southwest Water Quality	11
Overview of Climate Change Impacts	11
Climate Changes Alters Water Resources: Quality and Quantity.....	11
Arsenic Prevalence and Sources.....	11
Health Outcomes of Arsenic Exposure.....	12
Helicobacter pylori and Gastric Cancer	13
<i>Helicobacter pylori</i> Prevalence, Treatment, Risk Factors, and Diagnoses.....	13
Gastric Cancer Prevalence, Treatment, Diagnoses, and Risk Factors.....	14
Mitigating Gastric Cancer Risk Factors	15
Water Quality Regulations	16
Southwest Environmental Justice Lens	17
Gastric Cancer Burden.....	17
Environmental Justice Community Example in Arizona: Hispanics	17
Study Objectives	18
Methodology	19
Research Design Overview	19
Study Population and Setting	19
Recruitment	19
Active Recruitment.....	20
Inactive Recruitment.....	21
Participant Referral	21
Household Visit Overview	21
Household Visit Scheduling.....	21
Household Visit Sampling.....	22
Participant Compensation.....	24
Data Management.....	25
Statistical Analysis	25
Results	27
Recruitment Overview and Population Location	27
Concordance of UBT Results within Households	28
Risk Factors Associated with <i>H. pylori</i> Infections	28
Constitutional Factors	30
Lifestyle Factors.....	30
Social Determinants of Health.....	31
Constitutional Factors	37

Age.....	37
Lifestyle Factors	37
Alcohol Consumption	37
Social Determinants of Health	37
Diet and Home Cooked Meals.....	37
Healthcare Access and Awareness	38
Tap Water Quality	38
Strengths And Weaknesses	39
Future Studies.....	40
Conclusion.....	41
Appendices.....	42
Appendix A.....	42
Appendix B.....	51
Appendix C.....	52
Appendix D.....	53
Appendix E	66
Appendix F	89
Appendix G.....	92
References.....	93

List of Figures

FIGURE 1. COUNTY FINDINGS FROM THE UNITED STATES GEOLOGICAL SURVEY (USGS) WATER QUALITY STUDY FROM 1993 TO 2009. ⁸	12
FIGURE 2. SUMMARY OF KNOWN GASTRIC CANCER AND <i>HELICOBACTER PYLORI</i> (<i>H. PYLORI</i>) RISK FACTORS DISTINGUISHED BY COLOR (INDIVIDUAL LIFESTYLE FACTORS IN RED; CONSTITUTIONAL FACTORS IN BLACK; SOCIAL DETERMINANTS OF HEALTH IN BLUE). ^{32,65}	16
FIGURE 3. FLOW OF HOUSEHOLD RECRUITMENT FOR THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT FROM FEBRUARY 2ND, 2024 TO MARCH 9TH, 2024.	20
FIGURE 4. SUMMARY OF PARTICIPANT REQUIREMENTS AND TASK TIME COMMITMENTS FOR PARTICIPANTS IN THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT.	22
FIGURE 5. GEOGRAPHICAL DISTRIBUTION OF HOUSEHOLD ZIP CODES (N=15) INCLUDED IN THE PRELIMINARY ANALYSIS OF THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT, HISPANIC POPULATION DENSITY IN PIMA COUNTY IN 2020 FROM THE UNITED STATE CENSUS, AND THE TUCSON WATER SERVICE AREA.	27

List of Tables

TABLE 1. OVERVIEW OF HOUSEHOLD AND INDIVIDUAL CHARACTERISTICS AS WELL AS RISK FACTORS AND PREVALENCE OF <i>HELICOBACTER PYLORI</i> INFECTION DETERMINED BY UREA BREATH TEST (UBT).	29
TABLE 2. DIFFERENCES IN LIFESTYLE FACTORS AND <i>HELICOBACTER PYLORI</i> INFECTION STATUS MEASURED BY THE UREA BREATH TEST (UBT) IN PRELIMINARY DATA OF THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT.	31
TABLE 3. DIFFERENCES IN SELF-REPORTED <i>HELICOBACTER PYLORI</i> (<i>H. PYLORI</i>) AWARENESS BY <i>H. PYLORI</i> INFECTION STATUS MEASURED BY UREA BREATH TEST (UBT) IN PRELIMINARY DATA OF THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT.	32
TABLE 4. OVERVIEW OF POLLUTANTS AND ENVIRONMENTAL PARAMETERS TESTED FROM PRELIMINARY DRINKING WATER DATA (N=28 HOUSEHOLDS) FROM THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT.	33
TABLE 5. OVERVIEW OF ARSENIC AND CHROMIUM CONCENTRATIONS ABOVE AND BELOW THE GEOMETRIC MEAN AND TOTAL COLIFORM DETECTIONS FROM HOUSEHOLDS WITH AND WITHOUT PARTICIPANTS WHO HAVE <i>HELICOBACTER PYLORI</i> INFECTION AS DETERMINED BY UREA BREATH TEST (UBT). THIS IS PRELIMINARY DATA FROM THE FIRST 28 HOUSEHOLDS OF THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT. ...	34
TABLE 6. OVERVIEW OF SOCIAL DETERMINANTS OF HEALTH (SDH) ASSOCIATED WITH ELEVATED CONCENTRATIONS OF ARSENIC, CHROMIUM, AND TOTAL COLIFORM DETECTED IN TAP WATER AND ONE FIVE-GALLON WATER SOURCE FROM PRELIMINARY HOUSEHOLD WATER SAMPLE DATA FROM THE SOUTHERN ARIZONA HEALTHY STOMACH PROJECT.....	36

List of Acronyms

ALEC Arizona Laboratory for Emerging Contaminants

As Arsenic

BMI Body Mass Index

CITI Collaborative Institutional Training Initiative

Co Cobalt

CO₂ Carbon dioxide

Cr Chromium

CT scans computed tomography scans

E. coli *Escherichia coli*

EJ Environmental Justice

EPA United States Environmental Protection Agency

Fe Iron

Gastric Cancer GC

Parts per billion ppb

GIS Geographical Information Systems

Helicobacter pylori *H. pylori*

iAs Inorganic arsenic

ICP-MS Inductively Coupled Plasma - Mass Spectroscopy

IRB Institutional Review Board

MCL Maximum Contaminant Levels

MCLG Maximum Contaminant Level Goal

mL Milliliters

MPN Most Probable Number per 100 milliliters

MRL Minimum Reporting Limit

NTU Nephelometric Turbidity Units

POE Point-of-entry

POU Point-of-use

PWS Public water systems

SAT Stool antigen tests

SDH Social Determinants of Health

SDWA Safe Drinking Water Act

Se Selenium

SEER Surveillance, Epidemiology, and End Results

SES Socioeconomic Status

SoAZHSP Southern Arizona Healthy Stomach Project

SWFFQ Southwest Food Frequency Questionnaire

UA University of Arizona

UBT Urea Breath Test

US United States

USGS United States Geological Survey

V Vanadium
WHO World Health Organization

Abstract

This thesis investigated the occurrence of *Helicobacter pylori* (*H. pylori*) and other risk factors associated with gastric health in Hispanic communities as part of The Southern Arizona Healthy Stomach Project (SoAZHSP). This thesis report assessed tap water samples for culturable microorganism and metals, *H. pylori* infection using the urea breath test (UBT), and household and individual surveys to statistically assess predictors of known and identifiable risk factors of *H. pylori* infections in this subpopulation. Thirty-three percent (n=14 of 42) of the subpopulation tested positive for *H. pylori*. In the United States (US), *H. pylori* infection prevalence estimates range between 17.6% and 36.0%, while *H. pylori* prevalence rates for Hispanics living in the US range between 38% and 62%. Factors such as lack of health insurance (p=0.02), low consumption of restaurant and/or fast food (p =0.02), older age (p=0.04), lack of alcohol consumption (p=0.01), and tap water quality (p=0.04 for total coliforms detection) were predictors of *H. pylori* infections. Furthermore, only 41.9% of participants had heard of *H. pylori*, indicating low awareness. Despite sample size and reporting bias limitations, this report highlights the multifaceted nature of *H. pylori* infections and the importance of improving *H. pylori* awareness, water quality, health care access, and food hygiene practices. These findings underscore the need for targeted, comprehensive interventions to address *H. pylori* infections in Hispanic communities to improve overall health outcomes.

Introduction

Climate Change Influencing Southwest Water Quality

Overview of Climate Change Impacts

Climate change has altered water quality and landscape of the Southwestern United States (US). In the last 100 years, the average annual temperature has increased almost 1.1°C, resulting in increased frost free days, extended summer and fall seasons, and exacerbated drought conditions, notably in the southwest.¹ The southwest US, including California, Nevada, Utah, Colorado, New Mexico, and Arizona, is the driest, hottest region of the nation,¹ and studies indicate that southwest drought conditions are the worst recorded in 1,200 years. Compared to 1950 to 1999, temperature and precipitation were 0.91°C above and 8.3% below average from 2000 to 2021, respectively.² With less precipitation, there is less snowpack, reducing the water supply of all Colorado River Basin states and ecosystems.¹ Rising temperatures and reduced water availability are negatively affecting crop yields.¹ More intense and severe drought conditions increase wildfire threats as well, destroying homes, transforming ecosystems, and burdening economies.¹ With approximately 90% of the southwestern population residing in urban areas, urban heat island effect is one of the greatest health risks in this region.¹ Urban areas are known for concrete structures surrounded by pavement, and combined with prolonged, record-breaking heat waves in the southwest, heat-related illnesses have been on the rise.¹ Heat-related illness and stress are notably a threat to underserved communities without air conditioning. The population in the southwestern US is expected to increase of 70% by mid-century,¹ and greater demand on water and limited water availability could affect water access and quality in these “megadrought” conditions.²

Climate Changes Alters Water Resources: Quality and Quantity

Considering population growth, climate change, and drought, western US states have competing water sector demands, which can affect water quality and quantity. Groundwater in the southwest US, also known as fossil water, percolated into the ground millions of years ago and is considered a nonrenewable resource because it is being replenished naturally at rates slower than it is being withdrawn.³ By pumping more groundwater than is being recharged, the ground can compact, displace, and even sink, creating crevices or fissures in the land.⁴ This is referred to as land subsidence.⁴ In 2019, the USGS estimated that over 44,000 square kilometers in 45 states has been affected by land subsidence, which not only threatens infrastructure but also aquifer storage capacity and groundwater quality.⁴ Studies also show that increased dependence on groundwater and the resulting land subsidence, can increase arsenic (As) concentrations in groundwater, an important source of drinking water in the drought-stricken southwest.^{5,6}

Arsenic Prevalence and Sources

Elevated As concentrations in groundwater depend on anthropogenic and geological factors. As concentrations in groundwater in the US range from 1 parts per billion (ppb or 1 microgram per liter (ug/L)) to 1,000 ppb.⁷ From 1993 to 2009, the USGS conducted a nationwide study analyzing As concentrations in 6,600 wells and estimated that

approximately 2.1 million Americans (16% of drinking water wells in the southwest) are exposed to As above the US Environmental Protection Agency (EPA) drinking water standard of 10 ppb (details discussed later).⁸ The most elevated As concentrations occurred in the southwest states (Utah, Colorado, California, New Mexico, Nevada, and Arizona) where an estimated 1.4 million people, mostly in rural areas, rely on private, domestic wells (Figure 1).⁸ The USGS analyzed domestic (42%) and PWS wells (26%) and found that As, NO₂, and U levels in the southwest were more than twice the national average well concentrations.⁸

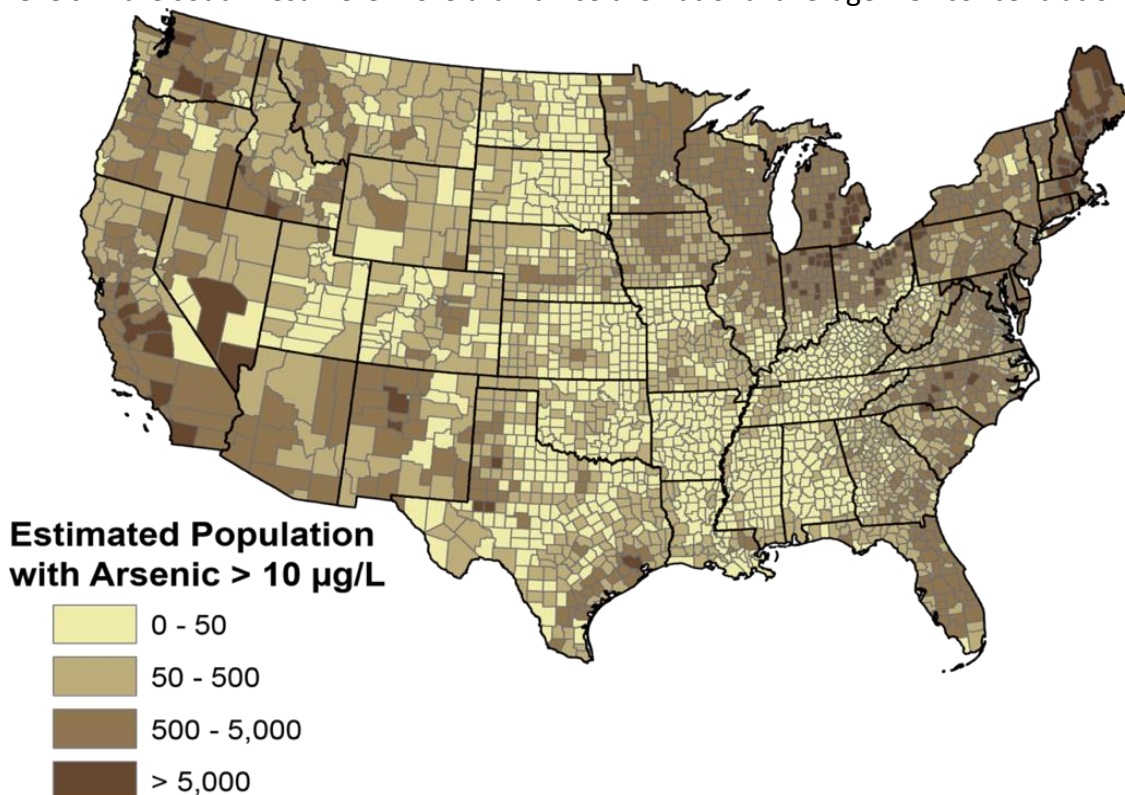


Figure 1. County findings from the United States Geological Survey (USGS) water quality study from 1993 to 2009.⁸

As is a naturally occurring metalloid utilized for many purposes, including medicine, industry, and agriculture.⁹ Historically, As metabolites were incorporated into lymphoma and leukemia therapy, paints, wood preservatives, metal alloys, insecticides, and pesticides.¹⁰⁻¹² To date, they are still used in medicine and electronics and importation of As pesticides remains high.¹³ Some factors contributing to high As groundwater concentrations include the geology of the area as well as proximity to hazardous waste sites, agriculture areas with elevated pesticide use, and As production industries.^{7,14} Organic As naturally leaches in groundwater sources from geographic processes or by anthropological sources and combines with other elements like oxygen, chlorine, and sulfur to form inorganic As (iAs) in pentavalent and hexavalent forms, which can also leach into groundwater.⁷

Health Outcomes of Arsenic Exposure

The prevalence of iAs in groundwater poses public health concerns, notably for those in the rural southwest reliant on private, domestic drinking water wells. Acute exposures

(300 – 30,000 ppb) to iAs can lead to gastrointestinal problems, blood-vessel damage, encephalopathy, and nerve impairments, while extreme exposures (above 60,000 ppb) can lead to death.¹⁵ Arsenicosis depends on individual susceptibility (e.g. genetics, age, dietary habits), dose, exposure route, duration, and frequency, and the specific metabolites of iAs.^{16–18} Though iAs inhalation and dermal absorption pose hazards, ingestion (food and water) is the most common route of exposure.^{14,15,19} It is estimated that approximately 70% of ingested iAs is metabolized in the liver and excreted in urine with a half-life ranging from two to four days, though some studies have suggested that iAs can accumulate for months in skin, hair, nail, and bone tissues.^{15,18,20,21} If iAs remains in the body for extended periods, it can easily distribute to and disrupt major organ systems such as the lungs, skin, liver, and kidneys.^{15,18,21} Exposure to iAs has been associated with increased mortality rates for liver, kidney, lung, bladder, and stomach cancer and increased risk of skin and prostate cancer as well as stroke.^{9,11,12,15,22} Studies have also elucidated that iAs can cause epigenetic and genetic mutations, disrupting the function and development of many organ systems, including nervous, reproductive, cardiovascular, immune, gastrointestinal, endocrine, respiratory, and renal.^{15,17}

Though health outcomes of iAs have been well documented for skin and bladder cancer, studies are increasingly pointing to the prospective effects of contaminant mixtures on gastric cancer (GC). The current study aims to build on studies exploring whether exposures to iAs and *Helicobacter pylori* (*H. pylori*) can explain why some individuals experience cancer outcomes while others with the same infection recover.

***Helicobacter pylori* and Gastric Cancer**

Helicobacter pylori Prevalence, Treatment, Risk Factors, and Diagnoses

H. pylori is a gram-negative, microaerophilic bacteria present in an estimated 50% of the world's population.²³ In the US, the prevalence of *H. pylori* estimations vary, depending on age and race/ethnicity. Some estimates have reported that in the US, the overall *H. pylori* infection prevalence is 36%,²⁴ though this estimation increases with age (~50% for those 60 or older). Additionally, one study estimated that *H. pylori* prevalence was higher for non-Hispanic Blacks (52.7%) and for Mexican Americans (61.6%) than non-Hispanic whites (26.2%).²⁴ Whereas, one metanalysis study published in 2024 estimated a global prevalence of 34.4% in adults and children, and when assessing 14 cohort studies in the US, the authors estimated a lower *H. pylori* prevalence of 17.6% with a 95% confidence interval of 16.0 to 98.4.²⁵

H. pylori has evolved to colonize the gastric epithelium, affecting the stomach lining and/or upper intestine.²⁶ Approximately 90% of *H. pylori* carriers are asymptomatic,²⁷ especially early in infection; however, once infected, triggered immune responses are insufficient in combatting *H. pylori*.²⁷ Only 10% of those with *H. pylori* will develop a gastric ulcer, or open stomach sore.²⁸ However, if left untreated, severe infections can cause inflammation, chronic gastritis, and lymphoma, increasing the risk of developing GC.²⁹ Since *H. pylori* infections have caused nearly 78% of non-cardia GC and 6.2% of cancers worldwide, the World Health Organization (WHO) has categorized *H. pylori* as a class 1 carcinogen.^{29,30}

Though not clearly demonstrated, *H. pylori* is hypothesized to be transmissible through the fecal-oral and oral-oral route,³¹ and similar to the risk factors of GC (discussed

later), *H. pylori* prevalence is higher among the elderly, possibly representing poorer, crowded living conditions in childhood.^{29,32} Most infections occur during childhood with symptoms manifesting later in life.³³ *H. pylori* infections have also been associated with nutritional deficiencies, poor hygiene, smoking status, and alcohol consumption.^{34–37} Additionally, impaired drinking water with *H. pylori* and/or unregulated water have been associated with infections, disproportionately affecting those of lower socioeconomic status living outside of PWS service areas.³² Minority ethnic populations in the US include Native Americans and Hispanic populations, which are three and two times more likely to die from non-cardia GC, respectively.³⁸

H. pylori can withstand adverse environmental conditions, including long intervals between meals, antibiotic therapy, and pH changes.^{39,40} *H. pylori* have evolved to shapeshift from spirochete, bacillus, or coccoid form,^{39,40} employ genetic mutations, and create biofilms⁴¹ that facilitate resistance to several antibiotics, such as clarithromycin, metronidazole, and fluoroquinolones.²⁸ Current *H. pylori* treatment regimens include quadruple treatment (proton-pump inhibitor, bismuth, and two antibiotics (amoxicillin and metronidazole/clarithromycin) for 14 days.^{27,42–44} Though with the uprise of antibiotic resistance, *H. pylori* is growing more difficult to treat and plan for intervention strategies.²⁷

Biopsies of gastric mucosa through endoscopy, rapid urease test, and/or culturing can diagnose a current *H. pylori* infection. Non-invasive methods of diagnoses include the urea breath test (UBT), stool antigen tests (SAT), and serology.⁴⁵ Serology measures *H. pylori* antibodies from current or previous infections; therefore, recent eradication of *H. pylori* cannot be determined.⁴⁵ Though false negatives can result from proton-pump-inhibitor, antibiotic, or bismuth product use two weeks before SAT and UBT testing, SAT and UBT are effective at diagnosing current *H. pylori* infections.⁴⁵ The SAT measures *H. pylori* antibodies and identifies current infections with a high specificity (94%) and sensitivity (97%).⁴⁵ The UBT requires that a patient collect a base breath sample, ingest a small amount of urea with carbon 13 or 14, and collect a second breath sample.⁴⁵ Following, a machine measures the difference in gases in the breath bags (*H. pylori* in the presence of urea produces CO₂ and NH₃)⁴⁶ and indicates a current *H. pylori* infection with high specificity (88-95%) and sensitivity (95-100%).⁴⁵ Though the SAT is the most cost-effective, non-invasive method for detecting a current infection, the UBT is considered the gold standard, non-invasive approach.⁴⁷

Gastric Cancer Prevalence, Treatment, Diagnoses, and Risk Factors

Accounting for nearly 10 million deaths in 2020, cancer is the leading cause of death worldwide.⁴⁸ The WHO has categorized GC as sixth most common cancer with over one million new cases reported annually.⁴⁸ Causing over 750,000 deaths per year, GC ranks fourth in most the common cancer-related deaths.⁴⁸ In 2023, there were 26,500 new GC diagnoses and an estimated 16,000 GC-related deaths in the US.⁴⁹ However, these estimates are probably under reported due to lack of insurance attainment. In 2022, the US Census Bureau reported that 8.9% of people were uninsured,⁵⁰ and lack of insurance attainment is a known barrier for those seeking medical care,⁵¹ which can lead to underestimates of GC reporting. Surveillance, Epidemiology, and End Results (SEER) reports that GC incidence and mortality are declining overall; however, the burden of disease remains high with a less than 50% 5-year survival rate.⁵² There are several tests to diagnose GC, including upper

endoscopy with biopsy (biomarker testing), barium swallow (the patient drinks barium and undergoes x-rays), and computed tomography scans (CT scans, often involves dye injection).⁵³ Treatment options for GC involve gastrectomy, or removing the affected areas of the stomach, and chemotherapy.⁵⁴

GC initiates in the stomach, and though the causes are largely unknown, several risk factors have been identified.⁵⁵ Risk factors for GC include host genetics, socioeconomic status, age, race/ethnicity, health access, and environmental factors.^{55–57} Most GC diagnoses occur in the elderly (60 years or older), though GC incidence is increasing in minority groups, notably for young Hispanic men in the US (1.6% increase incidence per year).⁵⁸ Diet plays a significant role in GC as well.⁵⁶ Chronic intake of salty, smoked, or preserved foods have correlated with GC.⁵⁶ Other behaviors such as smoking and alcohol consumption have been associated with GC.⁵⁶ Though risk factors of GC are multifactorial, the weight of evidence strongly suggests *H. pylori* infections facilitate adenocarcinoma development.⁵⁶ Studies have shown that testing and treating *H. pylori* can lead to a 50% reduction in GC incidence in some communities.^{59,60} GC is also common in underserved communities with substandard water infrastructure, housing, and waste disposal.⁵⁶ In the US, GC is more common in minority populations (Hispanic, African, Asian, and Native Americans) than in non-Hispanic whites, and family history of GC and other medical conditions, such as obesity and gastritis can also increase GC risk.⁵⁶

Mitigating Gastric Cancer Risk Factors

Risk factors, or elements that increase an individual or populations susceptibility to develop illnesses, are multifaceted.⁶¹ They include health behaviors, living and built environmental exposures, socioeconomic status, and constitutional factors, such as age and gender.⁶¹ According to WHO, social determinants of health (SDH) are a type of risk factor, that include one's living and built environment.⁶² SDH are the non-medical, environmental conditions that are larger predictors of adverse health outcomes than lifestyle choices.⁶² SDH include the surrounding living and built environment, as well as access to health, economic security, education, food, and clean water.⁶²

Individuals can take action to limit some risk factors to reduce the chance of developing GC. For instance, installation of at-home treatment systems at the tap (point-of-use (POU)) or for the whole household (point-of-entry (POE)) can reduce the odds of microbial exposure and/or metal exposure.⁶³ Prices for these at-home treatment system vary depending on the system size and type.⁶⁴ Additionally, reducing alcohol, smoking, or consumption of processed, salty foods could reduce the likelihood of developing GC. However, these lifestyle changes to limit GC risk factors (See Figure 2) may be challenging, especially for Environmental Justice (EJ) communities that may not have the financial autonomy or capacity to change their living and built environments.

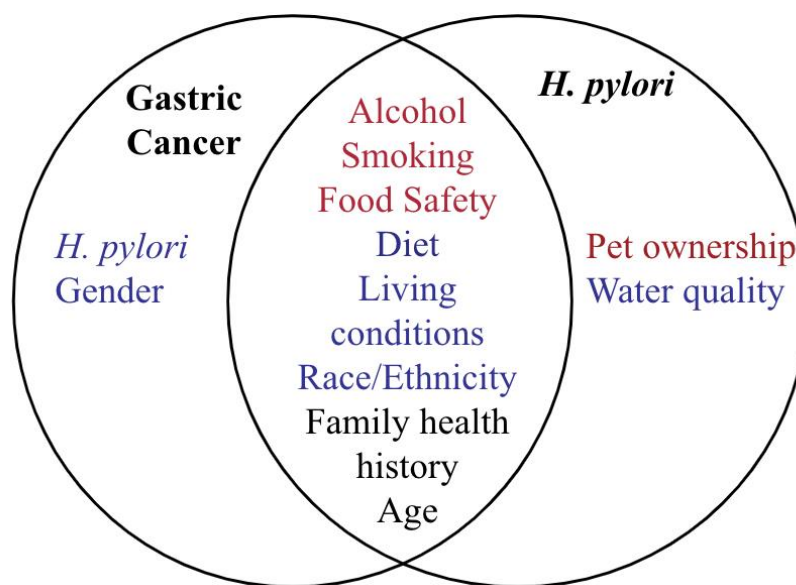


Figure 2. Summary of known gastric cancer and *Helicobacter pylori* (*H. pylori*) risk factors distinguished by color (Individual lifestyle factors in red; constitutional factors in black; social determinants of health in blue).^{32,65}

Water Quality Regulations

Federal regulations and public policy can also play a role in mitigating GC and *H. pylori* risk. There are also federal regulations in place that protect public health and set standards for the drinking water quality. Under the Safe Drinking Water Act (SDWA), the US Environmental Protection Agency (EPA) sets chemical and non-chemical (microbial) standards to ensure safe, clean drinking water is delivered by public water systems (PWS).⁶⁶ Established in 1974, the SDWA strives to provide safe drinking water for all by requiring source water pollution monitoring, dependable distribution systems, treatment, and transparency.⁶⁶ The SDWA creates a framework to protect public health by requiring PWS to comply with drinking water standards established by the EPA, also known as Maximum Contaminant Levels (MCLs).⁶⁶ However, those in rural areas reliant on private, domestic groundwater wells are not protected by these standards and may be disproportionately exposed to contaminants, contingent upon the geology of the region and other environmental exposures.

The process to establish a new drinking water standard for contaminants is thorough and arduous. The EPA has established MCL standards for over 90 contaminants, and to establish a new standard, the EPA must investigate: 1) the contaminant's prevalence in PWS 2) effects on public health, and 3) if regulation provides a meaningful opportunity to reduce risks for those served by the PWS.⁶⁶ Once sufficient evidence is gathered, the EPA can assess whether a regulatory determination is necessary.⁶⁷ If the agency decides to regulate the contaminant, the rulemaking process will commence to establish MCLs, which are legally enforceable standards PWS must abide by to protect public health. In the MCL determination process, the EPA accounts for treatment costs, technological feasibility, background and source concentrations, and exposure routes (aside from drinking water);⁶⁷

however, we are still unsure of the cumulative effects if someone is exposed to chemicals at or near the MCL along with other chemical mixtures for their entire lifetime. The EPA has established an As MCL of 10 ppb, but many support that As is unsafe at levels below the MCL.⁶³ The EPA has also provided Maximum Contaminant Level Goals (MCLG) that establish where there are no expected or known health risks.⁶⁶ MCLGs values are considered goals and are not enforced by the EPA (i.e. are unregulated) due to the limited feasibility and availability of treatment.⁶⁶ The MCLG of As is zero.⁶³

Southwest Environmental Justice Lens

Gastric Cancer Burden

Environmental Justice (EJ) communities are defined as communities of lower socioeconomic status (SES) disproportionately exposed to environmental hazards.⁶⁸ Some risk factors for GC and *H. pylori* (constitutional factors listed in black in Figure 2) cannot be altered, such as age, or family health history, and while other behavior changes may seem easy to adjust (behavioral factors listed in blue in Figure 2), this shift could be deemed a financial or social barrier to EJ communities. For instance, studies have demonstrated that EJ communities have significantly increased access to fast food restaurants and convenience stores than their non-Hispanic, white counterparts. Environmental barriers to affordable, healthy food promote unhealthy eating,⁷¹ facilitating chronic health problems such as obesity^{72,73} and indirectly, GC. Accessibility is a determinant of tobacco and alcohol use for EJ communities as well,^{70,74-76} along with tailored advertisements^{77,78} and enmeshment in social contexts.^{79,80} Lifestyle and diet choices for EJ communities are associated with social, economic, and health burdens.^{70,79}

GC-related SDH, such as living conditions (listed in blue in Figure 2), specifically, substandard water infrastructure, could be addressed at a price as well. Those outside of PWS service, normally in rural areas, rely on domestic groundwater wells for drinking water.⁸¹ The SDWA regulations do not apply to private wells;⁶⁶ therefore, water quality should be tested and impairments must be addressed by the well owner. It is imperative that at-home treatments are well maintained and serviced for optimal filtration, which could be an added expense.⁸² Though in-home water treatments are available to control metalloids and microorganisms, water treatment systems can be a financial barrier that further compound EJ communities to adverse health outcomes like GC. Financial barriers and disproportionate exposures of EJ communities should be considered to inform effective health policy and exposure mitigation.

Environmental Justice Community Example in Arizona: Hispanics

Limited studies have assessed *H. pylori* incidence in another community predisposed to GC: Hispanics, the largest ethnic minority group in the US.⁸³ Along the US-Mexico Border, Arizona hosts a growing Hispanic population, and Border residents are 1.6 times as likely (23%) to be immigrants compared to national percentages (14%).⁸⁴ The US Census reported that in Nogales, Arizona, bordering Mexico, 95% of residents (n~20,000) are Hispanic and of these, 45% are immigrants.⁸⁵ Tucson, Arizona is the second largest metropolitan city in the state with approximately 500,000 residents.⁸⁶ Hispanics and immigrants comprise approximately 44% and 14% of Tucson residents, respectively.⁸⁶ With a large Hispanic and

immigrant population, the geographic area between Tucson and Nogales provides unique access to study GC risk factors in Hispanic EJ communities in southern Arizona. Other elements to consider are the community's environmental and occupational exposures that correlate with GC.

With low SES and several barriers to education, healthcare, transportation, and affordable housing, Hispanics near the Border are vulnerable to water quality impairments and associated adverse health outcomes. Some barriers to health include lack of access to preventative care as well as language barriers, and of all racial and ethnic groups in the US, Hispanics have the highest uninsured rates.⁸³ Additionally, Mexican Americans have one of the highest rates of type two diabetes and obesity in the world, which could also increase their risk for GC.⁸⁷ Hispanics are more likely to be diagnosed with GC at stage four at the time of diagnosis.⁸⁸ In 2020, the Arizona-Mexico Border region had a higher unemployment rate (7%) compared to the national average (5%), which could inhibit their access to health care.⁸⁴

Study Objectives

Climate change and population growth are straining our water resources, and the more groundwater we pump out, the more degraded the remaining water becomes. This increases exposure risks, notably for those reliant on private, domestic groundwater wells that are not regulated by the SDWA. When investigating the health effects of contaminants to determine drinking water standards, water regulators have not considered that populations may be exposed to chemical and non-mixtures, such as *H. pylori* and As. Studies have shown that *H. pylori*, a class 1 carcinogen, infection severity can be higher in the presence of heavy metals, like As. Due to food, water, and energy demands and geology of the region, As concentrations in groundwater remain a health concern in the western US. GC prevalence is also increasing in young, Hispanic male populations, and few studies have assessed GC risk factors in southern Arizona EJ communities. Proximity to the US-Mexico Border also provides a unique opportunity to assess GC risk in who may be dependent on private domestic wells.

This thesis aims to better understand the prevalence of *H. pylori* infections as well as risk factors (e.g. SDH) associated with *H. pylori* infections among Hispanic adults living in Southern Arizona. Two objectives were developed to complete the project goal:

1. Assess *H. pylori* prevalence among Hispanic adults living in Southern Arizona using the UBT.
2. Statistically assess associations between *H. pylori* infections and known and probable household and individual risk factors of *H. pylori* (for example: water quality, living conditions, family health history, gender, education attainment, income).

A subset of data was assessed from the first six weeks (02/02-03/09/2024) of household visit data from the Southern Arizona Healthy Stomach Project (SoAZHSP) to complete these objectives.

Methodology

Research Design Overview

The project protocol for urine, water, surveys (household, individual, and diet), and UBT collection were reviewed for human research compliance by the University of Arizona's (UA) Institutional Review Board (IRB). Initial IRB approval was granted for protocol (STUDY00003028) in December 2023 and is reviewed annually for compliance. Before any contact with participants, all project personnel completed protection of human subjects training, known as the Collaborative Institutional Training Initiative (CITI) for the UA. All forms delivered to participants were offered in English and Spanish.

Study Population and Setting

To be eligible for the SoAZHSP, participants were non-pregnant adults (18 years or older) who self-identified as Hispanic and living in Southern Arizona (Tucson or south of Tucson). They were also mentally capable of understanding the consent form and the survey questions and physically capable of completing the UBT to identify a *H. pylori* infection.

To be eligible for the UBT, participants must not have been pregnant or allergic to phenylalanine, one of the components in aspartame (sweetening agent of mixture consumed for UBT). Additionally, the participant must not have taken any antibiotics, proton pump inhibitors, bismuth products, antacids, or histamine 2-receptor antagonists within two weeks of the household visit. Taking these medications would result in a false negative. The survey to screen eligible participants can be found in Appendix A.

Recruitment

The SoAZHSP participants were recruited in three ways: active recruitment at Nosotros meetings, inactive recruitment via phone call or text, or through participant referrals. Based at the UA College of Public Health, the Nosotros Comprometidos a Su Salud public health program works with underserved Hispanic communities in southern Arizona who experience health inequities. Their programs have led to increased physical activity, healthy eating habits, substance abuse awareness, smoking cessation, and diagnostic screenings. They have a recurring cohort of more than 1,000 individuals. Recruitment flow of data collected for this thesis can be found below (Figure 3).

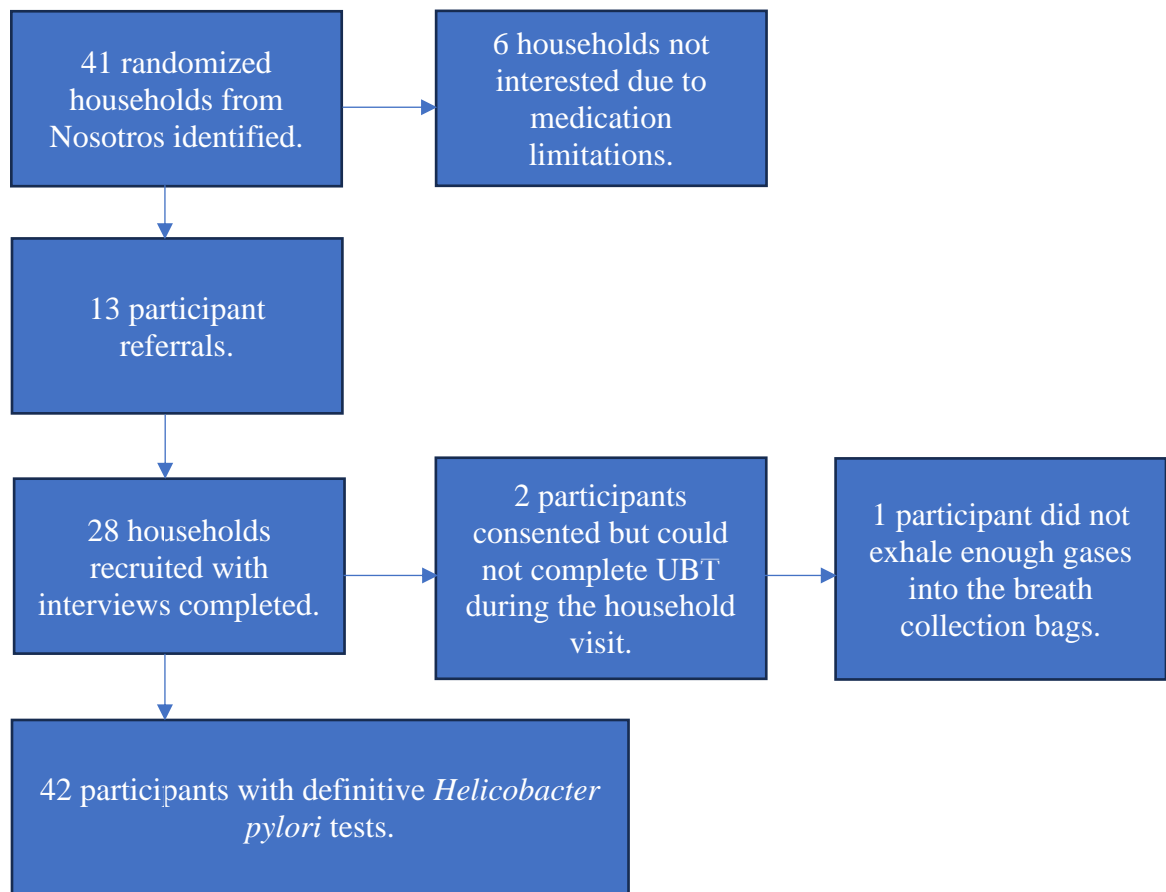


Figure 3. Flow of household recruitment for the Southern Arizona Healthy Stomach Project from February 2nd, 2024 to March 9th, 2024.

Active Recruitment

Following the Nosotros meetings at the UA Collaboratory for Metabolic Disease Prevention and Treatment offices (3950 S Country Club Rd, Floor 3, Suite 390) where participants were offered free cancer screenings, Nosotros participants were invited to learn more about the SoAZHSP in a neighboring room. Bilingual (Spanish and English) speakers were present to ensure smooth translation and participant understanding of the project. If interested in participating, eligible individuals were consented in person and asked to provide their contact information and living address for household visit scheduling. The consented individuals were then provided with a printed consent form, urine kit, urine collection instructions, and the Southwest Food Frequency Questionnaire (SWFFQ) as well as household visit information (details discussed later). Consent signatures were obtained using Qualtrics, though physical copies of the consent forms were provided to each participant. If the participant believed there was another eligible adult in their household, an additional urine and SWFFQ were provided. The only active recruitment event took place on January 27th, 2024.

Inactive Recruitment

With the large Nosotros cohort contact database, Nosotros participants were contacted through text message to determine their interest in learning more about the SoAZHSP. Prospective participants were distinguished by language. Spanish speakers were contacted in Spanish and bilingual speakers and English speakers were contacted in English. Appendix B contains the exact recruitment language in English and Spanish. If the prospective participants indicated that they were interested and provided their availability, phone calls were made to allow coordinators to expand on the study. In this phone call, coordinators provided the study purpose, eligibility requirements, household visit details, and project timelines. If the prospective participant was still interested, the pickup time for the kit and household visit were scheduled during the phone call. Prior to the household visit, participants were asked to meet up the Project Coordinators at the UA offices in the Abram's Building or at the UA Water Resources Research Center to pick up urine kits, urine collection instructions, the SWFFQ, and printed consent form. During this initial visit, they also consented to the study via Qualtrics.

Participant Referral

Though most participants were recruited from the Nosotros database of contacts, participants in the SoAZHSP were asked to provide contact information of other prospective participants to partake as subjects in the study. The same protocol of the previously mentioned inactive recruitment was made. In brief, the referred participants were texted to determine their interest in learning more about the SoAZHSP. Once they confirmed their interest and phone call availability, they were called to learn more about the study purpose, eligibility requirements, household visit details, and project timelines. During the phone call, participants were scheduled to pick up their kits and for the household visit.

Household Visit Overview

Household Visit Scheduling

Project Coordinator and Technician scheduling was kept up to date using the scheduling platform Teamup. There, team members could update their household visit availability months in advance. Household visits were distinguished by time (1.5 hour household visits with 30 minutes of buffer between each school, work, or other household visit obligation) as well as the preferred participant language (English/Spanish). One day before the scheduled visit, participants were reminded via text about the household visit requirements, including the *H. pylori* breath test requirements and fasting for one hour before the test, frozen urine sample, completed SWFFQ, and the two-liter drinking water sample collection as well as the two-part survey. Exact text reminder language can be found in Appendix C. Though the household visits were scheduled for 1.5 hours, they were normally completed within one hour. This thesis did not include SWFFQ, urine, or *H. pylori* water analysis (DNA extraction and PCR). Moving forward, these elements of the household visit will not be detailed.

Household Visit Sampling

Figure 4 outlines participant requirements and time commitments before and during the household visit.

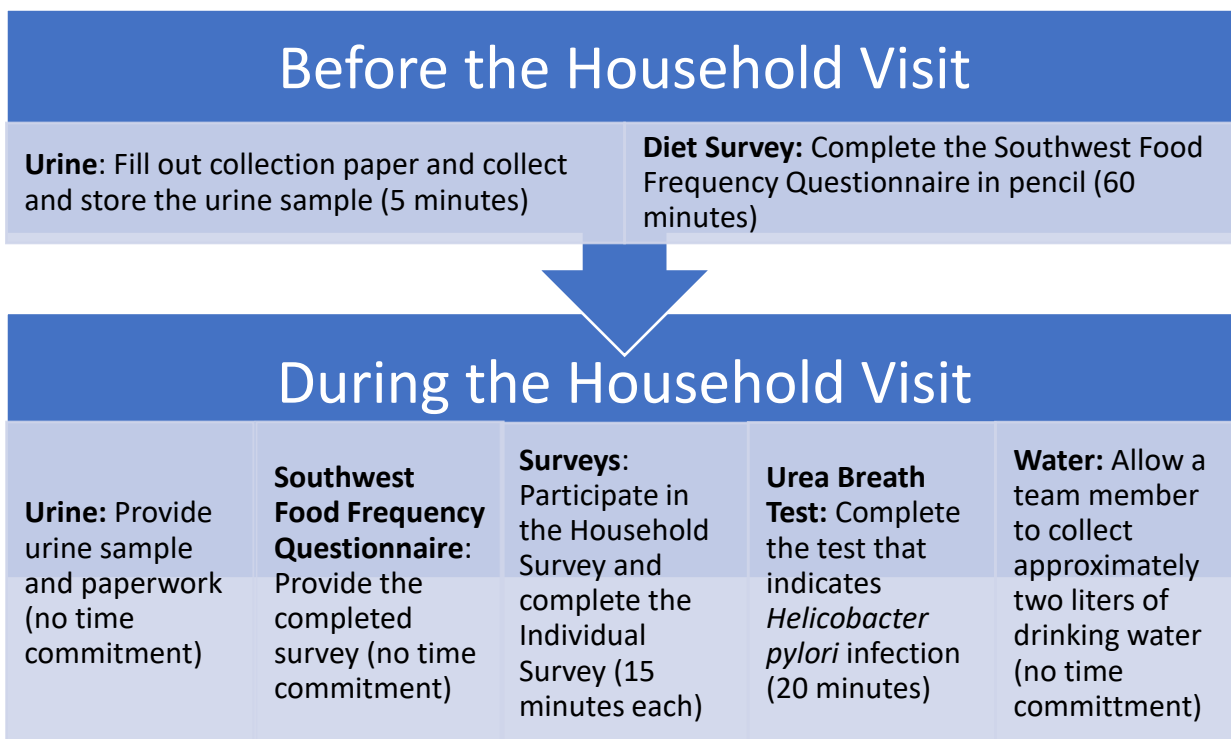


Figure 4. Summary of participant requirements and task time commitments for participants in the Southern Arizona Healthy Stomach Project.

Household and Individual Surveys

Surveys were created on Qualtrics (Qualtrics, 2005, copyright 2024, Provo, Utah, US) and downloaded on smart phones (app: Offline Surveys) to ensure that survey responses could be collected without cellular data at households. Questions related to the household (household survey) were asked to better understand GC and *H. pylori* risk factors, such as household conditions, pet ownership, drinking water sources, when the house was built, diet, and food access (Appendix D). There was one household survey per household. Any consenting individual in the household was encouraged to participate in this survey, whereas the individual surveys (another survey) were answered by one consenting individual. The individual survey was designed to identify individual risk factors associated with GC and *H. pylori*, including lifestyle behaviors (e.g. smoking), diet, weight (Taylor scale product number 761441932) and height (Hopkins Medical Products stadiometer; product number B00XPXQ6YS) measured by a field member), water and alcohol consumption, water quality perception, mental health, food and health access, and family health history (Appendix E). Each consented participant completed the individual survey. Surveys were conducted in the participant's preferred language.

Urea Breath Test

Participants were asked to complete a non-invasive, UBT test to detect the presence of a *H. pylori* infections. Sample collection followed Meridian Biosciences (3471 River Hills Drive Cincinnati, OH 45244 guidelines; Appendix F).⁸⁹ After participant eligibility confirmation (including fasting for one hour before the test) was confirmed during the household visit, the participants were asked to breathe into a breath collection bag to get their base breath. Then, the research team placed the urea citrate powder and urea-13C tablet into a plastic cup (provided in the UBT kit), and bottled water was poured to the fill line. Once the urea citrate powder and tablet (both provided in the UBT kit) were fully dissolved, the participant drank the solution within two minutes, waited fifteen minutes, and breathed into another breath sample collection bag. The BreathID machine (catalog #= AC00063, Machine#= 1725) measured the gas exchange differences in the pre-and post-dose breath bag, and machine output indicated if participants had an *H. pylori* infection.⁹⁰ Specifically, the BreathID machine measured the difference in isotope ratios of exhaled carbon dioxide (CO₂) (¹³CO₂/¹²CO₂).⁹⁰ *H. pylori* negative participants exhale more ¹³CO₂ in the second breath collection bag because they lack the urease enzyme associated with *H. pylori* in the stomach.⁹⁰ The BreathID threshold value of isotope baseline change is 5.0. In other words, if after ingesting the urea mixture, the participant exhaled five times more ¹³CO₂ in the second breath sample bag than they did in the base breath sample bag, they were considered positive for an active *H. pylori* infection.⁹⁰ The sample breath bags were analyzed at the Medical Research Building the same day as the household visit.

Water Sample Collection

During the household visits, drinking water sources were identified. Only unfiltered tap water or five-gallon, refillable 5-gallon water (for one household) was collected for analysis. It was decided by the SoAZHSP Project Coordinators that bottled water would not have as many contaminants as tap water; therefore, water sampling protocol changed mid-project, and only unfiltered tap water was collected moving forward. Samples were collected in compliance with the EPA methods of environmental sampling.⁹¹ The unfiltered cold, tap water line was flushed for three minutes and the faucet mouth was wiped with a 70% isopropyl alcohol wipe (brand: Acme United Corporation) before two liters were collected for metal and microbe processing.⁹¹ An additional mason jar (unsterile) of water (~1 cup) was collected to measure water temperature on site using a floating glass Top Fin thermometer (product number: 5289731) The two liters of water collected in the sterile Nalgene bottles were used for culture microbiology, molecular microbiology (not assessed in this thesis), and metal analysis, whereas the water placed in the mason jar was assessed for environmental water parameters, such as conductivity, pH, and turbidity (described below). Water samples collected during the household visit were transported to the UA Medical Research Building in coolers with nonleaking ice packs and were assessed within six hours of collection to minimize bacterial regrowth and/or decay.

Environmental Water Parameters

Upon arriving at the Medical Research Building at the UA environmental water parameters, such as conductivity, pH, and turbidity were assessed. Conductivity (units:

millisiemens per centimeter) and pH were assessed using the ProDSS Multiparameter Digital Water Quality Meter (Catalog number= W86-04). Calibrated in July 2023, this handheld device had compatible ProDSS sensors for conductivity (Product number= 626902) and pH (Product number= 626904) and displayed results in real time.⁹² The probes were placed in the mason jar of drinking water, and once the conductivity and pH values stabilized (~10 minutes), results were recorded on the household packed and uploaded to Microsoft Excel (Version: 16.84 (24041420)). The HACH 2100Q Portable Turbidimeter (product number= 2100Q01) is compliant with EPA Method 180.01 design criteria and was used to assess turbidity (units: Nephelometric Turbidity Units or NTU) of the drinking water samples.⁹³ The instrument was calibrated according to the Turbidimeter standards before use.⁹³ Once the instrument provided turbidity values, results were recorded and uploaded to Microsoft Excel.

Culture Microbiology

Upon arriving at the Medical Research Building at the UA, the IDEXX Colilert method (EPA 9223B)⁹⁴ was used to detect total coliforms and *Escherichia coli* (*E. coli*) in the drinking water samples.⁹⁵ Briefly, the one Nalgene bottle was agitated to ensure a homogenous solution. Following, 100 mL of the drinking water sample was pipetted into a sterile, 120 mL screw bottle with sodium thiosulfate (powder that rids of the chlorine effect, product number= 98-27163-00). Following, one pack of Colilert substrate (product number= 98-27163-00) was added to the 120 mL bottle. The mixture was agitated again for homogeneity. Once all the powder had dissolved in the drinking water sample, the mixture was carefully poured into a Colilert Quanti-Tray 2000[®] (product number= 98-21675-00), avoiding bubbles when possible. The labeled Quanti-Tray was sealed using the Quanti-Tray Sealer Plus (product number= 98-0002570-00) and incubated at 37 °C in a Precision Incubator (catalog number= 51221089). After 22 to 26-hour incubation, yellow wells were counted as positive for total coliform and yellow wells that fluoresced under black light (An Endress Hauser Company Handheld UV lamp with wavelength 365 nm; part number= 95-0006-02) were counted as positive for *E. coli*. Using the Colilert quantification sheet (Appendix G), most probable number (MPN) per 100 mL were obtained.

Metals

Upon arriving at the Medical Research Building at the UA, 15 mL of the drinking water sample was poured into a freezer proof, sterile plastic conical vial. The vial was stored in a freezer at -80°C. When ten water samples were accumulated, they were transferred to the Arizona Laboratory for Emerging Contaminants (ALEC), where the Laboratory thawed, aliquoted, treated with (1%) nitric acid to reduce pH and ensure all metals were dissolved to assess metal concentrations using Inductively Coupled Plasma - Mass Spectroscopy (ICP-MS). Each sample was assessed for As, iron (Fe), chromium (Cr), vanadium (V), selenium (Se), and cobalt (Co) and presented in ppb. De-identified results came via email after one month.

Participant Compensation

Each participant was provided \$25 cash after the completion of all household visit requirements. Per UA policy, upon receiving the confirmation, participants filled out

personal, identifiable information, including the date of the expense, their name, social security number, living address, and signature of receipt. This form is titled the *Record of Operational Advance Expenditures*.

Data Management

Once the participant confirmed their availability for a household visit, the household was assigned a randomized four-digit household identification number. Participant identifications were distinguished by adding “01” for the first consented individual of the household and “02” for the second (example: 1234 is the hypothetical household identification number, while 1234-01 is the individual identification number for the first person who consented). Household identification numbers were used for water samples and the household survey, while the individual identification numbers were used to distinguish individual surveys, urine samples (not assessed in this thesis), SWFFQ (not assessed in this thesis), and the UBT results. During the household visits, the individual and household surveys were collected using the Offline Qualtrics app using de-identified assignments, and samples (water, urine, SWFFQ, and UBT breath bags) were labeled with the corresponding household or participant identification numbers. All information (aside from the consent forms and individual and household surveys) was recorded on paper field forms with only de-identified numbers.

All de-identified data forms, surveys, and chemical data were scanned and entered into a Microsoft Excel file stored on Box, a password-protected server accessible only by those listed on the IRB and certified by the Principal Investigators. Qualitative data were uploaded from the Offline Survey app, downloaded directly from Qualtrics, and uploaded to Box. Water quality data were directly recorded from laboratory equipment (e.g. turbidity, pH, and conductivity meter) and uploaded to Box. All de-identified field form information was transported to the UA, transferred to digital format, and uploaded to Box.

Upon receiving the compensation, the *Record of Operational Advance Expenditures* with the participants’ identifiable information was transferred to the UA and given directly to the Principal Investigator to store in a locked filing cabinet, inaccessible to anyone else.

Statistical Analysis

Data gathered from the UBTs, the household and individual surveys, metal concentrations in urine and water, as well as environmental parameters, and culture microbiology of water from the first six weeks of SoAZHSP household visits were used in this thesis.

Descriptive statistics were compiled using Microsoft Excel and STATA (12.0 StataCorp, College Station, TX, USA), and geographical distribution of the households was displayed using Geographical Information Systems (GIS; 10.8.2 Version, ESRI, Redlands, California, USA). Descriptive statistics (geometric means, minimum, maximum, and geometric standard deviations) were used to summarize metal concentrations in water. Because the parameters were not normally distributed, geometric means of analyte concentrations as opposed to average concentrations were calculated. Water sample metal results below the minimum reporting limit (MRL) were replaced with the MRL divided by the square root of two. Chi squared analysis were used to determine statistically significant risk factors of *H. pylori*

diagnoses, including diet, Body Mass Index (BMI), smoking, gender, age, family health history via STATA. Findings were statistically significant if the p-value was less than or equal to 0.05. BMI was classified using the Centers for Disease Control calculations (weight (in pounds)/height (inches)² x 703) and guidelines of underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), and obese (≥30).⁹⁶

Results

Recruitment Overview and Population Location

From February 2nd to March 9th of 2024, 41 households were randomly selected from the Nosotros contact base (Figure 3). Of these, six households (14.6% of 41) did not want to participate in the study due to dependence on stomach medications that would alter UBT results. Interestingly, of the 28 households included in the data for this thesis, 13 households (46.4%) were from participant referrals, and just over 50% of households (n=15) were from the Nosotros contact base (Figure 3). Of the 28 households with completed interviews and at least one participant who successfully completed the UBT, three participants were not included in this thesis due to: being absent during the household visit for a work emergency, taking bismuth products less than two week before the household visit, and another for not exhaling enough into the UBT sample collection breath bags (Figure 3). Analysis for this thesis focused on 28 households and 42 participants. As a part of the eligibility criteria, all participants (n=42) were of Hispanic or Latino origin. Most participants identified as Mexican (n=38) with two participants identifying as Mexican American and one participant as Honduran.

Of the 42 participants who successfully completed the surveys and UBT, 14 tested positive for *H. pylori*. Though the SoAZHSP eligibility criteria for geographical location were loosely defined, the 42 participants lived in 28 households in 15 ZIP codes in Pima County, Arizona (Figure 5).

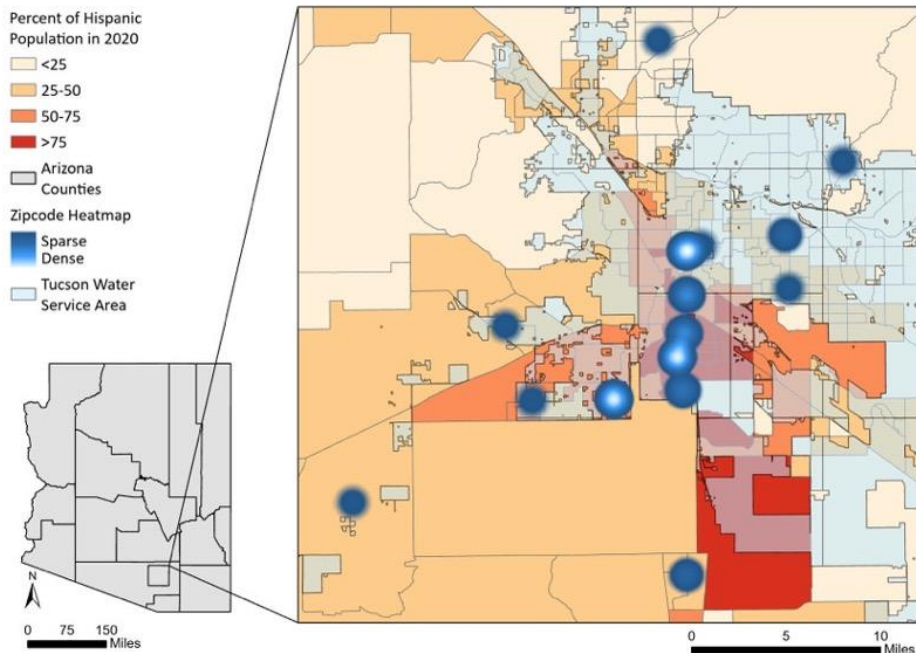


Figure 5. Geographical distribution of household ZIP codes (n=15) included in the preliminary analysis of the Southern Arizona Healthy Stomach Project, Hispanic population density in Pima County in 2020 from the United State Census, and the Tucson Water service area.

Concordance of UBT Results within Households

Of the 15 ZIP codes represented in the SoAZHSP preliminary data, eight ZIP codes (53.3%) had at least one *H. pylori* positive participant with six ZIP codes (42.9%) having both positive and both negative participants. Two ZIP codes had only positive participants. Approximately 40.0% (n=11 of 28) of the households had least one person with a positive UBT. Of the 14 households with multiple participants (max 2), 78.6% (n=11) were UBT-result concordant with 21.4% (n=3) of households having two *H. pylori* positive participants.

Risk Factors Associated with *H. pylori* Infections

The characteristics of the 42 participants who completed UBT and both the household and individual surveys are shown in Table 1. Active *H. pylori* infections were found in 14 of the 42 participants, with an overall crude prevalence of 33.3%. There were too few individuals for stratified analyses or logistic regression leading to highly unstable models; therefore, statistically significant associations determined by chi-square analysis.

Table 1. Overview of household and individual characteristics as well as risk factors and prevalence of *Helicobacter pylori* infection determined by urea breath test (UBT).

	Overall n=42	UBT Positive n=14	UBT Negative n=28	
Characteristics	n (%)	n (%)	n (%)	p ‡
Gender				1.00
Male	18 (42.9)	6 (42.9)	12 (42.9)	
Female	24 (57.1)	8 (57.1)	16 (57.1)	
Age, years				0.04
18-29	6 (14.3)	1 (7.1)	5 (17.9)	
30-39	7 (16.7)	0 (0.0)	7 (25.0)	
40-49	10 (23.8)	4 (28.6)	6 (21.4)	
50-59	13 (30.1)	8 (57.4)	5 (17.9)	
60-70	6 (14.3)	1 (7.1)	5 (17.9)	
Age, years, dichotomized				0.08
<50	23 (54.8)	5 (35.7)	18 (64.3)	
≥50	19 (45.2)	9 (64.3)	10 (35.7)	
Education				0.20
<High School	10 (23.8)	5 (35.7)	5 (17.9)	
≥High School	32 (76.2)	9 (64.3)	23 (82.1)	
Household Income				0.30
<\$40,000	12 (28.6)	4 (28.6)	8 (28.6)	
\$40,000-80,000	8 (19.1)	4 (28.6)	4 (14.3)	
\$80,000-120,000	3 (7.1)	1 (7.1)	2 (7.1)	
>\$120,000	7 (16.7)	0 (0.0)	7 (25.0)	
Prefer not to answer	12 (28.6)	5 (35.7)	7 (25.0)	
Water Sources				0.38
Treated tap water	20 (47.6)	8 (57.1)	12 (42.9)	
Bottled or gallon water	22 (52.4)	6 (42.9)	16 (57.1)	
Diet				0.02
<25% Outside meals	19 (30.2)	10 (71.4)	9 (32.1)	
≥25% Outside meals	23 (69.8)	4 (28.6)	19 (67.9)	
Health Insurance				0.05
Have	21 (53.5)	4 (28.6)	17 (60.7)	
Do not have	21 (46.5)	10 (71.4)	11 (39.3)	
Body Mass Index				0.97
Normal Weight	6 (14.3)	2 (14.3)	4 (14.3)	
Overweight	19 (45.2)	6 (42.9)	13 (46.4)	
Obese	17 (40.5)	6 (42.9)	11 (39.3)	
Clinical History				
Gastritis*	25 (59.5)	6 (42.9)	19 (67.9)	0.12
Ulcers*	6 (14.3)	1 (7.1)	5 (17.9)	0.35
Endoscopy/Gastroscopy*	20 (47.6)	7 (50.0)	13 (46.4)	0.83
Stomach Cancer**	11 (26.2)	2 (14.3)	9 (32.1)	0.22

UBT: Urea Breath Test

n: Sample size

*Participant and/or family member **Family members only

Note: p ‡ values were determined by chi squared tests comparing UBT positive and negative individuals.

Bolded values are statistically significant ($p \leq 0.05$).

Constitutional Factors

Constitutional factors assessed in this study included age and family health history (Figure 2, Table 1). Seventy one percent (n=30) of the participants were 40 or older, and of the 14 UBT positive participants, 13 (92.9%) were aged 40 or older. Using chi-squared analysis, age (categorized into five groups instead of two) was a positive predictor of UBT results ($p=0.04$). Those who were older were more likely to have a positive UBT result. Previous family history of ulcers was uncommon (n=6, 14.3%), while over half of participants (n = 25, 59.5%) had a family member with gastritis and/or were diagnosed with gastritis. Twenty participants (47.6%) reported that themselves or a family member had a gastroscopy/endoscopy, and only 11 participants (26.2%) shared that a family member had been diagnosed with stomach cancer. There was no statistical association between personal or family health history and *H. pylori* infection status.

Lifestyle Factors

Lifestyle factors assessed in this study included alcohol consumption, smoking status, and pet ownership (Figure 2, Table 2). Food safety was not assessed in this study. Most participants (n=29, 69.0%) had a dog and/or cat. In terms of smoking status, only four participants (9.5%) indicated that they actively smoke, while 59.5% of participants (n=25) have smoked before and 30.1% (n=13) have never smoked. There was no association between UBT results and pet ownership ($p=0.08$) or smoking status ($p=0.33$). However, there was a statistically significant association ($p=0.01$) between not drinking alcohol and positive UBT status. Approximately 61.9% of participants (n=26) indicated that they drink alcohol, and only five of the 14 UBT positive individuals drank alcohol.

Table 2. Differences in lifestyle factors and *Helicobacter pylori* infection status measured by the urea breath test (UBT) in preliminary data of the Southern Arizona Healthy Stomach Project.

	Overall n=42	UBT Positive n=14	UBT Negative n=28	
Characteristics	n (%)	n (%)	n (%)	p ‡
Alcohol				0.01
Yes	26 (61.9)	5 (35.7)	21 (75.0)	
No	16 (28.1)	9 (64.3)	7 (25.0)	
Smoking Status				0.33
Yes	4 (9.5)	0 (0.0)	4 (14.3)	
No, not anymore	25 (59.5)	9 (64.3)	16 (57.1)	
Never	13 (31.0)	5 (35.7)	8 (28.6)	
Pet Ownership				0.08
Yes	29 (69.0)	11 (78.6)	18 (64.3)	
No	13 (31.0)	3 (21.4)	10 (35.7)	

UBT: Urea Breath Test

n: sample size

Note: p ‡ values were determined by chi squared tests comparing UBT positive and negative individuals.

Bolded values are statistically significant ($p \leq 0.05$).

Social Determinants of Health

Table 1 also displays social determinants of health, including gender, education attainment, household income, BMI, diet, and access to healthcare. For the purposes of this thesis, BMI and diet are defined as SDH because studies have shown that disadvantaged communities have significantly increased access to fast food restaurants, which can be a barrier to affordable and healthy food,⁷¹ enabling chronic health problems such as obesity.^{72,73} The *H. pylori* infection prevalence for males was 42.9%, while the infection prevalence of females was 57.1%. Participants were primarily female (n=24, 57.1%) and between 50 and 59 years of age (n=14, 30.1%). There were no significant gender differences by *H. pylori* status. Of those who disclosed household income (71.4%; n=30 of 42 participants), most had a self-reported household income of less than \$40,000 (n=12, 28.6%), followed by \$40,000 to 80,000 (n=8, 19.1%), more than \$120,000 (n=7, 16.7%), and \$80,000 to 120,000 (n=3, 7.1%). The majority of participants (n=32, 76.2%) had at least a high school diploma or GED. Using the BMI, most participants were overweight (n=19, 45.2%) or obese (n=17, 40.5%). There was no statistically significant association between UBT status and BMI ($p=0.97$), income ($p=0.30$), gender ($p=1.0$), or education ($p=0.20$).

However, chi-squared analysis revealed two UBT positive predictors: diet and health insurance attainment. About half of participants (n=21, 53.5%) indicated that they do not have insurance, which was a predictor of an active *H. pylori* infection ($p=0.05$) (Table 1). Additionally, the majority of participants (n=23, 54.8%) indicated that at least 25% of their diet derives from restaurant and/or fast food, which served as a negative significant predictor of *H. pylori* test results ($p=0.02$) (Table 1). Lower household income was significantly associated with eating at home ($p=0.005$) and health insurance access ($p=0.001$) (numbers not shown). Of the 21 participants without insurance, almost half (n=10) had self-reported incomes of \$80,000 or less. The remaining 11 participants without health insurance

did not disclose household income information. Similarly, of the 19 participants (45.2%) who eat most meals at home, 15 (78.9%) reported a household income of \$80,000 or less.

H. pylori Awareness

Approximately 40% of participants (n=18, 41.9%) had heard of *H. pylori* before the study, while only 12.9% (n=13) had been tested for *H. pylori*. Table 3 shows the relationship between awareness of *H. pylori* and UBT status. Only one UBT positive individual (2.3%) had been tested before, whereas five participants (11.3%) who were UBT negative had been tested before.

Table 3. Differences in self-reported Helicobacter pylori (H. pylori) awareness by H. pylori infection status measured by urea breath test (UBT) in preliminary data of the Southern Arizona Healthy Stomach Project.

Characteristics	Overall	UBT Positive	UBT Negative	p ‡
	n=42	n=14	n=28	
	n (%)	n (%)	n (%)	
Ever heard of <i>H. pylori</i>	18 (42.3)	3 (21.4)	15 (53.6)	0.05
Ever been tested for <i>H. pylori</i>	6 (14.3)	1 (7.1)	5 (17.9)	0.35
Ever been diagnosed with <i>H. pylori</i>	6 (14.3)	2 (14.3)	4 (14.3)	1.0
Family member diagnosed with <i>H. pylori</i>	2 (4.8)	1 (7.1)	1 (3.6)	0.61

n: sample size

Note: p ‡ values were determined by chi squared tests comparing UBT positive and negative individuals. Bolded values are statistically significant (p ≤ 0.05).

Household Water Sources and Providers

SDH, such as living conditions, are also associated with municipal water provider service areas. Most households (n=25, 89.3%) relied on the municipal water provider Tucson Water, while three households were served by other PWS (Sahuarita (n=1) and La Casita (n=2)) (Figure 5). While all households (n=28) were connected to regulated (piped) water, no participants relied on untreated tap water for drinking water purposes. Approximately 50% of households (n=14) treated tap water for drinking, nine relied on less than one-gallon bottled water, four on five-gallon dispenser water, and one on bottled gallon water. Twenty-five households (89.3% of 28) used tap water for cooking, and three households (10.7%) used bottled water for cooking, while all households (n=28) relied on tap water for washing and bathing purposes.

Water Quality Parameters

As mentioned in the federal regulations section, the EPA can regulate contaminants from drinking water systems by establishing a primary drinking water standard, also known as MCL. These contaminants are enforceable standards that protect public health. Contaminants that may not be as detrimental but cause cosmetic effects, such as skin or tooth discoloration, or taste, smell, or color alterations in drinking water are considered Secondary Drinking Water Regulations. These regulations are not enforceable and do not require PWS compliance. The MCL for As is 10 ppb, and the MGCL of As is 0 ppb, while the MGCL and MCL are the same for Cr (100 ppb) and total coliform (0 ppb) (Table 4). Table 4

shows an overview of contaminants in the drinking water and their comparison to the MCL and MCLG established by the EPA.

All household water samples (n=28) were within the secondary drinking water standard levels for Fe, pH, and turbidity. As, Cr (n=1 non-detect of 28 HH samples), Se (n=28 non-detect), and *E. coli* (n=28 non-detect) concentrations were all below the corresponding MCLs, but all As concentrations were above the MCLG of zero (Table 4). The geometric mean and geometric standard deviation for As were 3.48 and 1.48 ppb respectively (Table 4). Total coliform concentrations (detected in 5 of 28 households) ranged from less than 1 to 65 MPN per 100 mL with a geometric mean concentration of 4.20 MPN per 100 mL.

Table 4. Overview of pollutants and environmental parameters tested from preliminary drinking water data (n=28 households) from the Southern Arizona Healthy Stomach Project.

Elements	Detects	Min	Max	Geometric Mean±SD	EPA Safety Criteria
Drinking Water Standards					
Arsenic (ppb)	28	1.50	9.59	3.48±1.48	10 ^a , 0 ^b , N/A ^{c,d}
Chromium (ppb)*	27	MRL	1.82	0.52±2.16	100 ^{a,b} , N/A ^{c,d}
Total Coliforms (MPN/100mL)	5	MRL	65.00	1.30±4.20	0 ^{a,b} , N/A ^{c,d}
Other Standards					
Iron (ppb)*	27	MRL	193.87	5.66±4.67	300 ^c , N/A ^{a,b,d}
pH	N/A	7.07	8.31	7.84±1.04	6.8-8.5 ^c , N/A ^{a,b,d}
Turbidity (NTU)	N/A	0.15	1.80	0.41±1.85	5 ^d , N/A ^{a,b,c}
No Standards					
Vanadium (ppb)	28	3.65	9.68	6.54±1.36	N/A ^{a,b,c,d}
Cobalt (ppb)*	3	MRL	4.04	0.05±2.93	N/A ^{a,b,c,d}
Conductivity (us/cm)	N/A	544.00	1071.00	835.66±1.19	N/A ^{a,b,c,d}
Temperature (C)	N/A	16.67	36.00	20.71±1.12	N/A ^{a,b,c,d}

*Some concentrations were non detect (n=1 for chromium and iron, n=25 for cobalt, and all of selenium and the *Escherichia coli* (*E. coli*) concentrations). Selenium and *E. coli* are not reported.

C: Celsius

EPA: United States Environmental Protection Agency

mL: milliliters

MPN: Most probable number

N/A: Not applicable

NTU: Nephelometric turbidity units

ppb: Parts per billion

SD: Standard deviation

Us/cm: micro Siemens per centimeter

^a United States Environmental Protection Agency Maximum Contaminant Level

^b United States Environmental Protection Agency Maximum Contaminant Level Goal

^c United States Environmental Protection Agency Secondary Maximum Contaminant Level

^d Treatment Technique Action Level Value

Note: Concentrations below the minimum reporting level (MRL) were substituted with the MRL divided by the square root of two. The MRLs (in ppb) were as follows: 0.01 for vanadium, 0.029 for chromium, 0.319 for iron, 0.005 for cobalt, 0.155 for arsenic, and 2.302 for selenium, and the MRLs were 1 MPN/100 mL for total coliforms and 1 colony forming unit (CFU)/100 mL for *E. coli*.

Household Drinking Water Contaminants as *H. pylori* Predictors

When assessing water quality characteristics with federal drinking water standards as UBT predictors (Table 5), concentrations (below the study geometric mean As value of 3.48 ppb, $p=0.03$) and presence of total coliforms ($p=0.04$) in tap water served as UBT positive household predictors.

Table 5. Overview of arsenic and chromium concentrations above and below the geometric mean and total coliform detections from households with and without participants who have *Helicobacter pylori* infection as determined by urea breath test (UBT). This is preliminary data from the first 28 households of the Southern Arizona Healthy Stomach Project.

Characteristics	Overall Household n=28 n (%)	UBT Positive Household n=11 n (%)	UBT Negative Household n=17 n (%)	p ‡
Arsenic				0.03
<3.48 ppb	11 (39.3)	7 (63.6)	4 (23.5)	
≥3.48 ppb	17 (60.7)**	4 (36.4)	13 (76.5)	
Chromium*				0.39
<0.52 ppb	13 (46.4)	4 (36.4)	9 (52.9)	
≥0.52 ppb	15 (53.6)**	7 (63.6)	8 (47.1)	
Total Coliforms				0.04
<1 MPN per 100mL	23 (82.1)**	7 (63.6)	16 (94.1)	
≥1 MPN per 100mL	5 (17.9)	4 (36.4)	1 (5.9)	

*One UBT negative household did not have detectable chromium concentrations in their tap water.

Concentrations below the minimum reporting level (MRL) were substituted with the MRL divided by the square root of two.

**This represents the one UBT positive household with 5-gallon water collected. The results from this household were 4.5 ppb for arsenic and 0.6 ppb for chromium, and no total coliforms were detected. For the other 27 households, tap water was collected.

n: sample size

mL: milliliters

MPN: Most probable number

ppb: parts per billion

Note: The MRL for arsenic and chromium (n=1 non-detect) were 0.155 ppb and 0.029 ppb, respectively.

The MRL was 1 MPN/100 mL for total coliforms (n=23 below the MRL). p ‡ values were determined by chi squared tests comparing UBT positive and negative individuals. Bolded values are statistically significant ($p \leq 0.05$).

Arsenic Concentrations in Relation to Chromium Concentrations and Total Coliform Detections

The geometric mean of As in this study was 3.48ppb. Sixty-four percent of households with a UBT positive participant (n=7 of 11 UBT positive HHs) had less than 3.48 ppb of As detected in their water. The households with As lower than the study geometric mean of 3.48 ppb (positive predictor of UBT household status) had a geometric mean Cr concentration of 0.39 ppb (0.13 ppb lower than overall Cr geometric mean), and interestingly, of the five households with detectable total coliforms, four had As concentrations below the As geometric mean of 3.48 ppb. Upon further investigation, there

was no statistical significance between As concentrations and total coliform presence ($p=0.30$) (data not shown).

Total Coliform Detections in Relation to Arsenic and Chromium Concentrations

For tap water with total coliforms present (positive predictor of UBT results), the geometric mean concentrations of As and Cr were 2.83 ppb (0.65 ppb below the overall geometric mean As concentration) and 0.65 ppb (0.13 ppb higher than the overall geometric mean Cr concentration), respectively. For the households without TC, the geometric mean As and Cr concentrations were 3.64 ppb (0.16 ppb more than the overall geometric As mean) and 0.50 (0.02 ppb less than the overall geometric Cr mean), respectively.

Table 6 displays the association between water quality parameters with federal MCLs and SDH (highest level of household educational attainment, household income, when the house was built, and the water provider). There was a statistically significant association ($p=0.04$) between elevated As concentrations and household income. Of the four household income categories (<\$40,000, \$40-80,000, \$80-120,000, and >\$120,000), most households reported a household income of less than \$40,000 ($n=8$ (28.6%) with $n=4$ households with As concentrations below and above the geometric mean of 3.48 ppb). Interestingly, no households with As below the overall mean of 3.48 ppb reported making more than \$80,000. This indicates that those with high As concentrations (above the overall mean) are more likely to be affluent. Because a quarter (25%, $n=7$ of 28) of households did not disclose household income information and the As geometric mean concentration is 37.4% of the federal MCL (10 ppb), these findings should be interpreted with caution. There was no other statistically significant relationship between water quality parameters and SDH, including primary sources of drinking water (data not shown).

Table 6. Overview of social determinants of health (SDH) associated with elevated concentrations of arsenic, chromium, and total coliform detected in tap water and one five-gallon water source from preliminary household water sample data from the Southern Arizona Healthy Stomach Project.

Characteristics	Above Mean Arsenic (n=17)* n (%)	Above Mean Chromium (n=15) n (%)	Total Coliforms Detected (n=5) n (%)
Household Education	N/A	N/A	N/A
<High School	0 (0.0)	0 (0.0)	0 (0.0)
≥High School**	17 (100.0)	15 (100.0)	5 (100.0)
Household Income	p=0.04	p=0.30	p=0.59
<\$40,000**	4 (23.5)	6 (0.4)	2 (40.0)
\$40,000-80,000	1 (5.9)	2 (13.3)	1 (20.0)
\$80,000-120,000	2 (11.8)	2 (13.3)	1 (20.0)
>\$120,000	5 (29.4)	2 (13.3)	0 (0.0)
Prefer not to answer	5 (29.4)	3 (20.0)	1 (20.0)
House Age***	p=0.74	p=0.45	p=0.40
<35 years old**	7 (41.2)	6 (40.0)	2 (40.0)
≥35 years old	10 (58.8)	9 (60.0)	3 (60.0)
Water Provider	p=0.30	p=0.08	p=0.46
Tucson Water**	16 (94.1)	12 (80.0)	4 (80.0)
Other Provider	1 (5.9)	3 (20.0)	1 (20.0)

N/A: not applicable since there were not two groups to conduct chi-square test.

n: sample size

*One UBT negative household did not have detectable chromium concentrations in their tap water.

**This represents the one UBT positive household with 5-gallon water collected. The highest level of education attainment in the household was some bachelors education. They reported a household income of less than \$40,000, and the household was built in 2024 and was served by Tucson Water. For the other 27 households, tap water was collected.

***Participants were asked when their house was built, and the mean age of homes was 35 years old.

This mean value was used to dichotomize the SDH related to water quality parameters.

Note: Concentrations below the minimum reporting level (MRL) were substituted with the MRL divided by the square root of two. The MRL for arsenic and chromium (n=1 non-detect) were 0.155 and 0.029 parts per billion, respectively. The MRL was 1 most probable number per 100 milliliter for total coliforms (n=23 below the MRL). p ≠ values were determined by chi squared tests comparing the SDH for households with elevated arsenic (≥3.48 parts per billion), chromium (≥0.52 parts per billion), and total coliform concentrations detected in water compared to those with lower concentrations (below the geometric mean for arsenic and chromium and non-detect for total coliforms). Bolded values are statistically significant (p<0.05).

Discussion

Using data from surveys, UBT results, and tap water quality assessments from the first six weeks of the SoAZHSP, this thesis aimed to summarize the prevalence of *H. pylori* infections and identify risk factors among Hispanics in southern Arizona. Preliminary data from the SoAZHSP suggests that older age, lack of alcohol consumption, increased intake of home cooked meals, tap water quality (total coliform detections), and lack of health insurance are positive predictors of active *H. pylori* infections. In this study, there was an *H. pylori* prevalence of 33.3%, which is in keeping with some US prevalence estimates of 36.0%²⁴ but is nearly double other US estimates of 17.6%.²⁵ Approximately 26% (n=11 of 42) participants had a family member with GC, which suggests that this ethnic group is susceptible to GC. This underscores the need for food hygiene, better health care access, and improving water quality (total coliforms) for the largest ethnic minority group in the US.⁸³

Constitutional Factors

Age

While family health history was not statistically associated with UBT results, older age significantly correlated ($p=0.04$) with active *H. pylori* infections. Notably, 92.9% of those who tested positive for *H. pylori* were 40 or older. This correlation has been observed in other studies and may be attributed to the cumulative exposure to *H. pylori* over time coupled with the decreased immune function, and potentially increased antibiotic resistance.^{97–99}

Lifestyle Factors

Alcohol Consumption

In this study, alcohol consumption appeared to be protective ($p=0.01$) against *H. pylori* infections. This inverse relationship is consistent with previous studies that have assessed the association between alcohol consumption and *H. pylori* infections.^{100–102} Alcohol has antimicrobial activity and stimulates acid secretion, which could inhibit *H. pylori* growth.¹⁰¹ However, it is important to note that the risk associated with alcohol consumption, such as its role as a risk factor for GC, may outweigh its benefits.⁵⁶

Social Determinants of Health

In this report, three SDH- diet, health insurance attainment, and tap water quality (total coliforms and low As) – were significantly associated with *H. pylori* infections.

Diet and Home Cooked Meals

Though in other studies consumption of fast and/or restaurant food (specifically or processed foods)⁵⁶ has been associated with GC, eating more than 25% of meals outside of the home was protective ($p=0.02$) against *H. pylori* infections in this subpopulation. *H. pylori* is an infectious disease thought to be transmissible by food and water,³¹ which could explain why eating meals outside of the home was protective against *H. pylori* infection. Of the 28 households in this report, 14 households had two participants, and of these, 11 showed

concordance in their infection status. Approximately three quarters of the participants (n=31, 73.8%) were married and may share home cooked meals, which could increase the risk of *H. pylori* transmission if food hygiene is poor. Eating meals at home was also significantly associated with household income (p=0.005, data not shown).

Healthcare Access and Awareness

In addition, though there was no correlation between *H. pylori* and other socioeconomic status factors, such as household income or educational attainment, insurance attainment was associated with household income (p=0.001) (data not shown). Participants without health insurance were more likely to have an *H. pylori* infection (p=0.05), which is in keeping with another study that found a positive association between seroprevalence of *H. pylori* (overall *H. pylori* prevalence: 57%) and lack of insurance attainment in Hispanic individuals living in the US.¹⁰³ Hispanics have the highest uninsured rates of all racial and ethnic groups in the US, which can inhibit health care access.⁸³ This underscores the importance of addressing health access disparities when assessing GC risk factors. SDH may play a role in *H. pylori* infections. Additionally, only 40% (n=18, 41.9%) of participants had heard of *H. pylori* before the study, and even fewer (n=13, 12.9%) had been tested. This low awareness, combined with limited testing and insurance status, indicates a need for education and free screening initiatives to improve early detection and treatment of *H. pylori*, especially within at-risk communities. If a patient has *H. pylori* infection symptoms, a UBT is covered by most insurance providers; however, a UBT without insurance can cost up to \$450 for laboratory analysis, which can inhibit EJ community members from getting tested.¹⁰⁴

Tap Water Quality

Previous studies have suggested that reliance on unregulated drinking water sources is associated with *H. pylori* infections.^{105,106} Though the SoAZHSP assessed regulated water sources (n=27 from tap water regulated by the EPA and one from 5-gallon water regulated by the US Food and Drug Administration) for metals and microbes that may be associated with *H. pylori*, total coliforms detections and low levels of As were positive predictors of *H. pylori* infections.

Total Coliforms

Total coliforms exceeded the MCL and MCLG of zero ppb for five households (17.9% of 28). Chi-squared analysis suggested that total coliforms in tap water was a significant predictor (p=0.04) of *H. pylori* infections. Though total coliforms are not likely to cause illness, it is an indication of pollution in water (*E. coli* is a subset of total coliforms). Total coliforms have not been significantly associated with *H. pylori* in the past; however some studies show a correlation between fecal coliform bacteria and *H. pylori* detections in water.¹⁰⁷ Inadequate housing and impaired water are known risk factors of *H. pylori*,⁵⁶ and total coliforms are predictors of potential fecal contamination,¹⁰⁷ suggesting that households with coliforms in tap water may have underlying infrastructure issues contributing to the transmission and/or persistence of *H. pylori* infections. Half of the households (n=14) in this study indicated that their primary source of drinking water is treated tap water, and the

majority of households (n=25, 89.3%) cook with tap water (presumably, untreated). Studies have demonstrated that *H. pylori* is resistant to chlorine water treatments.^{108,109} *H. pylori* positive individuals were also more likely to eat more than 75% of their meals at home (n=10, 71.4%) than those who did not test positive for *H. pylori* (n=9, 31.1%), which further links impaired water quality and *H. pylori* infections. This finding may change with a larger sample size from more geographically diverse areas of southern Arizona.

Arsenic

Additionally, though only regulated water samples were assessed in this study, all samples (n=28) were below the MCL of 10 ppb but all had detectable levels of As, which exceeds the MCL of zero. Interestingly, low concentrations of As (defined as less than the geometric mean of 3.48 ppb) in tap water were significantly associated (p=0.03) with *H. pylori* infections, a finding that was unexpected. However, most As exposure comes from food in areas where drinking water concentrations are low.¹⁵ Future studies should identify other sources of metal exposure to fully capture the relationship between *H. pylori* and As. These results should be interpreted with caution, considering the geometric mean concentration of As was well below (34.8% of) the MCL of 10 ppb.

Moreover, this finding may change with more participants in other geographically diverse areas of southern AZ. Though the SoAZHSP eligibility criteria encouraged participation from Hispanic households anywhere in and south of Pima County (including Santa Cruz and Cochise County that have residents dependent on private domestic wells for drinking water), the recruitment pool was more geographically limited than expected. The first six weeks of recruitment yielded 28 households within 15 zip codes in Pima County, and of these 28 households, 25 (89.3%) were reliant on a large, reputable municipal water provider. Metal exposures through drinking water are expected to be more demonstrated once the project expands to include participants south of Tucson and outside of Pima County.

Strengths And Weaknesses

This report investigated the environmental and social predictors of *H. pylori* infections, a risk factor of GC, in Hispanic households recruited from the SoAZHSP. This is a novel approach to assessing why GC rates have been increasing for Hispanics. The southwest also provides a unique opportunity to not only assess Hispanic risk factors of GC, but due to the geology of the area, the study also provides the opportunity to assess *H. pylori* risk factors through drinking water (once the project expands to include other counties more reliant on unregulated, private wells).

While this report has provided valuable insights into the factors contributing to *H. pylori* infections in this region and within this understudied population, it does have limitations, including the small sample size, self-reporting bias, and UBT limitations. With only 42 participants, logistic regression (i.e. quantifying associations) and controlling for confounders was not possible. Therefore, the magnitude of significant associations was not quantified. Additionally, data from 28 households is insufficient to assess mixed effects modeling (i.e. household correlation). For the individual and household surveys, many responses, such as health history and diet, can be challenging to recall, which can influence

the associations between *H. pylori* and risk factors. Another limiting factor was the UBT requirements. To be eligible for UBT, participants were required to abstain from bismuth products, antacids, and antibiotics. This excluded six households from participating in this study.

Future Studies

The SoAZHSP is a pilot project that will expand to include assessments of metal exposure through private wells, overall metal exposure, identification of *H. pylori* in water, and evaluations of virulence factors and antibiotic resistance. To determine the amount of metal exposure through food, the SoAZHSP will include the SWFFQ in their analysis (will give some insight on processed and/or foods as well as potential metal exposure) and overall metal exposure through urine, which are associated with *H. pylori* infections. Chlorine does not effectively eradicate *H. pylori*, but private wells are expected to have higher metal and microbe exposure, which may correlate with *H. pylori* infections. Additionally, the SoAZHSP hopes to identify *H. pylori* in the participant's drinking water through dPCR and DNA extraction, which will highlight the sources, transmission, and fate of *H. pylori* in the environment. Further, *H. pylori* positive participants will be invited to provide fecal samples to assess virulence factors, identify the *H. pylori* strain, and assess its antibiotic resistance, which is a growing concern for treatment.

Future research looking into at *H. pylori* and GC risk factors should expand the study population to include those in rural areas who are more likely to be dependent on private domestic wells. This will give provide a better understanding of how metal and microbe exposure through drinking water could be associated with *H. pylori* infections. To reach these rural communities, study investigators should partner with the UA Rural Public Health Program that has well established relationships with rural communities and non-profits along the Border. Also, including survey questions related to food hygiene literacy, environmental exposures, and genetic predispositions could give more definite insights on the relationship between diet and *H. pylori* infections.

Conclusion

The preliminary findings of the SoAZHSP shed light on several important factors associated with *H. pylori* infections among Hispanics in the region. Despite the limited sample size and possible recall bias, this report has helped address the limited data assessing *H. pylori* risk factors in Hispanics and identified potential risk factors of *H. pylori* infections. Key risk factors identified include older age, lack of alcohol consumption, lower household income, consumption of home cooked meals, tap water quality (total coliform detection), and disparities of healthcare access and *H. pylori* awareness. Overall, the findings underscore the complexities of sociodemographic, environmental, and behavioral factors that shape *H. pylori* prevalence. Addressing these factors through targeted interventions and public health initiatives will be essential to reduce the burden of *H. pylori* infection-related diseases in Hispanic populations in southern AZ and improving health outcomes globally.

Appendices

Appendix A

Eligibility Survey-Hp SoAz

Start of Block: Contact Information/Consent

Q1.1 Factores de riesgo de cáncer gástrico en el sur de Arizona: un estudio piloto
Formulario de elegibilidad de reclutamiento LEER EN VOZ ALTA: ¡Buenos días/buenas tardes! Mi nombre es _____ y trabajo con la Universidad de Arizona. Estás invitado a participar voluntariamente en la "Factores de riesgo de cáncer gástrico en el sur de Arizona: un estudio piloto". Este estudio piloto tiene como objetivo determinar los problemas de calidad de agua y las infecciones por *Helicobacter pylori* presentes en esta comunidad y desarrollar un plan de acción estratégico impulsado por la comunidad que se desarrollará en colaboración entre los residentes, las partes interesadas y el equipo de investigación.

Gastric Cancer Risk Factors In Southern Arizona: A Pilot Study

Recruitment Eligibility Form READ ALOUD: Good morning/afternoon! My name is _____, and I'm from the University of Arizona. You are invited to participate voluntarily in the "Gastric Cancer Risk Factors in Southern Arizona: A Pilot Study. " This pilot study aims to determine the water quality issues and *Helicobacter pylori* infections present in this community and to develop a community-driven strategic action plan between the residents, stakeholders, and research team.

Q1.2 ¿Tienes al menos 18 años de edad?

Are you at least 18 years old?

- Sí** Yes (1)
- No ("Lamento molestarlo/molestarla. Gracias por tu tiempo.")** No. ("I am sorry to bother you. Thank you for your time.") (5)

Skip To: End of Survey If ¿Tienes al menos 18 años de edad?Are you at least 18 years old? = No ("Lamento molestarlo/molestarla. Gracias por tu tiempo.") No. ("I am sorry to bother you. Thank you for your time.")

Q1.3 ¿Como se identifica? Se identifica como:

What is your race/ethnicity?

- Hispano o Latino** Hispanic or Latino (4)
- Caucásico** White or Caucasian (5)
- Africano Americano** Black or African American (6)
- Indígena Americano o Nativo de Alaska** American Indian or Alaskan Native (7)
- Asiático** Asian (8)
- Isleño del Pacifico o Hawaiano** Pacific Islander or Hawaiian (9)

Display This Question:

*If ¿Como se identifica? Se identifica como: What is your race/ethnicity? =
Hispano o Latino Hispanic or Latino*

Q1.4 Si es Hispano o Latino, ¿cuál de los siguientes lo describe mejor? (Puede elegir más de uno)

If Hispanic or Latino, which of the following best describes your racial heritage? (You may choose more than one category)

- Cubano** Cuban (5)
 - Mexicano** Mexican (1)
 - Mexicano-Americano** Mexican American (10)
 - Puertorriqueño** Puerto Rican (2)
 - Sud/Centro Americano** South/Central American (11)
 - Otro (por favor especifique)** Other (please specify) (9)
-

Q1.5 **¿Existe la posibilidad de que esté embarazada?**

Is there a chance you are pregnant?

- Sí ("Lamento molestarlo/molestarla. Gracias por tu tiempo.")** Yes ("I am sorry to bother you. Thank you for your time.") (1)
- No** (3)

Skip To: End of Survey If ¿Existe la posibilidad de que esté embarazada?/Is there a chance you are pregnant? = Sí ("Lamento molestarlo/molestarla. Gracias por tu tiempo.") Yes ("I am sorry to bother you. Thank you for your time.")

Q1.6 **¿Es alérgico a la fenilalanina o sus derivados (que se encuentran en bebidas dietéticas, huevos, pollo, hígado, carne de res, leche y soja)?**

Are you allergic to phenylalanine or its derivatives (found in diet drinks, eggs, chicken, liver, beef, milk, and soybeans)?

- Sí ("Lamento molestarlo/molestarla. Gracias por tu tiempo.")** Yes ("I am sorry to bother you. Thank you for your time.") (1)
- No** (9)

Skip To: End of Survey If ¿Es alérgico a la fenilalanina o sus derivados (que se encuentran en bebidas dietéticas, huevos,... = Sí ("Lamento molestarlo/molestarla. Gracias por tu tiempo.") Yes ("I am sorry to bother you. Thank you for your time.")

Q23 Notas del entrevistador: Verifique que el participante no tome antibióticos, inhibidores de la bomba de protones (IBP) ni preparaciones de bismuto como Pepto-Bismol u otros antiácidos. Si es así, verifique si pueden suspender los medicamentos durante 2 semanas antes de tomar BreathID UBT. Si han usado estos medicamentos en las últimas 2 semanas, quedan excluidos de la prueba porque los resultados no serán válidos. Interviewer Notes: Verify that the participant does not take any antibiotics, proton pump inhibitors (PPIs), or bismuth preparations such as Pepto-Bismol or other antacids. If so, verify if they can stop the medications for 2 weeks before taking the BreathID UBT. If they have used these medications within the past 2 weeks, they are excluded from the test because the results will not be valid.

- El participante no está tomando ningún medicamento.** The participant is not taking any medications. (1)
- El participante está tomando medicamentos, pero los dejará durante 2 semanas antes de la visita domiciliaria.** The participant is taking medication, but will stop for 2 weeks before the household visit. (2)
- El participante no puede o no quiere dejar de tomar el medicamento durante dos semanas antes de la visita domiciliaria.** The participant cannot or will not like to stop taking the medication for two weeks before the household visit. (3)

Skip To: End of Survey If Notas del entrevistador: Verifique que el participante no tome antibióticos, inhibidores de la bo... = El participante no puede o no quiere dejar de tomar el medicamento durante dos semanas antes de la visita domiciliaria. The participant cannot or will not like to stop taking the medication for two weeks before the household visit.

Q1.7 Felicidades. Usted es elegible para participar en este estudio. ¿Estás interesado en saber más y cómo participar?

Congrats. You are eligible to participate in this study. Are you interested in learning more and how to participate?

- Sí (Proceda a dar su consentimiento).** Yes (Proceed to consent.) (1)
- No ("Lamento molestarlo/molestarla. Gracias por tu tiempo.")** No. ("I am sorry to bother you. Thank you for your time.") (2)

Skip To: End of Survey If Felicidades. Usted es elegible para participar en este estudio. ¿Estás interesado en saber más... = No ("Lamento molestarlo/molestarla. Gracias por tu tiempo.") No. ("I am sorry to bother you. Thank you for your time.")

Display This Question:

If Felicidades. Usted es elegible para participar en este estudio. ¿Estás interesado en saber más... = Sí (Proceda a dar su consentimiento). Yes (Proceed to consent.)

Q1.8 Factores de riesgo de cáncer gástrico en el sur de Arizona: un estudio piloto

Participante con consentimiento Leer: La Junta de Revisión Institucional responsable de la investigación con seres humanos en la Universidad de Arizona revisó este proyecto de investigación y lo consideró aceptable, de acuerdo con las regulaciones estatales y federales aplicables y las políticas de la Universidad diseñadas para proteger los derechos y el bienestar de los participantes en la investigación. **ENTREGAR EL DOCUMENTO DE CONSENTIMIENTO INFORMADO AL PARTICIPANTE**

“Este formulario de consentimiento informado contiene información sobre los objetivos y procedimientos del estudio. No dude en leer el contenido, pero no firme el formulario hasta que lo revisemos en

detalle.” **Enlace:** https://docs.google.com/document/d/1XigAnzdqal9mZ0fqZkHshJaUIIQ3kooYreKNZU_csyM/edit?usp=sharing **OBTENER CONSENTIMIENTO INFORMADO:**

Revise cada sección del documento de consentimiento informado.

“¿Hay alguna pregunta sobre el documento de consentimiento informado?”

“En este momento, si acepta participar en este estudio, firme el consentimiento informado”. Comparta con ellos el kit de recolección de muestras de orina y las encuestas de frecuencia de alimentos.

Recuérdelos que deben ayunar una hora antes de realizar la UBT el día de la muestra

Gastric Cancer Risk Factors In Southern Arizona: A Pilot Study

Consent Participant

Read: The Institutional Review Board responsible for human subjects research at The University of Arizona reviewed this research project and found it to be acceptable, according

to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

GIVE PARTICIPANT INFORMED CONSENT DOCUMENT

“This informed consent form has information regarding the objectives and procedures of the study. Please feel free to read the content, but do not sign the form until we review it in detail.” **Link:** https://docs.google.com/document/d/1Qxal2n70sncqLUyX7Jysf77B_DjnGFWfmOMAlSZw7gs/edit?usp=sharing

OBTAIN INFORMED CONSENT: Review each section of the informed consent document.
“Are there any questions about the informed consent document?”
“At this time, if you agree to participate in this study, please sign the informed consent.”
Share the urine sampling collection kit and food frequency surveys with them.
Remind them that they should fast one hour before doing the UBT on sampling day.

Display This Question:

If Felicitaciones. Usted es elegible para participar en este estudio. ¿Estás interesado en saber más... = Sí (Proceda a dar su consentimiento). Yes (Proceed to consent.)

Q1.9 Firme aquí si desea participar en el estudio después de revisar el consentimiento.
(Please sign here if you wish to participate in the study after reviewing the consent.)

Q1.10 ¿Cuál es su información personal?

Esto se utilizará para programar una visita domiciliaria para: la encuesta sobre la dieta, la encuesta sobre el estilo de vida, la muestra de agua y la prueba del aliento con urea (visita de 1 a 1.5 horas). También recogeremos las muestras de orina ese día.

What is your personal information?

This will be used to schedule a home visit for: the diet survey, lifestyle survey, the water

sample, and the urea breath test (1-1.5hr visit). We will also collect the urine samples on this day.

Nombre Name (4) _____

Dirección Street Address (11)

Ciudad City (6) _____

Estado State (7) _____

Código postal Zip code (8)

Número de teléfono Phone number (9)

Correo electrónico Email Address (10)

Q1.11 ¿Cuándo es un buen día y hora para hacer la visita domiciliaria? Ten listo el calendario de Teamup en otra pestaña.

When is a good day and time to do the home visit? Have the Teamup calendar ready in another tab.

Spanish Scheudling (1)

English Scheduling (2)

Q1.13 Hasta donde usted sabe, ¿conoce algún adulto elegible en su hogar que pueda estar dispuesto a participar en este estudio? Queremos estar seguros antes de empacar suministros para la visita al hogar. También recibirán \$25 por completar la encuesta sobre dieta, la encuesta sobre estilo de vida y las pruebas de aliento y orina. Alentamos a un máximo de dos adultos por hogar a participar en este estudio.

To your knowledge, do you know of any eligible adults in your household that may be willing to participate in this study? We want to be sure before packing supplies for the

household visit. Every eligible adult will receive \$25 as well for completing the diet survey, lifestyle survey, and the breath and urine tests.

Sí Yes (1)

No (4)

Skip To: End of Survey If Hasta donde usted sabe, ¿conoce algún adulto elegible en su hogar que pueda estar dispuesto a par... = No

Display This Question:

If Hasta donde usted sabe, ¿conoce algún adulto elegible en su hogar que pueda estar dispuesto a par... = Sí Yes



Q22 ¿Cuántos adultos elegibles viven en su hogar?

How many eligible adults live in your household?

Q1.14 Le proporcionaremos un formulario de consentimiento adicional, un kit de muestreo de orina y una encuesta de frecuencia de alimentos para compartir con ellos en caso de que sean elegibles y estén interesados en participar en este estudio. Si no están interesados, recolectaremos la encuesta de frecuencia de alimentos en blanco y el kit de muestreo de orina no utilizado durante la visita domiciliaria. ¿Cuál es su información de contacto?

We will provide you with an extra consent form, urine sampling kit, and food frequency survey to share with them in case they are eligible and interested in participating in this

study. If they are not interested, we will collect the blank food frequency survey and unused urine sampling kit during the household visit. What is their contact information?

Nombre Name (4) _____

Número de teléfono Phone number (9)

Correo electrónico Email Address (10)

End of Block: Contact Information/Consent

Appendix B

Why does this Project focus on the stomach?

Stomach cancer is the third leading cause of cancer death worldwide.

Helicobacter pylori, one of the most common bacterial infections in the world, plays a role in the healthy human gut. However, *H. pylori* is also associated with multiple chronic diseases, including stomach cancer. Increased risk of infection with *H. pylori* is associated with age, living conditions and lower socioeconomic status.

Why does this Project focus on Hispanics and stomach cancer?

Hispanic populations are at higher risk for gastric cancer than the general U.S. population, **with rates of disease 2-3 times as high among the Latinx population as compared to the white population.**

It is important to establish a more in-depth understanding of the degree to which the Hispanic population is impacted by *H. pylori*. By doing so, health professionals may be better able to identify individuals who are at high risk for infection and who are better candidates for: a) preventive treatment or b) a screening endoscopy to treat early stages of cancer.

Why did this Project decide to conduct visits to Hispanic households?

- (1) **To talk with community members, in the comfort of their home, to understand what they currently know about *H. pylori* infections and stomach cancer**, which will help the Project to:
 - a. Identify what are the current Hispanic perceptions of *H. pylori*,
 - b. Identify what are the risk factors (diet, arsenic concentrations in water and urine, virulence factors, and antibiotic resistance) for *H. pylori* infections and stomach cancer in Hispanic households, and
 - c. Make recommendations on community-informed approaches for increasing awareness about stomach cancer and *H. pylori*.
- (2) **To estimate the prevalence (or current frequency) of *H. pylori* infections based on a random sample of households.**

Appendix C

English: Text Message before household surveys

Good morning/afternoon, My name is X with the Southern Arizona Healthy Stomach Project. As a reminder, we will be visiting your household tomorrow at X AM/PM – X AM/PM to collect the frozen urine samples, the completed food questionnaire, and water from your home. We will also interview you to better understand your home, health history, household practices, and diet as well as test you for *Helicobacter pylori* (*H. pylori*) using a breath test. As a reminder, for correct *H. pylori* test results, one must not take proton pump inhibitors, antibiotics, antiacids, or peptol bismol two weeks before the test. Additionally, fasting for one hour before the breath test is important for correct results.

We have your home address down as: X

If you have any questions, concerns, and/or would like to reschedule please let us know by replying to this number.

We look forward to seeing you tomorrow.

Espanol: Guión de texto para enviar al participante un día antes de la visita al hogar:

Buenos días/tardes, mi nombre es X con el Proyecto de Estómago Saludable del Sur de Arizona. Como recordatorio, visitaremos su hogar mañana a las X AM/PM – X AM/PM para recolectar las muestras de orina congelada, el cuestionario de alimentos completo y el agua de su hogar. También lo entrevistaremos para comprender mejor su hogar, antecedentes de salud, prácticas domésticas y dieta. así como prueba para detectar *Helicobacter pylori* (*H. pylori*) mediante una prueba de aliento. Como recordatorio, para obtener resultados correctos en la prueba de *H. pylori*, no se deben tomar inhibidores de la bomba de protones, antibióticos, antiácidos ni peptol bismol dos semanas antes de la prueba. Además, es importante ayunar una hora antes de la prueba de aliento para obtener resultados correctos.

Tenemos la dirección de su casa como: X

Si tiene alguna pregunta, inquietud y/o desea reprogramar, háganoslo saber respondiendo a este número.

Esperamos verte mañana.

Appendix D
Household H pylori Survey

Start of Block: Sample Collection Summary

Q1.1 IDENTIFICACIÓN DEL HOGAR
HOUSEHOLD ID



Q1.2 INICIALES DEL EVALUADOR
EVALUATOR'S INITIALS



Q1.3 FECHA DE LA ENCUESTA MM/DD/AAAA
DATE OF SURVEY MM/DD/YYYY

Q89 ¿La dirección postal es la misma que la dirección residencial?
Is the mailing address the same as the living address?

Yes (1)

No (2)

Skip To: End of Block If ¿La dirección postal es la misma que la dirección residencial? Is the mailing address the same as... = Yes

Q90 ¿Cuál es la dirección postal de su hogar?
What is your household mailing address?





End of Block: Sample Collection Summary

Start of Block: Household Demographics

Q2.1 ¿Cuántos bebés, niños y adultos mayores viven en el hogar?

How many infants, children, and elderly adults are living in the household?

0 1 2 3 4 5 6 7 8 9 10

Número de bebés (menores de 5 años) Number of infants (under 5 years old) ()	
Número de niños (de 5 a 18 años) Number of children (5 to 18 years old) ()	
Número de Adultos (19 a 60 años) Number of adults (19 to 60 years old) ()	
Número de adultos (>60 años) Number of adults (more than 60 years old) ()	

Q2.2 ¿Cuál es el nivel más alto de educación que ha recibido alguien en su hogar?

What is the highest level of education anyone in your household has received?

- Escuela Primaria** Elementary School (9)
 - Escuela secundaria** Middle School (1)
 - Preparatoria / Examen General equivalente a diploma secundaria** High School/GED (7)
 - Escuela de Comercio** Trade School (8)
 - Algunos Licenciaturas** Some Bachelors (2)
 - Licenciaturas** Bachelors (3)
 - Maestros** Masters (4)
 - Doctorado** Doctorate (5)
 - Prefiero no responder** Prefer not to answer (6)
-

Q2.3 ¿Cuál es el idioma principal que se habla en este hogar?

What is the main language spoken in this household?

- Español** Spanish (4)
 - Inglés** English (3)
 - Incluso mezcla de inglés y español** Even mix of English and Spanish (6)
 - Otra (por favor especificar)** Other (please specify) (5)
-

Q2.4 ¿Cuál es el ingreso del hogar?

What is the household's income?

- (1)
 - \$40,001 - \$80,000 (3)
 - \$80,001 - \$120,000 (4)
 - >\$120,000 (5)
 - Prefiero no responder** Prefer not to answer (6)
-



Q2.5 ¿Cuándo se construyó esta casa? (año)

When was this house built? (year)

Q2.6 ¿Esta casa tiene conexión séptica o de alcantarillado (cargo de alcantarillado en la factura del agua)?

Is this home on septic or sewer (sewer charge on water bill)?

- Séptica** Septic (1)
 - Alcantarillado** Sewer (2)
 - No sé** I don't know (3)
-

Q2.7 ¿Este hogar tiene mascotas?

Does this household have pets?

- Sí** Yes (1)
- No** (2)
- Prefiero no responder** Prefer not to answer (3)

Skip To: Q2.9 If ¿Este hogar tiene mascotas? Does this household have pets? != Sí Yes

Q2.8 ¿Qué tipo de mascotas tiene este hogar?

What kind of pets does this household have?

- Gatos de interior/exterior** Indoor/outdoor cats (1)
- Perros de interior/exterior** Indoor/outdoor dogs (6)

Q2.9 ¿Este hogar cultiva sus propios alimentos?

Does this household grow its own food?

- Sí** Yes (1)
- No** (2)
- Prefiero no responder** Prefer not to answer (3)

Skip To: End of Block If ¿Este hogar cultiva sus propios alimentos? Does this household grow its own food? != Sí Yes

Q2.10 ¿Se utiliza alguno de los siguientes en el jardín doméstico?

Are any of the following used in the household garden?

Pesticidas Pesticides (1)

Fertilizante Fertilizer (4)

End of Block: Household Demographics

Start of Block: Drinking water: Sources, Treatment, Quantity

Q3.1 ¿Cuál es la fuente principal de agua potable para este hogar?

What is the primary source of drinking water for this household?

Agua del grifo (sin tratar en casa) Tap water (untreated at home) (1)

Agua del grifo (tratada en casa) Tap water (treated at home) (4)

Agua embotellada Bottled water (2)

Otra (por favor especificar) Other (please specify) (3)

Skip To: Q3.3 If ¿Cuál es la fuente principal de agua potable para este hogar?What is the primary source of drinki... != Agua embotellada Bottled water

Page Break

Display This Question:

If ¿Cuál es la fuente principal de agua potable para este hogar? What is the primary source of drinki... = Agua embotellada Bottled water

Q3.2 ¿Cuál es la marca de agua embotellada más común que se utiliza en este hogar?

What is the most common brand of bottled water used for this household?

- Aquafina** (1)
 - Dasani** (2)
 - Agua inteligente** Smartwater (3)
 - Parque de ciervos** Deer Park (4)
 - Géiser de cristal** Crystal Geyser (5)
 - Montaña de hielo** Ice Mountain (6)
 - Otra (por favor especificar)** Other (please specify) (7)
-

Q3.3 ¿De dónde proviene el agua del grifo del hogar?

Where does the household's tap water come from?

- Sistema público de agua (si el participante recibe una factura de agua mensual)**
Public water system (if participant gets a monthly water bill) (1)
 - Agua de pozo privado (sirve sólo al hogar)** Private well water (serves only the household) (2)
 - Otra (por favor especificar)** Other (please specify) (3)
-

Display This Question:

If *¿De dónde proviene el agua del grifo del hogar?* Where does the household's tap water come from? = **Sistema público de agua (si el participante recibe una factura de agua mensual)** Public water system (if participant gets a monthly water bill)



Q3.4 ¿Qué sistema público de agua abastece a este hogar?

Which public water system serves this household?

Display This Question:

If *¿Cuál es la fuente principal de agua potable para este hogar?* What is the primary source of drinki... = **Agua del grifo (tratada en casa)** Tap water (treated at home)

Q3.5 ¿Cómo se trata el agua potable en este hogar?

How is drinking water treated in this household?

- Filtro de agua** Water filter (4)
- Hervir** Boil (1)
- Lejía o cloro** Bleach or chlorine (2)
- Desinfección solar** Solar disinfection (3)
- Otra (por favor especificar)** Other (specify) (6)

Skip To: Q3.7 If *¿Cómo se trata el agua potable en este hogar?* How is drinking water treated in this household? != **Filtro de agua** Water filter

Page Break

Display This Question:

If ¿Cuál es la fuente principal de agua potable para este hogar?What is the primary source of drinki... = Agua del grifo (tratada en casa) Tap water (treated at home)

Q3.6 ¿Qué tipo de filtro de agua utiliza el hogar?

What type of water filter does the household use?

Punto de uso (ej: frigorífico, debajo del fregadero, encimera, Brita) Point of use (ex: fridge, under the sink, countertop, Brita) (4)

Punto de entrada (por ejemplo, tratamiento de agua para todo el hogar, normalmente requiere un gran almacenamiento) Point of entry (ex: water treatment for the whole household, usually requires large storage) (2)

Otra (por favor especificar) Other (please specify) (6)

Display This Question:

If ¿Cuál es la fuente principal de agua potable para este hogar?What is the primary source of drinki... = Agua del grifo (tratada en casa) Tap water (treated at home)

Q3.7 ¿Por qué este hogar trata su agua potable?

Why does this household treat its drinking water?

- Gusto u olfato** Taste or smell (4)
 - Preocupado por los metales** Concerned about metals (2)
 - Preocupado por las bacterias** Concerned about bacteria (8)
 - Desconfianza en el proveedor de agua** Distrust in water provider (10)
 - No sé** I don't know (11)
 - Otra (por favor especificar)** Other (please specify) (6)
-

Q3.8 ¿Utiliza su hogar agua del grifo para cocinar, lavar y bañarse? (Se trata de agua del grifo sin tratar en casa.)

Does your household use tap water for cooking, washing, and bathing? (This is untreated tap water at home.)

- Sí** Yes (8)
- No** (10)

Skip To: Q3.12 If ¿Utiliza su hogar agua del grifo para cocinar, lavar y bañarse? (Se trata de agua del grifo sin t... = Sí Yes



Q3.9 ¿Qué fuente de agua utiliza su hogar para cocinar?

What source of water does your household use for cooking?



Q3.10 ¿De qué fuente de agua dispone su hogar para lavar (ropa y platos)?
What source of water does your household for washing (clothes and dishes)?



Q3.11 ¿Qué fuente de agua utiliza su hogar para ducharse o bañarse?
What source of water does your household use for showering or bathing?

Q3.12 ¿Cuántas comidas cocinadas en casa cada semana requieren el uso de agua (por ejemplo, hervir, lavar, enjuagar)?

How many meals cooked at home each week requires the use of water (e.g. boiling, washing, rinsing)?

Q3.13 ¿Cuántas lluvias ocurren cada semana en este hogar?

How many showers occur each week at this household?

Q3.14 ¿Cuánto dura la bañar promedio en este hogar? (minutos)

How long is the average shower in this household? (minutes)

End of Block: Drinking water: Sources, Treatment, Quantity

Start of Block: Household Food Access Questions

Q4.1 **¿A qué distancia está la tienda de comestibles más cercana a este hogar?**

How far is the nearest grocery store from this household?

- Distancia caminando** Walking distance (1)
 - 5-15 minutos en coche** (minute drive) (2)
 - 15-30 minutos en coche** (minute drive) (3)
 - 30-60 minutos en coche** (minute drive) (4)
 - >1 hora en coche** (hour drive) (5)
 - No sé** I don't know (6)
-

Q4.2 **¿Alguna vez su hogar ha tenido preocupaciones por no tener suficiente comida?**

Does your household ever have concerns about not having enough food?

- Sí** Yes (1)
- No** (2)
- Prefiero no responder** Prefer not to answer (3)

Skip To: End of Survey If ¿Alguna vez su hogar ha tenido preocupaciones por no tener suficiente comida? Does your household... != Sí Yes

Q4.3 **¿Alguna vez le ha preocupado que se acaben los alimentos de su hogar antes de tener suficiente dinero para comprar más?**

Have you ever been worried that household food would run out before you had enough money to buy more?

- Sí** Yes (1)
- No** (2)
- Prefiero no responder** Prefer not to answer (3)

Skip To: End of Survey If ¿Alguna vez le ha preocupado que se acaben los alimentos de su hogar antes de tener suficiente di... != Sí Yes

Q4.4 ¿Qué obstaculiza su capacidad para comprar alimentos?

What hinders your ability to buy food?

- Muy caro** Too expensive (1)
 - Limitaciones de transporte** Transportation limitations (2)
 - Demasiado lejos** Too far away (3)
 - Necesito estar en otro lugar (trabajo, cuidar del hogar/niños, etc.)** I need to be somewhere else (work, taking care of household/children, etc.) (4)
 - Otra (por favor especificar)** Other (please specify) (5)
-

End of Block: Household Food Access Questions

Start of Block: Evaluator Notes

Q5.1 **Notas del Evaluador**
(Evaluator's Notes)

End of Block: Evaluator Notes

Individual Survey H pylori

Start of Block: Sample Collection Summary

Q1.1 IDENTIFICACIÓN

Participant ID (should end in 01 or 02)



Q1.2 NÚMERO DE TELÉFONO DEL PARTICIPANTE

(Esto se utilizará para la encuesta de seguimiento de 6 meses.)

PARTICIPANT'S PHONE NUMBER

(This will be used for the 6 month follow up phone survey.)



Q1.3 INICIALES DEL EVALUADOR

EVALUATOR'S INITIALS



Q1.4 FECHA DE LA ENCUESTA MM/DD/AAAA

DATE OF SURVEY MM/DD/YYYY

End of Block: Sample Collection Summary

Start of Block: Demographics: gender, age, ethnicity, marital status, edu, disability

Q2.1 ¿Cuál es su género?

What is your gender?

- Masculino** Male (1)
- Femenino** Female (2)
- Prefiero no responder** Prefer not to answer (3)



Q2.2 ¿En qué año naciste?

What year were you born?

Q2.3 ¿Como se identifica? Se identifica como:

What is your race/ethnicity?

- Hispano o Latino** Hispanic or Latino (7)
- Caucásico** White or Caucasian (1)
- Africano Americano** Black or African American (2)
- Indígena Americano o Nativo de Alaska** American Indian or Alaskan Native (3)
- Asiático** Asian (4)
- Ileño del Pacifico o Hawaiano** Pacific Islander or Hawaiian (5)
- Dos o mas carreras** Two or More Races (6)

Display This Question:

If ¿Como se identifica? Se identifica como: What is your race/ethnicity? =
Hispano o Latino Hispanic or Latino

Q2.4 Si es Hispano o Latino, ¿cuál de los siguientes lo describe mejor? (Puede elegir más de uno)

If Hispanic or Latino, which of the following best describes your racial heritage? (You may choose more than one category)

- Cubano** Cuban (1)
 - Mexicano** Mexican (3)
 - Mexicano-Americano** Mexican American (4)
 - Puertorriqueño** Puerto Rican (5)
 - Sud/Centro Americano** South/Central American (7)
 - Otro (por favor especifique)** Other (please specify) (8)
-

Q2.5 ¿Cuál es su estado civil?

What is your marital status?

- Casado/pareja de hecho** Married/Domestic partnership (1)
 - Soltero** Single (2)
 - Divorciado** Divorced (4)
 - Prefiero no responder** Prefer not to answer (5)
-

Q2.6 ¿Cuál es el nivel más alto de educación que ha recibido?

What is the highest level of education you have received?

- Escuela Primaria** Elementary School (12)
 - Escuela Secundaria** Middle School (1)
 - Preparatoria / Examen General equivalente a diploma secundaria** High School/GED (7)
 - Escuela de Comercio** Trade School (8)
 - Algunos Licenciaturas** Some Bachelor's (2)
 - Licenciaturas** Bachelors (3)
 - Maestros** Masters (4)
 - Doctorado** Doctorate (5)
 - Prefiero no responder** Prefer not to answer (6)
-

Q2.7 ¿Tiene usted una discapacidad?

Do you have a disability?

- Sí** Yes (1)
 - No** (2)
 - Prefiero no responder** Prefer not to answer (3)
-



Q2.8 ¿Que tan alto eres? (tomar medidas en pulgadas)

How tall are you? (health worker: take measurement in inches)

Q2.9 ¿Cuánto pesas? (tomar medidas en libras)

How much do you weigh? (health worker: take measurement in pounds)

End of Block: Demographics: gender, age, ethnicity, marital status, edu, disability

Start of Block: Lifetime Exposures (Zip codes, water sources)

Q3.1 ¿Naciste en México?

Were you born in Mexico?

Yes (4)

No (5)

Skip To: Q3.4 If ¿Naciste en México? Were you born in Mexico? = No

Q3.2 ¿Cuál era su principal fuente de agua?

What was your main water source?

Agua del sistema público de agua (factura mensual recibida) Public water system water (received monthly bill) (1)

Agua de pozo privado Private well water (2)

Agua embotellada Bottled water (3)

No sé I don't know (5)

Otra (por favor especifique) Other (please specify) (4)



Q3.3 ¿Cuánto tiempo has vivido en los Estados Unidos? (años)

How long have you lived in the United States? (years)

Q3.4 **¿Cuándo se mudó a esta casa? (año)**
When did you move into this house? (year)

End of Block: Lifetime Exposures (Zip codes, water sources)

Start of Block: Drinking water: perception and quantity

Q4.1 **¿Está satisfecho con la calidad de su agua potable?**
Are you satisfied with the quality of your drinking water?

- Sí** Yes (1)
 - No** (2)
 - No sé** I don't know (3)
-

Display This Question:

If ¿Está satisfecho con la calidad de su agua potable?Are you satisfied with the quality of your dri... = No

Q4.2 ¿Por qué no está satisfecho con el agua que bebe?

Why are you unsatisfied with your drinking water?

- Gusto u olfato** Taste or smell (1)
 - Preocupado por los metales** Concerned about metals (6)
 - Preocupado por las bacterias** Concerned about bacteria (7)
 - Desconfianza en el proveedor de agua** Distrust in water provider (9)
 - No sé** I don't know (8)
 - Otra (por favor especifique)** Other (please specify) (3)
-

Display This Question:

If ¿Está satisfecho con la calidad de su agua potable? Are you satisfied with the quality of your dri... = No

Q4.3 ¿Cuáles cree que son las causas de su insatisfacción con el agua potable?

What do you think are the causes of your dissatisfaction with drinking water?

- Uso de suelo cercano (por ejemplo: sitios Superfund, vertederos, industria, granjas ganaderas o pastoreo)** Nearby land use (ex: Superfund sites, landfills, industry, livestock farms or grazing) (1)
 - Infraestructura hídrica inadecuada (tuberías viejas)** Inadequate water infrastructure (old pipes) (3)
 - Tratamiento inadecuado del agua** Inadequate water treatment (7)
 - Otra (por favor especifique)** Other (please specify) (6)
-

Q4.4 En promedio, ¿cuánta agua bebe al día desde tu casa? (1 taza = 8 oz; 4 tazas = 1 L; 4 L = 1 gal)

On average, how much water do you drink per day from your home? (1 cup = 8oz; 4 cups = 1L; 4L=1 gal)

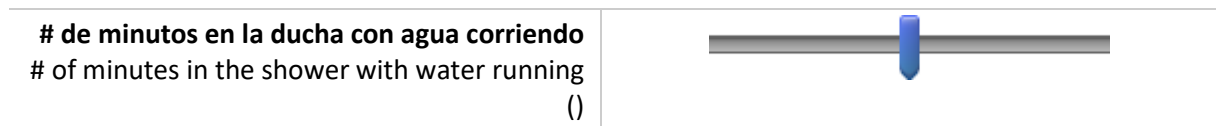
Q4.5 En promedio, ¿cuántas veces a la semana te duchas?

On average, how many times a week do you shower?

Q4.6 ¿Cuánto dura una ducha promedio?

How long is your average shower?

0 15 30 45 60



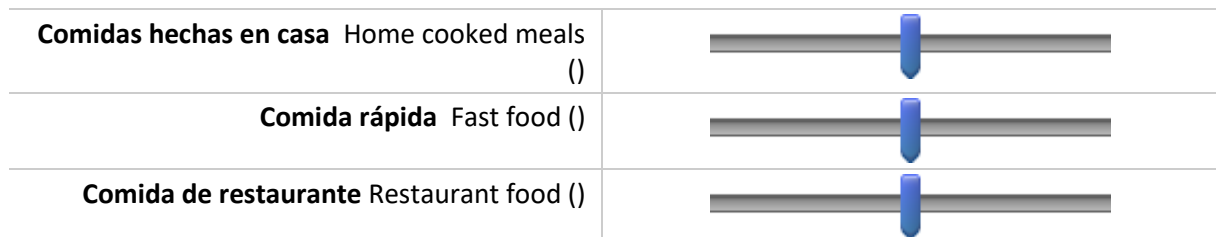
End of Block: Drinking water: perception and quantity

Start of Block: *H. pylori* risk factors: Exposures (smoking, drinking) and Mental Health

Q5.1 En promedio, ¿qué porcentaje de su dieta proviene de:

On average, what percentage of your diet comes from (needs to = 100%):

0 10 20 30 40 50 60 70 80 90 100



Q5.2 En los últimos seis meses, ¿ha experimentado alguno de los siguientes problemas estomacales?

In the last six months, have you experienced any of the following stomach issues?

- Náuseas** Nausea (1)
 - Dolor de estómago o ardor en el abdomen** Stomach ache or burning pain in your abdomen (4)
 - Pérdida de apetito** Loss of appetite (5)
 - Eructos frecuentes** Frequent burping (6)
 - Pérdida de peso inesperada** Unexpected weight loss (2)
 - Hinchazón severa** Severe bloating (7)
 - No** (8)
 - Prefiero no responder** Prefer not to answer (3)
-

Q5.3 ¿Fumas tabaco?

Do you smoke tobacco?

- Sí** Yes (1)
- No, nunca** No, never (2)
- Ya no** Not anymore (4)
- Prefiero no responder** Prefer not to answer (3)

Skip To: Q5.7 If ¿Fumas tabaco? Do you smoke tobacco? != Sí Yes

Display This Question:

If ¿Fumas tabaco? Do you smoke tobacco? = Ya no Not anymore



Q5.4 ¿Cuántos años fumaste?

How many years did you smoke?

Display This Question:

If ¿Fumas tabaco? Do you smoke tobacco? = Sí Yes



Q5.5 ¿A qué edad empezó a fumar tabaco?

At what age did you start smoking tobacco?

Display This Question:

If ¿Fumas tabaco? Do you smoke tobacco? = Sí Yes

Q5.6 En promedio, ¿cuántas cajetillas de cigarrillos fuma usted por semana?

On average, how many packs of cigarettes do you smoke per week? (20/pack)

0 2 4 6 8 10 12 14 16 18 20

Paquetes de cigarrillos por semana Packs of
cigarettes per week ()



Q5.7 ¿Bebes alcohol?

Do you drink alcohol?

- Sí** Yes (1)
- No** (2)
- Prefiero no responder** Prefer not to answer (3)

Skip To: Q5.9 If ¿Bebes alcohol?Do you drink alcohol? != Sí Yes

Q5.8 En promedio, ¿cuántas bebidas bebe por semana?

On average, how many drinks do you have per week?

Q5.9 ¿Cree que está expuesto a un exceso de sustancias químicas en el trabajo o en el hogar que podrían causar cáncer?

Do you believe you are exposed to excess chemicals at work or at home that could cause cancer?

- Sí** Yes (1)
- No** (2)
- Prefiero no responder** Prefer not to answer (3)

Skip To: Q5.11 If ¿Cree que está expuesto a un exceso de sustancias químicas en el trabajo o en el hogar que podría... != Sí Yes



Q5.10 ¿A qué sustancias está expuesto? Los ejemplos incluyen: pesticidas, productos de limpieza, bacterias, problemas de calidad del aire, moho, etc.

What substances are you exposed to? Examples include: pesticides, cleaning products,

bacteria, air quality issues, mold, etc.

Q5.11 ¿Con qué frecuencia se siente nervioso, estresado o ansioso?

How often do you feel nervous, stressed, or anxious?

- Siempre (diario)** Always (daily) (2)
- A menudo (3-4 veces por semana)** Often (3-4 times per week) (6)
- A veces (1-2 veces por semana)** Sometimes (1-2 times per week) (7)
- Rara vez (mensualmente)** Rarely (monthly) (8)
- Nunca** Never (9)

Skip To: End of Block If ¿Con qué frecuencia se siente nervioso, estresado o ansioso?How often do you feel nervous, stress... = Nunca Never

Q5.12 Durante el último mes, ¿qué síntomas de ansiedad ha experimentado?

In the past month, what symptoms of anxiety have you experienced?

- Sentirse nervioso, inquieto o tenso** Feeling nervous, restless, or tense (1)
- Tener una sensación de fatalidad, pánico o peligro inminente** Having a sense of impending doom, panic, or danger (2)
- Tener un ritmo cardíaco aumentado** Having an increased heart rate (3)
- Respiración rápida** Rapid breathing (4)
- Aumento de la sudoración no provocado por el trabajo o el ejercicio** Increased sweating not brought on by work or exercise (5)
- Dificultad para concentrarse en otras cosas que no sean preocupaciones futuras** Difficulty concentrating on things other than future worries (6)
- Ninguno de los síntomas anteriores** None of the above symptoms (7)

End of Block: H pylori risk factors: Exposures (smoking, drinking) and Mental Health

Start of Block: Health History (related to H pylori and stomach cancer)

Q6.1 ¿Has oído hablar de *Helicobacter pylori* (*H. pylori*)?

Have you heard of *Helicobacter pylori* (*H. pylori*)?

- Sí** Yes (1)
- No** (2)
- No sé** I don't know (3)

Skip To: Q6.4 If ¿Has oído hablar de Helicobacter pylori (H. pylori)? Have you heard of Helicobacter pylori (H. pyl... != Sí Yes

Q6.2 ¿Alguna vez le han hecho la prueba de *H. pylori*?

Have you ever been tested for *H. pylori*?

- Sí** Yes (1)
 - No** (2)
 - No sé** I don't know (3)
-

Q6.3 ¿Le han diagnosticado a usted o a alguien de su familia una infección por *H. pylori*?

Have you or anyone in your family been diagnosed with an *H. pylori* infection?

- Sí, yo mismo** Yes (1)
 - Si, un familiar** Yes, a family member (4)
 - No** (2)
 - No sé** I don't know (3)
-

Q6.4 ¿Usted o alguien de su familia se ha sometido a una endoscopia o gastroscopia?

Have you or anyone in your family had an endoscopy or gastroscopy?

- Si, yo mismo** Yes, myself (1)
- Si, un familiar** Yes, a family member (4)
- No** (2)
- No sé** I don't know (3)

Skip To: Q6.7 If ¿Usted o alguien de su familia se ha sometido a una endoscopia o gastroscopia?Have you or anyone... = No

Q6.5 ¿Cuál fue el motivo de la endoscopia o gastroscopia?

What was the reason for the endoscopy or gastroscopy?

- Chequeo** Checkup (1)
- Dolor epigástrico** Epigastric pain (2)
- Dolor abdominal** Abdominal Pain (3)
- ERGE** GERD (4)
- Hinchazón** Bloating (5)
- Dolor en el cuadrante superior derecho** Right upper quadrant pain (6)
- Dolor en el cuadrante superior izquierdo** Left upper quadrant pain (9)
- Gastritis** (11)
- Sangrado gastrointestinal** GI bleeding (12)
- Constipación** Constipation (13)
- Náuseas** Nausea (7)
- No sé** I don't know (14)
- Prefiero no responder** Prefer not to answer (15)

Page Break

Q6.6 ¿Cuáles fueron los hallazgos de la endoscopia o gastroscopia?
What were the findings of the endoscopy or gastroscopy?

- Normal** (1)
 - Gastritis** (19)
 - No sé I don't know** (20)
 - Prefiero no responder** Prefer not to answer (21)
-

Q6.7 ¿Usted o alguien de su familia ha tenido:
Have you or anyone in your family had:

	Sí, yo mismo Yes, myself (4)	Sí, un miembro de la familia Yes, a family member (5)	No (6)	Prefiero no responder/No sé Prefer not to answer/I don't know (7)
Cáncer gástrico (estómago) Gastric (stomach) cancer (5)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gastritis (inflamación del estómago) Gastritis (stomach inflammation) (7)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Úlceras pépticas Peptic ulcers (6)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cálculos biliares Gallstones (10)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Anemia perniciosa (no se puede procesar la vitamina B12) Pernicious Anemia (can't process vitamin B12) (9)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Aclorhidria (sin ácido clorhídrico para digerir los alimentos) Achlorhydria (no hydrochloric acid to digest food) (11)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Síndrome de Lynch Lynch syndrome (12)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cáncer de mama o de ovario Breast or ovarian cancer (13)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Poliposis
adenomatosa
familiar (PAF)**
Familial
adenomatous
polyposis (FAP)
(14)

Q6.8 ¿Usted o alguien en su familia ha tenido diabetes?

Have you or anyone in your family had diabetes?

Sí, yo mismo Yes, myself (3)

Sí, un miembro de la familia Yes, a member of the family (4)

No (2)

Skip To: End of Block If ¿Usted o alguien en su familia ha tenido diabetes? Have you or anyone in your family had diabetes? = No

Q6.9 ¿Qué tipo de diabetes?

What kind of diabetes?

Tipo (type) 1 (1)

Tipo (Type) 2 (2)

Otro (por favor especifique) Other (please specify) (3)

End of Block: Health History (related to H pylori and stomach cancer)

Start of Block: Healthcare Access

Q7.1 ¿Tiene seguro médico?

Do you have health insurance?

- Sí** Yes (1)
 - No** (2)
 - Prefiero no responder** Prefer not to answer (3)
-

Q7.2 ¿Tiene acceso a un centro de salud?

Do you have access to a health center?

- Sí** Yes (1)
 - No** (2)
 - No sé** I don't know (3)
-

Q7.3 ¿A qué distancia está el centro de salud más cercano a usted?

How far is the nearest health center from you?

- Distancia caminando** Walking distance (1)
 - 5-15 minutos en coche** (minute drive) (2)
 - 15-30 minutos en coche** (minute drive) (4)
 - 30-60 minutos en coche** (minute drive) (5)
 - >1 hora en coche** (hour drive) (7)
 - No sé** I don't know (3)
-

Q7.4 ¿Alguna vez no ha podido visitar al médico cuando lo necesita?

Are you ever unable to visit the doctor when you need to?

- Sí** Yes (1)
- No** (8)
- No sé** I don't know (9)

Skip To: Q7.6 If ¿Alguna vez no ha podido visitar al médico cuando lo necesita?Are you ever unable to visit the do... = No

Q7.5 ¿Qué obstaculiza su capacidad para visitar al médico?

What hinders your ability to visit the doctor?

- Muy caro** Too expensive (1)
 - No tengo un buen seguro medico** I don't have good health insurance (10)
 - Limitaciones de transporte** Transportation limitations (11)
 - Demasiado lejos** Too far away (13)
 - Necesito estar en otro lugar (trabajo, cuidar del hogar/niños, etc.)** I need to be somewhere else (work, taking care of household/children, etc.) (12)
 - Otra (por favor especificar)** Other (please specify) (8)
-

Q7.6 ¿Cuándo fue la última vez que usted o un familiar visitó al médico?

When was the last time you or a family member visited the doctor?

- En el último mes** In the past month (1)
 - En los últimos 3 meses** In the past 3 months (10)
 - En los últimos 6 meses** In the past 6 months (11)
 - En el año pasado** In the past year (15)
 - Hace más de un año** More than a year ago (13)
 - Otra (por favor especificar)** Other (please specify) (8)
-

Q7.7 ¿Por qué motivo usted o un familiar visitó al médico?

For what reason did you or a family member visit the doctor?

- Chequeo regular** Regular checkup (1)
 - Problemas estomacales (náuseas, calambres, pérdida de apetito, etc.)** Stomach problems (nausea, cramping, loss of appetite, etc.) (10)
 - Otra enfermedad (por favor especificar)** Other sickness (please specify) (16)
-

Q7.8 ¿Está satisfecho con los servicios prestados en el centro de salud?

Are you satisfied with the services provided at the health center?

- Sí** Yes (1)
- No** (3)
- No sé** I don't know (2)

Skip To: End of Block If ¿Está satisfecho con los servicios prestados en el centro de salud?Are you satisfied with the ser... = Sí Yes

Q7.9 ¿Por qué no está satisfecho con los servicios prestados en el centro de salud?
Why are you unsatisfied with the services provided at the health center?

- Tiempo de espera** Wait time (1)
 - Servicio al Cliente** Customer service (3)
 - Costo** Cost (4)
 - Limitaciones del seguro** Insurance limitations (5)
 - Otra (por favor especificar)** Other (please specify) (2)
-

End of Block: Healthcare Access

Start of Block: Evaluator Notes

Q8.1 Notas del Evaluador
(Evaluator's Notes)

End of Block: Evaluator Notes

Appendix F

Urea Breath Test (UBT) Protocol

Overview: Interviewing teams should follow the standard protocol to collect UBT samples per the instructions of the Meridian company (see kit items and protocol below). Questions ask about the participant's, allergies, pregnancy, etc. should have already been asked during the recruitment. However, the interviewer must reconfirm their medications in the last two weeks and fasting requirements (see below).

Once the samples are collected, the team labels each sample bag using the labels included on the labels in the household labels. Label the outside gallon bag (HHID, date, time, field worker initials) and both the first and second breath bags. Note that if consenting another second participant, then make sure that is the HHID-01,-02,etc. (which should correspond with their name and phone number on the excel file).

Administering BreathID UBT

I. What's included in the kit?

- Test instructions
- One (1) pouch of Pranactin-Citric powder (3 g)
- One (1) urea tablet
- A set of four (4) self-adhesive barcode stickers. All barcodes should bear the same number (placed on transport bag, tracking form, and both breath bags)
- Two (2) breath collection bags: one (1) blue bag for the BASELINE sample and one (1) pink bag for the POST-DOSE sample.
- One (1) sample transport bag
- One (1) plastic straw
- One (1) plastic drinking cup

II. Other Materials Required and should be the Field Team supplies:

- Bottle of Drinking water
- Timer (or use your cellphone)
- Blue cloth
- Gloves
- Sharpie

III. Verify that the participant has been prepared for the test

- a. Confirm that the participant understands that Pranactin-Citric contains phenylalanine (one of the components of Aspartame). Phenylketonurics restrict dietary phenylalanine and they are excluded from the test.

- b. Verify that the participant fasted at least 1 hour before the administration of BreathID UBT, even chewing gum. If participant has eaten something within the past hour, then move the UBT sample taking to the end of the survey time.
- c. Verify that the participant did not take any antibiotics, proton pump inhibitors (PPIs), or bismuth preparations such as Pepto-Bismol or other antacids within 2 weeks before taking the BreathID UBT. If they have used these medications within the past 2 weeks, they are excluded from the test because the results will not be valid. If the timing works and there are staff, then the team can decide to return to the household to take the sample test.
- d. Verify that the participant should not have taken any histamine 2-receptor antagonists (H2RAs) such as Pepcid or Zantac. If they have used these medications within the past 2 weeks, they are excluded from the test because the results will not be valid. If the timing works and there are staff, then the team can decide to return to the household to take the sample test.

IV. How To Administer BreathID UBT: A Step-By-Step Procedure

a. Preparation

1. Lay out the blue cloth on a table and put on gloves (for professional purposes)
2. Open the BreathID UBT Kit, which will have all the included materials
3. Label each breath collection bag with appropriate participant identification using the barcode labels provided.

b. Collecting the BASELINE breath sample

1. Pick up the blue breath collection bag.
2. Remove the pull-off cap from the mouthpiece of the breath collection bag.
3. Tell the participant to: (1) breath normally; (2) take a deep breath then pause for 5 seconds; (3) exhale into the mouthpiece of the bag.
4. Replace the cap firmly until it clicks on the mouthpiece of the bag.

c. Preparing the Pranactin-Citric pouch solution (*no more than 60 minutes before administering it to the patient*)

1. Pick up the Pranactin-Citric pouch. Tap the upright packet of Pranactin-Citric to settle the contents in the bottom half.
2. Tear off the top of the packet and carefully empty the powder into the drinking cup provided, making sure to transfer all of the contents by tapping on the bottom of the pouch.
3. Add the urea tablet to the cup.

4. Add drinking water to fill the line indicated on the outside of the cup by a raised plastic ridge.
5. Close the lid securely by pressing it down until you hear a click and swirl the mixture for up to 2 minutes to dissolve the packet contents. *It should be clear and all powder should be dissolved.*
6. Tell the participant to drink all of the solution with the straw without stopping. Tell them **not** to “rinse” the inside of his/her mouth with the solution before swallowing. The participant should drink it all within 2 minutes.
7. Throw away the straw after the participant is done drinking the solution.
8. Set the timer for 15 minutes. The participant should sit quietly and should not eat, drink, or smoke for these 15 minutes.
9. After 15 minutes have elapsed, pick up the pink breath collection bag. Collect the POST-DOSE breath sample.

d. Collecting the POST-DOSE Breath Sample & Storing Sample

1. Remove the pull-off cap from the mouthpiece of the breath collection bag.
2. Tell the participant to: (1) breath normally; (2) take a deep breath then pause for 5 seconds; (3) exhale into the mouthpiece of the bag.
3. Replace the cap firmly until it clicks on the mouthpiece of the bag.
4. Store the specimens at 15-30 C (59-86 F) until analysis is performed and place in sample transport bag.
5. These samples will be sent UofA for analysis within 7 days of collection.

IDEXX Quanti-Tray[®]/2000 MPN Table

Small Wells Positive

# Large Wells Positive	# Small Wells Positive																								
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	<1	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.1	15.1	16.1	17.1	18.1	19.1	20.2	21.2	22.2	23.3	24.3
1	1.0	2.0	3.0	4.0	5.0	6.0	7.1	8.1	9.1	10.1	11.1	12.1	13.2	14.2	15.2	16.2	17.3	18.3	19.3	20.4	21.4	22.4	23.5	24.5	25.6
2	2.0	3.0	4.1	5.1	6.1	7.1	8.1	9.2	10.2	11.2	12.2	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.6	21.6	22.7	23.7	24.8	25.8	26.9
3	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.3	11.3	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.7	20.8	21.8	22.9	23.9	25.0	26.1	27.1	28.2
4	4.1	5.2	6.2	7.2	8.3	9.3	10.4	11.4	12.5	13.5	14.6	15.6	16.7	17.8	18.8	19.9	21.0	22.1	24.2	25.3	26.3	27.4	28.5	29.6	30.7
5	5.2	6.3	7.3	8.4	9.4	10.5	11.5	12.6	13.7	14.7	15.8	16.9	17.9	19.0	20.1	21.2	22.2	23.3	24.4	25.5	26.6	27.7	28.8	29.9	31.0
6	6.3	7.4	8.4	9.5	10.6	11.6	12.7	13.8	14.9	16.0	17.0	18.1	19.2	20.3	21.4	22.5	23.6	24.7	25.8	26.9	28.0	29.1	30.2	31.3	32.4
7	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	26.0	27.1	28.3	29.4	30.5	31.6	32.8	33.9
8	8.6	9.7	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.8	22.9	24.1	25.2	26.3	27.4	28.6	29.7	30.8	32.0	33.1	34.3	35.4
9	9.8	10.9	12.0	13.1	14.2	15.3	16.4	17.6	18.7	19.8	20.9	22.0	23.2	24.3	25.4	26.6	27.7	28.9	30.0	31.2	32.3	33.5	34.6	35.8	37.0
10	11.0	12.1	13.2	14.4	15.5	16.6	17.7	18.9	20.0	21.1	22.3	23.4	24.6	25.7	26.9	28.0	29.2	30.3	31.5	32.7	33.8	35.0	36.2	37.4	38.6
11	12.2	13.4	14.5	15.6	16.8	17.9	19.1	20.2	21.4	22.5	23.7	24.8	26.0	27.2	28.3	29.5	30.7	31.9	33.0	34.2	35.4	36.6	37.8	39.0	40.2
12	13.5	14.6	15.8	16.9	18.1	19.3	20.4	21.6	22.8	23.9	25.1	26.3	27.5	28.6	29.8	31.0	32.2	33.4	34.6	35.8	37.0	38.2	39.5	40.7	41.9
13	14.8	16.0	17.1	18.3	19.5	20.6	21.8	23.0	24.2	25.4	26.6	27.8	29.0	30.2	31.4	32.6	33.8	35.0	36.2	37.5	38.7	39.9	41.2	42.4	43.6
14	16.1	17.3	18.5	19.7	20.9	22.1	23.3	24.5	25.7	26.9	28.1	29.3	30.5	31.7	33.0	34.2	35.4	36.7	37.9	39.1	40.4	41.6	42.9	44.2	45.4
15	17.5	18.7	19.9	21.1	22.3	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33.3	34.6	35.8	37.1	38.4	39.6	40.9	42.2	43.4	44.7	46.0	47.3
16	18.9	20.1	21.3	22.6	23.8	25.0	26.2	27.5	28.7	30.0	31.2	32.5	33.7	35.0	36.3	37.5	38.8	40.1	41.4	42.7	44.0	45.3	46.6	47.9	49.2
17	20.3	21.6	22.8	24.1	25.3	26.6	27.8	29.1	30.3	31.6	32.9	34.1	35.4	36.7	38.0	39.3	40.6	41.9	43.2	44.5	45.9	47.2	48.5	49.8	51.2
18	21.8	23.1	24.3	25.6	26.9	28.1	29.4	30.7	32.0	33.3	34.6	35.9	37.2	38.5	39.8	41.1	42.4	43.8	45.1	46.5	47.8	49.2	50.5	51.9	53.2
19	23.3	24.6	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.3	37.6	39.0	40.3	41.6	43.0	44.3	45.7	47.1	48.4	49.8	51.2	52.6	54.0	55.4
20	24.9	26.2	27.5	28.8	30.1	31.5	32.8	34.1	35.4	36.8	38.1	39.5	40.8	42.2	43.6	44.9	46.3	47.7	49.1	50.5	51.9	53.3	54.7	56.1	57.6
21	26.5	27.9	29.2	30.5	31.8	33.2	34.5	35.9	37.3	38.6	40.0	41.4	42.8	44.1	45.5	46.9	48.4	49.8	51.2	52.6	54.1	55.5	56.9	58.4	59.9
22	28.2	29.5	30.9	32.3	33.6	35.0	36.4	37.7	39.1	40.5	41.9	43.3	44.8	46.2	47.6	49.0	50.5	51.9	53.4	54.8	56.3	57.8	59.3	60.8	62.3
23	29.9	31.3	32.7	34.1	35.5	36.8	38.3	39.7	41.1	42.5	43.9	45.4	46.8	48.3	49.7	51.2	52.7	54.2	55.6	57.1	58.6	60.2	61.7	63.2	64.7
24	31.7	33.1	34.5	35.9	37.3	38.8	40.2	41.7	43.1	44.6	46.0	47.5	49.0	50.5	52.0	53.5	55.0	56.5	58.0	59.5	61.1	62.6	64.2	65.8	67.3
25	33.6	35.0	36.4	37.9	39.3	40.8	42.2	43.7	45.2	46.7	48.2	49.7	51.2	52.7	54.3	55.8	57.3	58.9	60.5	62.0	63.6	65.2	66.8	68.4	70.0
26	35.5	36.9	38.4	39.9	41.4	42.8	44.3	45.9	47.4	48.9	50.4	52.0	53.5	55.1	56.7	58.2	59.8	61.4	63.0	64.7	66.3	67.9	69.6	71.2	72.9
27	37.4	38.9	40.4	42.0	43.5	45.0	46.5	48.1	49.6	51.2	52.8	54.4	56.0	57.6	59.2	60.8	62.4	64.1	65.7	67.4	69.1	70.8	72.5	74.2	75.9
28	39.5	41.0	42.6	44.1	45.7	47.3	48.8	50.4	52.0	53.6	55.2	56.9	58.5	60.2	61.8	63.5	65.2	66.9	68.6	70.3	72.0	73.7	75.5	77.3	79.0
29	41.7	43.2	44.8	46.4	48.0	49.6	51.2	52.8	54.5	56.1	57.8	59.5	61.2	62.9	64.6	66.3	68.0	69.8	71.5	73.3	75.1	76.9	78.7	80.5	82.4
30	43.9	45.5	47.1	48.7	50.4	52.0	53.7	55.4	57.1	58.8	60.5	62.2	64.0	65.7	67.5	69.3	71.0	72.9	74.7	76.5	78.3	80.2	82.1	84.0	85.9
31	46.2	47.9	49.5	51.2	52.9	54.6	56.3	58.1	59.8	61.6	63.3	65.1	66.9	68.7	70.5	72.4	74.2	76.1	78.0	79.9	81.8	83.7	85.7	87.6	89.6
32	48.7	50.4	52.1	53.8	55.6	57.3	59.1	60.9	62.7	64.5	66.3	68.2	70.0	71.9	73.8	75.7	77.6	79.5	81.5	83.5	85.4	87.5	89.5	91.5	93.6
33	51.2	53.0	54.8	56.5	58.3	60.2	62.0	63.8	65.7	67.6	69.5	71.4	73.3	75.2	77.2	79.2	81.2	83.2	85.2	87.3	89.3	91.4	93.6	95.7	97.8
34	53.9	55.7	57.6	59.4	61.3	63.1	65.0	67.0	68.9	70.8	72.8	74.8	76.8	78.8	80.8	82.9	85.0	87.1	89.2	91.4	93.5	95.7	97.9	100.2	102.4
35	56.8	58.6	60.5	62.4	64.4	66.3	68.3	70.3	72.3	74.3	76.3	78.4	80.5	82.6	84.7	86.9	89.1	91.3	93.5	95.7	98.0	100.3	102.6	105.0	107.3
36	59.8	61.7	63.7	65.7	67.7	69.7	71.7	73.8	75.9	78.0	80.1	82.3	84.5	86.7	88.9	91.2	93.5	95.8	98.1	100.5	102.9	105.3	107.7	110.2	112.7
37	62.9	65.0	67.0	69.1	71.2	73.3	75.4	77.6	79.8	82.0	84.2	86.5	88.8	91.1	93.4	95.8	98.2	100.6	103.1	105.6	108.1	110.7	113.3	115.9	118.6
38	66.3	68.4	70.6	72.7	74.9	77.1	79.4	81.6	83.9	86.2	88.6	91.0	93.4	95.8	98.3	100.8	103.4	105.9	108.6	111.2	113.9	116.6	119.4	122.2	125.0
39	70.0	72.2	74.4	76.7	78.9	81.3	83.6	86.0	88.4	90.9	93.4	95.9	98.4	101.0	103.6	106.0	111.8	114.6	117.4	120.3	123.2	126.1	129.2	132.2	135.2
40	73.8	76.2	78.5	80.9	83.3	85.7	88.2	90.8	93.3	95.9	98.5	101.2	103.9	106.7	109.5	112.4	115.3	118.2	121.2	124.3	127.4	130.5	133.7	137.0	140.3
41	78.0	80.5	83.0	85.5	88.0	90.6	93.3	95.9	98.7	101.4	104.3	107.1	110.0	113.0	116.0	119.1	122.2	125.4	128.7	132.0	135.4	138.8	142.3	145.9	149.5
42	82.6	85.2	87.8	90.5	93.2	96.0	98.8	101.7	104.6	107.6	110.6	113.7	116.9	120.1	123.4	126.7	130.1	133.6	137.2	140.8	144.5	148.3	152.1	156.1	160.2
43	87.6	90.4	93.2	96.0	99.0	101.9	105.0	108.1	111.2	114.5	117.8	121.1	124.6	128.1	131.7	135.4	139.1	143.0	147.0	151.0	155.2	159.4	163.8	168.2	172.8
44	93.1	96.1	99.1	102.2	105.4	108.6	111.9	115.3	118.7	122.3	125.9	129.6	133.4	137.4	141.4	145.5	149.7	154.1	158.5	163.1	167.9	172.7	177.7	182.9	188.2
45	99.3	102.5	105.8	109.2	112.6	116.2	119.8	123.6	127.4	131.4	135.4	139.6	143.9	148.3	152.9	157.6	162.4	167.4	172.6	178.0	183.5	189.2	195.1	201.2	207.5
46	106.3	109.8	113.4	117.2	121.0	125.0	129.1	133.3	137.6	142.1	146.7	151.5	156.5	161.6	167.0	172.5	178.2	184.2	190.4	196.8	203.5	210.5	217.8	225.4	233.3
47	114.3	118.3	122.4	126.6	130.9	140.1	145.0	150.0	155.3	160.7	166.4	172.3	178.5	185.0	191.8	198.9	206.4	214.2	222.4	231.0	240.0	249.5	259.5	270.0	281.0
48	123.9	128.4	133.1	137.9	143.0	148.3	153.9	159.7	165.8	172.2	178.9	186.0	193.5	201.4	209.8	218.7	228.2	238.2	248.9	260.3	272.3	285.1	298.7	313.0	328.2
49	135.5	140.8	146.4	152.3	158.5	165.0	172.0	179.3	187.2	195.6	204.6	214.3	224.7	235.9	248.1	261.3	275.5	290.9	307.6	325.5	344.8	365.4	387.3	410.6	435.2

References

1. J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe., *Ch. 20: Southwest. Climate Change Impacts in the United States: The Third National Climate Assessment*. National Climate Assessment; 2014. <https://nca2014.globalchange.gov/report/regions/southwest>
2. Williams AP, Cook BI, Smerdon JE. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. *Nat Clim Change*. 2022;12(3):232-234. doi:10.1038/s41558-022-01290-z
3. Brian McGreal, Susanna Eden. *Arroyo 2021 Groundwater Management*. Water Resources Research Center; 2021. <https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/attachment/Arroyo-2021-Groundwater-Management.pdf>
4. *Summary of Estimated Water Use in the United States in 2015*. United States Geological Survey; 2018. <https://pubs.usgs.gov/publication/fs20183035>
5. Khorrami M, Hatami M, Alizadeh B, Khorrami H, Rahgozar P, Flood I. Impact of Ground Subsidence on Groundwater Quality: A Case Study in Los Angeles, California. In: *Computing in Civil Engineering 2019*. American Society of Civil Engineers; 2019:162-170. doi:10.1061/9780784482445.021
6. Smith R, Knight R, Fendorf S. Overpumping leads to California groundwater arsenic threat. *Nat Commun*. 2018;9(1):2089. doi:10.1038/s41467-018-04475-3
7. Erickson ML, Barnes RJ. Glacial Sediment Causing Regional-Scale Elevated Arsenic in Drinking Water. *Ground Water*. 2005;0(0):050824084415001. doi:10.1111/j.1745-6584.2005.00053.x
8. Thiros S, Paul A, Bexfield L, Anning D. *Water Quality in Basin-Fill Aquifers of the Southwestern United States: Arizona, California, Colorado, New Mexico, and Utah, 1993-2009*.; 2015.
9. IARC monographs on the evaluation of carcinogenic risks to humans. *Anal Chim Acta*. 1996;336(1-3):229-230. doi:10.1016/S0003-2670(97)89591-8
10. Ternes W. Arsenic in the environment part II: Human health and ecosystem effects. *Toxicol*. 1995;33(5):707-708. doi:10.1016/0041-0101(95)90109-4
11. Shih YH, Argos M, Turyk ME. Urinary arsenic concentration, airway inflammation, and lung function in the U.S. adult population. *Environ Res*. 2019;175:308-315. doi:10.1016/j.envres.2019.05.031
12. Zhou Q, Xi S. A review on arsenic carcinogenesis: Epidemiology, metabolism, genotoxicity and epigenetic changes. *Regul Toxicol Pharmacol*. 2018;99:78-88. doi:10.1016/j.yrtph.2018.09.010
13. *Where Is Arsenic Found?* Agency for Toxic Substances and Disease Registry; 2023. https://www.atsdr.cdc.gov/csem/arsenic/where_arsenic.html#:~:text=The%20preservative%20often%20gives%20wood,photo%20at%20the%20right%20below.&text=Arsenic%20is%20and%20has%20been,other%20cancers%20%5BMiller%20et%20al
14. Centre international de recherche sur le cancer, ed. *A Review of Human Carcinogens*. International agency for research on cancer; 2012.
15. *TOXICOLOGICAL PROFILE FOR ARSENIC*. Agency for Toxic Substances and Disease Registry; 2007. <https://www.atsdr.cdc.gov/toxprofiles/tp2.pdf>

16. Antonelli R, Shao K, Thomas DJ, Sams R, Cowden J. AS3MT, GSTO, and PNP polymorphisms: Impact on arsenic methylation and implications for disease susceptibility. *Environ Res*. 2014;132:156-167. doi:10.1016/j.envres.2014.03.012
17. Sinha D, Prasad P. Health effects inflicted by chronic low-level arsenic contamination in groundwater: A global public health challenge. *J Appl Toxicol*. 2020;40(1):87-131. doi:10.1002/jat.3823
18. Hong YS, Song KH, Chung JY. Health Effects of Chronic Arsenic Exposure. *J Prev Med Pub Health*. 2014;47(5):245-252. doi:10.3961/jpmph.14.035
19. Al Osman M, Yang F, Massey IY. Exposure routes and health effects of heavy metals on children. *BioMetals*. 2019;32(4):563-573. doi:10.1007/s10534-019-00193-5
20. Vahter M, Concha G. Role of Metabolism in Arsenic Toxicity. *Pharmacol Toxicol*. 2001;89(1):1-5. doi:10.1034/j.1600-0773.2001.d01-128.x
21. Gupta PK. Toxic effects of metals. In: *Fundamentals of Toxicology*. Elsevier; 2016:203-213. doi:10.1016/B978-0-12-805426-0.00018-4
22. Yuan W, Yang N, Li X. Advances in Understanding How Heavy Metal Pollution Triggers Gastric Cancer. *BioMed Res Int*. 2016;2016:1-10. doi:10.1155/2016/7825432
23. Salama NR, Hartung ML, Müller A. Life in the human stomach: persistence strategies of the bacterial pathogen *Helicobacter pylori*. *Nat Rev Microbiol*. 2013;11(6):385-399. doi:10.1038/nrmicro3016
24. Shah S, Cappell K, Sedgley R, et al. Diagnosis and treatment patterns among patients with newly diagnosed *Helicobacter pylori* infection in the United States 2016–2019. *Sci Rep*. 2023;13(1):1375. doi:10.1038/s41598-023-28200-3
25. Chen YC, Malfertheiner P, Yu HT, et al. Global Prevalence of *Helicobacter pylori* Infection and Incidence of Gastric Cancer Between 1980 and 2022. *Gastroenterology*. 2024;166(4):605-619. doi:10.1053/j.gastro.2023.12.022
26. Smith SM. Role of Toll-like receptors in *Helicobacter pylori* infection and immunity. *World J Gastrointest Pathophysiol*. 2014;5(3):133-146. doi:10.4291/wjgp.v5.i3.133
27. Fallone CA, Chiba N, Van Zanten SV, et al. The Toronto Consensus for the Treatment of *Helicobacter pylori* Infection in Adults. *Gastroenterology*. 2016;151(1):51-69.e14. doi:10.1053/j.gastro.2016.04.006
28. FitzGerald R, Smith SM. An Overview of *Helicobacter pylori* Infection. In: Smith SM, ed. *Helicobacter pylori*. Vol 2283. Methods in Molecular Biology. Springer US; 2021:1-14. doi:10.1007/978-1-0716-1302-3_1
29. McColl KEL. *Helicobacter pylori* Infection. *N Engl J Med*. 2010;362(17):1597-1604. doi:10.1056/NEJMcp1001110
30. Plummer M, Franceschi S, Vignat J, Forman D, De Martel C. Global burden of gastric cancer attributable to *Helicobacter pylori*: *Helicobacter pylori* in gastric cancer. *Int J Cancer*. 2015;136(2):487-490. doi:10.1002/ijc.28999
31. Harris RB, Oren E, Bui D, Brown HE. Serologic Evidence for Fecal–Oral Transmission of *Helicobacter pylori*. *Am J Trop Med Hyg*. 2016;94(1):82-88. doi:10.4269/ajtmh.15-0297
32. Krueger WS, Hilborn ED, Converse RR, Wade TJ. Environmental risk factors associated with *Helicobacter pylori* seroprevalence in the United States: a cross-sectional analysis of NHANES data. *Epidemiol Infect*. 2015;143(12):2520-2531. doi:10.1017/S0950268814003938

33. Sharndama HC, Mba IE. *Helicobacter pylori*: an up-to-date overview on the virulence and pathogenesis mechanisms. *Braz J Microbiol.* 2022;53(1):33-50. doi:10.1007/s42770-021-00675-0
34. Toh JWT, Wilson RB. Pathways of Gastric Carcinogenesis, *Helicobacter pylori* Virulence and Interactions with Antioxidant Systems, Vitamin C and Phytochemicals. *Int J Mol Sci.* 2020;21(17):6451. doi:10.3390/ijms21176451
35. Saxena A, Mukhopadhyay AK, Nandi SP. *Helicobacter pylori*: Perturbation and restoration of gut microbiome. *J Biosci.* 2020;45(1):110. doi:10.1007/s12038-020-00078-7
36. Park YH, Kim N. Review of Atrophic Gastritis and Intestinal Metaplasia as a Premalignant Lesion of Gastric Cancer. *J Cancer Prev.* 2015;20(1):25-40. doi:10.15430/JCP.2015.20.1.25
37. Ofori EG, Adinortey CA, Bockarie AS, Kyei F, Tagoe EA, Adinortey MB. *Helicobacter pylori* Infection, Virulence Genes' Distribution and Accompanying Clinical Outcomes: The West Africa Situation. *BioMed Res Int.* 2019;2019:1-13. doi:10.1155/2019/7312908
38. *Cancer Among the Navajo Incidence, Mortality, Stage of Diagnosis & Screening 2014 - 2018.* Navajo Epidemiology Center: Navajo Cancer Working Group; 2023. <https://nec.navajo-nsn.gov/Portals/0/Reports/Navajo%20Cancer%20Report%202014-2018%20OCT2023.pdf>
39. Kusters JG, Gerrits MM, Van Strijp JA, Vandenbroucke-Grauls CM. Coccoid forms of *Helicobacter pylori* are the morphologic manifestation of cell death. *Infect Immun.* 1997;65(9):3672-3679. doi:10.1128/iai.65.9.3672-3679.1997
40. Hanafiah A, Lopes BS. Genetic diversity and virulence characteristics of *Helicobacter pylori* isolates in different human ethnic groups. *Infect Genet Evol.* 2020;78:104135. doi:10.1016/j.meegid.2019.104135
41. Baj J, Forma A, Sitarz M, et al. *Helicobacter pylori* Virulence Factors—Mechanisms of Bacterial Pathogenicity in the Gastric Microenvironment. *Cells.* 2020;10(1):27. doi:10.3390/cells10010027
42. Chey WD, Leontiadis GI, Howden CW, Moss SF. ACG Clinical Guideline: Treatment of *Helicobacter pylori* Infection. *Am J Gastroenterol.* 2017;112(2):212-239. doi:10.1038/ajg.2016.563
43. Malfertheiner P, Megraud F, O'Morain CA, et al. Management of *Helicobacter pylori* infection—the Maastricht V/Florence Consensus Report. *Gut.* 2017;66(1):6-30. doi:10.1136/gutjnl-2016-312288
44. O'Connor A, Lamarque D, Gisbert JP, O'Morain C. Treatment of *Helicobacter pylori* infection 2017. *Helicobacter.* 2017;22(S1):e12410. doi:10.1111/hel.12410
45. Varga MG, Epplein M. *Helicobacter pylori* -Mediated Carcinogenesis. In: *Reference Module in Biomedical Sciences.* Elsevier; 2018:B9780128012383651723. doi:10.1016/B978-0-12-801238-3.65172-3
46. *IDKIT HP ONE- Citric Acid Anhydrous and 13c Urea Solution Meridian Bioscience Israel Ltd.* Meridian Bioscience; 2023. <https://dailymed.nlm.nih.gov/dailymed/fda/fdaDrugXsl.cfm?setid=8baab7a7-5d20-46ad-9c4a-762992ef6b51&type=display>
47. Roboz J. Applications of mass spectrometry in oncology. In: *Medical Applications of Mass Spectrometry.* Elsevier; 2008:379-406. doi:10.1016/B978-044451980-1.50019-7
48. *Cancer-Key Facts.* World Health Organization; :February 2022. <https://www.who.int/news-room/fact->

65. Yusefi AR, Bagheri Lankarani K, Bastani P, Radinmanesh M, Kavosi Z. Risk Factors for Gastric Cancer: A Systematic Review. *Asian Pac J Cancer Prev APJCP*. 2018;19(3):591-603. doi:10.22034/APJCP.2018.19.3.591
66. Humphreys EH, Tiemann M. *Safe Drinking Water Act (SDWA): A Summary of the Act and Its Major Requirements*. Congressional Research Service; 2021. <https://sgp.fas.org/crs/misc/RL31243.pdf>
67. Jan V. National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule; National Primary and Secondary Drinking Water Regulations: Approval of Analytical Methods for Chemical Contaminants; Proposed Rule. *Fed Regist*. 2003;68(159).
68. *Environmental Justice Definitions*. University of Michigan; 1997. <https://www.nmhealth.org/publication/view/help/309/#:~:text=Environmental%20Justice%20Community%20of%20Concern,significantly%20reduced%20quality%20of%20life>
69. Liddie JM, Schaider LA, Sunderland EM. Sociodemographic Factors Are Associated with the Abundance of PFAS Sources and Detection in U.S. Community Water Systems. *Environ Sci Technol*. 2023;57(21):7902-7912. doi:10.1021/acs.est.2c07255
70. Hilmers A, Hilmers DC, Dave J. Neighborhood disparities in access to healthy foods and their effects on environmental justice. *Am J Public Health*. 2012;102(9):1644-1654. doi:10.2105/AJPH.2012.300865
71. *Toward Environmental Justice: Research, Education, and Health Policy Needs*. National Academies Press; 1999:6034. doi:10.17226/6034
72. Horowitz CR, Colson KA, Hebert PL, Lancaster K. Barriers to buying healthy foods for people with diabetes: evidence of environmental disparities. *Am J Public Health*. 2004;94(9):1549-1554. doi:10.2105/ajph.94.9.1549
73. Black JL, Macinko J. Neighborhoods and obesity: Nutrition Reviews©, Vol. 66, No. 1. *Nutr Rev*. 2008;66(1):2-20. doi:10.1111/j.1753-4887.2007.00001.x
74. Shortt NK, Tisch C, Pearce J, et al. A cross-sectional analysis of the relationship between tobacco and alcohol outlet density and neighbourhood deprivation. *BMC Public Health*. 2015;15(1):1014. doi:10.1186/s12889-015-2321-1
75. Peterson NA, Lowe JB, Reid RJ. Tobacco Outlet Density, Cigarette Smoking Prevalence, and Demographics at the County Level of Analysis. *Subst Use Misuse*. 2005;40(11):1627-1635. doi:10.1080/10826080500222685
76. Fakunle D, Morton C, Peterson NA. The Importance of Income in the Link Between Tobacco Outlet Density and Demographics at the Tract Level of Analysis in New Jersey. *J Ethn Subst Abuse*. 2010;9(4):249-259. doi:10.1080/15332640.2010.522890
77. Lee JGL, Henriksen L, Rose SW, Moreland-Russell S, Ribisl KM. A Systematic Review of Neighborhood Disparities in Point-of-Sale Tobacco Marketing. *Am J Public Health*. 2015;105(9):e8-e18. doi:10.2105/AJPH.2015.302777
78. Hillier A, Chilton M, Zhao QW, Szymkowiak D, Coffman R, Mallya G. Concentration of tobacco advertisements at SNAP and WIC stores, Philadelphia, Pennsylvania, 2012. *Prev Chronic Dis*. 2015;12:E15. doi:10.5888/pcd12.140133
79. Mennis J, Stahler G, Mason M. Risky Substance Use Environments and Addiction: A New Frontier for Environmental Justice Research. *Int J Environ Res Public Health*. 2016;13(6):607. doi:10.3390/ijerph13060607
80. Hitchman SC, Fong GT, Zanna MP, Thrasher JF, Chung-Hall J, Siahpush M. Socioeconomic status and smokers' number of smoking friends: findings from the International Tobacco

- Control (ITC) Four Country Survey. *Drug Alcohol Depend.* 2014;143:158-166. doi:10.1016/j.drugalcdep.2014.07.019
81. Lee D, Murphy HM. Private Wells and Rural Health: Groundwater Contaminants of Emerging Concern. *Curr Environ Health Rep.* 2020;7(2):129-139. doi:10.1007/s40572-020-00267-4
 82. Beamer, Paloma, Richmond, Benjamin, Vargas, Mayra, et al. *Environmental Toxic Substance Assessment 2022 Update Per- and Polyfluoroalkyl Substances (PFAS) in Pima County Water.* Pima County, Arizona. University of Arizona Southwest Environmental Health Sciences Center; 2022. <https://content.civicplus.com/api/assets/601a025d-3d50-45c9-a917-22a90c56b3aa?cache=1800>
 83. *Hispanic/Latino Health.* United States Department of Health and Human Services <https://minorityhealth.hhs.gov/hispaniclatino-health#:~:text=In%202020%2C%2035.9%20percent%20of,33.0%20percent%20of%20Central%20Americans.>
 84. *The Southern Border Region at a Glance.* Southern Border Communities Coalition; 2023. https://www.southernborder.org/border_lens_southern_border_region_at_a_glance
 85. *United States Census Bureau: Nogales City, Arizona.* United States Census Bureau; 2023. <https://www.census.gov/quickfacts/nogalescityarizona>
 86. *United States Census Bureau: Tucson, Arizona.* United States Census Bureau; 2023. <https://www.census.gov/quickfacts/fact/table/tucsoncityarizona/PST045222>
 87. Carvajal SC, Huang S, Bell ML, et al. Behavioral and subjective health changes in US and Mexico border residing participants in two promotora-led chronic disease preventive interventions. *Health Educ Res.* 2018;33(6):522-534. doi:10.1093/her/cyy037
 88. Sanjeevaiah A, Cheedella N, Hester C, Porembka MR. Gastric Cancer: Recent Molecular Classification Advances, Racial Disparity, and Management Implications. *J Oncol Pract.* 2018;14(4):217-224. doi:10.1200/JOP.17.00025
 89. *BreathID Smart.* Meridian Bioscience; 2024. <https://www.meridianbioscience.com/diagnostics/disease-areas/gastrointestinal/h-pylori/idkit-hp-two-2/?country=US#support-documents>
 90. *Package Insert IDkit Hp® Two for BreathID® Hp Lab System and BreathID® Smart System Breath Test for Detection of H. Pylori.* Meridian Bioscience; 2022. https://www.meridianbioscience.com/uploads/ac00063_pi.pdf?country=US
 91. *Quick Guide To Drinking Water Sample Collection.* Environmental Protection Agency; 2016. https://www.epa.gov/sites/default/files/2015-11/documents/drinking_water_sample_collection.pdf
 92. *ProDSS Multiparameter Digital Water Quality Meter.* YSI: A Xylem Brand; 2024. <https://www.ysi.com/prodss>
 93. *2100Q Portable Turbidimeter (EPA), 0-1000 NTU.;* 2024. <https://www.hach.com/p-2100q-portable-turbidimeter-epa-0-1000-ntu/2100Q01>
 94. *Analytical Methods Approved for Compliance Monitoring under the Long Term 2 Enhanced Surface Water Treatment Rule.* United States Environmental Protection Agency: Office of Water; 2017. <https://www.epa.gov/sites/default/files/2017-08/documents/lt2-approved-methods.pdf>
 95. *Colilert Overview.* IDEXX; 2024. <https://www.idexx.com/en/water/water-products-services/colilert/#:~:text=The%20Colilert%20Test%20uses%20proprietary,%CE%20B%20Dgalactosidase%20and%20the%20E.>

96. *About Adult BMI*. Centers for Disease Control and Prevention; 2024.
https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html
97. Zendejdel A, Roham M. Role of *Helicobacter pylori* infection in the manifestation of old age-related diseases. *Mol Genet Genomic Med*. 2020;8(4):e1157. doi:10.1002/mgg3.1157
98. Huang Q, Jia X, Chu Y, Zhang X, Ye H. *Helicobacter pylori* Infection in Geriatric Patients: Current Situation and Treatment Regimens. *Front Med*. 2021;8:713908. doi:10.3389/fmed.2021.713908
99. Weck MN, Stegmaier C, Rothenbacher D, Brenner H. Epidemiology of chronic atrophic gastritis: population-based study among 9444 older adults from Germany. *Aliment Pharmacol Ther*. 2007;26(6):879-887. doi:10.1111/j.1365-2036.2007.03430.x
100. Kanakala VV, Thomas J, Vijayaraghavan S. Alcohol Consumption and Active *Helicobacter pylori* Infection. *Clin Gastroenterol Hepatol*. 2017;15(1):e18. doi:10.1016/j.cgh.2016.09.046
101. Brenner H, Berg G, Lappus N, Kliebsch U, Bode G, Boeing H. Alcohol consumption and *Helicobacter pylori* infection: results from the German National Health and Nutrition Survey. *Epidemiol Camb Mass*. 1999;10(3):214-218.
102. Westaby D, ed. *Therapeutic Gastrointestinal Endoscopy: A Problem-Oriented Approach*. 1. publ. Dunitz; 2002.
103. Tsang SH, Avilés-Santa ML, Abnet CC, et al. Seroprevalence and Determinants of *Helicobacter pylori* Infection in the Hispanic Community Health Study/Study of Latinos. *Clin Gastroenterol Hepatol Off Clin Pract J Am Gastroenterol Assoc*. 2022;20(3):e438-e451. doi:10.1016/j.cgh.2021.02.042
104. *What It's Like to Take the H. Pylori Breath Test*. Healthline; 2022.
<https://www.healthline.com/health/digestive-health/h-pylori-breath-test#treating-h-pylori>
105. Rolle-Kampczyk UE, Fritz GJ, Diez U, Lehmann I, Richter M, Herbarth O. Well water – one source of *Helicobacter pylori* colonization. *Int J Hyg Environ Health*. 2004;207(4):363-368. doi:10.1078/1438-4639-00301
106. Harris RB, Brown HE, Begay RL, et al. *Helicobacter pylori* Prevalence and Risk Factors in Three Rural Indigenous Communities of Northern Arizona. *Int J Environ Res Public Health*. 2022;19(2):797. doi:10.3390/ijerph19020797
107. Aziz RK, Khalifa MM, Sharaf RR. Contaminated water as a source of *Helicobacter pylori* infection: A review. *J Adv Res*. 2015;6(4):539-547. doi:10.1016/j.jare.2013.07.007
108. Farhadkhani M, Nikaeen M, Hassanzadeh A, Nikmanesh B. Potential transmission sources of *Helicobacter pylori* infection: detection of *H. pylori* in various environmental samples. *J Environ Health Sci Eng*. 2019;17(1):129-134. doi:10.1007/s40201-018-00333-y
109. Gião MS, Azevedo NF, Wilks SA, Vieira MJ, Keevil CW. Effect of chlorine on incorporation of *Helicobacter pylori* into drinking water biofilms. *Appl Environ Microbiol*. 2010;76(5):1669-1673. doi:10.1128/AEM.01378-09