

A DESCRIPTIVE ANALYSIS OF GASTRIC CANCER IN ALASKA

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A DESCRIPTIVE ANALYSIS OF GASTRIC CANCER IN ALASKA

A

PROJECT REPORT

Presented to the Faculty

Of the University of Alaska Anchorage

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By

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## **Abstract**

Gastric cancer or stomach cancer represents a major public health problem in the contiguous United States and in Alaska. Stomach cancer is the fourth most common malignancy and the second most common cause of cancer-related deaths throughout the world. A retrospective study of gastric cancer cases from 1996 to 2011 was undertaken and data were extracted from the Alaska Cancer Registry where cases are consistently recorded and centralized. Data were analyzed using the National Cancer Institute's SEER\* Stat statistical software (version 8.1.5). The goal of the project was to provide a detailed epidemiologic descriptive analysis of gastric cancer to better inform health professionals, the public and to provide additional resources for future research. Results showed that gastric cancer incidence rates in Alaska are significantly higher than the rest of the nation. Alaska Natives and American Indians in Alaska have the highest rate of gastric cancer than all races/ethnicities combined. Males have a risk prevalence of gastric cancer that is twice that for females. The Alaska Native male and Asian/Pacific Islander male gastric cancer incidence rates are much higher than males from other races. In addition, Southeast Alaska Natives' incidence rates are lower than rates for non-Southeast Alaska Natives. Based on the findings, study recommendations include the following: 1) Health education campaigns for at risk-groups; 2) Making health care services available; 3) Education of local health community workers and health care professionals; 4) Promoting new ways of preserving food in rural communities and consumption of fresh fruits and vegetables; 5) Encouraging patients to discuss their family history with healthcare providers to determine potential risks for inherited cancer syndromes.

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## **Chapter 1: Introduction**

### **1.1 Gastric Cancer: A Public Health Problem**

Gastric cancer (GC), or cancer of the stomach or stomach cancer is categorized into two main classes: gastric cardia cancer (cancer of the top inch of the stomach, where it meets the esophagus) and non-cardia gastric cancer (cancer in all other areas of the stomach). Gastric cancer remains the fourth most common malignancy and the second most common cause of cancer-related deaths throughout the world (Jemal et al. 2011). Despite advances in surgical techniques, combined with neoadjuvant chemotherapy and radiotherapy approaches, gastric cancer continues to present a major clinical challenge, due to most cases being diagnosed in advanced stages with poor prognosis and limited options (Van Ness et al. 2012).

The development of gastric cancer is recognized to be a complex and multifactorial process involving a number of etiological factors and multiple genetic and epigenetic alterations. According to the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program (2014), it is estimated that there will be 22,220 new cases of stomach cancer and an estimated 10,990 people will die of this chronic condition. Globally, gastric cancer caused the death of approximately 738,000 people worldwide in year 2008 (Ferlay et al., 2008) and most recently, the World Health Organization (WHO) estimated that gastric cancer caused the death of 723,000 people worldwide in 2012 (WHO, 2012). Furthermore it is predicted that by 2030, gastric cancer will be the 10<sup>th</sup> leading cause of mortality worldwide (Mathers & Loncar, 2006).

In the United States, an estimated 21,600 new cases of gastric cancer were diagnosed in 2013, and more than 10,000 people died of the disease (Shah & Enzinger, 2014). Previous studies on gastric cancer in Alaska have demonstrated that Alaska Native (AN) and American Indian (AI) populations are at a higher risk for gastric cancer than the general U.S. population

(Alberts et al. 2006). The higher incidence rate of gastric cancer in AN/AI populations is likely due to risk factors associated with *Helicobacter pylori* infection. In fact, AN/AI experience a seroprevalence of 75% (range: 61 to 84%, by region), making this rate of infection and stomach cancer rate higher than non-Native Alaskans (Wiggins et al., 2008). A study by the Centers for Disease Control and Prevention (CDC) Arctic Investigations Program (AIP) on *H. pylori*, endoscopic tissue biopsies were performed in Alaska. Results from the study show that antimicrobial resistance is more common in *H. pylori* isolates from AN/AI than in the U.S. population (Bruce et al., 2003). Furthermore, reinfection rates increase treatment failure to a current 35% for *H. pylori* Immunoglobulin G (IgG) antibody positivity with gastric cancer (McMahon et al., 2006). In developed nations, it is currently uncommon to find infected children; but the percentage of infected people increases with age, with about 50% infected for those over the age of 60 compared to around 10% between 18 and 30 years (WHO, 2012). The International Agency for Research on Cancer (IARC) estimates that 36 and 47% of all gastric cancer in developed and developing countries, respectively, are solely attributable to *H. pylori* infection. This accounts for almost 350,000 gastric cancers annually worldwide. One report indicated that of the 12.7 million new cancers occurring worldwide in 2008, a fraction or 16% is caused by *H. pylori* (de Martel et al., 2012).

## Chapter 2: Background and Significance

### 2.1 Background

This study was conducted to provide an epidemiologic descriptive analysis of gastric cancer in Alaska, and to determine how it compares to the rest of the nation in terms of disease distribution and rates of gastric cancer. To compare the Alaska incidence rate to the U.S. statistics, the study presented a trend analysis of gastric cancer incidence rates in Alaska and the U.S. The trend analysis was important for the project because it is one leg above the analytic triangle of person, place, and time. Furthermore, it is also an important tool in public health surveillance, monitoring, forecasting, program evaluation, policy analysis, and etiologic analysis (investigation of potentially causal relationships between risk factors and outcomes) (Greenland, 1995).

Rates for Alaska populations are presented for comparison with focus on patient demographics (sex, race/ethnicity and age) as well as boroughs/census areas for a regional distribution and plot on annual incidence rate for a trend analysis of gastric cancer. When comparing gastric cancer incidence rates from one geographic area to another, a trend analysis is used to understand disease distribution. Other benefits to trend analysis include comparing subgroups to population over time to explore socioeconomic determinants that may explain disease burden to a particular subgroup. For instance, one population may have consistently higher rates over time compared to another population; and the rates in both populations may be decreasing over time, but the disparity between the rates in the two populations at each point in time may as well be increasing or decreasing. For this study, a univariate regression analysis of gastric cancer cases was carried out as another analysis because it presents several benefits over the other techniques like the chi-square test for trend.

In general, regression analysis has the advantage of jointly considering the information contained in the series of counts or rates, rather than considering each time point separately. Analyzing series of rates as a unit allows a comparison of incidence rate for each unit. Therefore, a regression analysis, as Siegal et al., (2007) indicate, imposes stability that allows narrowing the confidence limits calculated for each case count as opposed to group of cases for more powerful results.

## **2.2 Predisposing Factors**

Gastric cancer has a number of etiological factors and multiple genetic and epigenetic alterations. Among the predisposing and/or influencing factors are: *Helicobacter pylori* infection, diet, environmental factors, and in a small percentage of patients a family genetic component (Sasako et al., 2010).

### **2.2.1 *Helicobacter Pylori* Infection**

*Helicobacter pylori*, previously known as *Campylobacter pylori*, are micro-aerophilic spiral-shaped gram-negative bacteria that are found in the gastric mucous layer or adherent to the epithelial lining of the stomach. *H. pylori* infection is responsible for a considerable global burden, including peptic ulcer disease and gastric cancer (Blaser, 2006). Treatment and eradication of *H. pylori* infection remains a recommendation in patients with gastritis, and several studies have shown the benefit of anti-*H. pylori* treatment in reducing both the progression of precancerous lesions and the risk of gastric cancer (Correa et al., 2000). A study of mass eradication of *H. pylori* infection started in Taiwan, demonstrated a reduction of gastric atrophy but not intestinal metaplasia when compared with the five-year period before the study started (Lee et al., 2013). There also have been research studies on antimicrobial-resistant strains, not only for *H. pylori* but for other infectious agents. Some studies have suggested that since *H.*

*pylori* has been present in human beings since ancient times; strong arguments exist that consider the bacteria a part of the human gastric microbiome. Therefore, its elimination may cause an increase in prevalence of diseases such as gastroesophageal reflux, Barrett's esophagus, and esophageal and cardia adenocarcinoma (Cover & Blaser, 2009).

### **2.2.2 Dietary and Environmental Factors**

In regard to dietary and environmental factors, ecological studies were conducted to assess the importance of salt and nitrite intake at the population level in 24 countries (Joossens et al., 1996). The results from these studies show a significant correlation between gastric cancer mortality and sodium intake as well as nitrate intake in both men and women. Furthermore, the relationship between gastric cancer mortality and sodium was stronger than with nitrate. A similar study from Malaysia concluded that a high intake of salted fish was significantly associated with gastric cancer (Goh et al., 2007). Therefore, the consumption of salted food appears to increase the possibility of persistent gastric inflammation (Tsugane et al., 1994). In fact, a high salt diet may damage the gastric mucosal barrier, so the epithelial cells are more susceptible to contact with carcinogens such as nitroso compounds (Xiao et al., 1986). A study on dietary factors and assessing traditional food preservation in Turkey concluded that salt curing or smoking and lack of refrigeration of food play a significant role in gastric cancer development in study areas (Yalcin, 2009). The latter study also explored the underlying causes of differences in gastric cancer rates in regions of Turkey. The researcher found reasons for the differences to be nutritional such as high salt and nitrate consumption, poor food preparation and poor drinking water. In most affected regions, cooking is done in more traditional ways like salting and pickling; and for cooking, charcoal, wood, and dried cow dung is more often used as fuel. An analysis of benzo(a)pyrene (BP) and 1,2-benzanthracene (BA) levels in cooked foods,

especially in bread and meat consumed, were found to be high, indicating that bread and cooked meat are contaminated with BP and BA. Lastly, the study also showed the carcinogenic role of traditional foods baked or cooked using animal manure or fuel oil in the study regions (Turdogan et al., 2003).

Unlike salt intake, several other prospective studies have reported significant reduction in gastric cancer risk arising from consumption of fresh fruits and vegetables. Evidence from these studies showed inverse association between fruit intake and gastric cancer incidence (Lunet et al., 2005). Fresh fruits and vegetables containing micronutrients are protective factors against gastric cancer and so there is a protective association with fresh fruits and vegetables and this association is independent of other dietary factors (Kono & Hirohata, 1996).

Following migration of Japanese individuals to Hawaii, the rate of intestinal type cancers dropped by 50% indicating causal environmental factors while that of diffuse gastric cancer remained similar suggesting a stable hereditary component (Correa et al., 1973). In a study on nutrition and smoking interactions and their impact on gastric carcinogenesis, it was suggested that although gastric cancer is the result of a long multi-step and multifactorial process, there are potential interactions between *H. pylori* infection, environmental exposures and host genetic susceptibility (Gonzales & Agudo, 2012). In fact, positive associations between risk factors associated with smoking, environmental exposure and genetic susceptibility imply that, in certain subgroups of the population, the risk of gastric cancer will be higher than that in the rest of the population. As indicated in a study conducted in Japan, smoking causes oxidative stress and deoxyribonucleic acid (DNA) damage in smokers' body, and active smokers have lower blood concentrations of ascorbic acid, alpha carotene, beta-carotene, which have been suggested as

explanations to why smokers benefit more from the consumption of fresh fruits and vegetables (Yuan et al., 2004).

### **2.2.3 Genetic Predisposition**

Several studies on genetic predisposition reported that interleukin (IL)-1 $\beta$  (-beta) gene polymorphism was closely related to the development of gastric cancer and that the risk of gastric cancer is two to ten times greater in subjects with a family history of the disease than in families without it (El-Omar et al., 2000). One of the studies on genetic predisposition suggested that (IL-1 $\beta$ ) and Tumor Necrosis Factor-Alpha (TNF- $\alpha$ ) gene clusters are consistent with gastric cancer predisposition; therefore, host genetic factors may determine why some individuals develop gastric cancer while others do not when exposed to the same gastric carcinogens (Zeng et al., 2002). In fact, the presence of cytokines and interleukin-1 $\beta$  (-beta) play a key role in the pathophysiology of gastric cancer and its role has been confirmed in animal models that mimic human gastric neoplasia (Robert et al., 1991). Another study on genetic predisposition indicated that the risk of gastric cancer is increased in first-degree relatives of patients with the disease by approximately two-to threefold. The most prominent study on gastric cancer and heredity is a Scandinavian Twin study of 44,788 pairs of twins in the Swedish, Danish, and Finnish twin registries that found an increased risk of gastric cancer in the twin of an affected person with gastric cancer (Lichtenstein et al., 2000).

### **2.3 Interventions**

A meta-analysis that included seven controlled trials (all in areas with high incidence of gastric cancer) found significantly lower rates of gastric cancer (1.1 versus 1.7%) for those who were screened for *H. pylori* and received early treatment (Fuccio et al., 2009).

In Japan and South Korea, where gastric cancer is highly prevalent, national programs for mass screening and early detection have been implemented and the results of early screening and treatment show a significant decrease in gastric cancer incidence rate among these populations. In a case-controlled study from Japan, it shows 40 to 60% decreases in mortality from gastric cancer in those who have been screened and treated for early onset of the disease (Leung et al., 2008).

Incidence rates of stomach cancer have been declining steadily during the past fifty years in both developed and developing nations. It is believed that this decrease is largely due to several factors. These factors are the use of refrigerated foods, the availability of fresh fruits and vegetables, and a decrease in the use of salt as a means of preserving food. Other associated factors include a decrease in the prevalence of *H. pylori* infection in many countries and the decline of smoking in some industrialized countries as well (Jemal et al., 2011). A study in Shanghai urban districts shows that long-term use of home refrigerator was a protective factor against gastric cancer (Su & Shu, 2006). Similarly, many case-controlled studies have also shown that vitamins A, C, E and  $\beta$ -carotene can reduce the risk of gastric cancer. In fact, ascorbic acid, which is the reduced form of vitamin C, can react with nitrite and convert it to nitrous oxide, which is not carcinogenic (Azevedo et al., 1999). Furthermore, the consumption of fresh fruits and vegetables as well as dairy products, vitamin supplements, and drinking green tea were negatively related to gastric cancer. The greater the consumption of fresh fruits and vegetables, the merrier is the protection for gastric cancer (Su & Shu, 2006). Epidemiological and experimental studies have shown that bean products are also protective factors of gastric cancer because of the presence of isoflavone which is the dye genistein contained in the beans and, can prevent cancer (Kim et al., 2002). Lastly, it also was shown that green tea contains

plenty of antioxidants like polyphenols, vitamins C and E, which were consistent protective factors against gastric cancer (Yang et al., 1997).

### Chapter 3: Project Goal and Objectives

Although gastric cancer data have been collected from various hospitals across the state and out of state for Alaska residents, these have not been analyzed to determine the overall epidemiology of gastric cancer in Alaska. There had been published studies on the effect of *H. pylori* infection and the distribution of gastric cancer among AN/AI (McMahon et al., 2006); but no study had analyzed the epidemiology of gastric cancer in Alaska for all races/ethnicities. This study, therefore, bridged the gap by providing information to various stakeholders.

The goal of this study was to provide a detailed epidemiologic descriptive analysis of gastric cancer to better inform health professionals, the public and provide additional resources for future research.

In accomplishing this goal, the project objectives were the following:

- To determine a regional distribution of gastric cancer,
- To conduct a trend analysis of gastric cancer,
- To identify and analyze disease case report demographics (race, age and sex) and
- To compare the Alaska statistics to the national (U.S.) statistics.

The purposes of this research were to provide information to populations, community partners and public health professionals. The study also has the potential for public health professionals to use results to daily healthcare practices in addition to provide information for high-risk populations, as well as epidemiological support for the prevention of gastritis leading to gastric cancer.

## **Chapter 4: Methods**

### **4.1 Study Population**

The population included in the study were annual cases of patients diagnosed with gastric cancer, all races (Whites, Blacks, AN/AI and Asians/Pacific Islanders) and ages from birth to 85 years and older (Alaska Cancer Registry, 2014). For the purpose of calculating rates for patients with Asian and Pacific Islander origin, both the national database and Alaska condensed patient cases to a single entity of Asians/Pacific Islanders. Data used were annual cases reported to the Alaska Cancer Registry (ACR) from 1996 to 2011, while the U.S. statistics data were from 1999 to 2011. All gastric cancer cases were from cases throughout the State of Alaska and from outside of the State of Alaska, so as long as the patient diagnosed was a resident of the State of Alaska. Several data items were collected and entered in both the national and the State of Alaska registry; however, for the purpose of the study, only aggregated data were reviewed, such as patients demographics (race/ethnicity, age and sex), and patients' residence at the time of diagnosis.

### **4.2 Data Source and Data Collection**

The study analyzed secondary data from ACR, which contained all reported cancer cases including gastric cancer from 1996 to 2011 (ACR, 2011). As a population-based cancer surveillance system that is funded by the Centers for Control Disease and Prevention (CDC), ACR have been collected data on all newly diagnosed cancer cases (including benign brain) for the State of Alaska. The registry operated under several statues and regulations required for compliance with Cancer Registries Amendment Act, Public Law (PL) 102-515; Alaska Administration Code 7 AAC 27.011-Reporting of cancer and brain tumors; and Alaska Statues

Sec. 18.05.042. The cancer registry's overall purpose is to collect a wide variety of information to determine cancer incidence, mortality, treatment and survival rates.

Data extracted from ACR included patient demographics (race/ethnicity, age and sex), year of diagnosis, and geographic location by borough and census area of reported cases as well as rates by years and case counts for statistical analyses and results. For this study, a research agreement was authorized between the principal investigator of the project and the community partner, from CDPHP, indicating the agency support of the research plan and its approval for data collection from ACR. The research letter of support is attached in the Appendix (See Appendix A).

#### **4.3 Protection of Human Research Subjects**

Permission to conduct the project while observing protection of human research subjects was requested through both UAA Institutional Review Board (IRB) and ACR. The investigator abided by the Health Insurance Portability and Accountability Act of 1996 (HIPAA) throughout the project. UAA IRB exempted this study because it did not involve human research subjects, rather it used secondary data analysis. An approval letter of exemption is provided in the appendix (See Appendix B). The process of seeking approval from an IRB is found in the Code of Federal Regulations for the protection of human research subjects (45 CFR 46), wherein UAA IRB was granted the authority to approve studies when they followed ethical guidelines, or disapprove research when they are concerns to human research subjects as covered by the University policy.

#### 4.4 Data Analysis

Data analysis methods included distribution by year/case counts for all races, Whites, AN/AI, distribution by race/ethnicity, age, borough/census area, race and sexes (male and female) for both Alaska and U.S., and a comparison by race/ethnicity for Alaska and U.S. When analyzing stomach cancer incidence rates by races/ethnicities in Alaska, the study calculated the upper and lower confidence intervals for all races as well as for each race separately.

Univariate analysis modeling with linear regression was also carried out using the National Cancer Institute's SEER\*Stat (version 8.1.5 built March 26, 2014) statistical software in order to calculate the relevance of gastric cancer and its 95% confidence interval (95% CI) to both lower CI and upper CI.

For the Alaska data, this study used ACR rates by year for all races/ethnicities combined as well as case counts from 1996 to 2011. The variables were transferred from ACR to the SEER\*Stat statistical program to get both lower and upper confidence intervals for statistical tables that were later used to create graphics from Microsoft Excel software. When comparing the Alaska trend to the U.S. trend of gastric cancer, this study used U.S. statistics from the national SEER\*Stat that combined data from the National Program of Cancer Registries and the National Cancer Institute's SEER program for diagnosis years 1999 to 2011. U.S. statistics data included patients' demographics (race/ethnicity, age and sex), year of diagnosis, case counts and residence. Cancer data from Alaska and the U.S. were formatted so that the SEER\*Stat software could read and process them. These data provided a trend analysis and compared the Alaska incidence rates to the national rates. The practice of collecting information and attempting to spot a pattern, or trend is the hallmark of epidemiologic analysis in the way that it allows researchers

to understand that health outcomes in a population can only be fully understood if their frequency and distribution is examined in terms of person, place, and time (Rosenberg, 1997).

When analyzing trend over the course of years, one may focus on the overall pattern of change in an indicator over time such as the years of disease diagnosis and whether there had been a significant increase or decrease over time (Rosenberg, 1997). The current study analyzed 16 years of data from 1996 to 2011 collected by ACR. Therefore, it was meaningful to analyze annual rates for disease distribution and trends to spot a particular time from which the incidence rates were high or low in any given year and tried to determine the cause of the increased or decreased. The relevance of spotting a pattern or determining a trend is supported by the work of Rosenberg who thinks that the most general goal of trend analysis for public health surveillance is to discern whether the level of a health status, service, or systems indicator has increased or decreased over time, and if it had, how quickly or slowly the increased or decreased had occurred (Rosenberg, 1997). In fact, when comparing the level of an indicator across geographic areas, only looking at one point in time can be misleading. For instance, one geographic area may consistently have a higher value on an indicator in one year, but a lower value in the next; therefore, analyzing the trend over several years can give a more precise comparison of the two geographic areas and determine how they compared to one another. Upon analysis of both quantitative and qualitative data, results were presented to the public, community partners and health professionals in aggregated format. The results did not include any identifier to human research subjects such as name, social security number, and/or address.

## **Chapter 5: Results**

The study reviewed 587 cases of gastric cancer reported to ACR from 1996 to 2011 for the Alaska data and from 1999 to 2011 for the U.S. statistics. The national statistics were provided from the National Program of Cancer Registries database SEER program. A data analysis included a report of cases by year from 1996 to 2011 and annual cases by borough to determine a regional distribution as well as to conduct a trend analysis.

Further analyses included rates distribution of patient demographics (race/ethnicity, age and sex) and comparing the Alaska rates to the national U.S. statistics. Furthermore, a trend analysis included rates by year for Alaska and U.S. statistics; and finally a comparison of annual incidence rates for AN/AI, Whites and all races combined. The study also conducted analyses by age from 00 to 85 years and older, boroughs/censuses areas for 32 boroughs as recognized by the 2000 and 2010 censuses, sexes (male and female), and separately for male and female. Lastly, this study analyzed distribution by race/ethnicity for all races combined, as well as separately for Whites, Blacks, AN/AI and Asians/Pacific Islanders.

### **5.1 Distribution by Year/Case Counts**

Overall, when analyzing Alaska rates, the study found that the trend of stomach cancer had decreased over time with a rate of (8.9 per 100,000) in 1996 to a rate of (7.2 per 100,000) in 2011. The incidence rate for AN/AI had also varied over time; but it remained higher than other races. The study also found a variability and/or significant range when comparing rates from one race to another, which led to peaks when graphing for trend analysis. This variability was due to the fact that cases less than 20 per year are statistically unreliable and should therefore be used with caution when analyzing for trend. Figure 1 presents an analysis all races/ethnicities

combined, for Whites and AN/AI; while Table 1 shows annual rates and case counts all races combined in Alaska.

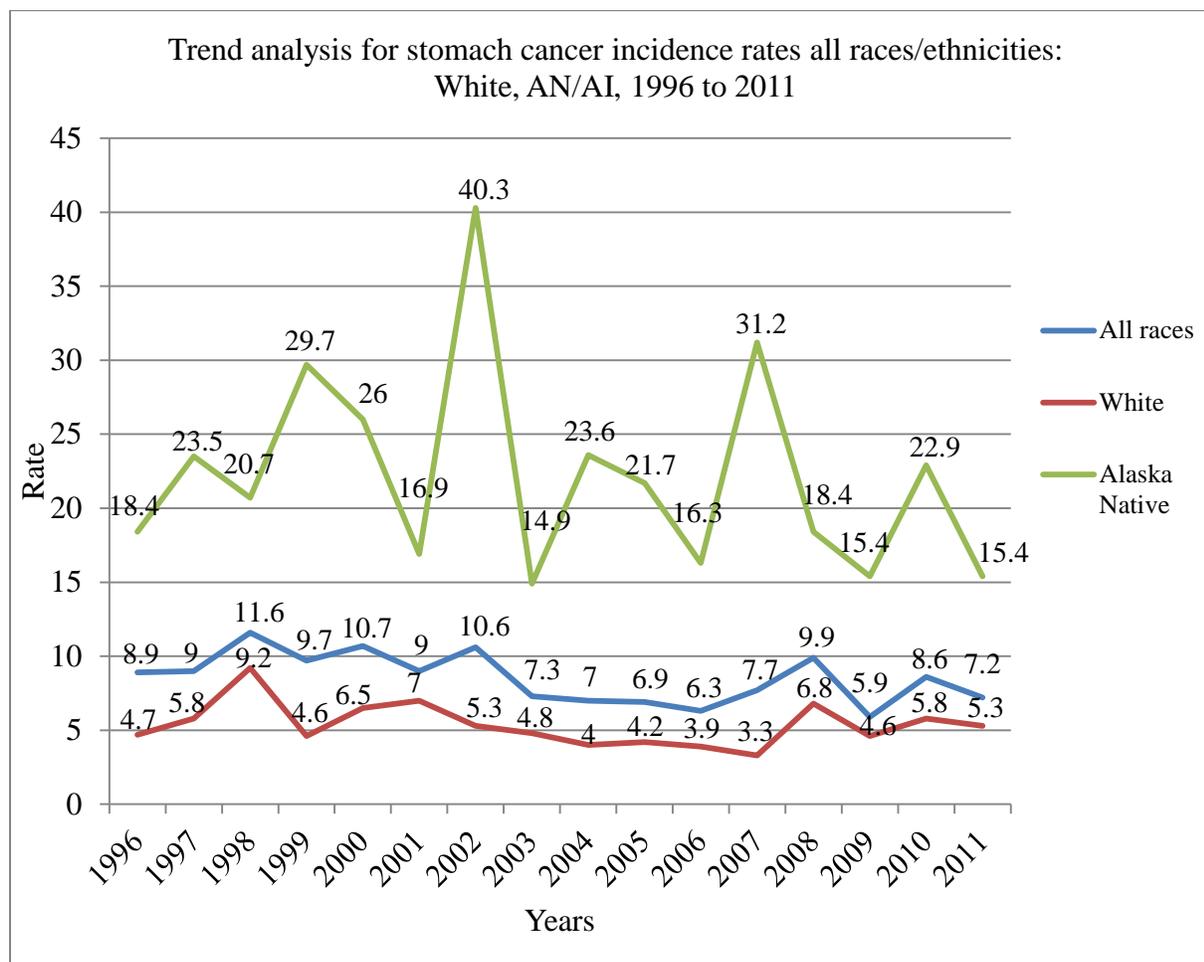


Figure 1: Trend analysis for stomach cancer incidence rates all races/ethnicities: White, AN/AI, 1996 to 2011.

Table 1: Stomach cancer incidence rates by year for all races/ethnicities combined: Alaska, 1996 to 2011

Years	All races		White		Black		Alaska Native/AI		Asian/Pacific Islander	
	Rate	Case Counts	Rate	Case Counts	Rate	Case Counts	Rate	Case Counts	Rate	Case Counts
1996	8.9	29	4.7	10	11	1	18	12	56	6
1997	9	31	5.8	14	21	2	24	14	7.6	1
1998	11.6	37	9.2	18	24	1	21	14	20	4
1999	9.7	36	4.6	14	22	1	30	18	21	3
2000	10.7	38	6.5	17	12	1	26	14	26	6
2001	9	33	7	22	18	1	17	9	15	1
2002	10.6	39	5.3	15	0	0	40	22	10	2
2003	7.3	30	4.8	16	18	2	15	9	14	3
2004	7	32	4	14	12	1	24	16	4.6	1
2005	6.9	36	4.2	18	4.2	1	22	16	5.8	1
2006	6.3	30	3.9	13	0	0	16	14	17	3
2007	7.7	38	3.3	13	3.8	1	31	22	10	2
2008	9.9	48	6.8	24	0	0	18	15	34	9
2009	5.9	35	4.6	21	3.4	1	15	12	2	1
2010	8.6	48	5.8	24	3.3	1	23	19	11	4
2011	7.2	47	5.3	23	7	2	15	16	9.3	5

Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard Population (19 age groups-Census P25-1130).

W: White B/A: Black AN: Alaska Native A/PI: Asian/Pacific Islander

## 5.2 Distribution by Race/Ethnicity

When analyzing by race/ethnicity, the study determined and compared rates for all races, as well as Whites, Blacks, AN/AI and Asians/Pacific Islanders. From the analysis, the study presented most affected races with the potential to focusing on prevention measures and/or culturally health education tools to be applied to at risk-groups. The study found that rates in Alaska were significantly distributed with higher incidence for AN/AI (22.1 per 100,000) as opposed to Blacks (8.9 per 100,000); Whites (5.2 per 100,000) and Asians/Pacific Islanders (14.8 per 100,000). All rates of gastric cancer are per 100,000 populations age-adjusted to the 2000 U.S. standard population. In addition, the study also found that Asians/Pacific Islanders were the

second racially group most affected with a rate of 14.8 cases per 100,000 populations. The incidence rates by race/ethnicity in Alaska from 1996 to 2011 for the study population are shown in Table 2 while Figure 2 shows incidence rates by race/ethnicity in Alaska from 1996 to 2011.

Table 2: Stomach cancer incidence rates by race/ethnicity: Alaska, 1996 to 2011

	Rate	Lower CI	Upper CI	Count
All races	8.3	7.6	9.1	587
White	5.2	4.6	5.9	276
Black	8.9	4.7	15	16
Alaska Native	22.1	19.2	25.2	242
Asian/Pacific Islander	14.8	10.7	19.7	52

Rates are per 100,000 and age-adjusted to the 2000 U.S. Standard population (19 age groups - Census P25-1130) standard; confidence intervals (Tiwari mod) are 95% for rates.

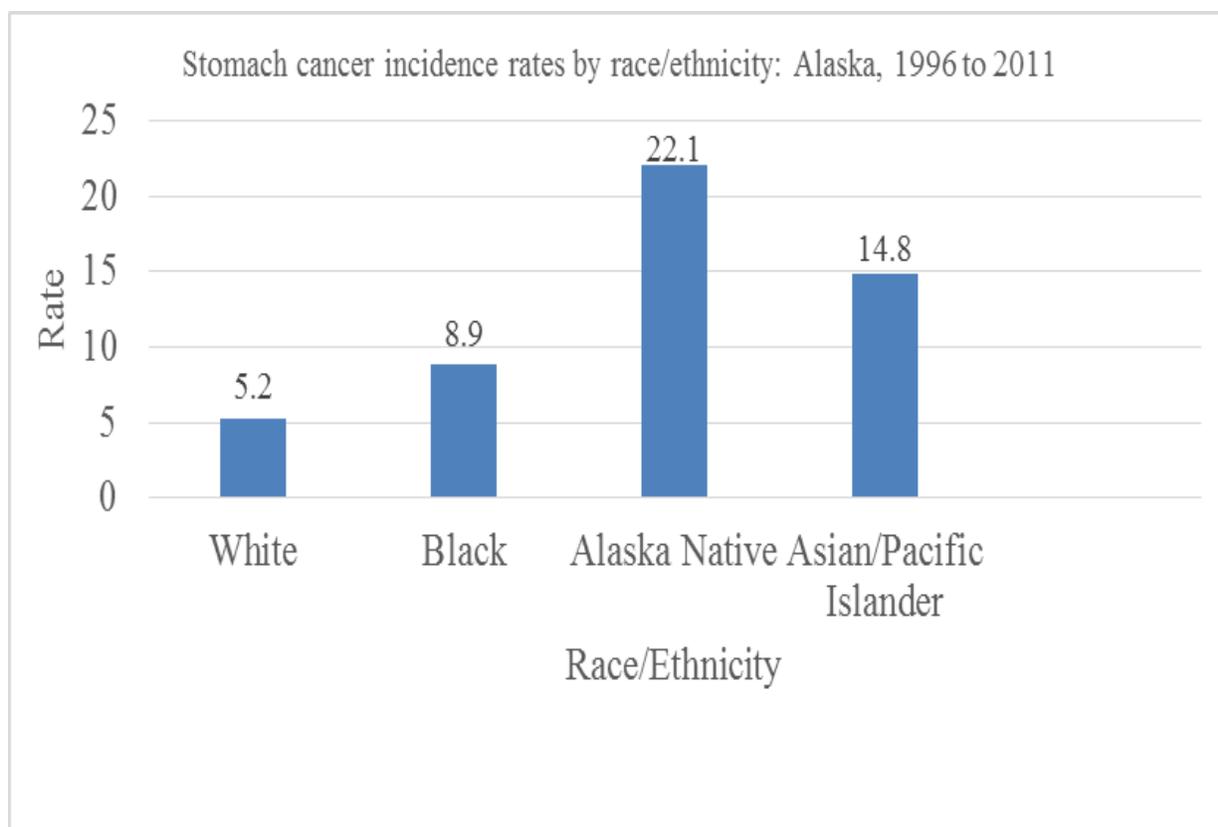


Figure 2: Stomach cancer incidence rates by race/ethnicity: Alaska, 1996 to 2011.

### 5.3 Distribution by Age

The analysis of rates by age all races combined included patient's ages from 0 to 85 years and older. The study found that age is significantly related to disease. No cases were reported between 0 to 14 years and double were the rates at age 65 years with a much greater increase at age 75 years and older.

To conduct a trend analysis by age and all races/ethnicities combined, the study presented in Table 3 the age distribution by years, rates, case counts as well as lower and upper confidence intervals for each age category. Figure 3 shows a graphic representation by age and all races/ethnicities combined.

Table 3: Univariate regression analysis of stomach cancer incidence rates by age and all races/ethnicities: Alaska (n=587)

All races				
	Rates	Lower CI	Upper CI	Case Counts
Age Group (years)	8.3	7.6	9.1	587
00-04	0.0	0.0	0.5	0
05-09	0.0	0.0	0.5	0
10-14	0.0	0.0	0.4	0
15-19	0.2	0.0	0.9	2
20-24	0.3	0.0	0.9	2
25-29	0.6	0.2	1.4	4
30-34	1.3	0.6	2.4	10
35-39	2.7	1.7	4.1	22
40-44	2.2	1.3	3.4	19
45-49	6.9	5.3	8.9	60
50-54	5.8	4.2	7.7	44
55-59	11.9	9.2	15.0	69
60-64	15.1	11.5	19.5	59
65-69	38.4	31.1	46.8	97
70-74	39.4	30.6	49.8	69
75-75	54.1	41.9	68.9	66
80-84	46.1	31.5	64.4	34
85+ years	55.5	37.5	79.3	30

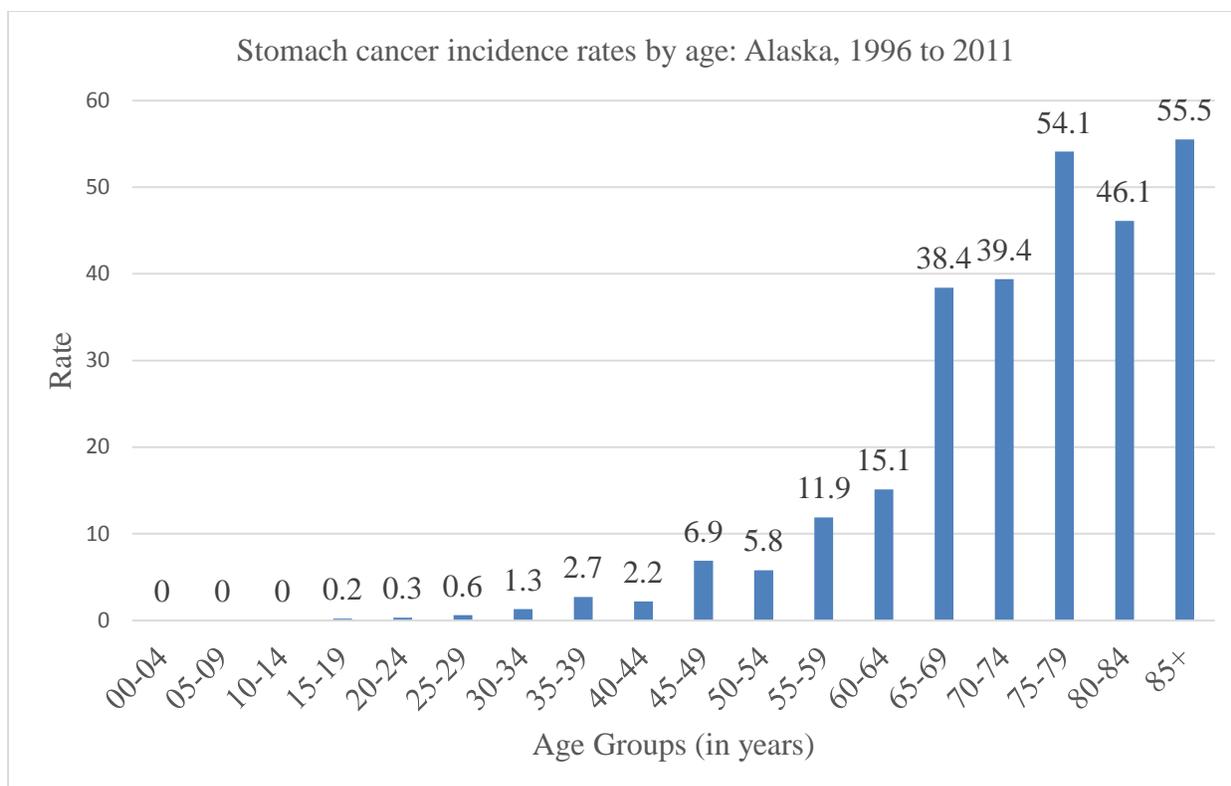


Figure 3: Stomach cancer incidence rates by age: Alaska, 1996 to 2011.

#### 5.4 Distribution by Borough/Census Area

The distribution by borough/census area analyzed 32 boroughs/censuses areas as recognized by the U.S. census of 2010. In this regard, the study found that the Municipality of Anchorage had the highest case counts with 218 cases; Matanuska-Susitna borough had 43 cases and Fairbanks North Star borough had 42 cases. The highest incidence rates were attributed to Prince of Wales-Hyder Census area (39.2 per 100,000); Northwest Arctic Borough (37.3 per 100,000); North Slope Borough (36 per 100,000); Bethel census area (26.6 per 100,000) and Wade Hampton census area (26.5 per 100,000). Table 4 shows the incidence rates by borough/census area while Figure 4 shows the incidence rates by borough/census from the same year as well.

Table 4: Stomach cancer incidence rates and case counts by borough/census area:  
Alaska, 1996 to 2011

Boroughs/Census Areas	Incidence Rates	Case Counts
Prince of Wales-Hyder Census Area (PWHCA)	39.2	2
Northwest Arctic Borough (NWAB)	37.3	29
North Slope Borough (NSB)	36.0	24
Bethel Census Area (BCA)	26.6	38
Wade Hampton Census Area (WHCA)	26.5	16
Nome Census Area (NCA)	24.5	24
Yakutat Borough (YB)	23.1	2
Yukon-Koyukuk Census Area (YKCA)	20.3	18
Lake Peninsula Borough (LPB)	18.8	4
Aleutians West Census Area (AWCA)	14.2	3
Kodiak Island Borough (KIB)	12.8	11
Skagway-Hoonah-Angoon Census Area (SHACA)	10.5	6
Prince of Wales-Outer Ketchikan Census (PWOKC)	10.2	7
Wrangell-Petersburg Census Area (WPCA)	8.9	8
Municipality of Anchorage (MOA)	8.1	218
Dillingham Census Area (DCA)	7.9	5
Valdez-Cordova Census Area (VCCA)	7.3	8
Ketchikan Gateway Borough (KGB)	6.5	11
Juneau Borough (JB)	5.6	22
Kenai Peninsula Borough (KPB)	5.3	35
Matanuska-Susitna Borough (MSB)	5.1	43
Fairbanks North Star Borough (FNSB)	4.8	42
Bristol Bay Borough (BBB)	4.3	1
Haines Borough (HB)	4.3	2
Aleutians East Borough (AEB)	3.7	2
Southeast Fairbanks Borough (SFB)	3.6	4
Sitka Borough (SB)	1.9	2
Denali Borough (DB)	0	0
Hoonah-Angoon Census Area (HACA)	0	0
Petersburg Census Area (PCA)	0	0
Skagway Municipality (SM)	0	0
Wrangell Borough (WB)	0	0

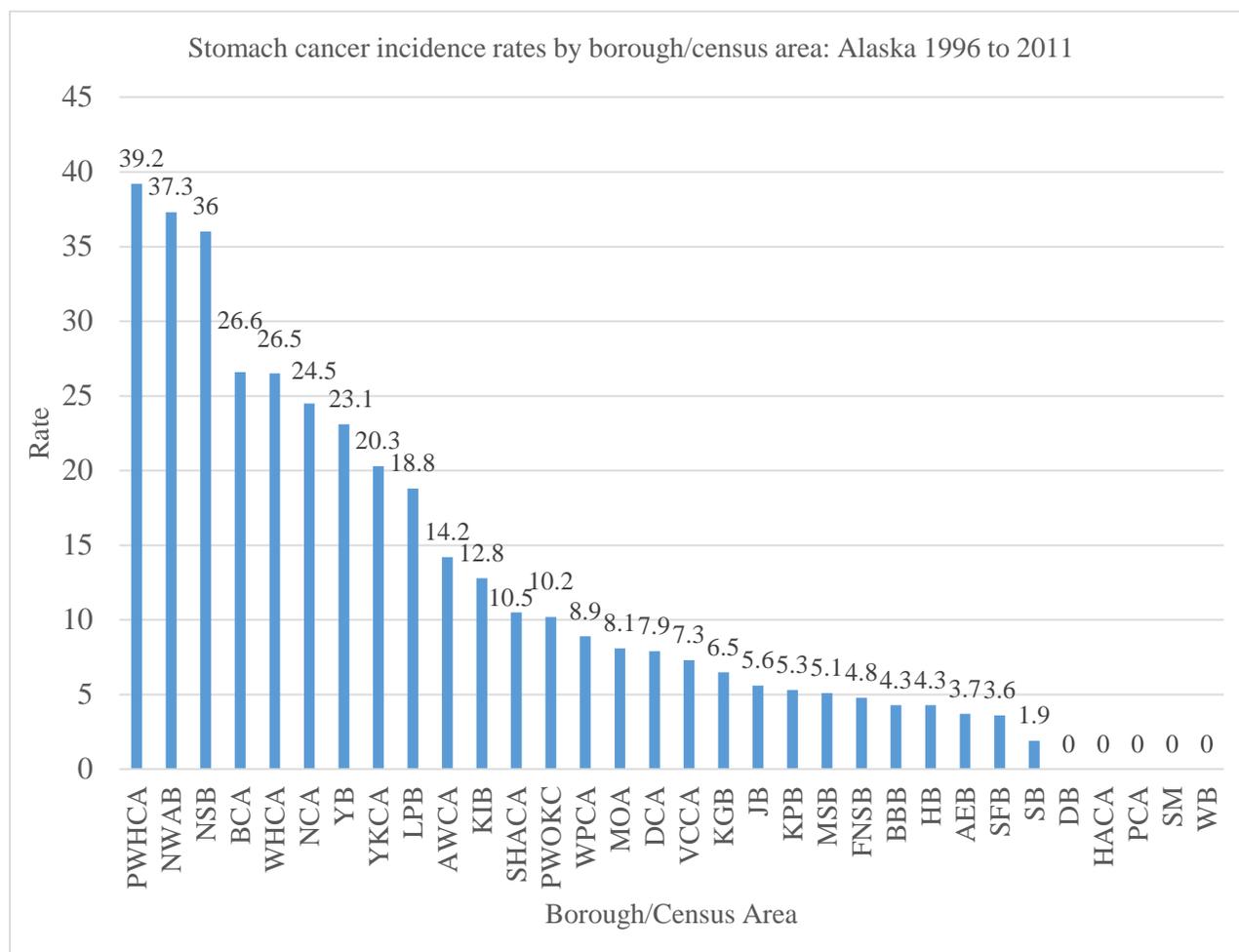


Figure 4: Stomach cancer incidence rates by borough/census area: Alaska, 1996 to 2011.

Also, out of the 32 boroughs/censuses areas in Alaska, 9 of these had higher rates and Figure 5 shows a map by boroughs/censuses areas.

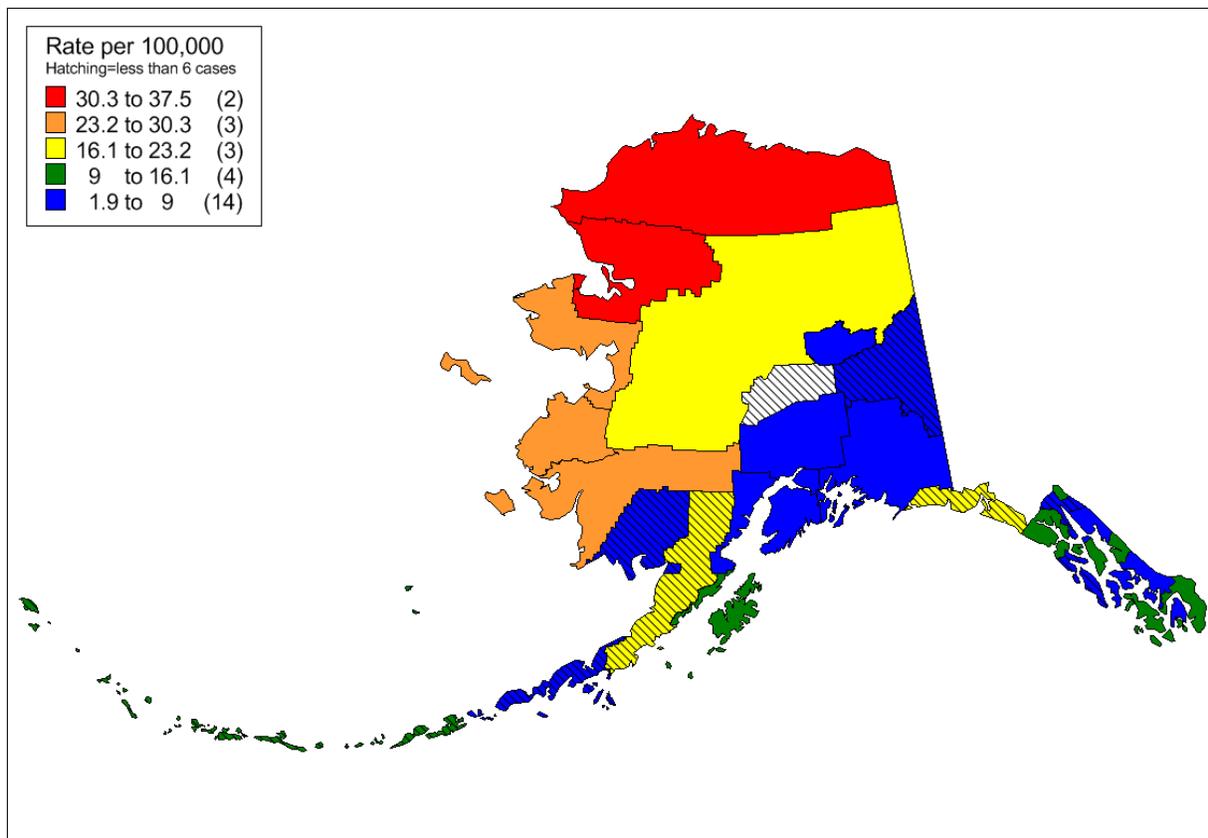


Figure 5: Stomach cancer incidence map: Alaska, 1996 to 2011. Map created in MapInfo Professional version 12.5 by David O'Brien, PhD, GISP.

### 5.5 Distribution by Race/Ethnicity and Sex

In the analysis by race/ethnicity and sex, the study used data for both sexes (male and female) as well as separately for males and females to provide incidence rates for each aggregate.

In Alaska, the disease distribution by race/ethnicity and sex indicated that for all races/ethnicities combined, the males' incidence (11.6 per 100,000) is twice as high as the females' incidence (5.4 per 100,000). The study also examined incidence rates for Alaska Natives in Southeast (SE) Alaska versus non-SE Alaska. The incidence rates of the two groups indicated that SE Alaska Natives had a much high incidence rates as compared to non-SE Alaska Natives.

The White males' incidence rate (7.6 cases per 100,000) was two times higher than the White females' incidence rate (2.9 per 100,000). In addition, the Black males incidence rate (15.7 per 100,000) was five times higher than the Black females incidence rate (3.2 per 100,000). The AN/AI incidence rate (29.6 per 100,000) was higher in males than in females (16.5 per 100,000). Lastly, the Asians/Pacific Islanders incidence rate (25.8 per 100,000) was three times higher in males than it was in females (8.2 per 100,000). Figure 6 shows incidence rates by race/ethnicity and sex (male and female) in Alaska.

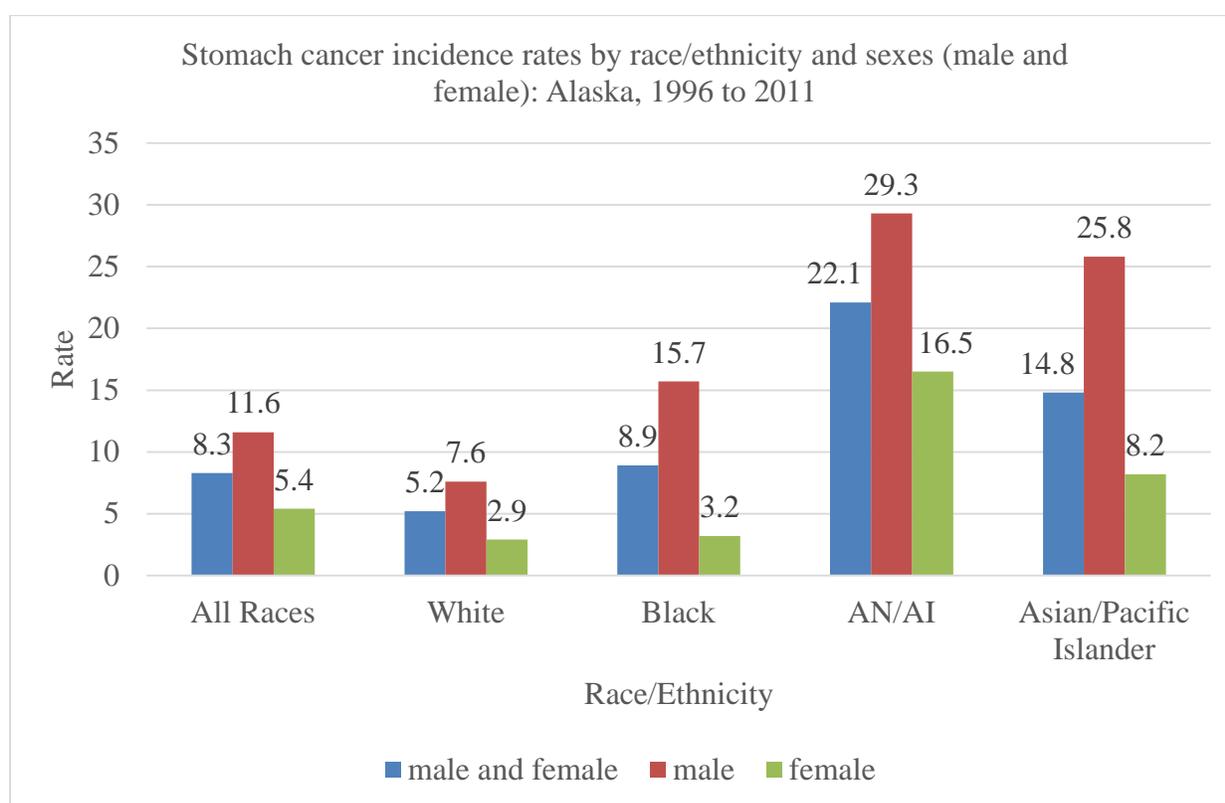


Figure 6: Stomach cancer incidence rates by race/ethnicity and sexes (male and female): Alaska, 1996 to 2011.

In the U.S. statistics, the distribution by sex for all races/ethnicities combined indicated that the incidence rate for males was twice as high as the incidence rate for females. The incidence rate for males was (9.83 per 100,000) while the incidence rate for females was (4.81 per 100,000). White males had an incidence rate of (8.88 per 100,000) which was twice as high

as the incidence rate for White females (4.17 per 100,000). In addition, Black males incidence rate (6.88 per 100,000) was also twice as high as the incidence rate for Black females (8.52 per 100,000).

The incidence rate for AN/AI males (9.44 per 100,000) was twice as high as the incidence rate for AN/AI females (4.95 per 100,000). Lastly, the Asians/Pacific Islanders males' rate (16.91 per 100,000) was also twice as high as the Asians/Pacific Islanders females' rate (9.58 per 100,000) population. Figure 7 shows incidence rates by race/ethnicity and sexes (male and female), in the U.S. from 1999 to 2011.

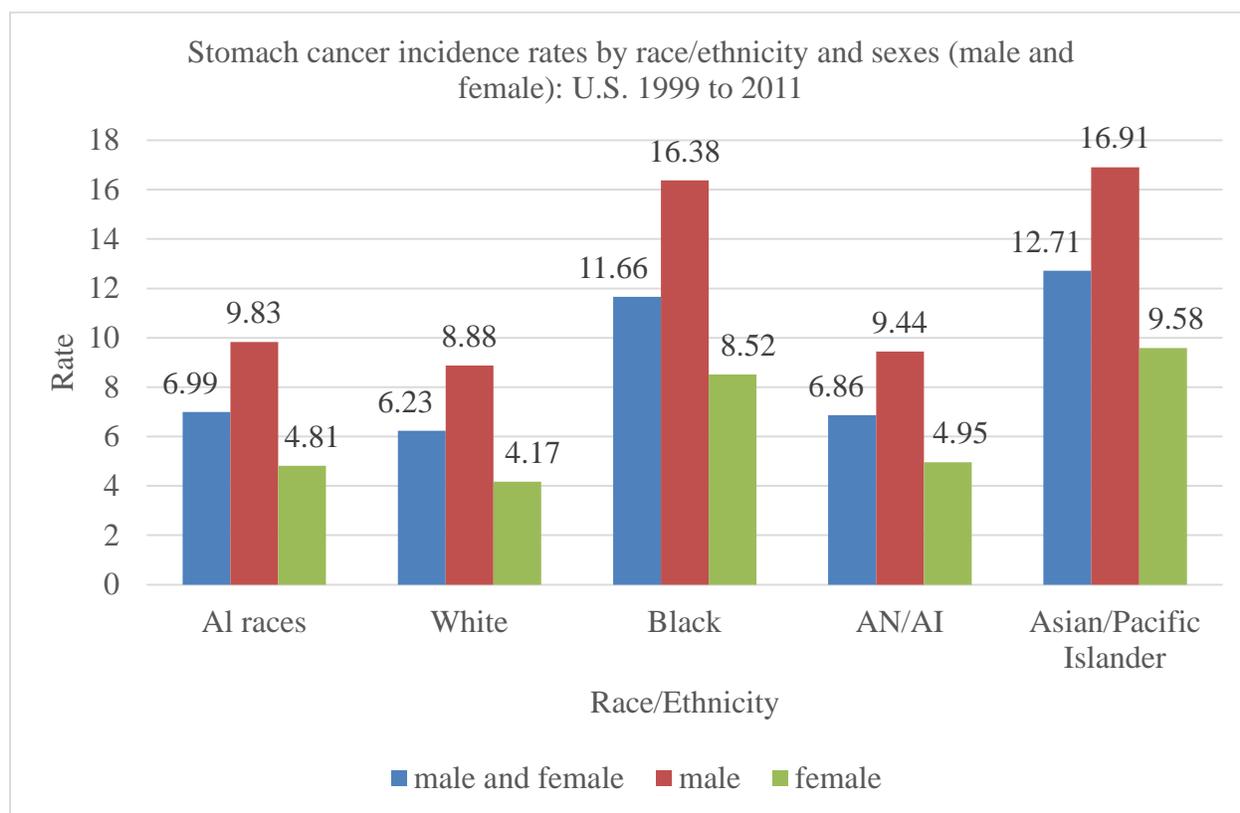


Figure 7: Stomach cancer incidence rates by race/ethnicity and sexes (male and female): U.S. 1999 to 2011.

## 5.6 Distribution by Race/Ethnicity Alaska and U.S.

The rates distribution by race/ethnicity in Alaska and its comparison with the U.S. statistics included an analysis of the following: combined races/ethnicities (Whites, Blacks, AN/AI, Asians/Pacific Islanders) and separately for each one of the races/ethnicities mentioned above.

When comparing incidence rates for Alaska and the U.S. incidence rates, this study found that rates in Alaska, all races/ethnicities combined, were higher than national rates. During the stated periods of time, incidence rates for AN/AI were three times the national rates. Figure 8 shows rates for all races in Alaska from 1996 to 2011 and from 1999 to 2011 for the U.S. statistics. Rates for American Indians living in the continental U.S. were much lower than Alaska Natives living in Alaska; and that the incidence rates for U.S. Asians living in the continental U.S. were also much lower than Asians living in Alaska. Figure 8 shows the incidence rates by races/ethnicities for Alaska and the U.S.

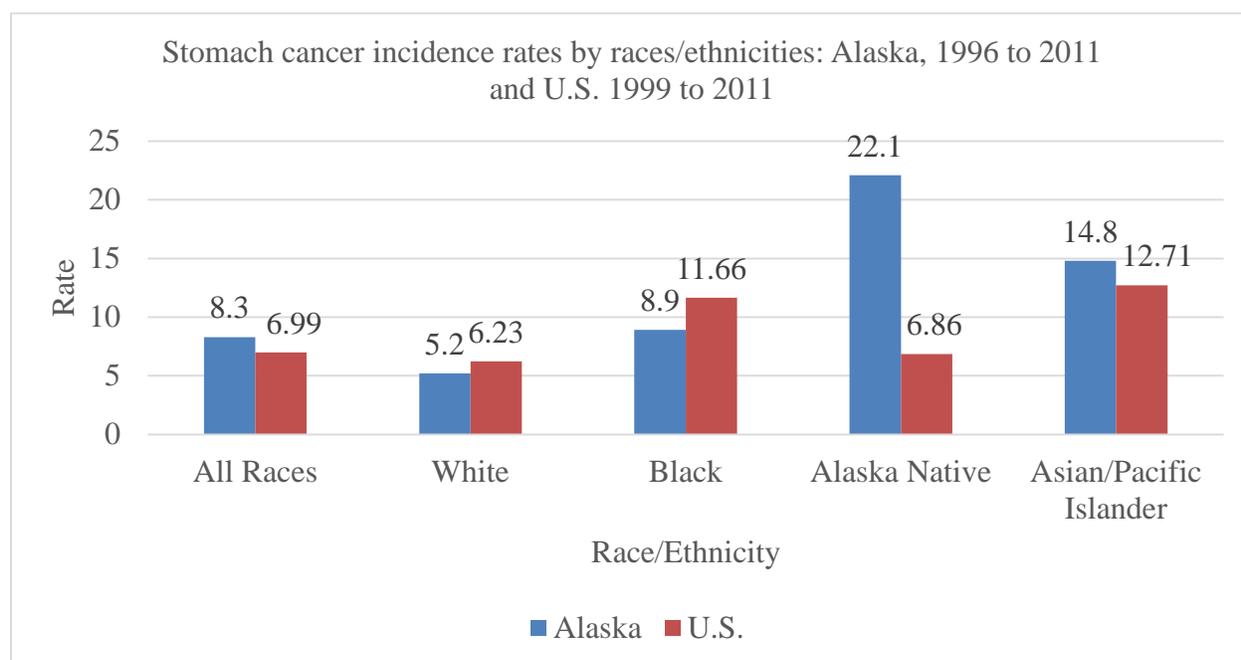


Figure 8: Stomach cancer incidence rates by races/ethnicities: Alaska, 1996 to 2011 and U.S. 1999 to 2011.

## Chapter 6: Discussion

The study results on gastric cancer, the first large scale study that provided a descriptive analysis of the disease with the potential to inform health professionals, the public and resources for future research was consistent with the already great number of gender difference in cancer studies. This study analyzed 16 years of data collected by ACR and 12 years of data for the U.S. statistics for comparison to Alaska rates and U.S. incidence rates. Overall, stomach cancer incidence rates in Alaska had decreased over the course of the study years from a rate of (8.9 per 100,000) in 1996 to a rate of (7.2 per 100,000) in 2011. Despite the decrease, there were higher rates in 1998 with (11.6 per 100,000); and 2002 with (10.6 per 100,000); and incidence rates also fluctuated over the years with the lowest rates (6.3 per 100,000) in 2006. The study also found that incidence rates were higher in Blacks as opposed to Whites and Asians/Pacific Islanders. Alaska Natives, continued to have the highest rates compared to others races/ethnicities (Whites, Blacks and Asians/Pacific Islanders). Age was significantly related to disease all races combined with increasing rates at age 70 years and older. The older a person was, the more likely he or she developed gastric cancer. Older adults risk was twice the risk for younger adults and none to children. The study also found that in Alaska, males were twice at risk as females and that rate for Alaska Native males and Asians/Pacific Islanders males was much higher than males from other races/ethnicities. Alaska Natives living in Alaska had a higher incidence rates than American Indians living in the continental U.S. Moreover, SE Alaska Natives incidence rates were also higher than non-SE Alaska Natives. The rates for Asians/Pacific Islanders males were also twice as high as the rates for Asians/Pacific Islanders females. In addition, Asians/Pacific Islanders from the continental U.S. rates were higher than Asians/Pacific Islanders living in

Alaska. The disease distribution by boroughs/censuses areas found a higher incidence rates for boroughs that were mostly populated by Alaska Natives.

In Alaska, the disease distribution by race/ethnicity and sexes (male and female) indicated that for all races combined, the males' rates were twice as high as the females' rates. In the U.S. statistics, the distribution by sex for all races/ethnicities combined indicated that the rate for males was twice as higher as females. When the Alaska incidence rates were compared to the U.S. statistics, the study found that although the rates had decreased over time for Alaska, as indicated earlier, they remained higher than national incidence rates.

## **Chapter 7: Strengths and Limitations**

### **7.1 Strengths**

Strength of this study was the access to the database from ACR. This study analyzed 16 years of data collected by ACR included all reported cases of gastric cancer. The Alaska Cancer Registry had been in place since January 1996 and was enacted by state regulations (7 AAC 27.011) that established reporting requirements for statewide cancer registry. As a population-based registry, ACR recorded all cancer cases diagnosed and treated in Alaska since 1996. ACR's purpose was to identify all reportable cases of cancer in Alaska in order to provide information on the burden of cancer, types of cancer, and changing patterns of cancer among residents of Alaska. Hospitals, outpatient centers, free-standing pathology or diagnostic laboratories, physicians, home health agencies, hospices, nursing homes and intermediate care facilities are all required to report cancer cases to ACR. When cancer cases are diagnosed, the timeframe for reporting it to ACR was within 6 months of initial diagnosis. If the cancer diagnosis was made prior to the patient being seen at that facility, the reporting timeframe was within 6 months from the patient's first visit to that facility. The cancer registry collected over 400 data items that included: patient identifiers (name, date of birth, gender, race/ethnicity, social security number, residence, zip code, place of birth, marital status, age at time of diagnosis and medical record number), cancer diagnosis information, and cancer treatment information. Second, this study analyzed patient demographics for consistency with the objectives to provide incidence rates distribution by year for all races/ethnicities ages and sexes. Third, the distribution of gastric cancer rates correlated to the overall geographic distribution of Alaska population by race/ethnicity for boroughs and/or census areas. For example, many of the borough/census areas had a high concentration of Natives, while others had a high concentration of Whites and

regions with high populations of Natives also had high incidence rates. Another was that ACR data were annually certified by the North American Association of Central Cancer Registries (NAACCR), whereas the high quality and the completeness required under the Gold Certification requirements. Lastly, ACR data had continuously undergone quality assurance reviews for data accuracy. ACR data were reviewed by NAACCR and certified to be over 95% complete.

## **7.2 Limitations**

When rates for Alaska and the U.S. were compared, the study considered U.S. statistics from 1999 to 2011. Gastric cancer data from 1999 to 2011 reported by the National Program of Cancer Registries (NPCR) represented at least 95% completeness of data, whereas data prior to 1999 were not validated due to confounders and bias. Second, cancer incidence data were based on patient data reported to ACR from a variety of sources, including hospitals, physicians, pathology laboratories, and other cancer registries, as per public health reporting laws. If a healthcare provider did not report a cancer patient and that patient was not seen by any other healthcare provider, then that patient was not in ACR database. Another was that, incidence and mortality rates were based on calculations using Alaska population data by borough and census area. These data were originally from the U.S. Census Bureau, compiled by the National Center for Health Statistics, and provided to ACR by the National Cancer Institute's SEER program. The population data were as accurate as the information provided to the U.S. Census Bureau. Lastly, healthcare statistics such as cancer rates were not exact figures. The actual figure might have been slightly higher or slightly lower, and there could have been a calculation of what the range was in the form of a "confidence interval". Therefore, the size of the confidence interval depended on the population of the group being evaluated. The larger the group, the smaller the

confidence interval, and the more precise the statistic was. The population of the entire state of Alaska would have had a relatively small confidence interval compared to that of a rural village. Lastly, other studies on the subject could look at the difference in rates between Alaska and the U.S. and/or the disparity male/female. Further studies could also evaluate the difference within Alaska for AN/AI living in southeast versus AN/AI living in southwest and/or the efficacy of health programs and campaigns that addressed predisposing factors for at risk-groups.

## **Chapter 8: Public Health Implications**

Gastric cancer or stomach cancer had been a public health concern to both the Alaska Native Tribal Health Consortium through its Alaska Native Epidemiology Center and the State of Alaska Department of Health and Social Services through its Division of Public Health - Section of Chronic Disease Prevention and Health Promotion.

This study had the potential to support and promote disease surveillance because public health professionals and other community partners were able to report data to the Alaska Cancer Registry. It also had the potential for epidemiologists to be informed on the pattern and progression of the disease for surveillance. In addition, this study had the potential to affect populations and public health professionals because they could use results for culturally health education campaigns to at risk-groups in the communities they practice. Similarly, results could be published with the Section of Chronic Disease Prevention and Health Promotion as well as the Epidemiology Bulletin in the Section of Epidemiology and/or the Alaska Native Epidemiology Center for dissemination of this epidemiological information for use by other public health professionals.

In addition to the public health implications at the local level (State of Alaska, community partners, populations and stakeholders), this study addressed three out of the ten Essential Public Health Services (EPHS) outlined by CDC (2010). First, “to diagnose and investigate health problems and health hazards in the community” (EPHS#2) by using data from the Alaska Cancer Registry to examine the burden of gastric cancer in Alaska as well as determining how Alaska compared to the rest of the nation in term of rate of infection. Second, “to inform, educate, and empower people about health issues (EPHS#3). Results from the study could provide information to the public, future researchers and public health professionals to use

for themselves or in their daily practices. Lastly, “to research for new insights and innovative solutions to health problems” (EPHS#10). This included using approaches such as genetic screenings for early detection and treatment as well as mass detection in at-risk-populations. Empowering at risk-groups to discuss to health care providers and others genetic specialists about family history of the disease could lead to early intervention and longitudinal studies to determine those who developed gastric cancer.

## Chapter 9: Conclusion and Recommendations

### 9.1 Conclusion

This study concludes that stomach cancer has continued to be a burden in Alaska for all races/ethnicities combined with a greater incidence in AN/AI populations. Additionally, across races/ethnicities, the older a person was, the more likely he or she was at risk. Moreover, males were significantly at risk to being diagnosed than females. The incidence rate for males was two times the rate for females. Alaska incidence rates were significantly higher than national rates. When analyzing boroughs/censuses areas data, this study concluded that boroughs/censuses areas with higher incidence rates were mostly-populated by AN/AI. Within Alaska, there also were differences in incidence rates for AN/I living in southeast versus AN/AI living in southwest Alaska. The incidence rates for Asians/Pacific Islanders were also significantly higher than the Whites and the Blacks. As referenced in the literature, a diet rich in fresh fruits and vegetables significantly reduced gastric cancer risk (Kobayashi et al., 2002). In fact, a diet rich in fresh fruits and vegetables was a protective effect against gastric cancer because of ascorbic acid, carotenoid and beta-carotene. Ascorbic acid is an anti-oxidant that significantly reduces mitotic activity in tumor cells without disturbing the growth of normal cells (Poydock et al., 1979).

As indicated in the literature, this study did not look at cases that were solely due to *H. pylori* infection, diet and/or environmental factors as well as genetic predisposition. Future research can analyze the impact of each one of the aforementioned factors and their contribution to gastritis leading to gastric cancer. Other studies can also look at males and females incidence rates; the difference within Alaska, the reasons why borough/census areas mostly affected were populated by AN/AI. Future studies can also explore the difference between Asians/Pacific Islanders living in the continental U.S. with those living in Alaska and perhaps evaluating

education campaigns that have been in place to promote early screening, detection and treatment. Lastly, studies can also look at challenges to lifestyle in rural Alaska and factors related to subsistence food and the lack of health care services in rural communities.

## **9.2 Recommendations**

Based on the study analyses and the literature, the following recommendations are suggested in order to reduce the burden of gastric cancer in Alaska.

Recommendation #1:

### **Health education campaigns for at risk-groups**

Promoting health education campaigns for at risk-groups will mean cultural sensitivity when designing and implementing programs to these groups. The cultural difference between AN/AI populations from each borough does not allow for a “one size fits all” campaign. Because AN/AI living in southwest Alaska have different practices than AN/AI living in southeast; it will be important to design health education campaigns that are specific to each area. By educating at risk-groups, there is the potential to empower them to take charge of their health by closely monitoring their healthcare status and allowing them to act as peer support to other individuals in the community.

Recommendation #2:

### **Making health care services available**

Alaska health care system is scarce with a presence of major hospitals in hub areas and in cities with larger population. This makes rural communities and populations living in these communities more vulnerable. To improve preventive care, it may be valuable to encourage at-risk groups to have checkups at their local clinic. If the budget allows, public health

professionals can travel to these isolated rural communities for screening and establishing follow-up to at risk-populations with community health aid workers.

Recommendation #3:

### **Education of local health community workers and health care professionals**

By providing results from this study, there is the potential to inform and educate local health community workers and health professionals to use them to their daily practices. These health professionals will be able to discuss to at risk-groups they served about disease risk - factors, interventions, early screening, early detection and early treatment.

Recommendation #4

### **Promoting new ways of preserving food in rural communities and consumption of fresh fruits and vegetables**

In rural communities, food are often preserved by salt and based on the literature, sodium and nitrate significantly damage stomach mucosal biome which increases the risk for other gastric diseases like Barrett's disease and gastritis. This study therefore recommends preserving foods by smoking or using refrigeration as a way of conservation. However, this recommendation can challenging to rural communities of the cultural ties of preserving food and related expenses to fuel consumption and energy rate. Another challenge is the availability of fresh fruits and vegetables all year long. As a circumpolar area, a long winter season makes it harder for communities to grow and produce fresh fruits and vegetables for their populations. Substituting canned fruits and canned vegetables with fresh fruits and vegetables may be expensive in the long term for at-risk groups.

Recommendation #5:

**Encouraging patients to discuss their family history with healthcare providers determine potential risks for inherited cancer syndromes.**

As referenced early in the literature review, patients with family history of gastric cancer and those with certain polymorphism might be at greater risk of the disease. Therefore, discussing with a genetics professional about genetic testing may be helpful for patients to take appropriate steps toward early detection and treatment if testing results show a mutation or abnormal change.

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## Appendix A



THE STATE  
of ALASKA  
GOVERNOR SEAN PARNELL

Department of  
Health and Social Services

DIVISION OF PUBLIC HEALTH  
Section of Chronic Disease and Health Promotion

3601 C St, Suite 722  
Anchorage, AK, 99503  
Main: 907.269.2020  
Fax: 907.269.5446

September 29, 2014

Attn: Institutional Review Board  
Office of Research and Graduate Studies  
University of Alaska Anchorage  
3211 Providence Drive  
Anchorage, AK 99508

Dear IRB Members,

This memo certifies that <Fabrice E. Evengue> has shared and discussed the study titled <A Descriptive Analysis of Gastric Cancer in Alaska> with myself and/or a representative of our agency, <Alaska Cancer Registry>. The research aims to provide a detailed epidemiologic descriptive analysis of Gastric Cancer in Alaska to better inform health professionals and the public and to provide additional epidemiological support for future research. The study collects gastric cancer cases reported to the registry from 1996 to 2011 and performs a univariate analysis with linear regression using the National Cancer Institute's Surveillance, Epidemiology, and End Result (SEER) statistics program. This memo also confirms that <Fabrice E. Evengue> has permission to conduct the above stated study at <the Alaska Cancer Registry> for the <Master of Public Health Program at the University of Alaska Anchorage>.

I do not have concerns about the proposed study based on communication with <Fabrice E. Evengue>. The agency supports the research plan and approves of the project, which includes data collection from our registry.

Sincerely,

A handwritten signature in cursive script, appearing to read "David O'Brien".

David O'Brien, PhD, GISP  
Alaska Cancer Registry- Alaska Department of Health and Social Services  
3601 C Street, Suite 722, Anchorage, AK 99503,  
907-269-8047 (ph), 907-269-5446 (fax), david.obrien@alaska.gov

## Appendix B



DATE: October 15, 2014

TO: Fabrice Evengue  
FROM: University of Alaska Anchorage IRB

PROJECT TITLE: [862804-1] A Descriptive Analysis of Gastric Cancer in Alaska  
SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS  
DECISION DATE: October 15, 2014

Your Institutional Review Board (IRB) proposal meets the U.S. Department of Health and Human Services requirements for the protection of human research subjects (45 CFR 46 as amended/revised) as being exempt from full Board review. In keeping with the usual policies and procedures of the IRB, your research project is approved with the addition of your faculty signature.

Therefore, you have permission to begin data collection for your study. If this study goes beyond one year from the date of this submission, you will need to submit a Progress Report for approval to continue the research. Please submit a Final Report at the end of your project.

Please report promptly proposed changes in the research protocol for IRB review and approval.

On behalf of the Board, I wish to extend my best wishes for success in accomplishing the objectives of your study.

A handwritten signature in black ink, appearing to read 'Sharilyn Mumaw', is positioned above the typed name.

Sharilyn Mumaw, M.P.A.

Research Integrity & Compliance Officer

### Appendix C

Race alone	White	Black	AN/AI	Asian	Pacific Islander	Other
Prince of Wales-Hyder Census Area	2,799	17	2,207	21	21	20
Northwest Arctic Borough	846	37	6,121	42	12	17
North Slope Borough	3,147	94	5,100	425	104	67
Bethel Census Area	1,894	65	14,109	160	27	45
Wade Hampton Census Area	201	1	7,085	18	0	3
Nome Census Area	1,552	27	7,199	96	9	22
Yakutat Borough	281	2	237	27	12	1
Yukon-Koyukuk Census Area	1,243	10	3,992	14	6	9
Lake Peninsula Borough	380	9	1,061	6	5	6

Census data from the Alaska Department of Labor (2010). Retrieved from <http://live.laborstats.alaska.gov/cen/dparea.cfm>