

RECENT TRENDS OF COLON CANCER: POSSIBLE ASSOCIATIONS WITH OBESITY,
TYPE 2 DIABETES, AND AGING PATTERNS

by

Mei So

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Approved by:

Carrie Merkle

Carrie Merkle, PhD, RN FAAN
College of Nursing

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Abstract

The incidence of colon cancer between 1999 and 2009 has warranted studies on type 2 diabetes, obesity, and the aging American population as risk factors. The purpose of this work was to determine if the incidence of colon cancer was associated with obesity, type 2 diabetes, and or changes in aging pattern using existing databases. The databases used were from Centers for Disease Control, *CA, A Cancer Journal for Clinicians*, and the U.S. Census Bureau. Correlation coefficients were calculated for colon CA and type 2 diabetes, colon CA and obesity, and colon CA and ages 45 years and over. The correlation coefficients for colon CA and type 2 diabetes, colon CA and obesity, and colon CA and ages 45 years and over were +0.27, +0.20, and +0.27 respectively. No association was found. While the study found a decrease in the incidence of colon CA, the incidences of obesity and type 2 diabetes have significantly increase between 1999 and 2009. The correlation coefficient for obesity and type 2 diabetes was +0.84.

Chapter 1: Introduction and Significance

Introduction:

Of cancers affecting both men and women, colon cancer is the second leading cancer killer in the United States (CDC, 2010). The incidence of colon cancer between 1999 and 2009 has induced speculations about the contributions of risk factors that include the high incidences of obesity, type 2 diabetes, and the aging American population (National Cancer Institute, 2011). The purpose of this work was to determine if the incidence of colon cancer was associated with obesity, type 2 diabetes, and or changes in aging pattern using existing databases.

The development of carcinomas in the colon increases with age and the consumption of a western diet are factors that support the presumed increase in colon cancer in the aging American population. In westernized country such as the United States, colon cancer has been positively associated with the adoption of a diet high in fat and low in fiber (National Cancer Institute, 2011). This dietary pattern is also correlated to type 2 diabetes and obesity. A Body Mass Index of 30.0 or greater is classified as obesity (National Cancer Institute, 2011). Obesity has been associated with the increase risk of developing colon cancer. While obesity does not cause type 2 diabetes, it predisposes the individual in developing the condition. As a result of these factors, the analysis of the existing database on colon cancer, type 2 diabetes, and obesity will help future studies in prospect of decreasing mortality from colon cancer.

Statement of Purpose:

The purpose of this work was to determine if the incidence of colon cancer is associated with obesity, type 2 diabetes, and or changes in aging pattern using existing databases. The long term goal of the study is to decrease mortality from colon cancer.

Specific Aims:

The specific aims for this study were:

1. To identify existing databases that can be used to establish an association between colon cancer, obesity, type 2 diabetes, and changes in the aging pattern.
2. To extract data from specific databases and to plot trends patterns in colon cancer, obesity, type 2 diabetes, and changes in the aging pattern.
3. To determine possible associations between colon cancer, obesity, type 2 diabetes, and changes in the aging pattern.

Significance to Nursing:

The importance of determining if the incidence of colon cancer is associated with obesity, type 2 diabetes, and changes in aging pattern will affect nursing in both the clinical and research setting. As the American baby boomer generation begins to age, the risk of colon cancer in the population will significantly increase. By understanding how obesity and type 2 diabetes correlate with colon cancer, it will give nurses a better representation of the outlook in diseases the aging population will experience in the future. Studies that focused on the cause of colon cancer have been inconclusive; however, many risk factors have been identified. These risk factors include a low fiber high diet, excess body fat, deficiency in exercise on a regular basis, and the lack of awareness for preventative care. These areas give nursing an opportunity to educate client about the importance of adapting and maintaining a colon healthy lifestyle and promote preventative care. Equally important, this study will help drive further investigation in colon cancer, and its association with obesity and type 2 diabetes. Therefore, by gaining a better understanding of colon cancer in relation to type 2 diabetes, obesity, and changes in aging

pattern, it will help healthcare providers implement interventions to decrease mortality from colon cancer.

Chapter 2: Literature Review

The impact of colon cancer in the United States is a current public health concern. The severity may be intensified by the change in aging pattern in the next two decades. In 2011, the first members of the Baby Boom will reach age 65 (U.S. Census Bureau, 2010). The last of the Baby-Boom population will reach age 65 in the year 2029 (U.S. Census Bureau, 2010). While the hereditary aspect of the disease is non-modifiable, the relationships of colon cancer with obesity, type 2 diabetes, and the change in aging pattern are worth exploring.

Colon Cancer

Of the cancer that affecting men and women, colon cancer is the second leading cause of cancer-related deaths in the United States and is one of the most commonly diagnosed cancer in the country (CDC, 2011). The disease presents itself in two forms, hereditary and nonhereditary. The hereditary form contributes 5 – 10% of total annual cases (Guttmacher & Collins, 2003). Hereditary is defined as “Mendelian in nature- an autosomal dominant inheritance” (Guttmach & Collins, 2003). The nonhereditary form makes up the remainder of the total yearly burden.

Epidemiological research suggests the absolute number of cases will increase as a result of aging in the next two decades (Winawer, 2007). Although the incidences of colon cancer in the United States since 1998 have decreased about 2.8% for men and 2.2% for women per year, the rate of colon cancer per 100,000 in adults between the ages of 20-49 years have increased by 1.5% per year in men and 1.6% per year in men from 1992-2005 (Siegel, Jemal & Ward, 2009). The increase incidence in young adults is in contrast with rapidly declining incidence among older adults. Contributing to this trend are the increase prevalence of type 2 diabetes and obesity in the U.S. population. While the connection amongst type 2 diabetes and obesity with colon

cancers is still under investigation, studies suggest that insulin production in the body and total body fat increase the risk of developing colon cancer (Wachtel & Chiriva-Internati, 2010).

Colorectal cancer develops from adenomatous polyps, which are fingerlike projection arising from the mucosal epithelium and thought to be due to mutations on chromosome 5 (McCance & Huether, 2006). Colon cancer is a complex, multistep disease process. Colon cancer is thought to have both genetic and environmental contributions. It is caused by accumulation of mutations in oncogenes and tumors suppressor genes. Cells that over-express β -catenin are the most likely to form tumors (McCance & Huether, 2006). Mutations in adenomatous polyposis coli (*APC*) are early events in tumorigenic pathway. β -catenin is a protein responsible for the creation and maintenance of epithelia cell layers (McCance & Huether, 2006). It is also responsible for transmitting signal that causes cells to stop dividing once the epithelia sheet is complete. *APC* mutation is also a common acquired genetic change in colon cancer. *APC* is a tumor suppressor gene. Its main function is to prevent uncontrolled growth of cells that may result in cancerous tumors. The most common mutation in colon CA is inactivation of *APC*. Additionally, in 85% of colorectal cancer, alterations occur in the tumor suppressor *p53* gene (Samowitz, et al., 2007).

Obesity

Obesity is a major public health concern in the World and in the United States. The disease is defined as having a body mass index of 30 kg/m^2 or greater. Globally, more than 300 million people are obese (Gunter & Leitzmann, 2005). In the United States, data obtained from 1999 to 2002 found that 27.6% of men and 33.2% of women are obese, and one in every six children and adolescents is overweight (Baskin, Ard, Franklin & Allison, 2005). Statistically

significant associations with obesity are found with the incidences of type 2 diabetes and all cancers except esophageal and prostate cancer (Guh, Zhang, Bansback, Amarsi & Birmingham, 2005). Increased body mass index, waist circumference, and waist-hip-ratio in both men and women increases one's potential of developing colon cancer (Larrison & Wolk, 2007).

In an obese individual, leptin, a protein hormone responsible for energy balance in the body is found in high levels. Leptin regulate appetite and metabolism. Its level in the body is proportional to the percentage of body fat. High level of leptin is a risk factor for colon cancer because it induces colon epithelial cells carrying a mutation to produce increased concentration of vascular endothelial growth factor (VEGF). VEGF is a signal protein produced by cells that stimulate angiogenesis (He et al., 2010). When it is overexpressed, it can contribute to tumor growth by supplying adequate blood supply to the cancerous area (Farooqi et al., 2007).

Type 2 Diabetes

The Centers for Disease Control report that in 2009 23.6 million people are diabetic (CDC, 2009). This is about 7.8% of the total population. Of the 23.6 million, 5.7 million are undiagnosed (CDC, 2009). Many epidemiologic studies suggest that the risk of developing colon cancer in patients with type 2 diabetes. One study found that individuals with type 2 diabetes have a 30% increase in chance of developing the disease in their life time (Berster & Goke, 2008). This risk is doubled in patients undergoing insulin therapy (Berster & Goke, 2008). Another study reported that an individual with diabetes have a 19% greater risk of developing colon cancer than a non diabetic person (He, Stram, Kolonel & Henderson, 2010). While the results are not conclusive, it is suggesting that type 2 diabetes is a risk factor for developing colon cancer.

Type 2 diabetes is a chronic disease marked by high level of glucose in the blood. The body becomes resistant to insulin, a hormone central to regulating carbohydrate and fat metabolism in the body. Accumulating evidence indicates that lowering the level of insulin and insulin growth factor-1 (IGF-1) is critical to anticancer. High levels of IGF-1 stimulate growth of normal colonic and carcinoma cells. Levels of IGF-1 are moderated by insulin growth factor binding protein-1 (IGFBP-1). Elevated levels of IGFBP is associated with reduction in mortality from colon cancer. In chronic hyperinsulinemia (pre-diabetes), the level of IGF-1 is elevated (Yan et al, 2009).

Change in Aging Pattern in the United States

According to the Centers for Disease Control, the percentage of people ages 65 or greater is expected to increase from 12.4% in 2000 to 19.6 % in 2030 (CDC, 2003). The biggest risk factor for colon cancer is age. More than 90% of people diagnosed are 50 years or greater with the average age of 64 (Langman, 2000). The impact of diabetes is expected to intensify for the 65 years and greater population. Currently 18.7% of the population is affected by the illness (CDC, 2003). Similarly, the anticipated affect of obesity on the population is also significant. The incidence of obesity is increasing at a range from 0.3-0.9% annually (Wang & Beydoun, 2007). If this continues, by 2015, 74% of adults will be overweight, and 41% will be obese (Wang & Beydoun, 2007).

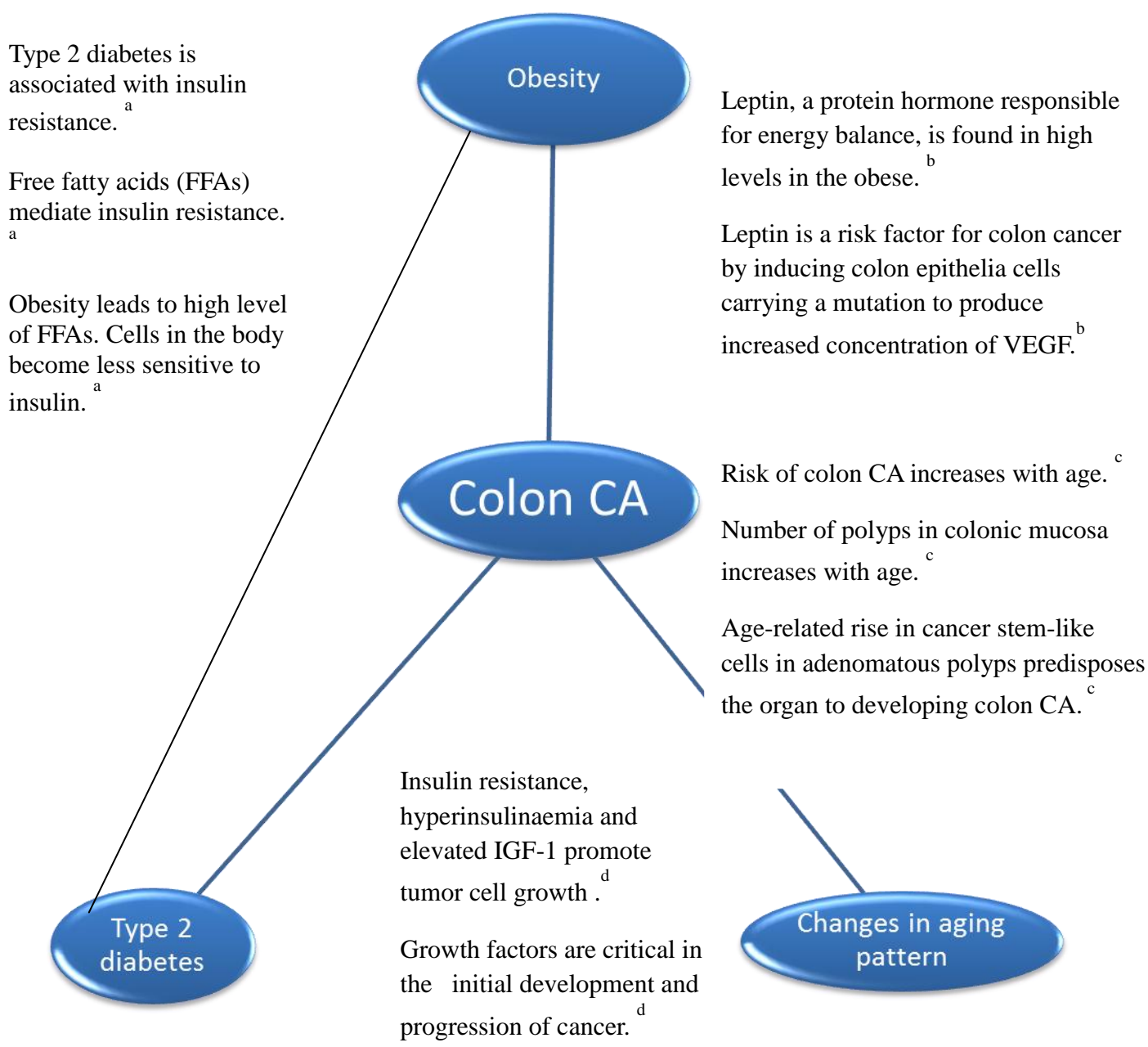
The risk for colon CA increases with age. The number of polyps in the colonic mucosa increases with age (National Cancer Institute, 2011). This increase in stem-like cells in adenomatous polyps predisposes the organ to developing colon CA.

Rationale for Study and Organizing Framework

The rational and organizing framework for this study are explained as follows. First, one of the many risk factors for developing colon cancer is age. Most people diagnosed with the disease are over 50 years of age (Langman, 2000). Secondly, a study done between 1999 and 2002 suggested that 27.6% of men and 33.2% of women are obese, and one in every six children and adolescents is overweight. Type 2 diabetes is linked with the increased incidence of colon cancer because of elevated level of growth hormone and the use to insulin therapy (Berster & Goke, 2008). As of 2009, the CDC reported that about 7.8% of the population is diabetic. This rate is likely to increase as people begin to live longer. The connection between obesity and type 2 diabetes is established by the level of free fatty acids (FFAs). FFAs mediate insulin resistance. Obesity leads to high level of FFAs causing cells in the body to become less sensitive to insulin (Guilherme et al., 2008). This organizing framework as shown in Figure 1 has been used to plan the methodology.

Figure 1

Organizing Framework



Chapter 3: Method

This chapter addresses the research plan that was used to achieve each of the aims, 1) to identify existing databases that can be used to establish an association between colon cancer, type 2 diabetes, obesity, and changes in the aging pattern, 2) to extract data from specific databases and to plot trends patterns in colon cancer, type 2 diabetes, obesity, and changes in the aging pattern, and 3) to determine possible associations between colon cancer, type 2 diabetes, obesity, and changes in the aging pattern.

Aim 1: To identify existing databases that can be used to establish an association between colon cancer, type 2 diabetes, obesity, and changes in the aging pattern.

To achieve Aim 1, a computerized literature search and consultation with a librarian from the Arizona Health Science Center Library, who are assigned to the College of Nursing, were performed. With the computerized literature search, the databases must have met four key criteria. First, for the computerized literature search, the sources used were between 1999 and 2009 surveillance for colorectal cancer, type 2 diabetes, obesity, and the aging population. The data were from the United States. The age group of the subjects must be 45 years and older, and lastly, the data for colorectal cancer, type 2 diabetes, and obesity must have total cases for each of years between 1999- 2009. These three search criteria allowed for consistent and reliable application of the information to meeting the goal of Aim 1.

The Google search engine was used to help identify databases. The following search terms listed in Table 1 were used for colorectal cancer, type 2 diabetes, obesity, and the changes in the aging pattern.

Table 1:

Google Search Terms

Colon cancer	Type 2 diabetes	Obesity	Changes in the aging pattern
1) total cases of colorectal cancer, United States 1999 - 2009	1) type 2 diabetes trends in the United States	1) obesity trend in the United States 1999 – 2009	1) aging trends- United States
2) colorectal cancer total cases- United States 1999 -2009	2) type 2 diabetes 1999 – 2009, United States, total cases	2) United States obesity- total cases.	

The next step was to consult with the University of Arizona College Of Nursing Librarian, Hannah Fisher, from the Arizona Health Science Library. AHSL is the largest, most comprehensive health sciences library in Arizona, providing electronic access to vast stores of biomedical literature.

Hannah Fisher was first contacted through electronic mail. The electronic mail explained to Ms. Fisher about 1) the purpose of the honors thesis, 2) the three aims with a focus on Aim 1, and 3) the established search criteria.

Aim 2: To extract data from specific databases and to plot trends patterns in colon cancer, type 2 diabetes, obesity, and changes in the aging pattern.

Following the identification of databases to be used in this study, a spreadsheet on Microsoft Excel was constructed. The data on statistics for colorectal cancer, type 2 diabetes, obesity, and changes in the aging pattern for the United States from 1999 – 2009 were entered onto the spreadsheet.

The spreadsheet has ten columns and eleven rows. The first column is labeled years and listed below it were years from 1999 to 2009. The first column was the number of colon cancer cases followed by number nonhereditary colon cancer cases and the corrected number of colon cancer cases per 100,000. The subsequent columns were the following: number of type 2 diabetes cases, corrected number of type 2 diabetes cases per 100,000, number of obesity cases, corrected number of obesity cases per 100,000, number of people in the United States who are 45 years or older, and corrected number of people in the United States who are 45 years or older per 100,000.

The data were then plotted on a graph with the x-axis being the years from 1999 to 2009. The y-axis was incidence per 100,100. The graph contained four lines. Each line corresponded to the prevalence of colon cancer, type 2 diabetes, obesity, and changes in the aging pattern. Each plot on the graph represented the number of cases per 100,000 for that specific year.

Aim 3: To determine possible associations between colon cancer, type 2 diabetes, obesity, and changes in the aging pattern.

To achieve Aim 3, the correlation coefficient was utilized in determining possible associations between colon cancer, type 2 diabetes, obesity, and changes in the aging pattern. Three graphs were constructed from data extracted in Aim 2. Consistent in all the graphs, the x-axis was the number of cases colon cancer per 100,000. The three graphs varied in their y-axis,

type 2 diabetes, obesity, and changes in the aging pattern. Each plot on the graph was labeled with the year.

If the correlation coefficient is greater or equal to +0.7, then there is a correlation between colon cancer and type 2 diabetes, obesity, or changes in the aging pattern. If the correlation coefficient is less than +0.7, then there is no correlation between colon cancer and type 2 diabetes, obesity, or changes in the aging pattern.

Chapter 4: Results

Introduction:

The increased prevalence of colon cancer between 1999 and 2009 has induced different speculations about risk factors. Three of the speculations include the high incidences of type 2 diabetes, obesity, and the aging American population. The purpose of this work was to determine if the incidence of colon cancer is associated with obesity, type 2 diabetes, and or changes in aging pattern using existing databases.

Aim 1:

The first aim of the study was to identify existing databases that can be used to establish an association between colon cancer, type 2 diabetes, obesity, and changes in the aging pattern. The database identified for colon cancer statistics from CA- A Cancer Journal for Clinicians 1999-2009. The database identified for type 2 diabetes was from Center for Disease Control. Lastly, the obesity database was obtained from National Health and Nutrition Examination Survey. The data for number of American 45 years and over are obtained from the U.S. Census Bureau. Table 2 shows the databases used to establish possible associations between colon cancer, obesity, type 2 diabetes, and changes in aging patterns.

Table 2

Databases Used to Establish Possible Associations Between Colon Cancer, Obesity, Type 2 Diabetes, and Changes in Aging Patterns

Disease	Database
Colon CA	<i>CA, A Cancer Journal for Clinicians</i>
Type 2 diabetes	Centers for Disease Control
Obesity	Centers for Disease Control
Ages \geq 45	U.S. Census Bureau

Aim 2:

The second aim of the study was to extract data from specific databases and to plot trends patterns in colon cancer, type 2 diabetes, obesity, and changes in the aging pattern. The data from CA-A Cancer Journal for Clinicians were estimated number of new colon cancer cases. The data was corrected to exclude the number of colon cancer cases related to hereditary which was 10%. The data were then corrected to reflect the number of new cases of colon cancer in the United States per 100,000 people. The statistics from the CDC was provided as incidences of diagnosed type 2 diabetes per 1,000 people. This was corrected to reflect per 100,000 people. The number of people 45 years and over is taken directly from the census and corrected to reflect per 100,000. The obesity data was incomplete because data were only obtained for 2000, 2002, 2004, 2006, and 2008.

Table 3 as shown below list the incidences of colon cancer, obesity, type 2 diabetes, and people 45 years over per 100,000 between 1999-2009.

Table 3

Incidences of Colon Cancer, Obesity, Type 2 Diabetes, and People 45 Years and Over per 100,000 Between 1999-2009

Years	Colon CA Cases per 100,000 ^e $\times 10^{-7}$	Type 2 Diabetes Cases per 100,000 ^f $\times 10^{-2}$	Obesity Cases per 100,000 ^g $\times 10^3$	≥ 45 per 100,000 ^h $\times 10^4$
1999	3.47	5.6		3.4372
2000	3.32	6.2	3.520	3.4350
2001	3.44	6.7		3.4974
2002	3.72	7.1	3.570	3.5471
2003	3.63	7.2		3.5915
2004	3.62	7.3	3.700	3.6367
2005	3.54	7.6		3.6888
2006	3.58	7.7	4.020	3.7477
2007	3.73	8.0		3.7930
2008	3.55	8.5	3.950	3.8366
2009	3.40	8.8		3.8745

^eNote: Jemal, A., Siegel, R., Ward, E., Hao, Y., Xu, J., Murray, T., & Thun, M.J. (1999-2009). Cancer statistic, 1999-2009. *CA: A Cancer Journal for Clinicians*.

^fNote: Center for Disease Control. (2009). Crude and age-adjusted incidence of diagnosed diabetes per 1,000 population aged 18 to 79 years, United States, 1980-2009. Center for Disease Control. Retrieved from <http://www.cdc.gov/diabetes/statistics/prev/national/figage.htm>

^gNote: Center for Disease Control (2010). Prevalence of overweight, obesity, and extreme obesity among adults: United States, trends 1976-180 through 2007-2008. Center for Disease Control. Retrieved from http://www.cdc.gov/NCHS/data/hestat/obesity_adult_07_08/obesity_adult_07_08.pdf

^hNote: United States Census Bureau (1999-2009). Population and area. U.S. Census Bureau. Retrieved from http://www.allcountries.org/uscensus/1_population_and_area.html

In Figure 2, a graph plots the data from Table 3 to provide a visual for the trend of colon cancer, obesity, type 2 diabetes and people 45 years and over per 100,000 between 1999- 2009. Colon cancer is represented by blue diamonds, type 2 diabetes is represented by red boxes, the green triangles are obesity, and the gray X presents people 45 years and over per 100,000.

Figure 2

Incidences of Colon Cancer, Obesity, Type 2 Diabetes, and People 45 Years and Over per 100,000 Between 1999-2009

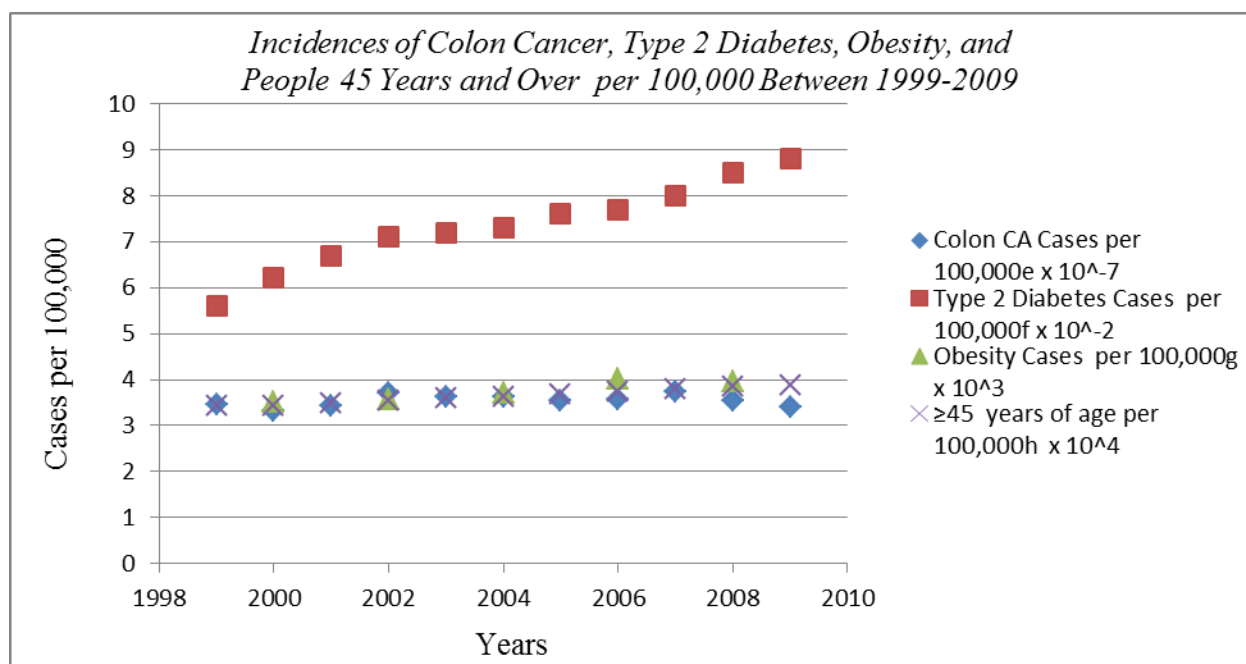
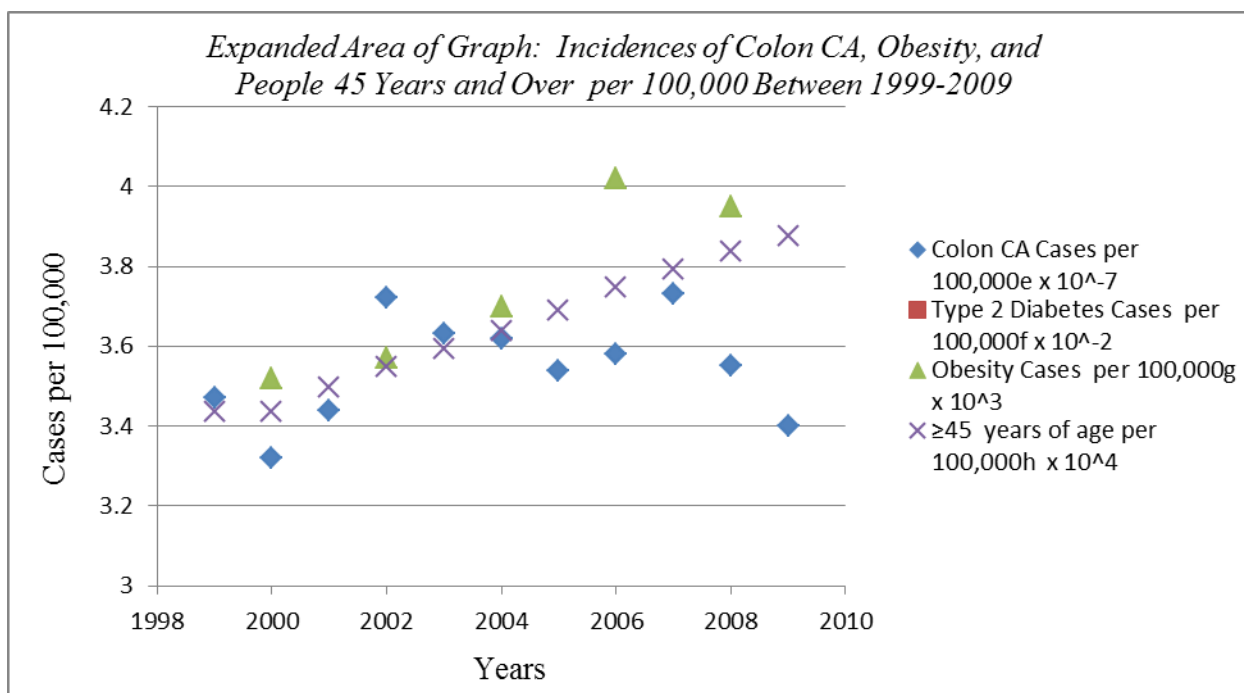


Figure 3 expanded the area of the graph of Figure 2 to provide a better visual of the incidences of colon cancer between 1999-2009. Colon cancer is represented by blue diamonds, the green triangles are obesity, and the gray X presents people 45 years and over per 100,000.

Figure 3

Expanded Area of Graph: Incidences of Colon Cancer, Obesity, and People 45 Years and Over per 100,000 Between 1999-2009



Aim 3:

The third aim was to determine possible associations between colon cancer, obesity, type 2 diabetes, and changes in the aging pattern. As shown in Table 4, correlation coefficients for colon cancer and type 2 diabetes were +0.27, colon cancer and obesity were +0.20, and colon cancer and people ages 45 years and over were +0.27.

Table 4

Correlations Coefficients for Obesity, Type 2 Diabetes, and Aging with Colon Cancer and Type 2 Diabetes and Obesity

Risk Factors	Correlation Coefficient
Colon Cancer and Type 2 Diabetes	+0.27
Colon Cancer and Obesity	+0.20
Colon Cancer and People 45 Years and Over	+0.27
Obesity and type 2 diabetes	+0.84

Chapter 5: Discussion

Summary

The correlation coefficient for colon CA and type 2 diabetes, obesity, and age were between +0.20- +0.30. There was no correlation between colon CA and type 2 diabetes, obesity, and the aging population. Although no association was found, the incidences of type 2 diabetes, obesity, and the number of people ages 45 years and over are increasing significantly. The correlation coefficient for obesity and type 2 diabetes was +0.84. The number of cases of colon CA is decreasing.

Possible Explanation

Despite the increase in the aging population, the incidences of colon CA are decreasing. This finding was surprising because of the increase incidences of obesity, type 2 diabetes, and the increase in the 45 years and over population. This decrease is likely due to better diet, screening, and healthier lifestyle. Tests that find polyps and cancer include flexible sigmoidoscopy every five years, colonoscopy every ten years, double contrast barium enema every five years, and CT colonography every five years. People are becoming more aware of the positive effects high fiber low red meat diets and exercises contribute to the overall health of the body. The increase awareness and interests have helped decreased the rate of colon cancer. Unlike other cancers that are linked to obesity and type 2 diabetes such as breast CA, these factors do not pose increase for colon CA (Larsson & Wolk, 2007).

Limitation

The limitation of the study was found the incomplete data on obesity statistics. The CDC surveys obesity in the American population every two years. Data gap exists for 1999, 2001,

2003, 2005, 2007, and 2009. Furthermore, obesity may be underreported because the survey conducted by CDC was based on a self-report survey. Body Mass Index (BMI) is a relative recent tool for health assessment. It's in the last 40 years did this country began to standardize the weight and height ranges for BMI. It was first recommended for use in pediatric in 199 (Klein et al., 2011). It was until 1971 did the National Health and Nutrition Examination Survey adopted the use of BMI to assess the health and nutrition status of adults and children (Klein et al., 2011).

Further Research

The correlation coefficient correlation for obesity and type 2 diabetes warrants further researcher. The cases of obesity and type 2 diabetes are rising significantly, and its impact can cause other diseases such as cardiovascular illnesses, hyperlipidemia, and other forms of cancer. Risks factors for obesity and type 2 diabetes involve many modifiable factors, and nurses can promote awareness through preventative teaching and promoting healthy lifestyle.

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