

Prevalence of gastrointestinal disease in US Military Veterans under outpatient care at the Veterans Health Administration

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Abstract

Objectives: There are currently no reliable estimates of the prevalence of gastrointestinal disease in the US Military Veterans. Hence, the study aims to determine its prevalence in military Veterans in the United States.

Methods: This study utilized a retrospective, correlational design using a patient record database from the Department of Veteran's Affairs. The participants in the study were Veterans diagnosed with gastrointestinal disease. Specific gastrointestinal diseases include more than 500,000 ambulatory care visits annually in the United States, which included peptic ulcer disease, gastroesophageal reflux disease, diverticular disease, ulcerative colitis, Crohn's disease, irritable bowel syndrome, and functional dyspepsia, as well as the symptoms of constipation and nausea/vomiting. This study revealed the exact prevalence of gastrointestinal disease diagnosed in Veterans served in outpatient settings by the Veterans Health Administration and broke down this prevalence over time and by the Veteran period of service.

Results: Findings revealed that gastrointestinal disease prevalence among Veterans varied according to their period of service.

Conclusions: Findings may help improve screening for Veterans with this increased risk factor. However, further research should be performed to verify the prevalence of gastrointestinal disease in Veterans as compared to the general American population.

Keywords

Gastroenterology/hepatology, US military, Veterans

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Introduction

Approximately 60–70 million Americans are affected by digestive diseases.¹ Abdominal pain prompted 15.9 million visits to US clinics in 2012. Gastroesophageal reflux prompted 8.9 million clinic visits. In addition, there were over two million visits due to nausea, diarrhea, constipation, and vomiting.¹ Current estimates of adult Americans with gastrointestinal (GI) disease are as follows: irritable bowel syndrome (IBS)—11%,² peptic ulcer disease—10%, gastroesophageal reflux disease (GERD)—20%, diverticular disease—35–58%,³ inflammatory bowel disease (IBD)—1.3%—including Crohn's disease and ulcerative colitis,⁴ chronic constipation—2–27%,⁵ and functional dyspepsia—as high as 40%.⁶ There are currently no reliable estimates for prevalence of GI disease in US Veterans.

However, there are literature reports that some Veterans are at a higher risk for chronic medical conditions than the

general American population. In particular, Gulf War Veterans have been exposed to toxic chemicals such as chemical warfare, pesticides, and prophylactic drugs, which could contribute to higher incidence of chronic illnesses such as GI and respiratory diseases, chronic fatigue syndrome, neurological disorders, and other symptoms.⁷ A study of 73 Veterans found that 39% of Gulf War Veterans with symptoms of chronic abdominal pain and diarrhea had increased intestinal permeability. Those with intestinal hyperpermeability had greater pain and stool frequency than those without intestinal hyperpermeability. The authors suggested that this may contribute to the pathophysiology of chronic GI

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symptoms in Veterans.⁸ In addition to toxin exposure, changes in the gut microbiome may contribute to the development of GI symptoms. Acute enteric infections have been associated with microbiome changes, particularly an abundance of the bacteria *Escherichia*, when compared with healthy family members.⁹ In a study of military personnel returning from deployment in Operation Iraqi Freedom and Operating Enduring Freedom, 76.8% of those returning from Iraq and 54.4% of those returning from Afghanistan reported diarrhea.¹⁰ Although diarrhea is a symptom of enteric infection, microbiome changes were not assessed in this study.

In a review of GI conditions in Veterans, the authors suggested that increased incidence of diarrhea in Veterans may be related to food- or water-borne pathogens or deployment-related stress, both of which can alter the gut microbiome in the short term, and contribute to disease in the long term, as infectious gastroenteritis is a risk factor for the development of IBS.^{11,12} The authors also offer other suggestions for factors that may contribute to the development of GI disease in Veterans, such as chronic stress, infections, toxins, and non-steroidal anti-inflammatory medications that contribute to leaky gut. However, further research is necessary to investigate the mechanisms underlying the development of GI disease in Veterans.¹¹

The aforementioned research has established that there are numerous potential exposures that are risk factors for GI disease in Veterans. However, the research does not establish current prevalence, which is needed to fully evaluate the scope of the problem. This study aims to determine the prevalence of GI disease in military Veterans in the United States, using a retrospective, correlational design from the patient records database at the Department of Veterans Affairs.

Research variables

For the purposes of this study, researchers will differentiate between functional and structural GI diseases. Functional GI disease is a group of illnesses diagnosed using the Rome Criteria, which is based on symptomology, with no identifiable change in the body or structure of the organs.¹³ The functional GI diseases included in this study were IBS, chronic constipation, and functional dyspepsia. Structural or motility diseases are a group of illnesses diagnosed based on a change in physiology of the organ at the macro or micro level, or altered motility related to muscle activity.¹³ The structural GI diseases included in this study were GERD, peptic ulcer disease, IBD, ulcerative colitis, diverticular disease, and Crohn's disease. For the purpose of this study, the term "chronic disease" is defined as a physiological condition of length greater than 3 months.

The period of service is defined as the period during which the Veteran served. The rates of some illnesses in Veterans vary according to the period in which the Veteran served. The Department of Veterans Affairs defines periods of service as the following wartime periods:

- Mexican Border Period (9 May 1916 to 5 April 1917)
- World War I (6 April 1917 to 11 November 1918)
- World War II (7 December 1941 to 31 December 1946)
- Korean Conflict (27 June 1950 to 31 January 1955)
- Vietnam Era (28 February 1961 to 7 May 1975)
- Gulf War (2 August 1990 to a future date to be set by law or Presidential Proclamation).¹⁴

For the purposes of this study, Veterans will be classified into the following service periods: World War I, World War II, Pre-Korean, Korean, Post-Korean, Vietnam Era, Post-Vietnam, and Persian Gulf War.

Methods

The design

This retrospective, correlational study obtained data from the Department of Veteran's Affairs patient database, managed by the VA Information Resource Center. This design was used to make use of existing data for a large population, requiring minimal risk to that population.

The population and setting

This population of subjects contains all Veterans that are currently enrolled in the Veterans Healthcare system in the United States. Participants were aged 18 years or older, potentially all ethnicities, and males and females. Data were created when a healthcare provider entered an ICD-9 or ICD-10 diagnosis associated with a patient care visit to the Department of Veteran's Affairs patient charting system, the computerized patient record system. Data creation can occur at any inpatient or outpatient encounter within a Department of Veterans Affairs facility anywhere in the United States, but since inpatient and outpatient data were stored separately in the Veterans Health Administration (VHA) databases, this study utilized outpatient data only to improve the ease and accuracy of data processing and avoid redundancy in the data.

Participant inclusion criteria

The participants in the study were Veterans diagnosed with GI disease. Specific GI diseases were those that accounted for more than 500,000 ambulatory care visits annually in the United States, which included peptic ulcer disease, GERD, diverticular disease, ulcerative colitis, Crohn's disease, IBS, and functional dyspepsia, as well as the symptoms of constipation and nausea/vomiting.^{15,16} As data were collected as part of a larger research project, Veterans with a diagnosis of post-traumatic stress disorder (PTSD) were also included in the data collection and were therefore reported in the total number of participants for this report.

Table 1. ICD-9 and ICD-10 diagnostic codes included in the study for recording of gastrointestinal disease.

Gastrointestinal disease	ICD-9 codes	ICD-10 codes
Gastroesophageal reflux disease	530.81	K.21.0, K21.9
Peptic ulcer disease	533	K.27 (all subcodes)
Functional dyspepsia	536.8	K30 (all subcodes)
Crohn's disease	555 (all subcodes)	K50 (all subcodes)
Ulcerative colitis	556 (all subcodes)	K51 (all subcodes)
Diverticular disease	562 (all subcodes)	K57 (all subcodes)
Irritable bowel syndrome	564.1	K58 (all subcodes)
Constipation	564.00, 564.01, 564.02, 564.09	K59.04
Nausea/Vomiting	787 (all subcodes)	R11 (all subcodes)

Participant exclusion criteria

Participants who were not diagnosed with GI disease were excluded from the study. To focus on diseases that most commonly affect Veterans, GI diseases accumulating less than 500,000 ambulatory care visits annually in the United States were excluded, such as rare diseases, such as eosinophilic enteropathy. Diseases with an identifiable, diagnosed non-GI cause were excluded, such as cancer, infection, genetic disease, and acute injury or hernia. Diseases of the liver, gallbladder, and pancreas were excluded.

The sampling method

The data manager at National Data Systems (NDS) assembled a cohort of all patients treated by the VHA system with a diagnosis of GI disease and/or GI symptoms since the creation of the database in 1999. The total number of patients and Veterans treated by VHA for each year 2000–2019 and the total over the course of these years was given to the researcher by NDS. Since the study aimed to identify the exact prevalence of GI disease, the researcher chose to collect data on all available outpatient records at VHA nationally instead of calculating a sample size prior to data collection.

Human subjects: Institutional review board approval

The study was deemed exempted from review, and the consent process was waived by the Institutional Review Board (IRB) and the Research Safety Committee at the Tennessee Valley Healthcare System branch of the Department of Veterans Affairs and by the IRB at the University of Texas Medical Branch. The risks to the participants in this study were minimal. Participants' confidentiality was protected in several ways. The Health Insurance Portability and Accountability Act (HIPAA) identifying information was not included in the data set pulled using the Standard Query Language (SQL) query.

The NDS office created a cohort of VHA patients that met the researcher's ICD-9 and ICD-10 criteria. The cohort was accessed by the researcher using the Microsoft SQL server,

which was only accessible via a remote workspace with VHA identification card and login. The researcher used the SQL to query the data and then transfer the saved tables to SAS 9.4 software, which is located on the VHA remote workspace, for data analysis. VHA security measures prevented data from being removed from the remote workspace.

Data collection process

Data were created when a licensed provider entered diagnostic codes in the patient record system during an outpatient encounter at the Department of Veterans Affairs. This occurred at any outpatient setting at any VA hospital or clinic throughout the United States. Demographic data were formed when the patient is entered into the VA system upon discharge from the US military. The NDS stored these data on all patients treated with VHA from 1999 to the present.

Guidelines for querying data

Data for the study consisted of demographic data and diagnostic codes for GI disease, GI symptoms, and PTSD. Demographic data included the participant's age in years, gender, ethnicity, and period service. Table 1 lists the ICD-9 and ICD-10 codes requested for GI disease. When utilizing ICD coding, there are often multiple code options for a disease to allow the coder to be more specific. When indicated in the table, "all subcodes" denoted the inclusion of the various subtypes of a disease. For example, the broad category of ICD-10 codes for peptic ulcer disease is K27. In this study, all subcodes were included: K27.0 acute peptic ulcer, site unspecified, with hemorrhage, K27.1 acute peptic ulcer, site unspecified, with perforation, K27.2 acute peptic ulcer, site unspecified, with both hemorrhage and perforation, and so on through K27.9 peptic ulcer, site unspecified, unspecified as acute or chronic, without hemorrhage or perforation. This designation allows for the inclusion of all GI codes without listing each subtype.

Data were queried by patient outpatient visits that occurred within each year time frame, such as 1 January 2015 to 31 December 2015. This created 21 tables for years

Table 2. Observed counts of gastrointestinal disease among patients treated outpatient at VHA 1999–2019.

GERD	3,488,344
Peptic ulcer disease	248,132
Functional dyspepsia	415,307
Crohn's disease	55,758
Ulcerative colitis	103,076
Diverticular disease	1,396,359
Irritable bowel syndrome	288,368
Constipation	871,109
Nausea/Vomiting	2,159,137

VHA: Veterans Health Administration; GERD: gastroesophageal reflux disease.

1999–2019. The tables for 1999 and 2019 were partial tables for separate reasons. The year 1999 was the creation of a computerized record database and, therefore, was a transition year in which not all records were computerized. For this reason, NDS was not able to provide the researcher with a total number of patients treated within the VHA system in 1999. The year 2019 was collected as a partial year because the project start date was 1 April 2019. Data collected for 2019 pertained only to visits from 1 January 2019 to 31 March 2019. For this reason, the number of participants from 2019 cannot be accurately compared to the total VHA patient counts for 2019 yet is still valuable when reviewing total prevalence of disease.

Once the data were organized into the 21 tables, these tables were combined with a second SQL query to create a table for all years. This second query eliminated records that repeat in more than 1 year, so that the patient appears in the “All-Years” table only once. If a Veteran was treated for GERD in 2000, but then resolved and was not treated in 2001, then this Veteran would not be recorded in the 2001-year table. When combining all years, the Veteran would be recorded as positive for a diagnosis of GERD in the “All Years” table.

Veteran age. Age was measured at the time of the last visit. When 21 years were combined into one comprehensive table, age was recorded as the most recent age. For example, if a Veteran was aged 40 years at the last related visit in 2000 and then deceased before 2001, that Veteran would not be recorded in the 2001 table. However, in the “All Years” table, that Veteran record would be included, and the age would be 40 years.

Period of service. The period of service showed as the most recent period of service in which the Veteran served. It is possible that a Veteran served multiple periods of service. If a Veteran served in both the Vietnam Era and the Persian Gulf War, then VHA stores that Veteran's Period of Service information as “Persian Gulf War,” and this is what is shown in both yearly tables and the “All Years” combined tables.

Table 3. Veterans' age at the time of last gastrointestinal outpatient visit, by decade.

Age (years)	Number of participants
<20	1239
20–29	80,677
30–39	490,447
40–49	449,135
50–59	746,103
60–69	1,274,236
70–79	1,745,874
80–89	1,166,161
90–99	388,816
100–109	9650

Final tables

The final “All Years” table and the 21 yearly tables were saved as permanent files within the Microsoft SQL Server. They were transferred to SAS 9.4 analytical software via SAS query language. The researcher used SAS 9.4 September 2017, software to transform the data and interpret the statistics. Descriptive statistics, including means, percentages, histograms, and contingency tables were used to describe and explain the data outcomes.

Analysis

There were 6,352,586 participants with either the included GI diseases, GI symptoms, or PTSD in the study. The VHA provided the researcher with minimal population data. From 2000 to 2019, VHA reported that it treated 13,669,058 Veterans and 15,842,376 patients (including some non-Veteran patients treated by VHA for a variety of reasons).

Observed counts of GI disease

The initial frequency counts of GI disease observed in patients treated in the outpatient setting at VHA are reported in Table 2.

Veteran age by decade

In this study, ages ranged from 18 to 140 years; therefore, it was assumed that some ages were inaccurate in the patient record. Table 3 shows breakdown of the participants' age at the time of their last visit that met inclusion criteria. When analyzing data, any participant aged 110 years or above was removed from the analysis.

Gender of Veterans

The participants included 500,997 females and 5,851,856 males, with three participants with missing gender information. Participants with missing gender identification were excluded from the analysis.

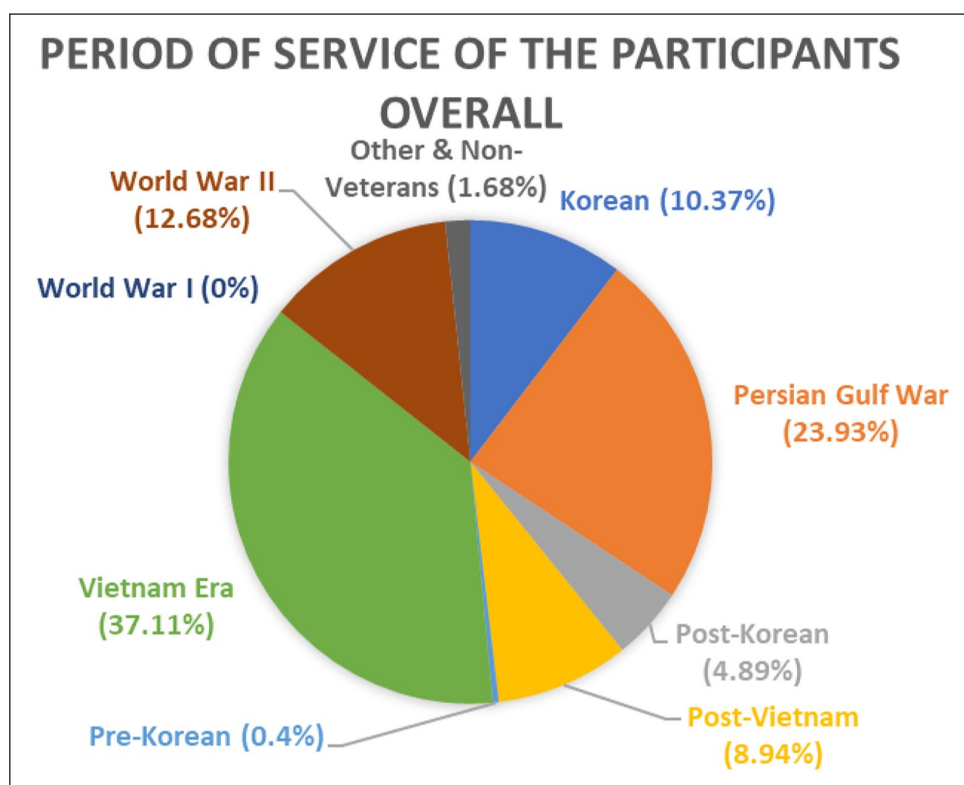


Figure 1. Percentage of Veteran participants who served in each wartime period.

Period of service of Veterans

The period of service of Veterans was collected, and it was noted that there are some periods of service that participants did not qualify as a Veteran. Figure 1 shows the percentages of Veterans who served during wartime periods with other non-Veteran groups combined into a category marked “other.” Since these “other” category participants were not Veterans, this group was removed from the analysis. Together the service periods identified as Korean, Persian Gulf War, Post-Korean, Post-Vietnam, Pre-Korean, Vietnam Era, World War I, and World War II accounted for more than 98% of the sample. The participants who served in the period of service of the Spanish American War were removed from the study, as it is not expected that any members of the Spanish American War would still be living in 1999, and it is likely that these individuals were mistakenly never marked as deceased in their medical records.

In addition, the Department of Veterans Affairs’ data services provided the researcher with population information for the period of service of all Veterans treated by VHA (Table 6). Of note, some Veterans may have served in two periods of service and therefore have occurred in multiple conflicts in the period of service column in Table 6. These occurrences cannot be removed because this information is not study data, but population information provided by VHA. However, in this study, period of service for each Veteran only shows once, listed as the most

Table 4. Prevalence of gastrointestinal disease after removing outliers.

Condition	Prevalence of disease
Gastroesophageal reflux disease	25.52% (n = 3,446,381)
Peptic ulcer disease	2.06% (n = 281,744)
Functional dyspepsia	2.99% (n = 408,202)
Crohn’s disease	0.81% (n = 110,472)
Ulcerative colitis	0.74% (n = 101,831)
Diverticular disease	10.12% (n = 1,383,472)
Irritable bowel syndrome	2.07% (n = 282,618)
Constipation	6.29% (n = 859,428)
Nausea/Vomiting	15.45% (n = 2,111,482)

recent period of service at the time of discharge from the military.

Statistical analysis

Descriptive statistics were used to describe the prevalence of GI disease in Veterans. Prevalence of GI disease over the years 2000–2019 was calculated as a percentage, using the total number of Veterans treated by VHA between the years 2000 and 2019: 13,669,058, shown in Table 4. For prevalence occurring in each calendar year, percentages were calculated by dividing the number of Veterans identified with the disease by the total numbers of Veterans treated by VHA for each calendar year, listed as “x” in Table 5.

Table 5. Prevalence of GI disease over time in Veterans treated outpatient by VHA.

	Gastroesophageal reflux disease	Peptic ulcer disease	Functional dyspepsia	Crohn's disease	Ulcerative colitis	Diverticular disease	Irritable bowel syndrome	Constipation	Nausea/Vomiting
2000 (x = 4,137,010)	7.61% (n = 314,818)	1.26% (n = 52,199)	1.01% (n = 41,899)	0.17% (n = 6,936)	0.24% (n = 10,005)	1.79% (n = 73,869)	0.46% (n = 18,844)	0% (n = 146)	3.03% (n = 125,212)
2003 (x = 5,087,136)	11.69% (n = 594,589)	0.94% (n = 47,979)	0.88% (n = 44,812)	0.20% (n = 10,082)	0.28% (n = 14,005)	2.19% (n = 111,193)	0.48% (n = 24,335)	1.44% (n = 73,209)	3.24% (n = 164,928)
2006 (x = 5,462,608)	13.34% (n = 728,732)	0.76% (n = 41,508)	0.77% (n = 42,319)	0.21% (n = 11,671)	0.28% (n = 15,378)	2.38% (n = 129,976)	0.54% (n = 29,298)	1.71% (n = 93,596)	3.63% (n = 198,536)
2009 (x = 5,843,242)	13.78% (n = 805,221)	0.60% (n = 35,067)	0.66% (n = 38,766)	0.23% (n = 13,310)	0.35% (n = 20,731)	2.46% (n = 143,561)	0.58% (n = 33,779)	1.90% (n = 111,192)	4.02% (n = 234,658)
2012 (x = 6,237,423)	13.84% (n = 863,375)	0.46% (n = 28,795)	0.57% (n = 35,595)	0.24% (n = 15,140)	0.31% (n = 19,116)	2.39% (n = 149,255)	0.64% (n = 40,016)	2.02% (n = 125,899)	4.26% (n = 265,563)
2015 (x = 6,463,211)	14.26% (n = 921,335)	0.32% (n = 20,462)	0.45% (n = 29,384)	0.26% (n = 16,714)	0.37% (n = 23,764)	2.37% (n = 152,887)	0.77% (n = 49,777)	1.68% (n = 108,733)	4.14% (n = 267,262)
2018 (x = 6,529,365)	14.41% (n = 941,008)	0.10% (n = 6,610)	0.26% (n = 16,908)	0.27% (n = 17,532)	0.46% (n = 29,978)	1.79% (n = 116,860)	0.96% (n = 62,381)	0.16% (n = 10,186)	1.19% (n = 77,956)

GI: gastrointestinal; VHA: Veterans Health Administration.

Results

Prevalence of GI disease

The prevalence of GI disease among Veterans has not been reported in the literature prior to this study. Therefore, as a result, this study has identified overall prevalence of GI disease within Veterans treated at VHA over a 20-year period as shown in Table 4. After removal of missing gender, age over 110 years, Veterans who served in the Spanish American War, and non-Veteran status in period of service, the observed frequency counts of the studied conditions within the participants are shown in Table 4.

In addition, Table 5 shows how the prevalence of GI disease changes over time in Veterans. Prevalence was calculated every year for the calendar years of 1 January through 31 December of each year from 2000 to 2018, but is only shown every 3 years in Table 5 in the interest of space.

Summary of disease prevalence over time in Veterans

It was observed that prevalence of

- GERD, IBS, and Crohn's disease has increased since 2000.
- Peptic ulcer disease and functional dyspepsia has decreased over time since the year 2000.
- Ulcerative colitis has fluctuated over time with an upward trend.
- Diverticular disease has fluctuated with a downward trend.
- Constipation and nausea/vomiting steadily increased over time until 2015, when a dramatic decrease was observed.

The prevalence of GI disease was calculated by the variable of period of service, as shown in Table 6, in chronological order of conflict. Results were calculated by dividing the number of Veterans within the period of service that were observed to have the indicated GI disease by the total number of Veterans within that period of service who have been treated by VHA in the outpatient setting over the course of the years from 2000 to 2019. The frequency of observation of each indicated condition as well as the VHA-reported data on Veterans who were treated in each period of service is reported in Table 6. Since population data reflect multiple periods of service for Veterans who served in multiple periods, whereas this study only reflects the most recent period of service in which the Veteran served, this prevalence is the minimum seen within the period. The prevalence of disease per period of service could potentially be higher if multiple periods of service were considered.

Discussion

The findings of this study expand upon the work of previous researchers who have reviewed the burden and prevalence of

Table 6. Prevalence of GI disease by Veteran period of service.

Period of service	GERD	Peptic ulcer disease	Functional dyspepsia	Crohn's disease	Ulcerative colitis	Diverticular disease	IBS	Constipation	Nausea/Vomiting
World War I (n = 4098)	3.22% (f = 132)	0.61% (f = 25)	0.39% (f = 16)	0% (f = 1)	0.07% (f = 3)	0.98% (f = 40)	0.12% (f = 5)	0.98% (f = 40)	2.24% (f = 92)
World War II (n = 2,020,736)	22.34% (f = 451,525)	3.25% (f = 65,759)	2.55% (f = 51,441)	0.24% (f = 5039)	0.51% (f = 10,276)	7.83% (f = 158,272)	0.95% (f = 19,237)	8.57% (f = 177,795)	15.42% (f = 311,659)
Pre-Korean (n = 66,250)	23.38% (f = 15,488)	2.69% (f = 1779)	2.27% (f = 1501)	0.32% (f = 214)	0.65% (f = 437)	8.39% (f = 5559)	0.83% (f = 553)	7.21% (f = 4779)	12.95% (f = 8581)
Korean (n = 1,438,639)	27.93% (f = 401,777)	3.35% (f = 48,206)	3.30% (f = 47,502)	0.37% (f = 5313)	0.76% (f = 10,900)	12.07% (f = 173,603)	1.21% (f = 17,426)	8.96% (f = 128,916)	17.38% (f = 249,867)
Post-Korean (n = 691,885)	28.29% (f = 195,731)	2.76% (f = 19,095)	3.29% (f = 22,785)	0.43% (f = 2966)	0.83% (f = 5739)	13.33% (f = 92,234)	1.33% (f = 9195)	7.26% (f = 50,236)	15.99% (f = 110,658)
Vietnam Era (n = 4,495,928)	30.10% (f = 1,353,239)	2.34% (f = 105,378)	3.65% (f = 164,091)	0.48% (f = 21,744)	0.92% (f = 41,368)	15.58% (f = 700,539)	1.78% (f = 80,047)	7.03% (f = 316,161)	18.52% (f = 832,719)
Post-Vietnam (n = 1,259,470)	26.10% (f = 328,653)	1.53% (f = 19,240)	3.49% (f = 43,986)	0.50% (f = 6296)	0.83% (f = 10,969)	10.02% (f = 126,913)	2.50% (f = 31,454)	5.87% (f = 73,990)	16.78% (f = 211,320)
Persian Gulf War (n = 3,605,995)	19.40% (f = 699,734)	0.62% (f = 22,257)	2.13% (f = 76,872)	0.36% (f = 13,141)	0.61% (f = 22,138)	3.52% (f = 126,953)	3.46% (f = 124,690)	2.98% (f = 107,504)	10.72% (f = 386,551)

GI: gastrointestinal; GERD: gastroesophageal reflux disease; IBS: irritable bowel syndrome; VHA: Veterans Health Administration.

In Table 6, n = the number of Veterans in each service period treated by VHA and f = the frequency of disease occurring within the Veterans of each service period.

GI disease.^{15,17} Prior to this study, there were estimates of its prevalence in the general American population, but there were no available data on the prevalence of GI disease specific to Veterans.^{2–6,17} The following discussion will review and compare the literature on each GI disease investigated in this study.

GERD

Estimates of the prevalence of GERD in the United States have ranged from 6% to 30%, depending on the questionnaire and methodology used in each study.¹⁸ A systematic review of 29 studies on the prevalence of GERD in North America narrowed this range to 18.1%–27.8%.¹⁹ The rate of GERD in US Veterans treated at VHA as identified in this study was 25.52%. While this rate is higher than many of the studies cited in the systematic review,¹⁹ it is not conclusive whether the rate of GERD in Veterans is higher than the rate of GERD in the general US population. It is noteworthy that this prevalence varied by period of service, with the most considerable differences in the Vietnam Era, with 30.10% of service members experiencing, and the Persian Gulf War, with only 19.40% of service members experiencing GERD. However, this may be age related, as the Persian Gulf War Veterans are generally substantially younger than Vietnam Era Veterans, and the incidence of GERD increases with age due to lower esophageal sphincter pressure in older individuals.²⁰

Peptic ulcer disease

The prevalence of peptic ulcer disease has been reported to be as high as 10% among US adults.³ However, this rate has decreased over time with the identification of *Helicobacter pylori* as the cause of more than 90% of gastric ulcers, which has led to treatment of the condition with antisecretory drugs.²¹ This study supports prior findings, as rates of peptic ulcer disease have been falling in Veterans treated with VHA from 2000 to 2018.

Functional dyspepsia

Studies on the prevalence of functional dyspepsia in US adults vary from 20%¹⁸ to the highest reported prevalence as up to 40% of the US adult population.⁶ These estimates appear quite high when compared to the 2.99% of Veterans who were diagnosed with functional dyspepsia in this study. However, another study also acknowledges the 40% estimated prevalence, but further explains that only 10% of those who suffer from functional dyspepsia seek medication attention.²² To simplify, 40 people out of 100 experienced symptoms of functional dyspepsia, but only 4 people seek treatment. We can extrapolate a 4% prevalence of diagnoses in adults in the United States. This may explain some of the discrepancy in prevalence estimates, as participants in this study were only Veterans who had reported symptoms and/or sought treatment for the condition.

IBD

The conditions of ulcerative colitis and Crohn's disease were investigated separately in this study but can often be found in the literature together as IBD. The Centers for Disease Control and Prevention (CDC) has reported the prevalence of IBD to be 1.3% in adults in the United States.⁴ This rate is rising in the United States, and it has been hypothesized that this is due to increased exposure to poor sanitation and bacteria in urban and industrialized areas.²³ Similarly, the prevalence of both ulcerative colitis and Crohn's disease was observed to be rising in US Veterans treated at VHA and were highest in Veterans who served in the countries of Korea and Vietnam, where sanitary conditions were poor.²⁴

Diverticular disease

The CDC reports the prevalence of diverticular disease in US adults ranging from 35% to 58%.³ However, these estimates can be misleading, as diagnosis of diverticular disease is highly dependent on age. One study reports a prevalence of 10% in those under 40 and 50 years to 70% in those over 80 years.²⁵ The prevalence rate of diverticular disease identified in this study was 10.22% for all Veterans treated in the outpatient setting at VHA, so it is not possible to conclude that the prevalence of diverticular disease is different for Veterans than the general population. However, the highest prevalence was observed in those who served during the Vietnam Era. Due to the significant age correlation in other studies, the expectation would have been for the highest rates to be in the oldest generations who served during periods of service such as World War I, World War II, and the Korean Conflict.

IBS

In US adults, the prevalence of IBS has been estimated to be 11%,³ or 10%–15% by the American College of Gastroenterology.²⁶ However, the authors note that only 5%–7% of US adults have been diagnosed, and IBS is twice as likely in women than in men.²⁶ Since only 14% of active military duty personnel are women and this study's participants were 87.32% male, the lower prevalence rate of IBS in the study was expected. The prevalence of IBS was highest during the period of service of the Persian Gulf War, which had lower rates of all other GI diseases when compared to other periods. This difference may be due to higher numbers of women serving in the Persian Gulf War than in other periods of service.²⁷

Constipation

Constipation prevalence estimates range from 2% to 27% in US adults, depending on study methodology.⁵ This study's findings of a prevalence of 6.29% in Veterans was therefore expected, and it is not possible to conclude that prevalence of

constipation in all Veterans is different from that in the general population.

Nausea

General prevalence estimates of nausea in US adults have not been reported in the literature. Nausea is more difficult to report as it is a symptom of many other disorders. The prevalence of nausea in Veteran in this study was found to be 15.45%

Additional observations

Another observation is that the prevalence of GI disease was generally higher in all GI conditions in the Veterans who served in the Korean and Vietnam Era periods of service. This may again be related to age. However, it is also worth reviewing the potential that environmental exposures in Asian countries such as chemical toxins (Agent Orange), infections, or parasites may have contributed to the alteration of the gut microbiome.¹¹

Finally, the prevalence of all GI diseases was substantially lower in those who had served in the Persian Gulf War than those who served in other periods. Since this is the only group who has not yet reached geriatric age status, they should be monitored over time to explore whether the incidence and prevalence of disease increases with age. In addition, future research should investigate the differences in environmental and situational exposures in Asian countries and conflicts of Korea and Vietnam versus the Middle Eastern countries and operations of Iraq and Afghanistan, as well as the impact of such on the development of GI disease in Veterans.

Study strengths

The study's participant recruitment strategy was a strength because it gathered the exact counts of GI disease within the Veteran population treated in outpatient care across VHA nationally. The prevalence of diseases was provided as of 31 March 2019. These findings may provide information that will enhance future research by providing population information on Veterans treated by VHA.

Limitations

The study was limited by the lack of access to population data for all VHA-treated Veterans. The study did not have access to exact age, ethnicity, and period of service data for the selected population. The literature showed estimates of gender in Veterans, but the specific data were not accessible through VHA. The study could not control for all possible confounding variables together without these data.

Data on inpatient cases of GI disease were not collected. Veterans who were treated inpatient for an acute episode of

GI disease and did not follow up in the outpatient clinics may have been missed in the total report of cases.

In addition, the data gathered included both ICD-9 and ICD-10 codes. The United States, including the VHA, switched from ICD-9 to ICD-10 codes in the year 2015. In 2016, this study found prevalence of disease to be unexpectedly dissimilar from the trend from the previous years. It is likely that the change in ICD coding procedures influenced the results of this study. To confirm this effect, the study should be repeated with data gathered by month rather than by year to follow the change more precisely as coding changed.

It is difficult to compare the results of this study with those reported in the literature. In each case, the literature reports an estimated rate of disease, whereas this study recorded a count of all cases of diagnosis. It is possible that disease is underreported or underdiagnosed in Veterans. It is also important to note that this study does not account for Veterans that were only treated for a disease in an inpatient setting within the VA, so some cases of GI disease in Veterans may not be counted. In addition, the prevalence calculated in this study was over a 20-year period, while the time frame in the literature either varies or is not reported. This large time frame does not account for incidence, which may make the yearly prevalence smaller than the total prevalence over time.

Finally, it was assumed that some Veterans served in multiple service periods. To prevent redundancy in the prevalence reporting, each Veteran was counted only once, in their most recent period of service. While this does not affect total prevalence of each GI disease in Veterans treated by VHA as a whole, it could potentially affect the prevalence by period of service. For example, if a Veteran served in both the Vietnam era and the Post-Vietnam era, that Veteran's positive GI disease would be counted under the Post-Vietnam era only. Therefore, results by period of service could potentially be higher than observed.

Conclusion

This study revealed the prevalence of GI disease diagnosed in Veterans served in outpatient settings by the VHA and broke down these data over time and by the Veteran period of service. Findings revealed that GI disease prevalence among Veterans varies by the period of service in which the Veteran served. This may lead providers to improve screening for Veterans with this increased risk factor. However, further research should be performed to verify this study's findings as compared to the general American population.

Declaration of conflicting interests

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Ethical approval

Ethical approval for this study was waived by the Institutional Review Boards (IRBs) at the University of Texas Medical Branch and the Department of Veterans Affairs Tennessee Valley Healthcare System because there was minimal risk to participants. No Health Insurance Portability and Accountability Act (HIPAA) identifying information was collected. University of Texas Medical Branch IRB exemption number 19-0039.

Informed consent

Informed consent was waived by the institutional review boards (IRBs).

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