DISSERTATION

THE BURDEN OF ACUTE GASTROINTESTINAL ILLNESS AND FOODBORNE ILLNESS CAUSED BY FIVE MAJOR PATHOGENS AMONG NONDEPLOYED ACTIVE DUTY US ARMY SERVICE MEMBERS 2014-2015

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ABSTRACT

THE BURDEN OF ACUTE GASTROINTESTINAL ILLNESS AND FOODBORNE ILLNESS CAUSED BY FIVE MAJOR PATHOGENS AMONG NONDEPLOYED ACTIVE DUTY US ARMY SERVICE MEMBERS 2014-2015

The US Army has a robust food protection program in place to prevent foodborne illness from occurring in service members. However, there is no system in place to assess the effectiveness of this program. The purpose of this dissertation is to estimate the burden of acute gastrointestinal illness (AGI) among nondeployed active duty US Army service members, to estimate the number of foodborne illnesses caused annually by five major pathogens, and to make recommendations for a DoD-wide comprehensive and integrated active foodborne illness surveillance system that meets the seven objectives of foodborne disease surveillance. This is accomplished through a four-part project.

Part 1: To estimate the magnitude and distribution of self-reported, acute gastrointestinal illness (AGI) among nondeployed active duty Army service members, we conducted a retrospective, cross-sectional, web-based survey that reached 60,003 randomly selected service members from April to May 2015. There were a total of 2,047 completed surveys received (response rate 3.2%). The estimated 30-day prevalence of self reported AGI was 18.5% (95% CI: 16.66-20.25), and the estimated annual incidence rate was 2.24 AGI episodes per person-year (95% CI: 2.04-2.49). Risk factors for AGI included region of residence, eating at the on-post dining facility, and eating at other on-post establishments when controlling for gender, rank, and race. Those who were assigned to the installations with the highest annual AGI incidence rate

were more likely to purchase food at on-post establishments. Extrapolation of the estimates indicates that there are more than 1 million cases of AGI occurring per year among nondeployed active duty US Army service members, which translates to as much as $847,451,629 (95% CI: $727,331,502-$978,720,151) in paid work lost due to AGI.

Part 2: Laboratory surveillance is imperative for estimating the burden of foodborne illness in a population. Many cases of foodborne illness are not captured by laboratory surveillance because many ill individuals do not seek medical care and submit a stool sample. Identifying the factors associated with individuals who report AGI seeking medical care and submitting a stool sample is an important step in calculating the true burden of AGI caused by foodborne pathogens in a population. We characterized the severity of AGI among nondeployed US Army service members, comparing these results to other published studies, and found that our population associated missing work for their illness and respiratory symptoms (sore throat cough) with seeking medical care. We used univariable and multivariable logistic regression to analyze data from a 2015 population-based web survey of nondeployed active duty US Army service members to identify the factors associated with this population seeking medical care and submitting a stool sample for AGI. In order to compare our results to other published results, we used two different case definitions for AGI. Sixteen and a half percent reported symptoms of AGI in the four weeks prior to completing the survey, and 20.2% sought medical care for their illness. We found that among nondeployed US Army service members with AGI, the factors associated with seeking medical care included: gender, rank, education, experiencing sore throat or cough, vomiting, and missing work. Of the service members seeking medical care, 11.7% provided a stool sample. When controlling for gender and age, experiencing $\geq$ 5 loose stools in a 24-hour period and absence of a sore throat was associated with submitting a stool specimen.

We found that for every one nondeployed active duty US Army service member with bloody diarrhea who went to the doctor and submitted a stool sample, there are 17-23 service members in the population with bloody diarrhea. For every one nondeployed active duty US Army service member with non-bloody diarrhea who went to the doctor and submitted a stool sample, there are 31-44 service members in the population with non-bloody diarrhea.

Part 3: Laboratory-based surveillance systems rely on clinical laboratories to identify pathogens of public health importance through microbiological testing. We surveyed US Army laboratories to describe general laboratory practices including: specimen handling, routine testing procedures for *Campylobacter* spp., *E. coli* O157:H7 and other shiga toxin producing *E. coli* (STEC), *Salmonella* spp., and *Shigella* spp., and reporting procedures for these pathogens. We surveyed 13 clinical laboratories out of 41 fixed US Army medical facilities, which tested an estimated 26,373 stool specimens in 2014. All laboratories reported routinely testing for *Salmonella* and *Shigella* species. All but one laboratory reported routinely testing for *Campylobacter* and *E. coli* O157:H7 and other STEC. Laboratory testing and specimen handling procedures varied across surveyed labs, though the majority of laboratories followed recommended guidelines. When compared to FoodNet proportion positive samples, the US Army laboratory percent of samples positive for *Campylobacter, Salmonella,* and STEC were lower. Reporting procedures were similar across laboratories, and we found that some methods of reporting could result in underreporting of these pathogens. Data from this survey will serve as a baseline for enhancing relevant surveillance, and will guide the development of underreporting and underdiagnosis multipliers for burden of illness studies.

Part 4: Estimates of foodborne illness caused by specific pathogens can help to direct US Army food protection policies and intervention strategies. We used data from a 2015 US Army

population survey, a 2015 US Army laboratory survey, and data from FoodNet to create inputs for two model structures. Model type 1 scaled up case counts of *Campylobacter jejuni*, *Shigella* spp., *Salmonella enterica* non-typhoidal, and STEC non-O157 ascertained from the Disease Reporting System Internet (DRSi) database from 2010-2015. Model type 2 scaled-down cases of self-reported acute gastrointestinal illness to estimate the annual burden of noroviral illness. We estimate that these five pathogens caused 45, 608 (5%-95% range, 30,338-64,193) annual foodborne illnesses among nondeployed active duty US Army Service members. Of these pathogens, *Norovirus*, *Campylobacter jejuni*, and *Salmonella enterica* non-typhoidal were responsible for the most illness. These data can serve as an initial baseline for future military burden of illness studies, and support the implementation of a Department of Defense (DoD)-wide active laboratory surveillance system for foodborne illness.

In the final chapter of this dissertation, we use the results of the data from parts 1-4 to make recommendations for a comprehensive and integrated active foodborne illness surveillance system and to make recommendations to modernize the current US Army food protection program.

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Chapter 1 : Introduction

Foodborne pathogens are an important cause of illness in the United States [1]. Laboratory surveillance for potential foodborne pathogens, though informative, does not give a complete picture of the true burden of foodborne illness in a population. This is because in order for a foodborne illness to be identified by laboratory surveillance a number of steps must occur: 1) The ill person must seek medical care 2) the physician must submit an appropriate sample for testing 3) the laboratory must test for the appropriate pathogen 4) the pathogen must be identified by the test and 5) the positive result must be reported. If any one of these steps is missed, the case does not get reported. To account for underreporting and underdiagnosis of disease caused by foodborne pathogens, Scallan et al. (2011), used population based surveys, laboratory surveys, and outbreak data to develop a series of multipliers to scale-up laboratory confirmed cases of foodborne pathogens. They estimate that 48 million Americans are affected by foodborne illness each year.[2]

In 2012, more than 15,000 active duty service members sought medical care for acute gastroenteritis.[3] Foodborne pathogens are a preventable cause of acute gastroenteritis. The annual burden of acute gastroenteritis and foodborne illness in the active duty military population has never been estimated. Estimating the burden of foodborne illness among active duty service members through an approach similar to that used by Scallan et al. (2011) and the International Collaboration on Enteric Disease Burden of Illness studies can be an important step in evaluating the current United States Army food protection program, and advocate for a formalized foodborne illness surveillance system in the military.

The purpose of this dissertation is to advocate for a comprehensive and integrated Department of Defense (DOD)-wide active foodborne illness surveillance system. The specific aims are to demonstrate the burden of acute gastroenteritis and the burden foodborne illness caused by five major pathogens. These aims will be met through a four-part project. Part 1 (Chapter 3) estimates the overall burden of acute gastroenteritis among active duty Army service members. Part 2 (Chapter 4) determines the factors associated with active duty Army service members seeking medical care and submitting a stool sample for acute gastrointestinal illness. Part 3 (Chapter 5) evaluates US Army laboratory practices in enteric pathogen receiving and testing. Results from Chapters 3-5 are used in Part 4 (Chapter 6) to calculate underdiagnosis and under reporting multipliers to scale up laboratory confirmed cases of *Salmonella*, *Shigella*, *Campylobacter*, and non-O157:H7 *Escherichia coli*, and to scale down total acute gastroenteritis cases to the number of annual *Norovirus* cases. Ultimately this yields more accurate estimates of the true burden of foodborne illness caused by five major pathogens among active duty Army service members. The overall approach is outlined in Figure 1.1.

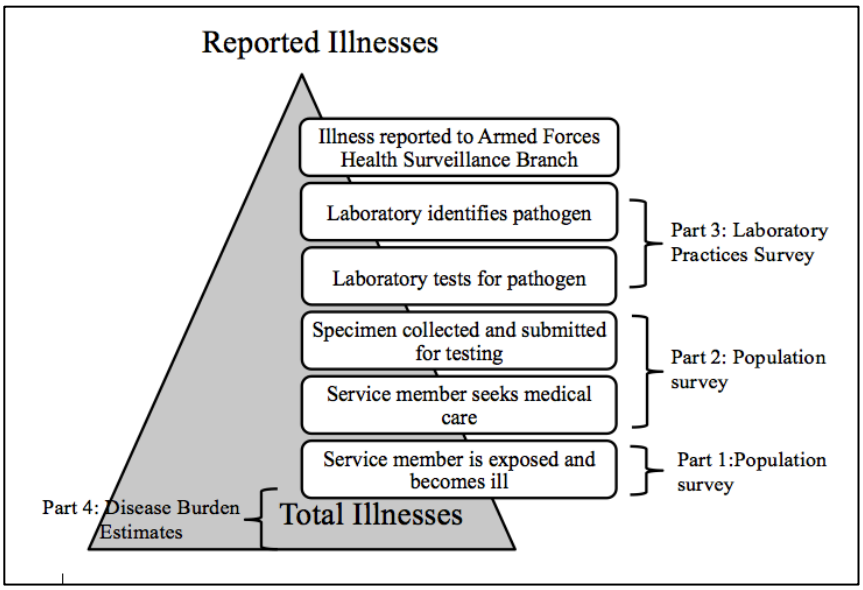


Figure 1.1. Overall approach showing the burden of illness period and the steps it takes for a case of foodborne illness to be reported through current US Army surveillance. The figure also depicts each of the four parts of the overall project.

Chapter 2 is a systematic review and critical assessment of previously published studies that pertain to the topics under discussion throughout this dissertation. This includes an overview of current foodborne illness surveillance systems in the United States, population-based studies of the burden of acute gastroenteritis, and studies that estimate the burden of foodborne illness caused by specific pathogens.

Chapter 3 is the manuscript submitted for Part 1: A population-based estimate of the burden of acute gastrointestinal illness among nondeployed active duty US Army service members. This chapter describes the results of a population-based web survey sent to a random selection of nondeployed US Army service members. We identify risk factors for AGI in this population and associated costs to the military.

Chapter 4 is the manuscript submitted for Part 2: Factors associated with active duty Army service members seeking medical care and submitting a stool sample for acute gastroenteritis. This chapter uses the results of the population-based survey to draw conclusions about the magnitude of underdiagnosis of gastrointestinal illness and stool sample submission among service members.

Chapter 5 is the manuscript submitted for Part 3: Army laboratory practices for stool-specimen culture for bacterial pathogens. This chapter describes the results of a survey sent to fifteen Army clinical laboratories and draws conclusions about the magnitude of underdiagnosis and underreporting of gastrointestinal illness caused by foodborne pathogens.

Chapter 6 is the manuscript submitted for Part 4: Estimating the annual burden of foodborne illness caused by 5 major pathogens among active duty Army service members. Results from Parts 1, 2, and 3 are used to create under-reporting and under-diagnosis multipliers to scale-up laboratory confirmed cases of 4 major pathogens. Total AGI burden estimates are

scaled down to estimate the annual number of illnesses caused by *Norovirus*. This chapter also discusses the implications of foodborne illness and importance of prevention of these 5 major pathogens.

Chapter 7 summarizes the findings of this dissertation and makes recommendations for a comprehensive and integrated active DoD-wide foodborne illness surveillance system. The chapter outlines the goals of foodborne illness surveillance in the military, and potential strategies to mitigate the burden of foodborne illness among active duty service members.

References

1. Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. *Emerg Infect Dis.* 1999;5(5):607-625.

2. Scallan E, Hoekstra R, Angulo F, et al. Foodborne illness acquired in the United States--major pathogens. *Emerging infectious diseases.* 2011;17(1):7-15.

3. Armed Forces Health Surveillance Center. Absolute and relative morbidity burdens attributable to various illnesses and injuries, U.S. Armed Forces. *MSMR.* 2012;20(4):5-10.

Chapter 2 : Literature Review

The Burden of Acute Gastrointestinal Illness

Acute gastrointestinal illness (AGI) and other infectious diseases of the gastrointestinal system cause significant morbidity and mortality worldwide.[1] Diarrheal disease accounts for 21% of deaths among children under 5 years of age, and is responsible for more than 2.5 million childhood deaths each year.[2] Though mortality associated with diarrheal illness is highest in developing countries, the burden of AGI remains substantial in developed countries.[3] In the United States, there are an estimated 375 million annual episodes of AGI, which account for 4% of hospital admissions among children.[4] AGI is characterized by diarrhea, nausea, vomiting, abdominal pain, abdominal cramps, fever and other systemic symptoms.[5]

Determining the burden of AGI in a population is challenging for a number of reasons: not every person with diarrhea will seek medical attention, many of those who do will not have their stool samples cultured, stool cultures often are negative for pathogens, and pathogens that are detected may not be reported through public health channels.[3] This means many cases of AGI go undiagnosed and unreported, so the diagnosed cases are an underestimation of the true burden of disease. With the World Health Organization's (WHO) initiatives to estimate the global burden of both diarrheal disease and foodborne disease (a major cause of AGI), studies estimating the burden of AGI in countries have increased in recent years.[6,7] It is difficult to compare the results of many of these studies because the case definitions for AGI often vary between studies.[8] The International Collaboration on Enteric Disease 'Burden of Illness' Studies was established in 2004.[9] The purpose of this group is to facilitate communications among those

who have or are interested in conducting studies to determine the burden of enteric or foodborne diseases.[9] As part of this collaboration, Majowicz et al. developed a standard case definition and minimum set of results to be reported to allow for international comparison between AGI burden of illness studies.[8]

Systematic Review of AGI Burden Studies

The goal of this systematic review was to answer a number of research questions including: 'Are modern (post-2008) AGI burden studies using the recommended standard case definition for AGI?, 'Are they including the minimum recommended set of results?', 'Are risk factors for AGI identified?', and 'Are any studies proposing interventions to reduce the burden of AGI in a population?'. This review consisted of several steps: after a thorough search of the literature to identify all relevant AGI burden studies, the identified literature was screened for relevance to the goals of this study, data were extracted from the relevant studies, and the data were summarized.

A literature search was conducted in PubMed to find peer-reviewed literature estimating the burden of AGI in a population. Figure 2.1 outlines the results of this search. The following search string was used: ((((((((((incidence or prevalence or burden or frequency))) AND (("infectious intestinal disease" or diarrhea or diarrhoea or "gastrointestinal illness" or "gastrointestinal disease" or "diarrheal" or "diarrhoeal"))) AND (("population-based" or "community" or "self-reported" or "in")))))) NOT Child*[Title]) NOT Rotavirus [Title]) NOT "*clostridium difficile*"[Title] resulting in 2,108 titles. The filters 'Human', and 'English' were added removing 310 titles, and leaving 1,798 articles. Each title was screened by hand for relevance, and all articles that were not potentially relevant burden of illness studies were

removed, leaving 77 potentially relevant articles. These articles were reviewed in more detail and additional exclusion criteria were applied; including removing any studies that focused on only geriatric or child populations, and removing any articles that were not about AGI. This resulted in 28 AGI burden studies published between 2008 and September 2015.[10-37]

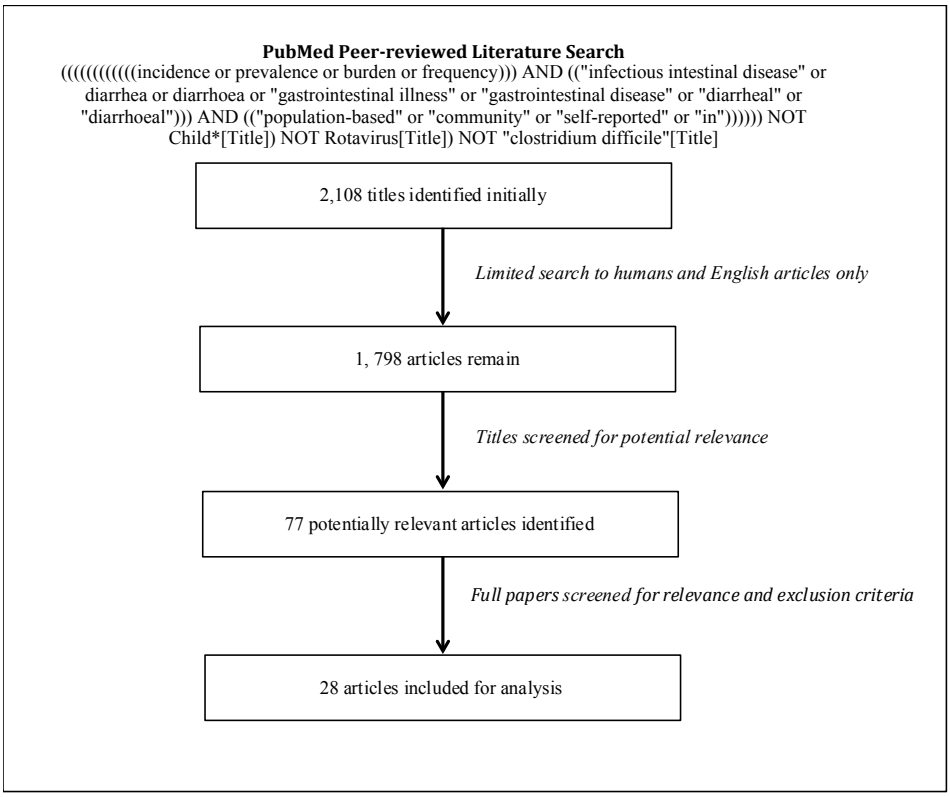


Figure 2.1. Results of the systematic review to identify modern burden of AGI studies published between January 1, 2008 and September 10, 2015.

Each article was reviewed in detail, and the following information was extracted: type of study design, data collection method, population sampling method, response rates, use of the recommended international case definition, reports of recommended results, recall period, whether risk factors for AGI were identified, and whether interventions for AGI were recommended. The results of this review are summarized in Table 2.1.

Table 2.1. Summary of information extracted from the selected studies of the burden of acute gastrointestinal illness.

Population Studied	Author	Year Published	Data collection method	Sampling type	Response rate	% Population interviewed	Used international case definition	Listed minimum results	Recall time period	Identified risk factors	AGI interventions suggested
New Zealand	Adlam *et al.*	2011	Telephone	Random plus booster	21.4%	0.08%	No/Yes	No	4 weeks	Yes	No
Cuba	Aguiar *et al.*	2009	Face-to-face	Purposive/random	97.3%	0.06%	No	No	30 days	Yes	No
Dominica	Ahmed *et al.*	2013	Face-to-face	Random	80.4%	1.70%	No	No	4 weeks	Yes	Yes
Poland	Baumann-Popczyk *et al.*	2012	Telephone	Random	26.1%	0.01%	Yes	No	4 weeks	Yes	Yes
China	Chen *et al.*	2013	Face-to-face	Purposive/random	93.4%	0.00%	Yes	Yes	4 weeks	Yes	No
Uganda: Botwa Pygmy population	Clark *et al.*	2015	Face-to-face	Census	99.0%	77.7%	Yes	No	4 weeks	Yes	No
Netherlands	Doorduyn *et al.*	2012	Paper or Web	Random	33.0%	0.01%	Yes	No	4 weeks	Yes	No
Jamaica	Fletcher *et al*.	2013	Face-to-face	Random/multistage/cluster	65.8%	0.04%	No	No	30 days	No	No
Saint Lucia	Gabriel *et al.*	2013	Face-to-face	Random	87.5%	0.57%	No	No	4 weeks	Yes	No
India: Sikkim and Darjeeling Districts	Gajamer *et al.*	2014	Face-to-face	Random/stratified	100.0%	0.02%	No	No	Unknown	Yes	No
Jordan	Gargouri *et al.*	2009	Face-to-face	Random/multistage/cluster	91.0%	0.01%	No	No	30 days	No	No
Grenada	Glasgow *et al.*	2013	Face-to-face	Random/stratified	94.8%	1.14%	No	No	4 weeks	Yes	Yes
Malaysia	Gurpreet *et al.*	2011	Face-to-face	Random/two-stage	90.0%	0.26%	No	No	4 weeks	Yes	No
Sweden	Hansdotter *et al.*	2015	Paper or Web	Random	64.0%	0.03%	No	No	12 months	No	No
Canada: Rigolet & Iqaluit Inuit Communities	Harper *et al.*	2015	Face-to-Face, Phone	Random/two-stage	55.0/92.0%	3.73%	No	No	14/28 days	Yes	No
Hong Kong	Ho *et al.*	2010	Telephone	Random digit dialing	41.0%	0.11%	Yes	Yes	4 Weeks	Yes	No
Barbados	Ingram *et al.*	2013	Face-to-face	Random/multistage/cluster	84.0%	0.50%	No	No	4 weeks	Yes	No
Japan	Kubota *et al.*	2011	Telephone	Random digit dialing	19.3%	0.18%	Yes	No	4 weeks	No	No
Trinidad & Tobago	Lakhan *et al.*	2013	Face-to-face	Random/multistage/cluster	99.5%	0.17%	No	No	4 weeks	Yes	Yes
Denmark	Muller *et al.*	2012	Telephone	Random	80.5%	0.04%	Yes	No	4 weeks	Yes	No
Guyana	Persuad *et al.*	2013	Face-to-face	Random/stratified	96.5%	0.17%	No	No	4 weeks	No	Yes
China: Gansu Province	Sang *et al.*	2014	Face-to-face	Purposive/random	86.0%	0.01%	Yes	Yes	4 weeks	Yes	No
Canada: Ontario	Sargeant *et al.*	2008	Telephone	Random/two-stage	36.6%	0.02%	No	No	4 weeks	Yes	No
Italy	Scavia *et al.*	2012	Telephone	Random/two-stage	39.5%	0.01%	Yes	Yes	30 days	Yes	No
Argentina: Galvez	Thomas *et al.*	2010	Face-to-face	Random	61.1%	4.07%	No	Yes	7 days/30 days	Yes	No
Chile: Metropolitan region	Thomas *et al.*	2011	Face-to-face	Random/stratified	75.8%	0.10%	No/Yes	Yes	7days/15days/30days	Yes	No
Germany	Wilking *et al.*	2013	Telephone	Random	29.1%	0.03%	No	No	4 weeks	Yes	No
China: Jiangsu province	Zhou *et al.*	2013	Face-to-face	Purposive/random	87.0%	0.01%	No/Yes	Yes	4 weeks	Yes	No

Study Design and Data Collection

In the past, studies that estimate the burden of AGI have fallen into one of two categories: prospective cohort study, or retrospective cross-sectional study.[38] When compared to prospective cohort studies, cross-sectional studies generally are less expensive and easier to carry out.[38] In this literature review, all studies used a cross-sectional, retrospective study design. Prospective studies are thought to be more accurate because they eliminate recall bias, which often plague retrospective studies.[5] On the other hand, prospective studies can suffer from reporting fatigue.[5] In an extensive literature review of AGI studies published between 1953 and 2006 conducted by Roy et al. (2006), it was not clear which study design provided the most accurate estimate of AGI burden.[5]

In the 28 selected studies different data collection methods were used including: face-to-face interviews, telephone interviews, the option of face-to-face or telephone interviews, and the option of paper or web-based survey. Seventeen of the 28 studies (60.7%) used face-to-face interviews for data collection.[11,12,14,15,17-22,26,28,30,31,34,35,37] Eight studies (28.6%) used phone interviews to collect data.[10,13,25,27,29,32,33,36] One (3.6%) study used face-to-face and the option of face-to-face or telephone survey for two different groups of interviewees.[24] Two studies (7.1%) gave their respondents the option to answer a web-based or paper survey.[16,23]

In general, the face-to-face interviews were used in countries where segments of the population do not have access to a phone, or in countries where there is no national phone registry. The studies that did use phones as the primary method for conducting interviews took place in more industrialized countries/regions, where a greater segment of the population had telephone access. The Danish Civil Registration System contains information about every citizen in Denmark including age, gender, and address, so it is relatively simple to select interview

subjects.[29] Once selected, phone numbers can be obtained from web-based national phone books.[29] When combined, the studies that used face-to-face data collection techniques had a higher average response rate (87.6%), than those conducted by phone (36.1%), or through paper or web-based survey instruments (46.0%).

Face-to-face surveys have both strengths and disadvantages. Strengths include a clearly defined structure, and flexibility/adaptability of the survey during the interview.[39] Disadvantages include high cost per respondent, geographical limitations, time pressure on respondents, and interviewer bias.[40] Telephone surveys are advantageous due to possibility of random digit dialing, personal interaction at a lower cost (vs. face-to-face), and good geographic coverage.[39,41] Disadvantages of telephone surveys include the inability to use visual help during the survey, interviewer bias, and lower response rates.[39,41] Another specific disadvantage of landline-only telephone surveys is underrepresentation of certain subpopulations including patients in hospitals, nursing and rest home residents, homeless individuals, low-income individuals, migrants, and individuals who only own a mobile phone.[33] According to the Centers for Disease Control and prevention, almost half (47.4%) of all American households have only wireless/mobile telephones.[41] A major disadvantage of web-based surveys center around the fact that a limited percent of the population has access to the Internet, and creating sampling frames that give complete coverage of the general population of interest are very difficult, if not impossible.[42] On the other hand, web surveys allow for real-time data access, can take less time to complete, and may be more convenient for respondents to answer.[42] Based on this information, when determining the method of data collection for burden of AGI studies, the investigator must consider cost, time, desired response rate, and certain population characteristics such as cell phone access, general accessibility, and availability of national registries. As

Internet access becomes more commonplace, further research into the benefit of constructing sampling frames using email addresses, social media profiles, and other electronic media should be explored. This could be especially useful for very specific population burden estimates, such as estimating the burden of a disease among military service members, government employees, college students, or corporate employees. Rather than analyzing the population as a whole, future AGI burden of illness studies should try to focus on very specific subsets of the population to determine specific risk factors and interventions. It seems that if future studies start focusing on more specific populations, then the identified issues of cost, coverage, and low response rates could be avoided. More specific studies could start to make a real impact on incidence of AGI in that specific population. Prospective studies also should be considered, especially if a more specific population is targeted. Though fatigue from filling out a diary daily was previously identified as an issue with prospective studies, more technologically advanced and less cumbersome options for daily diaries could be considered. A simple cell phone application could provide real-time prospective results to investigators and potentially yield more accurate estimations of illness burden.

Sampling Methods

A variety of sampling methods were used: one study (3.6%) used a random sample plus booster to ensure a specific segment of the population was sampled,[10] one (3.6%) used a census [15], two (7.1%) used random digit dialing,[25,27] four (14.3%) used purposive selection of sentinel sites, followed by random sampling,[11,14,31,37] four (14.3%) used a multistage cluster design,[17,20,26,28] seven (28.6%) used a random sample based on neighborhoods, national lists of households or individuals,[12,13,16,18,23,29,34,36] and eight (28.6%) used a stratified random sample.[19,21,22,24,30,32,33,35]

A census is when all of the individuals in the population are selected for survey.[43] An advantage of a census is that the resulting summary statistics are measurements from all members of the population, not a representation that has to be extrapolated.[43] The main disadvantage of a census is the cost and time associated with reaching every member of the population.[43] In this review, the study that used a census was for a very small population of subjects.[15] Though the census had one of the highest population coverage percentages (77.7%), a census would be cost and time prohibitive for the larger populations evaluated in the other studies.

Two studies, one in Japan and one in Hong Kong, used random digit dialing to conduct a simple random sample of households.[25,27] Once the household was reached, the next birthday technique was used to choose subjects.[25,27] For a simple random sample to be representative of the population, the entire sampling frame must be known and labeled prior to sampling.[43] Using random digit dialing for a simple random sample limits the sampling frame to only those with a phone, and therefore may not be representative of the population, which was observed in both studies. In stratified random sampling, the sampling frame can be divided into strata and sampling can be performed separately within each of the strata.[43] Advantages of stratification includes lower standard error, being able to obtain estimates for each of the strata, and in some instances it may be easier than a simple random sample.[43]

Cluster sampling is advantageous when each individual unit in a sampling frame is not known, not feasible to obtain, or is cost prohibitive to obtain.[43] This often is the case with human populations; it just is not feasible to generate a list of every household or individual in the United States.[43] Cluster sampling works by identifying and selecting clusters of enumeration units in the population (city block, county, school, etc.), then obtaining a list of individuals in only the

selected clusters for sampling.[43] Cluster sampling can be conducted in stages. A single-stage cluster sample is when only one step defines the sample. The clusters are selected, then every listing unit within that cluster is included in the sample.[43] Multi-stage cluster sampling often is employed for surveys that cover a larger geographic area. For example, in the case where the cluster is a county in a state, you first select the clusters.[43] Then, from each selected cluster (county) you select a sample of towns, and then from each town you select a sample of city blocks, and then a sample of households, and then the individual. This is an example of five-stage sampling involving four different clusters (county, town, blocks, households). A disadvantage of cluster sampling is that standard errors of the estimates obtained from a cluster sample often are higher than other sampling designs.[43] This is because clusters usually are homogenous with respect to many sociodemographic characteristics, so if more than one household from a single cluster is selected, it is redundant and results in a higher standard error.[43]

When determining the method of sampling of the population for AGI burden of illness studies, it is imperative to first look at the goals of the study. If the goal is to have more precise estimates, no matter the cost or feasibility, then a census or simple random sample should be performed. If cost and feasibility outweigh the reliability of the estimate, then cluster sampling is a good option.

Response Rates

Response rates varied, with a range of 19.3%-100%. The studies with the lowest response rates included those that used a random sampling plan and telephone for data collection. Those with the highest response rate included those with face-to-face data collection and random multistage or stratified sampling. To get an idea of what percent of the target population was surveyed, we divided the number of completed interviews for each study by the

population. The range was 0.003%-77.7%. The highest coverage rate was the census, which is expected. If economically feasible, face-to-face data collection with a multistage or stratified sampling plan should be used. Though a random sample and telephone interviews may be a more feasible option in most instances, the higher response rates from face-to-face representative surveys should lead to more accurate results. Twenty-three of the 28 studies (82.1%) used responses from less than one percent of the population to extrapolate to the rest of the population. This leaves a lot of room for wide margins of error and bias in results. In the future, studies of smaller more focused subsets of the population could help to improve the accuracy of AGI burden of illness studies.

Recall Period

One of the commonly reported limitations of retrospective survey research is the effect of recall period on outcome due to recall bias. Often observed in survey research is forward telescoping, the reporting of events as being more recent than they actually are, resulting in inaccurate data (over-reporting).[44] An AGI burden of illness study from England by Wheeler et al. (1999) highlights this phenomenon. They used active surveillance (diary) to estimate the incidence of AGI and compared the results to AGI incidence calculated by using a 3-week recall period.[45] They found that the 3-week recall period incidence was almost three times higher than the rate estimated through active surveillance.[45] According to Rodrigues et al., the most common way to prevent telescoping is to ask about the occurrence of the outcome of interest over a very short period of time (1-2 days), or by using active surveillance (such as a diary tracking daily symptoms).[46]

More recently, Cantwell et al. (2010) used FoodNet data to specifically study the effect of different recall periods on the prevalence of AGI. They found that the length of recall period had

a major impact on AGI estimates, with 7-day recall periods yielding rates of AGI that were 1.8-3.4 higher when compared to 30-day recall periods, the opposite of telescoping.[38] In this literature review, recall time periods varied among studies ranging from two weeks to one year. The majority of studies used either a 4-week (64.3%) or 30 day (14.3%) recall period.

There were two studies that used two or more different recall periods and compared the results.[34,35] The 2010 study by Thomas et al. estimated the 2007 burden of acute gastrointestinal illness in Galvez, Argentina. Two different recall periods were used, 7 days and 30 days. They found that the 7-day recall period resulted in an annual AGI incidence rate that is 1.7-5.4 times the rate when using a longer 30-day recall period.[34] The 2011 study by Thomas et al., estimated the 2008 burden of acute gastrointestinal illness in the Metropolitan region, Chile. Three different recall periods were used: 7 days, 15 days, and 30 days. They found significant differences in annual AGI incidence rates between all of the recall periods.[35] The 7-day recall period (2.3 episodes/ person-year) was 1.4 times higher than the 15-day recall period (1.6 episodes/ person-year) and 2.3 times higher than the 30-day recall period (0.98 episodes/person-year).[35]

The results of the Cantwell et al., and two Thomas et al. studies is contrary to the reports that 'telescoping' results in overestimates of population disease burdens in retrospective studies. With these conflicting results, it is important to consider the recall periods used in studies before comparing the estimated AGI burden between studies. Careful consideration of recall period length also is important when designing a retrospective burden of illness study. If the goal is to compare results to a specific study, the length of recall period should be consistent with the comparison study. If the goal is to be able to compare results to studies using various recall periods, it would be worthwhile to include more than one recall period in the survey design. The

results of varying recall periods within the same study also could be compared to see what effect the different recall periods have on the results. However, it is possible that asking about more than one recall period within the same survey might confuse some respondents, so methods to reduce this confusion should be considered during the survey design.

Use of the Standard, International Case Definition for AGI and Recommended Results

The International case definition for AGI recommended by Majowicz et al. is as follows: a case of gastroenteritis is an individual with ⩾3 loose stools, or any vomiting, in 24 h, but excluding those (*a*) with cancer of the bowel, irritable bowel syndrome, Crohn's disease, ulcerative colitis, cystic fibrosis, coeliac disease, or another chronic illness with symptoms of diarrhea or vomiting, or (*b*) who report their symptoms were due to drugs, alcohol, or pregnancy.[8]

Nine (32.1%) studies used the recommended National standard case definition for AGI exclusively,[13-16,25,27,29,31,33] three (10.7%) used their own case definition plus the standard case definition for international comparison,[10,35,37] and 16 (57.1%) did not use the standard case definition.[11,12,17-24,26,28,30,32,34,36] Of the articles that used the standard case definition, only 6 (50.0%) provided the recommended list of results for AGI burden studies. Table 2.2 lists the standard recommended results from the five articles identified in the current literature review, as well as from four other articles published prior to 2008 not included in this review that also reported the recommended results.

Table 2.2. Minimum list of results recommended for burden of AGI studies.

	China	China: Gansu province	China: Jiangsu province	Italy	Chile	Hong Kong	United States	Canada	Ireland	Malta
Incidence per person-year	0.57	1.16	0.63	1.08	0.98	0.91	0.83	0.91	0.64	0.37
95% Confidence Interval	(0.56-0.57)	(1.14-1.18)	(0.63-0.64)	(0.9-1.1)	(0.89-1.07)	(0.81-1.01)	(0.78-0.89)	(0.80-1.02)	(0.59-0.70)	(0.36-1.89)
Incidence per pers-year males	0.53	1.17	0.61	0.89	0.95	0.88	0.78	0.78	0.51	0.31
Incidence per person-year females	0.61	1.14	0.66	1.13	1	0.94	0.80	1.00	0.77	0.44
Mean age of cases (years)	44	39.5	46.0	-	36.0	35.2	28.4	36.0	24.2	34.8
Mean duration of illness (days)	2.1	2.48	1.85	3.2	2.09	3.6	3.1	4.2	2.9	4.2
Cases with bloody diarrhea (%)	2.66	0.96	0.89	0.3	2.36	1.9	2.3	3.2	0.9	5.1
Cases who saw physician (%)	55.9	73.8	38.3	36.1	21.2	39.3	18.1	21.0	25.5	39.4
Cases submitting a stool sample for testing (%)	18.1	37.3	15.0	1.00	1.93	1.9	2.9	3.2	1.8	2.0
Cases with respiratory symptoms (%)	-	9.6	-	25.2	14.13	8.8	47.8	48.4	-	19.2
Cases with symptoms still ongoing (%)	9.3	8.65	4.92	7.7	12.85	16.4	10.3	13.1	16.9	18.2

Majowicz et al. (2008) compared different results from previous studies by applying four different case definitions for gastrointestinal illness to the data. When applying the four different case definitions, the incidence within a given country changed, so comparison of these estimates between studies with different case definitions may not be valid.[8] Using a broad case definition for AGI generally results in overestimation of AGI burden, while very specific case definitions tend to underestimate the true burden. They found that the very liberal definition of "loose stool or vomiting" generated incidence estimates 1.5-2.0 times greater than those with stricter definitions (FoodNet definition ≥3 loose stools in 24 h, lasting >1 day or resulting in activity restriction).[8] One interesting finding from this study was that even though incidence values did change depending on the case definition, the overall conclusions were not impacted significantly.[8] For example, if a certain demographic categories had higher incidence of AGI, these differences were seen no matter which case definition only the magnitude of the difference varied.

When designing gastrointestinal burden of illness studies, it is important to determine the specific goals of the study and keep that in mind when developing a case definition. If the goal is comparability, it is best to use the same case definition as the comparison study. If the goal is to determine the burden and cost due to bloody diarrhea for example, one must analyze how the case definition could affect that outcome, and report it.[8] Majowicz et al. (2008) also found that

proportion of cases seeking medical care and submitting stool samples for testing also was impacted by the choice of case definition, so case definitions should be consistent for comparability. The international case definition is a broad case definition for AGI. It does not exclude cases that also experience concurrent respiratory symptoms, so there is the possibility of capturing not only primary gastrointestinal cases, but also cases that are primary respiratory cases with secondary gastrointestinal symptoms.[47] The benefit of a broad case definition like this is that it increases the likelihood of capturing all AGI cases, however, it also increase the likelihood of capturing some non-primary AGI cases (false positives). It is beneficial to have a standard case definition across studies to allow for comparability, however some studies may need a more specific case definition to meet their immediate goals. To allow for international comparability while also allowing for more specific case definitions (as needed by individual investigations), reporting results using more than one case definition is recommended. An example of this is the Chile study by Thomas et al. (2010) where they used a more specific case definition that could be compared with other studies in South America, but also reported the proposed set of minimum results using the recommended International case definition to allow international comparison.[35] The 57% of studies in this review that did not use the standard case definition should be re-evaluated to determine whether the raw data could be reanalyzed to provide the recommended minimum set of results using the standard case definition.

Identification of Risk Factors and Interventions for AGI

One of the goals of burden of illness studies in general is to identify risk factors for the illness of interest. Five (17.9%) of the selected studies did not identify specific risk factors for AGI. The primary goals of these studies were either to determine the burden of specific AGI-associated pathogens,[20,27] or to provide prevalence data only.[17,23,30] Most (82.1%) articles

identified risk factors for AGI, which varied. The most commonly investigated risk factors included sociodemographic factors such as age, gender, ethnic group, occupation, education level, household size, residence type (urban vs. rural), and region of residence, family income, and type of healthcare access.[10-16,18,19,21,22,24-26,28,29,31-36] In addition to socio-demographic factors, others investigated health related behavior determinants, including taking gastric acid suppression medication, antibiotic use, having asthma, smoking, alcohol consumption, amount of fruits, vegetables, and fruit juices consumed, presence of concurrent symptoms (respiratory symptoms, headache, fever), consuming raw or undercooked meat and poultry, and consuming a vegetarian diet.[16,19,33,36] One article explored whether a very specific list of eating practices was associated with AGI (consuming takeaway food, roadside snacks, hot pot, oysters, etc.).[25] Environmental exposures also were investigated including: hand washing practices, the use of soap, owning animals, exposure to specific animals, drinking water source, drinking water quality, drinking water storage, amount of money spent on retail food, toilet facility quality, sewer system type, and whether animals come inside the house.[12,15,18,24,26,35] Which risk factors were investigated and the results of the investigation varied across articles. The determination of risk factors to investigate should depend on the stated objectives of the study, pre-study hypotheses, and what makes logical sense for the population of interest.

Once risk factors are identified, the next goal usually is to identify specific interventions. Of the 22 studies that did identify risk factors, very few (22.7%) made recommendations regarding specific interventions for the identified risk factors. Those that did mainly discussed general interventions and surveillance improvements, and did not offer specific avenues to reduce the burden of AGI.[12,21,25,28,30] AGI burden studies are becoming more commonplace, and many identify similar risk factors. It would be advantageous to shift the focus of these studies to

identify practical, specific interventions to be applied to a variety of populations. It has been made obvious that AGI is a problem, now the scientific community needs to develop a solution. Table 2.3 provides a summary of the proposed interventions for AGI reported in the articles reviewed in this study. Investigators designing future studies to determine the AGI burden in a population should keep this in mind.

Table 2.3. Summary of proposed AGI interventions reported in the reviewed literature.

Study Country	Proposed intervention(s)
Guyana	Improve surveillance for AGI and foodborne disease to reduce the burden of disease by: 1) Enhanced surveillance of AGI and foodborne disease including stool collection, detection of pathogens, timely notification, reporting, and investigation of outbreaks 2) Training and implementation of testing for *Giardia* and other protozoa from AGI stool specimens in all the regional laboratories and implementing Norovirus testing at the reference laboratory 3) Implementation of measures to ensure timely and complete four-week reporting of laboratory data to the Ministry of Health and provision of timely feedback to clinicians, environmental health, and laboratory personnel on reported AGI over four weeks 4) Training and updating of all health workers and other stakeholders on the relevant reporting systems and AGI investigations over the next 2 years.
Trinidad & Tobago	1) Educational campaigns targeting doctors and patients to improve specimen collection 2) Hygiene interventions that target the general public 3) Doctors properly filling out laboratory forms
Grenada	1) Introduce public education programs which promote and encourage proper hygiene practices 2) Implement more robust surveillance systems of street-based food vendors 3) Strengthen the overall quality control monitoring of the farm-to-table food production and preparation continuum 4) Improve the collaboration between the Ministry of Health and other ministries and organizations with the responsibility for food safety and the environment in order to strengthen capacity, improve surveillance systems, and ensure appropriate information is tabled for consideration in the development and implantation of policies that address the control and prevention of foodborne disease
Dominica	1) Develop pathogen-specific prevention guidelines for norovirus
Hong Kong	1) Promotion of food hygiene and the exercise of caution in the consumption of some potentially risky foods or meal types

Limitations

Identified limitations included: recall bias, survey population not representative of the target population, selection bias, low response rates, use of a generous case definition, misclassification bias, and inadvertently omitted questions.

As previously discussed, recall bias is inherent to cross-sectional retrospective surveys. There are mixed reports as to the length of recall period and accuracy of results. The articles that reported their surveyed population was not representative of the target population with respect to certain demographic factors weighed the survey responses. Unfortunately, none of the papers did a very good job of defining how the weighting was performed. It is therefore difficult to follow the same weighting process and maintain comparability of results. Limitations such as

selection bias, low response rates, varying case definitions, and misclassification are inherent to these types of studies. Even though these biases exist, each study of the same designs share these biases and thus the results likely still are comparable.[8]

Acute Gastrointestinal Illness in the US Military

Throughout military history, diarrhea has been an important cause of morbidity and mortality among military populations.[48] During the Revolutionary war, diarrheal disease resulted in more deaths than those caused by enemy action.[48] In the American Civil War, diarrheal disease occurred with more frequency and produced more sickness and mortality than any other disease.[48] Acute diarrhea was the most common illness reported among military personnel in World War II.[48] Diarrhea accounted for four times more hospital admissions than malaria during the Vietnam conflict.[49] Over time, basic improvements in sanitation, improved healthcare, and advances in preventive medicine helped to decrease the morbidity and mortality associated with diarrheal illness among military members. Despite these medical advances, AGI continues to be a significant cause of illness among service members. During Operation Desert Shield, 57% of surveyed troops reported experiencing at least one episode of diarrhea, with 20% reporting they were temporarily unable to perform their duties due to their symptoms.[50] In 2012, diarrheal diseases were responsible for more than 17,000 healthcare encounters affecting over 15,000 U.S. service members.[51] During an 11-year surveillance period from 2002-2012, there were 286,305 cases of gastrointestinal infections diagnosed in active duty US service members[1]. Of these, 82,576 cases were caused by bacteria, 194,329 were caused by viruses, and 9,400 were attributed to parasites[1]. In addition, there were 379,509 other healthcare encounters where the recorded diagnosis was “diarrhea”. Of the cases of diarrhea with a confirmed diagnosis, 76% were

caused by pathogens known to be associated with foodborne illness. Outbreaks of AGI affecting a large percentage of deployed personnel can result in degraded military operational effectiveness, which can have serious consequences.[1] To our knowledge, no one has attempted to estimate the burden of AGI in the US Army population.

Foodborne Illness

One important and preventable cause of AGI is foodborne illness. The WHO estimates that at as much as 70% of diarrheal diseases worldwide can be attributed to foodborne pathogens.[52] Each year in the United States, foodborne diseases cause an estimated 48 million illness, with an estimated 9.4 million caused by 31 major pathogens.[53,54]

Foodborne illnesses often are underreported and/or underdiagnosed, so laboratory surveillance for these diseases is not an accurate estimate of the true annual burden. In order for a case of foodborne infection to be reported through laboratory surveillance, the following steps must occur: 1) the ill person must seek medical care, 2) the physician must submit an appropriate sample for testing, 3) the laboratory must test for the appropriate pathogen, 4) the pathogen must be identified by the test, and 5) the positive result must be reported. If any one of these steps is not performed, the case does not get reported (Figure 2.2). A more accurate estimate of the true burden of foodborne illness in a population is important because the results are used to direct food safety programs, policies, and interventions; evaluate the costs associated with foodborne disease; and attribute the infections to various food commodities.

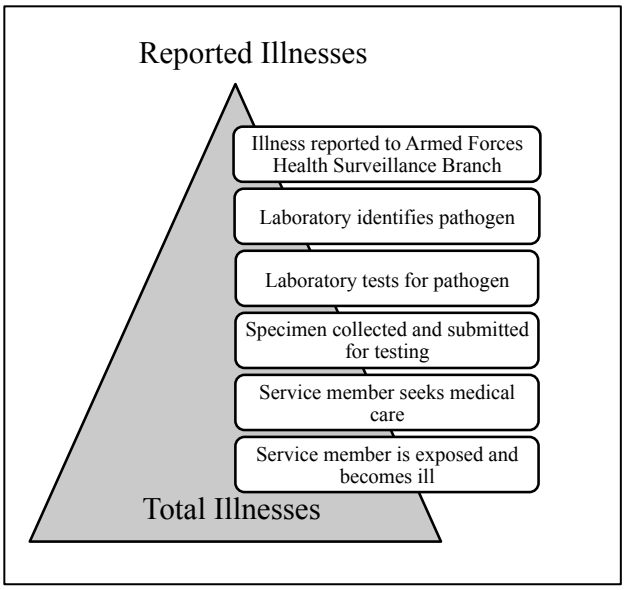


Figure 2.2. Burden of Illness pyramid illustrating the steps that must occur for an episode of illness in the active duty Army population to be reported through laboratory surveillance.

Statistical modeling is used to account for the underreporting and underdiagnosis of disease caused by specific foodborne pathogens and gain a more accurate estimate of the true burden of diseases caused by these pathogens. One modeling approach is to begin with counts of laboratory confirmed illness (top of pyramid) and scale them up. Another approach is to begin with the total population of interest and AGI incidence data, and scale down the estimated number of AGI illnesses to those caused by the specific pathogen of interest. Multipliers are calculated in a number of ways, as highlighted by three different examples in the literature:

The first example is Foodborne Illness Acquired in the United States by Scallan et al. (2011). They used surveys of FoodNet laboratories and FoodNet population-based telephone surveys conducted in 2000-2001, 2002-2003, and 2006-2007 to adjust for underdiagnosis that results from ill individuals not seeking care, not submitting specimens, different laboratory test sensitivities, and varying laboratory testing practices.[54] Survey responses were analyzed and used to estimate the proportion of persons who reported AGI and sought medical care and submitted a stool sample for their illness.[54] They associated care-seeking behavior with more severe illness

and used medical care seeking and stool sample submission rates for bloody and non-bloody diarrhea as surrogates for severe and mild cases of illnesses.[54] They also accounted for the percentage of laboratories that routinely tested for specific pathogens, and test sensitivities using laboratory survey results.[54] They created underreporting and underdiagnosis multipliers for each pathogen of interest using a complex modeling approach and the program evaluation and review technique (PERT) distribution for many inputs. For each pathogen of interest, they used surveillance data, risk factor studies, and the current literature to estimate the proportion of illnesses that is caused by consuming contaminated food.[54] They used both of the modeling approaches described above. For infections that are captured by one or more surveillance system, they scaled up counts of laboratory confirmed illness. [54] For infections that are not reported through routine surveillance, they scaled down the US population to annual cases of AGI to those caused by these pathogens of interest (Rotavirus, Astrovirus, Sapovirus, *Norovirus*, and *Toxoplasma gondii*). [54]

Kubota, et al. (2011) estimated the burden of AGI and foodborne illness in the Miyagi prefecture, Japan caused by three different pathogens. The population-based telephone survey determined the 4-week prevalence of AGI.[27] AGI cases were further characterized by medical care seeking behavior and stool sample submission. They also conducted active surveillance for all laboratory confirmed cases of the pathogens of interest at two different laboratories for one year.[27] To estimate the total number of ill for each pathogen, they multiplied number of laboratory-confirmed cases for each pathogen identified through active surveillance by the inverse of the coverage rate of stool samples by these laboratories, the inverse of the rate of stool sample submission, and the inverse of the rate of physician consultation. [27] They used a Monte Carlo simulation to calculate a mean and range of outcomes. They used the total population to

calculate estimated illness per 100,000 populations per year.[27] To estimate the number of the AGI episodes that were foodborne, they used the previously reported US estimates for the percentage of foodborne transmission for each pathogen. The limitations of this methodology as reported by the authors was assuming the laboratory testing methods have a 100% sensitivity and specificity, and assuming 52% coverage of the region by the two chosen laboratories. They suggested that a survey of the clinical laboratories about testing methods could help to increase the accuracy of test sensitivity estimation. In addition, they used the US estimations for the proportion of illness that is foodborne for each pathogen, which may be different than in Japan. Overall, they suggested that their foodborne illness surveillance system should include laboratory-based active surveillance at sentinel sites.[27]

Gargouri et al. (2009) estimated the burden of human *Salmonella, Shigella,* and *Brucella* infections in Jordan from 2003-2004. They conducted a survey of laboratories to estimate the number of stool cultures, *Brucella* tube agglutination tests and blood cultures performed, and the number of lab confirmed cases of *Salmonella* (isolation from stool or blood)*, Shigella* (isolation from stool), and *Brucella* (agglutination test >1:160).[20] They conducted a national surveillance review to compare the number of cases of the pathogens of interest that were reported in Jordan to the number reported in their laboratory survey.[20] They used a population survey to estimate burden of diarrhea and fever. They calculated burden of disease estimates by determining two different proportions: first, the proportion of ill persons who sought care, and second, the proportion of all ill persons who sought care and submitted a stool or blood specimen to a laboratory.[20] They took the multiplicative inverse of these proportions to develop multipliers that correspond to the proportion of infections lost at each stage of the surveillance reporting system. They found there was significant underreporting from the laboratories.[20] The reported limitation

from this study was that only Ministry of Health Laboratories were included in the laboratory surveys, but the population survey sample was drawn from the general Jordan population.[20] They felt that the number of lab-confirmed cases from all labs would be higher than just the Ministry laboratories alone, so their data underestimated the true burden of disease.[20]

When designing a study of this type it is important to consider all steps in the surveillance system that lead to the reporting of the disease of interest. From there, you must determine the most feasible way to obtain the data required to calculate under-reporting/under-diagnosis multipliers for each step. Once the data are available, the modeling approach should be based on initial data analysis and surveillance system structure.

Foodborne Illness in the US Military

To our knowledge, no one has estimated the burden of foodborne illness for any branch of the US military. There are published reports of foodborne illness outbreaks among service members. In July, 2012 there was an outbreak of staphylococcal food poisoning at a military unit lunch party.[55] The outbreak was attributed to a dish called perlo, a chicken, sausage, and rice dish.[55] A total of 22 individuals met the case definition for this outbreak.[55] In 2004, there was a small cluster of *E. coli* O157:H7 infections associated with consumption of ground beef from a commissary on a US military installation in Okinawa, Japan.[56] In 2006, *Norovirus* affected a field training exercise at Fort Dix, New Jersey, causing illness in more than 40 US Army soldiers.[57] The source of the outbreak was not determined.[57] *Norovirus* also affected a total of 290 cadets and support staff during a training exercise at the US Air Force Academy.[58] The investigation revealed that the virus was likely introduced into the field dining facility by one or more service workers, then transmitted by common-use serving utensils, and then even further

through person-to-person contact.[58] *Norovirus* also was the culprit in an outbreak at Fort Bliss, Texas in 1998, hospitalizing 99 Army trainees.[59] Between September 17 and October 3, 1997, more than 110 ill US Army Soldiers stationed at Eagle Town base camp in Saudi Arabia were affected by a foodborne illness outbreak caused by *Salmonella.*[60]

US Army Food Protection Program

The US Army has a robust system in place to prevent foodborne illness among service members and their families. The US Army Veterinary Service is responsible for the mission to ensure the quality and safety of food procured by the Department of Defense (DoD).[61] The food protection program has several programs that act at many levels from acquisition of food to consumption. The main programs include: sanitation audits of commercial food establishments, veterinary/medical food inspections, veterinary laboratory services, and the subsistence laboratory analysis program.

Commercial sanitation audits

The Worldwide Directory of Sanitarily Approved Food Establishments lists all food establishments and food distributors that are approved as sources of supply for Armed Forces procurement.[62] In order to be listed in this directory, food establishments and distributors, whether in the continental United States, or outside the continental United States must follow current good manufacturing prices (CGMPs) as outlined in the United States Code of Federal Regulations (CFR).[63] The US Army Veterinary Services ensures CGMPs are being followed through sanitation audits of commercial food establishments.[61] Normally, personnel audit only the establishments that manufacture, process, store, and supply the end food item to be procured.[61] However, sometimes there is a need to audit subcontractors or source plants that

supply ingredients or components.[61] Veterinary Corps officers and warrant officers with training in sanitation audit procedures usually perform the sanitary audit inspections.[63] The Military Handbook 3006C: Guidelines for Auditing Food Establishments outlines audit procedures and requirements for various food products.[64] Once the establishment has been approved through the sanitation audit process, they can gain listing in the worldwide directory. The approved facilities are re-inspected on a regular basis. The frequency of inspection depends on the type of food that is produced, stored, or distributed by the establishment. In general, foods that carry a higher risk require more frequent inspections, as well as plants that receive critical findings during audit inspections.[64] There are certain food establishments that are exempt from the requirement to be listed in the Worldwide Directory.[64] These establishments are federally approved sources including those with listing on the interstate certified shellfish shippers list (ICSSL) and the interstate milk shippers list, dairy plants surveyed and approved for the USDA grading service, establishments approved by the US Department of Commerce, plants operating under the USDA poultry and egg grading programs, those listed in the directory of grading offices, and those listed in the meat, poultry and egg product inspection directory.[62]

Veterinary/medical food inspections

As outlined by Army Regulation 40-657, there are three categories of food inspection, category I, II, and III. Category I inspections are origin acceptance inspections, and occur during ante mortem, postmortem, at operational ration assembly plants, and at other food production plants.[61] These inspections generally are conducted to ensure the produced food is safe, wholesome, and unadulterated. Category II inspections are receipt inspections which occur when food is delivered to the Armed Forces.[61] These inspections occur through the installation support plan (ISP), which is developed by each veterinary unit responsible for the installations in

their catchment area. Category III inspections are surveillance inspections. Surveillance inspections are made to determine if Government-owned foods are wholesome and suitable for further storage, shipment, issue, sale, and consumption.[61] These inspections usually are made at installations, storage facilities, ships, activities, and wholesale stocks.[61] Veterinary personnel also are responsible for sanitation inspections of facilities on military installations including commissaries, PX/BX Marts, NEX Marts, exchange facilities, cook/chill facilities, and Morale, Welfare, and Recreation (MWR) activities.[61] The DoD has a hazardous food and nonprescription drug recall program (ALFOODACT), and veterinary personnel are required to ensure facilities have removed any recalled food and nonprescription drugs from their retail shelves and inventory through ALFOODACT inspections.[61]

Veterinary Laboratory Service

There are two main US military veterinary laboratories that conduct laboratory services for food: the DoD Food Analysis & Diagnostic Laboratory (FADL) in San Antonio, TX, and the Veterinary Laboratory-Europe in Landstuhl, Germany. These laboratories conduct microbiological, chemical, toxicological, and radiological analysis of food items, nonprescription drugs, water, dietary supplements, and cosmetics to help submitting inspectors to determine their fitness for consumption/issue/resale, and conformance with contractual requirements.[61]

Subsistence Laboratory Analysis Program

This program supports the food safety and quality assurance program and is a three-part program with three sampling methods: sanitation audit sampling, other origin sampling, and destination monitoring sampling. Sanitation audit sampling is the testing of food items collected at their place of manufacture as part of the sanitation audit program. Other origin sampling is testing of food items their place of manufacture not in conjunction with sanitation audits.

Destination monitor sampling is testing of food items (usually potentially hazardous foods) collected from commissaries, military exchange activities, MWR activities, and prime vendor/troop feeding facilities. Army Regulation 40-657 outlines the actions taken for nonconforming laboratory results. If a pathogen or adulterant is discovered as part of the origin monitoring program, the product or entire establishment will be suspended. Within 24-hours, the production establishment is notified and if a recall is required, the appropriate food safety office will be notified. Within 48 hours, a routine sanitation audit will be scheduled to investigate the source of the problem, unless the production facility is under Federal regulatory authority, in which case the federal agency is notified. Three consecutive conforming laboratory tests from three different production lots are required for products/establishments to be reinstated. If pathogens or adulterants are found as part of the destination monitoring program, the products are placed on medical hold, and the veterinary unit that sampled the product at the destination will notify the veterinary unit responsible for sanitation audits of the production establishment. Subsequently, the same steps outline above are followed.

An evaluation of the US Army destination monitoring program was conducted in 2015.[65] The review found several strengths to the program. The sampled and tested foods represented foods with a high potential for contamination. Shipping and processing of the food samples happened quickly, and results were reported in a timely manner. The FADL is accredited, so quality laboratory testing procedures were used. The limitations included relying on small sample sizes to make decisions about the safety of entire food lots. The online database used to extract sample results is difficult to navigate and use. The program is not integrated well with other surveillance systems such as the Armed Forces Reportable Medical Events, The Foodborne

Diseases Active Surveillance Network (FoodNet), and the National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet).[65]

Foodborne Illness Surveillance in the United States

There are many surveillance systems in the US used to provide information about the occurrence of foodborne disease. The Center for Disease Control and Prevention provides leadership for a variety of these surveillance systems, which are outlined below:

The Foodborne Diseases Active Surveillance Network (FoodNet)

FoodNet was established in 1996 as the principal foodborne disease component of CDC's Emerging Infections Program.[66] FoodNet is a collaborative sentinel surveillance program among the CDC, 10 state health departments, the US Department of Agriculture's Food Safety and Inspection Service (USDA-FSIS), and the Food and Drug Administration (FDA). There currently are 10 FoodNet sites located in California, Connecticut, Georgia, Minnesota, Oregon, Colorado, New Mexico, Tennessee, New York, and Maryland. These sites conduct active surveillance for laboratory confirmed detection of seven bacterial and two parasitic infections commonly transmitted through food.[66,67] FoodNet surveillance accounts for 44.9 million persons, or 15% of the US population in 2005.[66] The stated objectives of FoodNet are to: determine the burden of foodborne disease, monitor trends of the burden of specific foodborne diseases over time, attribute the burden of foodborne illness to specific foods and settings, and develop and assess interventions to reduce foodborne illness.[66] FoodNet uses active surveillance, meaning they contact >600 clinical laboratories that serve the FoodNet sites to ascertain laboratory-confirmed infections for *Campylobacter* species, *Listeria monocytogenes, Salmonella* species, *Shigella* species, shiga toxin-producing *Escherichia coli* O157:H7, *Vibrio* species, *Yersinia*

enterocolitica, Cryptosporidium, *Cyclospora*, and non O157 Shiga toxin-producing *E. coli.*[66] FoodNet data is used to track trends and incidence of foodborne and diarrheal disease across the US.[67]

National Antimicrobial Resistance Monitoring System—enteric bacteria (NARMS)

NARMS is a collaboration between public health and agriculture agencies and conducts surveillance for antimicrobial resistance of foodborne bacteria in humans (CDC), retail meat (FDA), and animals (USDA). The goal is to detect, respond, and prevent the development of antimicrobial resistance in foodborne bacteria.[67]

The National Electronic *Norovirus* Outbreak Network (CaliciNet)

CaliciNet is a national surveillance network of local, state, and federal public health laboratories in the US. It is a national framework where public health labs can submit genetic sequences of isolated *Norovirus* strains and epidemiological data from *Norovirus* outbreaks. The different strains can be compared to help link outbreaks to a common source, monitor for circulating strains, and to identify newly emerging *Norovirus* strains.[67] *Norovirus* is the number one cause of foodborne illness in the United States.[54]

The National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet)

PulseNet is a network of local, state, territorial, agricultural, and federal laboratories that use standardized methods to perform pulse-field gel electrophoresis (PFGE) on foodborne pathogens. Participating sites upload PFGE patterns into a national electronic database along with patterns of other pathogens that have been isolated from humans, animals, and foods. PulseNet collects PFGE data for the following bacterial pathogens*: E. coli* O157 and other STEC, *Campylobacter jejuni*, *Clostridium botulinum*, *Listeria monocytogenes*, *Salmonella, Shigella*, *Vibrio cholera*, *Vibrio parahaemolyticus*, and *Cronobacter.* The database is analyzed

to identify matches and possible outbreaks, and allows for seemingly isolated cases to be tied to existing outbreaks.[67]

National Notifiable Diseases Surveillance System (NNDSS)

NNDSS collects data on nationally notifiable diseases. Nationally notifiable diseases are those that health care providers and laboratory professionals are required by law to report to local public health agencies when diagnosed.[67] Local public health agencies in turn report these diseases to the state or territorial public health agency, which then voluntarily submits the information to NNDSS. This system relies on passive data collection, because it relies on the reports from physicians, local, and state public health agencies.[67] Reportable foodborne diseases in the US include botulism, hemolytic uremic syndrome (HUS), listeriosis, salmonellosis, shiga toxin-producing *Escherichia coli* (STEC) infections, and vibriosis.[67]

National Outbreak Reporting System (NORS)

NORS collects reports of foodborne outbreaks due to enteric bacterial, viral, parasitic, and chemical agents. State, local, and territorial public health agencies report these outbreaks through the National Outbreak Reporting System (NORS).[67] The NORS surveillance team conducts analyses of these data to improve understanding of the human health impact of foodborne outbreaks and the pathogens, foods, settings, and contributing factors involved in these outbreaks.[67] Starting in 2009, the system has included modules for reporting enteric disease outbreaks transmitted through water, person-to-person contact, or direct contact with animals.[67]

Health Surveillance in the Military

There is no specific foodborne illness surveillance system for the US Military. There is, however, a health surveillance system. Department of Defense Directive 6490.2 states that

comprehensive health surveillance is an important element of force health protection (FHP) programs to promote, protect, and restore the physical and mental health of DoD personnel.[68] Comprehensive, continuous, and consistent health surveillance shall be conducted by the military services to implement early intervention and control strategies using technologies, practices, and procedures in a consistent manner across the DoD. This directive establishes the Armed Forces Health Surveillance Center (AFHSC), now called the Armed Forces Health Surveillance Branch (AFHSB) as the single source for DoD-level health surveillance information.[68]

The AFHSB established a listing of 66 Reportable Medical Events (RME) and case definitions. These reportable medical events represent an inherent, significant threat to public health and military operation.[69] These events have the potential to affect large numbers of people, to be widely transmitted within a population, to have severe/life threatening clinical manifestations, and to disrupt military training and deployment.[69] The reportable events were chosen based on consensus and recommendations from each of the military services about notifiable diseases from the CDC, Council of State and Territorial Epidemiologists (CSTE), as well as events that military public health experts have identified as representing military threats.[69] The list of Reportable Events contains specific disease and environmental exposures that have clear case definitions and laboratory criteria for diagnosis. Events among all military healthcare system beneficiaries (family members, retirees, government employees) are reported.[69] Medical events are reported via ICD-9 codes. Though the AFHSB does not specifically monitor for foodborne illness, 17 of the 66 RME's have the potential to be foodborne in origin (Appendix A-2). Currently, the military utilizes a number of health surveillance systems, all of which rely on passive data collection.

Defense Medical Surveillance System (DMSS)

AFHSB operates the Defense Medical Surveillance System (DMSS), a continuously expanding relational database that documents military and medical experiences of service members throughout their careers. As the central repository of medical surveillance data for the U.S. Armed Forces, DMSS contains up-to-date and historical data on diseases and medical events (e.g., hospitalizations, ambulatory visits, reportable medical events, HIV tests, and casualty data) and longitudinal data on personnel and deployments.[70] AFHSB routinely publishes summaries of notifiable diseases, trends of illnesses of special surveillance interest and field reports describing outbreaks and case occurrences in the Medical Surveillance Monthly Report (MSMR), the principal vehicle for disseminating medical surveillance information of broad interest.[70]

Defense Health Services Systems (DHSS) Electronic Surveillance System for Early Notification of Community-Based Epidemics (ESSENCE)

ESSENCE is a syndromic surveillance system for capturing and organizing clinical data from the Military Health System (MHS) into disease syndrome groupings intended to promote early detection of disease outbreaks.[71] ESSENCE monitors and provides alerts for rapid or unusual increases in the occurrence of infectious diseases and biological outbreaks.[71]

DRSi (Disease Reporting System Internet)

DRSi is a web-based reporting system for Reportable Medical Events (RME). All RMEs are reviewed by hospital preventive medicine staff before they are converted to Medical Event Reports and formally entered into the DRSi system.[72] Data in DRSi is used to track disease outbreaks and perform RME trend analysis at the installation or regional level. It also is used to monitor and report submission rates and trends across military medical treatment facilities.[72]

The Military Health System Data Repository (MDR)

The MDR is the centralized data repository that captures, archives, validates, integrates and distributes Defense Health Agency (DHA) corporate health care data worldwide.[73] It receives and validates data from the Department of Defense's (DoD) worldwide network of more than 260 health care facilities and from non-DoD data sources.[73]

Despite this robust surveillance system, there is no system in place specifically for the surveillance of foodborne illness. In addition, all of these systems employ passive data collection, which increases the likelihood of underreporting of data. To our knowledge there is no direct connection between these surveillance systems and the surveillance systems under the leadership of the CDC. Further investigation into how these surveillance systems could complement the CDC's surveillance systems is warranted.

Conclusion

This literature review highlights many important aspects to consider when designing a burden of illness study for a population of interest. More accurate estimates can be obtained if smaller, clearly defined populations are studied. Use of face-to-face surveys yields higher response rates, though using technology like emailed electronic surveys for specific populations (such as the military) also could produce easily obtained, accurate results. Smaller study populations also increase the feasibility to conduct prospective studies, which if designed to allow for easy data tracking by the participants, could yield more accurate data. Regardless of study design, authors should attempt to pinpoint specific risk factors for illness so specific interventions to reduce illness burden can be suggested. In the following pages, we describe our four-part burden of foodborne illness study in the nondeployed active duty US Army population.

In this study, we attempted to overcome the limitations described in this literature review to develop the most accurate estimates possible. Some of the limitations were unavoidable, and certain military-specific data were unavailable, but to our knowledge, this is the first study of this kind for the US Army. Ultimately, we were able to make recommendations for a comprehensive and integrated DoD-wide active foodborne illness surveillance system, and make recommendations for future, cross-sectional, case-control, and prospective studies that can yield not only more accurate data, but also identify specific targeted foodborne illness interventions in the military population. This is the first step to accomplishing the ultimate goal of the US Army Food Protection: prevent foodborne illness in the military.

References

1. Armed Forces Health Surveillance Center. Gastrointestinal infections, active component, U.S. Armed Forces, 2002-2012. *MSMR.* 2013;20(10):7-11.

2. Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease, as estimated from studies published between 1992 and 2000. *Bulletin of the World Health Organization.* 2003;81(3):197-204.

3. Jones TF, McMillian MB, Scallan E, et al. A population-based estimate of the substantial burden of diarrhoeal disease in the United States; FoodNet, 1996-2003. *Epidemiol Infect.* 2007;135(2):293-301.

4. Herikstad H, Yang S, Van Gilder T, et al. A population-based estimate of the burden of diarrhoeal illness in the United States: FoodNet, 1996-7. *Epidemiology and Infection.* 2002;129(1):9-17.

5. Roy SL, Scallan E, Beach MJ. The rate of acute gastrointestinal illness in developed countries. *Journal of water and health.* 2006;4 Suppl 2:31-69.

6. Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease, as estimated from studies published between 1992 and 2000. *Bulletin of the World Health Organization.* 2003;81:197-204.

7. Kuchenmuller T, Hird S, Stein C, Kramarz P, Nanda A, Havelaar AH. Estimating the global burden of foodborne diseases--a collaborative effort. *Euro surveillance : bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin.* 2009;14(18).

8. Majowicz SE, Hall G, Scallan E, et al. A common, symptom-based case definition for gastroenteritis. *Epidemiol Infect.* 2008;136(7):886-894.

9. Centers for Disease Control and Prevention. *International Collaboration on Enteric Disease 'Burden of Illness' Studies.* 2012. http://www.cdc.gov/ncezid/dfwed/international/enteric-burden-collaboration.html. Accessed January 15, 2016.

10. Adlam SB, Perera S, Lake RJ, Campbell DM, Williman JA, Baker MG. Acute gastrointestinal illness in New Zealand: a community study. *Epidemiol Infect.* 2011;139(2):302-308.

11. Aguiar Prieto P, Finley RL, Muchaal PK, et al. Burden of self-reported acute gastrointestinal illness in Cuba. *Journal of health, population, and nutrition.* 2009;27(3):345-357.

12. Ahmed S, Ricketts P, Bergeron M, Jones W, Indar L. Distribution, burden, and impact of acute gastroenteritis in Dominica, 2009-2010. *Journal of health, population, and nutrition.* 2013;31(4 Suppl 1):43-56.

13. Baumann-Popczyk A, Sadkowska-Todys M, Rogalska J, Stefanoff P. Incidence of self-reported acute gastrointestinal infections in the community in Poland: a population-based study. *Epidemiol Infect.* 2012;140(7):1173-1184.

14. Chen Y, Yan WX, Zhou YJ, et al. Burden of self-reported acute gastrointestinal illness in China: a population-based survey. *BMC public health.* 2013;13:456.

15. Clark S, Berrang-Ford L, Lwasa S, Namanya DB, Edge VL, Harper S. The burden and determinants of self-reported acute gastrointestinal illness in an Indigenous Batwa Pygmy population in southwestern Uganda. *Epidemiology and infection.* 2015;143(11):2287-2298.

16. Doorduyn Y, Van Pelt W, Havelaar AH. The burden of infectious intestinal disease (IID) in the community: a survey of self-reported IID in The Netherlands. *Epidemiology and infection.* 2012;140(7):1185-1192.

17. Fletcher SM, Lewis-Fuller E, Williams H, et al. Magnitude, distribution, and estimated level of underreporting of acute gastroenteritis in Jamaica. *Journal of health, population, and nutrition.* 2013;31(4 Suppl 1):69-80.

18. Gabriel OO, Jaime A, McKensie M, Auguste A, Perez E, Indar L. Estimating the burden of acute gastrointestinal illness: a pilot study of the prevalence and underreporting in Saint Lucia, Eastern Caribbean. *J Health Popul Nutr.* 2013;31(4 Suppl 1):3-16.

19. Gajamer VR, Tiwari HK. Prevalence of gastrointestinal disease and its associated risk factors in Sikkim and Darjeeling Districts. *Journal of community health.* 2014;39(4):767-774.

20. Gargouri N, Walke H, Belbeisi A, et al. Estimated burden of human Salmonella, Shigella, and Brucella infections in Jordan, 2003-2004. *Foodborne pathogens and disease.* 2009;6(4):481-486.

21. Glasgow LM, Forde MS, Antoine SC, Perez E, Indar L. Estimating the burden of acute gastrointestinal illness in Grenada. *Journal of health, population, and nutrition.* 2013;31(4 Suppl 1):17-29.

22. Gurpreet K, Tee GH, Amal NM, Paramesarvathy R, Karuthan C. Incidence and determinants of acute diarrhoea in Malaysia: a population-based study. *Journal of health, population, and nutrition.* 2011;29(2):103-112.

23. Hansdotter FI, Magnusson M, Kuhlmann-Berenzon S, et al. The incidence of acute gastrointestinal illness in Sweden. *Scandinavian journal of public health.* 2015;43(5):540-547.

24. Harper SL, Edge VL, Ford J, et al. Acute gastrointestinal illness in two Inuit communities: burden of illness in Rigolet and Iqaluit, Canada. *Epidemiology and infection.* 2015;143(14):3048-3063.

25. Ho SC, Chau PH, Fung PK, Sham A, Nelson EA, Sung J. Acute gastroenteritis in Hong Kong: a population-based telephone survey. *Epidemiol Infect.* 2010;138(7):982-991.

26. Ingram M, St John J, Applewhaite T, Gaskin P, Springer K, Indar L. Population-based estimates of acute gastrointestinal and foodborne illness in Barbados: a retrospective cross-sectional study. *Journal of health, population, and nutrition.* 2013;31(4 Suppl 1):81-97.

27. Kubota K, Kasuga F, Iwasaki E, et al. Estimating the burden of acute gastroenteritis and foodborne illness caused by Campylobacter, Salmonella, and Vibrio parahaemolyticus by using population-based telephone survey data, Miyagi Prefecture, Japan, 2005 to 2006. *Journal of food protection.* 2011;74(10):1592-1598.

28. Lakhan C, Badrie N, Ramsubhag A, Sundaraneedi K, Indar L. Burden and impact of acute gastroenteritis and foodborne pathogens in Trinidad and Tobago. *Journal of health, population, and nutrition.* 2013;31(4 Suppl 1):30-42.

29. Muller L, Korsgaard H, Ethelberg S. Burden of acute gastrointestinal illness in Denmark 2009: a population-based telephone survey. *Epidemiol Infection.* 2012;140(2):290-298.

30. Persuad S, Mohamed-Rambaran P, Wilson A, James C, Indar L. Determining the community prevalence of acute gastrointestinal illness and gaps in surveillance of acute gastroenteritis and foodborne diseases in Guyana. *Journal of health, population, and nutrition.* 2013;31(4 Suppl 1):57-68.

31. Sang XL, Liang XC, Chen Y, et al. Estimating the burden of acute gastrointestinal illness in the community in Gansu Province, northwest China, 2012-2013. *BMC public health.* 2014;14:787.

32. Sargeant JM, Majowicz SE, Snelgrove J. The burden of acute gastrointestinal illness in Ontario, Canada, 2005-2006. *Epidemiol Infect.* 2008;136(4):451-460.

33. Scavia G, Baldinelli F, Busani L, Caprioli A. The burden of self-reported acute gastrointestinal illness in Italy: a retrospective survey, 2008-2009. *Epidemiol Infect.* 2012;140(7):1193-1206.

34. Thomas MK, Perez E, Majowicz SE, et al. Burden of acute gastrointestinal illness in Galvez, Argentina, 2007. *Journal of health, population, and nutrition.* 2010;28(2):149-158.

35. Thomas MK, Perez E, Majowicz SE, et al. Burden of acute gastrointestinal illness in the Metropolitan region, Chile, 2008. *Epidemiol Infect.* 2011;139(4):560-571.

36. Wilking H, Spitznagel H, Werber D, Lange C, Jansen A, Stark K. Acute gastrointestinal illness in adults in Germany: a population-based telephone survey. *Epidemiology and infection.* 2013;141(11):2365-2375.

37. Zhou YJ, Dai Y, Yuan BJ, et al. Population-based estimate of the burden of acute gastrointestinal illness in Jiangsu province, China, 2010-2011. *Epidemiology and infection.* 2013;141(5):944-952.

38. Cantwell LB, Henao OL, Hoekstra RM, Scallan E. The effect of different recall periods on estimates of acute gastroenteritis in the United States, FoodNet Population Survey 2006-2007. *Foodborne pathogens and disease.* 2010;7(10):1225-1228.

39. Holbrook AL, Green MC, Krosnick JA. Telephone versus face-to-face interviewing of national probability samples with long questionnaires: Comparisons of respondent satisficing and social desirability response bias. *Public Opinion Quarterly.* 2003;67(1):79-125.

40. Alreck P, Settle, R. *Survey Research Handbook.* 3rd ed. New York, NY: McGraw Hill; 2004.

41. Blumberg S, Luke JV. *Wireless substitution: Early release of estimates from the National Health Interview Survey, January-June 2015.* National Center for Health Statistics: Centers for Disease Control and Prevention;2015.

42. Tourangeau R. Survey research and societal change. *Annu. Rev. Psychol.* 2004;55:775-801.

43. Levy PS, Lemeshow S. *Sampling for Health Professionals.* Lifetime Learning Publications; 1980.

44. Prohaska V, Brown NR, Belli RF. Forward telescoping: the question matters. *Memory (Hove, England).* 1998;6(4):455-465.

45. Wheeler JG, Sethi D, Cowden JM, et al. Study of infectious intestinal disease in England: rates in the community, presenting to general practice, and reported to national surveillance. The Infectious Intestinal Disease Study Executive. *BMJ (Clinical research ed.).* 1999;318(7190):1046-1050.

46. Rodrigues L. TC, Lordan G., Normand C., Martin D., Higgins C. Let us not forget telescoping as a major risk of telephone surveys. *BMC public health.* 2006;(6):208.

47. Hall G, McDonald L, Majowicz SE, et al. Respiratory symptoms and the case definition of gastroenteritis: an international analysis of the potential impact on burden estimates. *Epidemiol Infect.* 2010;138(1):117-124.

48. United States Army Medical Service. *Preventive medicine in World War II.* Washington: Office of the Surgeon General, Dept. of the Army; 1955.

49. Riddle MS, Tribble DR, Putnam SD, et al. Past Trends and Current Status of Self-Reported Incidence and Impact of Disease and Nonbattle Injury in Military Operations in Southwest Asia and the Middle East. *American journal of public health.* 2008;98(12):2199-2206.

50. Hyams KC, Bourgeois AL, Merrell BR, et al. Diarrheal Disease during Operation Desert Shield. *New England Journal of Medicine.* 1991;325(20):1423-1428.

51. Armed Forces Health Surveillance Center. Absolute and relative morbidity burdens attributable to various illnesses and injuries, U.S. Armed Forces. *MSMR.* 2012;20(4):5-10.

52. M. Adams YM. Basic food safety for health workers. *Geneva: World Health Organization.* 1999:116.

53. Painter JA, Hoekstra RM, Ayers T, et al. Attribution of foodborne illnesses, hospitalizations, and deaths to food commodities by using outbreak data, United States, 1998-2008. *Emerg Infect Dis.* 2013;19(3):407-415.

54. Scallan E, Hoekstra R, Angulo F, et al. Foodborne illness acquired in the United States--major pathogens. *Emerging infectious diseases.* 2011;17(1):7-15.

55. Outbreak of staphylococcal food poisoning from a military unit lunch party - United States, July 2012. *MMWR.* 2013;62(50):1026-1028.

56. Escherichia coli O157:H7 infections associated with ground beef from a U.S. military installation--Okinawa, Japan, February 2004. *MMWR.* 2005;54(2):40-42.

57. Plummer K, Bayles M, Lee H, et al. Outbreak of acute gastroenteritis due to Norovirus, Fort Dix, New Jersey, December 2006. *MSMR.* 2007;14(2):11-13.

58. Chapman AS, Witkop CT, Escobar JD, et al. Norovirus outbreak associated with person-to-person transmission, U.S. Air Force Academy, July 2011. *MSMR.* 2011;18(11):2-5.

59. Arness MK, Feighner BH, Canham ML, et al. Norwalk-like viral gastroenteritis outbreak in U.S. Army trainees. *Emerg Infect Dis.* 2000;6(2):204-207.

60. Armed Forces Health Surveillance Center. Foodborne Outbreak of Salmonella Gastroenteritis among US Army Soldiers, Dhahran, Saudi Arabia. *MSMR.* 1998;4(6):15-18.

61. Army Regulation 40-657: Veterinary/Medical Food Safety, Quality Assurance, and Laboratory Service. In: Army UDot, ed. Washington, DC2005.

62. USAPHC Circular 40-1: Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement. In: Army Dot, ed. Aberdeen Proving Ground, MD: US Army Publich Health Command; June 2012.

63. Sanitation Requirements for Food Establishments. In: Defense Do, ed. Washington, DCJune 2008.

64. Military Handbook 3006C: Guidelines for Auditing Food Establishments. In: Defense UDo, ed. Washington, DCJune 2008.

65. Rapp-Santos K, Havas K, Vest K. Evaluation of the US Army Institute of Public Health Destination Monitoring Program, a food safety surveillance program. *U.S. Army Medical Department journal.* 2015:16-24.

66. Scallan E. Activities, achievements, and lessons learned during the first 10 years of the Foodborne Diseases Active Surveillance Network: 1996-2005. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America.* 2007;44(5):718-725.

67. Centers for Disease Control and Prevention. Foodborne Illness Surveillance Systems. In: National Center for Emerging and Zoonotic Infectious Diseases, Division of Foodborne W, and Environmental Diseases,, eds. Atlanta, GA2011.

68. Department of Defense Directive (DODD) 6490.02E. Washington DC HeadquartersFebruary 8, 2012.

69. Armed Forces Health Surveillance Branch. Armed Forces Reportable Events Guidelines & Case Definitions. 2012; https://www.afhsc.mil/Home/ReportableEvents. Accessed January 18, 2016.

70. Defense Medical Surveillance System. 2016; https://www.afhsc.mil/Home/DMSS. Accessed January, 18, 2016.

71. Electronic Surveillance System for Early Notification of Community based Epidemics. http://www.health.mil/Military-Health-Topics/Technology/Clinical-Support/Centralized-Credentials-Quality-Assurance-System/Decision-Support/Electronic-Surveillance-System-for-the-Early-Notification-of-Community-based-Epidemics. Accessed January 18, 2016.

72. McCormic Z. Disease Reporting System internet (DRSi). 2014.

73. Military Health System Data Repository. 2013; I:http://www.health.mil/Military-Health-Topics/Technology/Clinical-Support/Military-Health-System-Data-Repository. Accessed January 18, 2016, 2016.

Chapter 3 : The burden of self-reported gastroenteritis among nondeployed active duty Army service members: a population-based email survey May 2015

Introduction

Throughout military history, acute gastrointestinal illness (AGI) has been a significant cause of morbidity and mortality among United States service members.[1] Diarrheal disease was responsible for more deaths than by enemy action during the Revolutionary War, and during the civil war diarrheal disease occurred with more frequency and produced more sickness and mortality than any other form of disease.[1] Despite advances in medicine and improvements in basic sanitation, modern day military operations still are affected by gastrointestinal illness. During Operation Desert Shield, 57% of surveyed troops reported experiencing at least one episode of diarrhea, with 20% reporting they were temporarily unable to perform duties due to their symptoms.[2] In 2012, diarrheal diseases were responsible for more than 17,000 healthcare encounters affecting over 15,000 U.S. service members.[3] AGI often is characterized by diarrhea, vomiting, fever, malaise, and/or weakness. If a large proportion of the military population is affected by AGI, military operational effectiveness can be degraded.[4]

One important preventable cause of AGI is foodborne illness. The WHO estimates that at as much as 70% of diarrheal diseases worldwide can be attributed to foodborne pathogens.[5] Foodborne infections are an important cause of illness in the United States,[6] with more than 48 million Americans becoming ill from infected foods annually.[7] Members of the US Army also are at risk for foodborne illness. The US Army is a unique population that is globally distributed, has its own food procurement system, and a food protection system dedicated to the

prevention of both unintentional and intentional contamination of food. To our knowledge, incidence of foodborne illness among the nondeployed active duty US Army military population has not been determined. Foodborne illness burden measures are necessary for directing policy and interventions aimed at reducing the incidence of foodborne disease. Estimating the number of foodborne illnesses among US Army service members can be very challenging for a number of reasons. One challenge is that food can be contaminated by a number of agents that can cause illness including viruses, bacteria, parasites, and chemicals.[7] Transmission of these agents can occur through nonfood routes such as consumption of contaminated water or contact with infected animals.[7] The amount of infection transmitted by food depends on the level of contamination in the food, the environment in which the food is prepared, the pathogen itself, and certain host factors such as immune status and age.[7] Finally, we generally rely on laboratory surveillance to detect cases of foodborne illness, which results in many cases going undetected.[8] For the US Army, these issues are compounded by the fact that the US Army does not have a foodborne illness-specific surveillance system in place.

In the US Army, foodborne disease is only detected through passive surveillance, mainly through the medical event reporting system, and only 17 of the 31 major causes of foodborne illness are included as reportable medical events (Appendix A-2).[7,9] This system relies on laboratory confirmation of illness and is not an accurate reflection of the true burden of foodborne disease. For a reportable medical event to be documented, the ill service member must seek medical care and submit a stool specimen, the laboratory must isolate and identify the organism from the sample, and positive results must be entered into the reportable medical events system (Figure 3.1). If any one of these events does not occur, the illness is not recorded. In order to determine a more accurate estimate of the incidence of foodborne illness in the US

Army, we need to estimate the number of cases of disease that go unrecognized at each surveillance step. Scallan et al. (2011) calculated estimates of foodborne illness in the United States through the use of telephone surveys, laboratory surveys, and data from outbreak investigations.[7] Our current study uses similar methods through a web-based survey of the nondeployed active duty US Army population and of US Army clinical laboratories. This chapter describes part one of a four-part study to estimate the burden of foodborne illness among nondeployed US Army active duty service members caused by five major pathogens. In part one of this study, we use survey data to estimate the burden of AGI among nondeployed active duty US Army service members and identify risk factors associated with the occurrence of AGI among service members. These are the necessary first steps to developing an estimate of the prevalence of AGI due to specific exposures such as foodborne illness.[8] Ultimately, the results of this study will be used to make recommendations for a DOD-wide foodborne illness surveillance system, identify strategies for foodborne illness intervention, and to modernize the current US Army food protection program (Chapter 7).

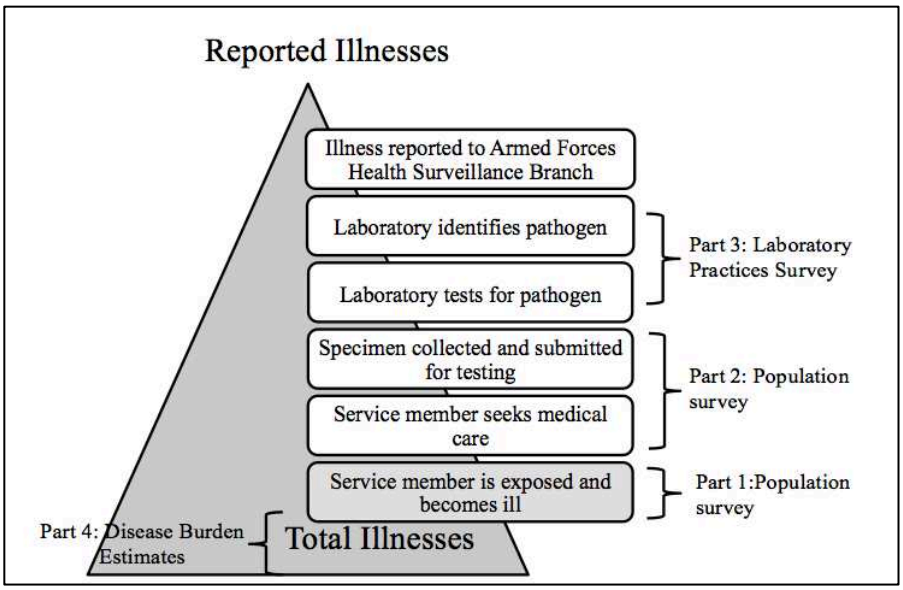


Figure 3.1. Burden of Illness pyramid illustrating the steps that must occur for an episode of illness in the active duty Army population to be reported through laboratory surveillance.

Ethics Statement

The Colorado State University Institutional Review Board (IRB) determined this project is exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b). The project qualifies for category 2 exemption (IRB ID# 131-15H). The United States Army Public Health Command IRB determined that this project did not meet the definition of research as provided by 45 CFR46.102(d), and has approved this project as a Public Health Practice—surveillance (IRB# 14-316). The purpose of the study was explained to all participants, and participation was voluntary.

Methods

Study design and Data Collection

A geographically representative random sample of the active duty US Army population was selected using a two-stage stratified sampling strategy.[10] First, the active duty US Army population was divided by regional medical command. There are 5 Regional Medical Commands (RMC): Europe (ERMC), Pacific (PRMC), Southern (SRMC), Northern (NRMC), and Eastern (ERMC). Because the goal of the sampling strategy was to gain a geographically representative sample, the US Army installations that were more geographically dispersed in each region were selected, and then a random selection of geographically clustered installations in each region were selected. Once the installations were selected, service members were randomly selected using installation email distribution lists. The required sample size calculation was made using the following equation in OpenEpi.[11]

$$n = deff \times \frac{N\hat{p}\hat{q}}{\frac{d^2}{1.96^2}(N-1) + \hat{p}\hat{q}}$$

n=sample size
deff=design effect
N=population size
p=estimated proportion
d=desired absolute precision

The 2013 active duty US Army population (N) was 528,070. The AGI estimated prevalence of 3% (p) was calculated from a small pilot study. The resulting sample size required using a 1% precision was 1116. On average, electronic military surveys have a 2% response rate, which translates to a required sample size of 55,800 (N. Thompson [nicole.j.thompson14.civ@mail. mil], email, January 20, 2015). The number of soldiers sampled at each installation was proportionally allocated based on the installation population to ensure equal probability of selection for all individuals. An additional 10% was added to account for out of office messages, invalid email addresses, emails to non-active duty service members, and emails to service members who are no longer actively serving.

The Enterprise Email system was used to select survey recipients and disseminate the survey.[12] The address book for each selected installation was imported into Microsoft Excel®.[13] In order to protect personally identifiable information we deleted the columns containing first and last name, addresses, and phone numbers. In addition, email addresses were hidden from view by shading the email address cells black. All files were password protected and stored on a password protected, secure computer. Contacts were excluded if they had civilian email addresses designated by specific name suffixes (.ln, .civ, .naf, .fm), or if they had a military email address belonging to another branch of the military (Air Force, Marines, etc.). Once these contacts were removed, a random number was assigned to each remaining contact. Contacts

were sorted from lowest random number to highest random number. The required number of survey recipients for each installation was selected starting with the lowest random number. A link to an electronic survey was sent to each selected contact through the Enterprise Email system. A total of 61,380 survey instruments were sent via email on April 6, 2015. Reminder emails were sent every two weeks until the survey closed on May 15th, 2015. Appendix A-3 contains a detailed explanation of how installations were selected, how the required number of service members from each installation was calculated, and a copy of the introductory email sent to each selected service member.

The survey instrument was created using Enterprise Feedback Management (EFM), a web enabled surveying solution used to capture, analyze, track, and act on customer feedback.[14] The survey instrument contained questions about sociodemographic characteristics, how often respondents ate at various on- and off-post establishments, where certain food items are procured, general health status, and any experience of diarrhea within 30 days of completing the survey. If respondents reported diarrhea, additional questions about concurrent symptoms, duration of illness, medical care seeking, and stool sample submission were asked. The survey questions were developed using the FoodNet Proposed AGI Behavioral Risk Factor Surveillance System Survey Module provided by Dr. Elaine Scallan. Questions were modified based on feedback from a class of graduate students enrolled in the Quantitative Data Collection Methods and Analysis course at Colorado State University. Questions were adjusted based on feedback from a small sample of active duty service members. The changes made included rewording questions to make them more clear, adding clarification to some questions, and updating terminology more familiar to the service member population. The complete survey instrument can be found in Appendix B-3. Survey results were compiled into an Excel (Microsoft

Corporation, Redmond, WA, USA) spreadsheet by Public Health Command information technology staff before being sent to the primary investigator. No personally identifying information that could link survey responses back to the respondents were included. All files used in analysis were password protected and stored on a secure computer.

Case Definition, Recall Period, and Inclusion/Exclusion Criteria

We used the internationally recognized case definition for gastroenteritis: three or more loose stools or any vomiting in a 24-hour period, but excluding those (a) with cancer of the bowel, irritable bowel syndrome, Cohn's disease, ulcerative colitis, cystic fibrosis, coeliac disease, or another chronic illness with symptoms of diarrhea or vomiting, or (b) who report their symptoms were due to drugs, alcohol, or pregnancy.[15] Individuals with (a) or (b) were counted as non-cases. Service members who deployed or travelled outside their country of residence within 30 days of completing the survey were excluded. To account for overestimation of the burden of AGI due to the inclusion of primary respiratory cases with secondary gastrointestinal symptoms, we also assessed the occurrence and distribution of cases of AGI without concurrent respiratory symptoms.[16] The survey recall period was 30 days prior to the date of survey response.

Data Analyses

Descriptive statistics for categorical variables included frequency, percentages, and relative 95% confidence intervals (CI). Differences in proportion were assessed by the χ^2test, or Fisher's exact test where appropriate.[17] Continuous variables were described by histogram, mean and standard deviation, or median and range. Differences in diarrhea duration, vomiting duration, duration of both diarrhea and vomiting, and number of days of missed work were compared between the five regions using the Kruskall-Wallis test.[17] The mean age of respondents was compared between the five regions using one-way ANOVA, and Tukey's

honest significant difference post-hoc test.[17] All continuous variables were eventually recoded as categorical variables for statistical analysis. Appendix C-3 contains specific descriptive analysis and statistical test outputs.

We used the proportion of respondents with AGI to estimate the 30-day AGI prevalence for the population of interest. (Hereafter, this estimated 30-day prevalence is referred to as prevalence or monthly prevalence.) The prevalence of AGI was calculated as the proportion of survey respondents who reported episodes of AGI in the 30 days prior to survey completion. The point prevalence of AGI was obtained as the proportion of cases with AGI symptoms on the day of filling out the survey. Proportions were adjusted for known demographic differences between those who completed the survey and the target population by weighting for age, sex, region of residence, education, rank, and race. Gender and age also were weighted by rank, and rank was weighted by age. Methods for weighting are explained in Appendix D-3.

We calculated AGI incidence density in episodes per person-year based on survey responses, and used this to estimate the AGI incidence density for the population. (Hereafter, this estimated AGI incidence density is referred to as annual incidence or incidence rate). The annual incidence was adjusted to account for those respondents who reported AGI during the 30 day observation and either (a) developed AGI during the 30-day period (incident case), or (b) developed the illness prior to the 30-day period and were still ill at the start of the period, therefore representing existing cases that should be excluded from incidence measures.[18] Cases were defined as those who met the AGI case definition, and the population at risk was defined as all who completed the survey. As outlined by Majowicz et al., we adjusted incidence by using the average duration of illness (x) to calculate the proportion of existing cases, assuming that cases occur equally throughout the 30 day period, using the formula: $[x-1]/30+(x-1)$.[18] This

proportion was subtracted from the number of cases and initial number at risk to adjust the incidence measures. Incidence rates also were adjusted for known demographic differences between the respondents and target population using weights for region of residence, gender, rank, and age (Appendix D-3). SAS code and output of crude and weighted data and the formulas for prevalence and incidence calculations are in Appendix E-3.

Univariable and multivariable logistic regression was used to identify the factors associated with the occurrence of AGI. Characteristics of AGI cases were compared with those of respondents who either reported no gastrointestinal symptoms, or reported vomiting and/or diarrhea, but did not meet the case definition of AGI. In the analysis, the outcome variable was being a case of AGI or not, and the explanatory variables were the demographic characteristics of the respondents. Independent variables were weighted to compensate for the under- and over-represented demographic factors. The models were adjusted to account for the two-stage stratified sampling plan. In the multivariable analysis, the full model started with all variables with p-value <0.25 from the univariable analysis. Variables were removed in a step-wise fashion, starting with the highest p-value, until all variables with p-value >0.05 were removed. Independent variables were assessed for confounding by looking for a change in model coefficients of ≥ 10 percent as variables were removed/added to the model. Independent variables were assessed for interaction by adding interaction terms back into the model and assessing for significance. The final model fit was assessed using the Pearson's chi-square goodness-of-fit and deviance test, with $P \geq 0.05$ indicating good fit. Appendix F-3 displays the steps of this univariable and multivariable analysis including SAS codes and outputs.

The salary costs associated with AGI occurrence were calculated using the average hourly base pay for officers and enlisted active duty service members provided by the US Army

Research Institute (N. Thompson [Nicole.j.thompson14.civ@mail.mil], email, February 26, 2015). Descriptive statistics were performed using Microsoft Excel for Mac 2010 (Microsoft Corporation, Redmond, WA, USA), StatCrunch (Pearson Education, 2007-2016), and the online statistical calculator, OpenEpi Version 3.03a 2015.[11,13] Statistical analysis was performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA) and StatCrunch (Pearson Education, 2007-2016).[19] Response rates were calculated using an online calculator provided by the Council of American Survey Research Organizations (CASRO) by SISA.[20] The statistical significance level for these results was <0.05.

Results

Response Rate and Respondent Representativeness

A total of 1642 out-of-office messages, 482 permanent out-of-office (retired, discharged, etc.), and 895 non-deliverable messages were received from the 61,380 emails sent. The survey instrument therefore reached a total of 60,003 Enterprise email inboxes. A total of 2,307 surveys were submitted. Of these, 86 were completed by ineligible, non active-duty US Army service members. Twelve of the submitted surveys were completely blank and 162 were less than 50% completed. These surveys responses were excluded from analysis. In total, 2047 completed surveys were received. The simple response rate was 3.4%, and the CASRO response rate was 1.2%. The overall survey completion rate was 92.2%. It took cases an average of six minutes and 25 seconds to complete the survey. It took non-cases an average of two minutes to complete the survey. The demographic characteristics of survey respondents are compared to the 2013 Active Duty US Army demographics in Table 3.1.[21] Demographic features of the respondents were different from the US Army demographic data in many categories. Demographic

characteristics that were over-represented included: living in Europe, age groups 31 and older, obtaining a Bachelor's degree and higher, female gender, and being an officer. Demographic characteristics that were under-represented included: living in the United States, age groups 30 and younger, those with less than a bachelor's degree, white race, male gender, and being enlisted. Respondents who reside in the Europe and Pacific regions tended to be younger on average, and those in the Southern region tended to be older on average.

Table 3.1. Characteristics of respondents, estimates of weighted monthly prevalence (95% confidence interval) and weighted annual incidence rate (95% CI) of self-reported acute gastrointestinal illness (AGI) in the 2015 web-based survey of non-deployed active duty Army service members.

			AGI cases not deployed in last 30 days								
			All cases (n=337)					Only cases without respiratory symptoms (n=230)			
	Army population [T]	Survey respondents	Weighted[¶] 30-day prevalence			Weighted[¶] annual incidence		Weighted[¶] 30 day prevalence		Weighted[¶] annual incidence	
	(n=528 070) (%)	(n=2047) (%)	n*	(%)	95% CI	No. of AGI episodes per person-year	95% CI	(%)	95% CI	No. of AGI episodes per person-year	95% CI
Region		(n=2000)									
ERMC	5.8	7.7	69	27.2	(16.68-37.67)	3.30	(2.09-4.91)	13.0	(5.10-20.99)	1.56	(0.79-2.66)
NRMC	20.8	20.3	386	17.8	(13.96-21.59)	2.16	(1.71-2.70)	11.9	(8.70-15.17)	1.43	(1.09-1.90)
PRMC	8.0	7.1	121	17.8	(10.94-24.57)	2.16	(1.39-3.11)	12.1	(6.32-17.98)	1.45	(0.88-2.30)
SRMC	35.8	33.2	673	19.1	(16.1-22.04)	2.32	(1.95-2.73)	13.7	(11.07-16.26)	1.64	(1.35-2.02)
WRMC	29.7	31.8	547	17.2	(14.07-20.4)	2.10	(1.71-2.53)	12.3	(9.54-15.04)	1.47	(1.17-1.87)
Location		(n=2000)									
United States	89.1	85.3	1660	18.1	(16.23-19.93)	2.20	(1.96-2.45)	12.7	(11.14-14.35)	1.53	(1.35-1.77)
Overseas	5.7	14.8	78	22.1	(12.87-31.35)	2.68	(1.67-4.08)	12.6	(5.19-19.94)	1.51	(0.81-2.58)
Gender		(n=2029)									
Male	86.4	79.4	1518	18.2	(16.29-20.17)	2.22	(1.97-2.48)	12.6	(10.67-13.98)	1.48	(1.30-1.72)
Female	13.6	20.6	255	19.1	(14.53-24.24)	2.36	(1.77-3.04)	13.3	(8.55-16.71)	1.51	(1.09-2.10)
Rank		(n=2037)									
Officer	18.7	36.3	328	18.6	(14.39-22.81)	2.26	(1.76-2.86)	13.5	(9.60-16.95)	1.59	(1.20-2.13)
Enlisted	81.3	63.7	1489	21.3	(19.18-23.33)	2.59	(2.31-2.87)	12.2	(11.55-15.00)	1.59	(1.40-1.85)
Age (years)		(n=2021)									
25 or younger	39.6	10.5	731	22.7	(19.66-25.74)	2.76	(2.37-3.19)	12.5	(10.99-15.93)	1.61	(1.34-1.97)
26-30	22.6	17.4	411	22.9	(18.87-27)	2.79	(2.28-3.38)	14.9	(11.29-18.15)	1.76	(1.38-2.26)
31-35	15.7	19.4	290	16.7	(12.39-20.97)	2.03	(1.52-2.62)	12.6	(8.31-15.81)	1.44	(1.04-1.97)
36-40	11.0	20.0	194	20.2	(14.51-25.81)	2.45	(1.80-3.28)	12.5	(7.75-17.03)	1.48	(0.99-2.13)
41 and Over	13.0	32.6	192	15.7	(10.54-20.81)	1.90	(1.33-2.63)	11.8	(7.58-16.84)	1.46	(0.97-2.11)
Race		(n=2022)									
White non-Hispanic	68.5	55.8	1202	19.3	(17.07-21.53)	2.35	(2.06-2.65)	13.1	(11.07-14.87)	1.56	(1.35-1.83)
Black or African American	21.0	19.4	377	16.9	(13.12-20.69)	2.05	(1.60-2.58)	10.3	(7.24-13.39)	1.24	(0.91-1.66)
All other races	10.5	24.7	186	18.7	(13.11-24.33)	2.27	(1.63-3.08)	14.5	(9.36-19.48)	1.73	(1.20-2.46)
Education		(n=2040)									
Associate/technical degree or less	77.7	52.2	1401	19.7	(17.58-21.75)	2.39	(2.13-2.68)	12.9	(11.11-14.62)	1.54	(1.35-1.80)
Bachelor's degree	14.2	28.3	247	15.9	(11.29-20.41)	1.93	(1.41-2.57)	10.0	(6.23-13.72)	1.20	(0.82-1.74)
Advanced degree	7.3	19.5	131	19.3	(12.49-26.02)	2.34	(1.58-3.33)	16.1	(9.79-22.39)	1.93	(1.28-2.88)
Overall	100.0	100.0	332	18.5	(16.66-20.25)	2.24	(2.04-2.49)	12.7	(11.19-14.27)	1.53	(1.36-1.75)

CI, Confidence interval

Ŧ Data from 2013 Military Demographics Report

¶ 30-day prevalance and annual incidence rates were adjusted for differences between the survey respondent and US Army population demographics. Gender weighted by rank, rank weighted by gender, and age weighted by rank.

*Number at risk are after stratification by region and installation using SAS STRATA statement.

Burden and Distribution of AGI

Gastrointestinal symptoms were reported by 739 (36.1%) of the respondents during the 30 days prior to completing the survey. Of the individuals with gastrointestinal symptoms, 402 (54.4%) did not meet the case definition of AGI because they reported chronic illness, alcohol, or pregnancy as the cause of their symptoms (n=125), they deployed in the last 30 days (n=91), or they experienced less than three loose stools and no vomiting in 24 hours (n=186). A total of 241 (12%) respondents were excluded from analysis because they deployed or travelled outside their country of residents during the 30 days prior to taking the survey. There were 337 (18.7%) non-excluded respondents who reported experiencing clinical symptoms consistent with the AGI case definition criteria in the 30 days prior to the survey date. Of these, 107 (31.8%) also reported experiencing respiratory symptoms (sore throat, cough) during their illness. The overall monthly prevalence of self-reported AGI was 18.5% (95% CI:16.66-20.25), and the overall incidence rate was 2.24 AGI episodes/person-year (95% CI 2.04-2.49). When excluding cases of AGI that also experienced respiratory symptoms, the monthly prevalence was 12.7% (95% CI: 11.19-14.27), and the corresponding incidence rate was 1.53 AGI episodes/person-year (95% CI:1.36-1.76). There were 4 respondents who reported diarrhea or vomiting on the day of the survey, corresponding to an AGI point prevalence of 0.22% (95% CI 0.005-0.438).

The 30-day prevalence and annual incidence of AGI by demographic characteristics of respondents are reported in Table 1. AGI prevalence and annual incidence rate was highest among those living in the Europe region, and those living in the Southern region. Females had a slightly higher 30-day AGI prevalence and annual incidence rate than males. The prevalence and annual incidence rate of AGI was higher among enlisted service members than officers. Overall, the AGI prevalence and annual incidence rate was highest among those in the 30 years

of age and below categories, and lowest among those 41 years of age and older. The annual AGI incidence and 30 day AGI prevalence was highest among white, non-Hispanic individuals, and lowest among African Americans. The lowest prevalence and annual incidence rate of AGI was reported among those with a Bachelor's degree. Removing the AGI cases with concurrent respiratory symptoms from the cases decreased the overall prevalence and annual incidence of AGI by 31.4%. When removing cases with concurrent respiratory symptoms, we saw a profound decrease in prevalence and annual AGI incidence among those residing in the Europe region (52.1% decrease), among enlisted service members (42.5% decrease) and among those aged 25 years and younger (44.9%).

Results of univariable and multivariable logistic regression to identify factors associated with the occurrence of AGI among nondeployed active duty US Army service members are reported in Table 3.2. Risk factors associated with the occurrence of AGI in the univariable analysis included: region of residence, age of respondents, eating at the on-post dining facility (DFAC), and eating at other on-post eating establishments. The variables in the final multivariable model included region of residence, eating at the DFAC, and eating at other on-post establishments, when controlling for confounding by gender, rank, and race. There was no evidence of confounding or effect modification by the other independent variables. The Pearson goodness-of-fit test P-value was 0.38, and the deviance test P-value was 0.06, indicating good model fit. When controlling for race, rank, gender, and eating habits, respondents living in Europe were 1.73 (95% CI: 1.02-2.94) times more likely to report an episode of AGI than those living in the Western region. When controlling for race, rank, gender, region of residence, and eating at other on-post establishments, respondents who reported eating at the DFAC more than twice a day were 2.80 (95%CI: 1.30-6.02) times more likely to report an episode of AGI than

respondents who reported never eating at the DFAC. When controlling for race, rank, gender, region of residence, and eating at the DFAC, respondents who reported eating at other on-post establishments at least once a week but less than twice a day were 1.49 (95%CI: 1.15-1.93) times more likely to report an episode of AGI than respondents who reported never eating at other on-post establishments.

Table 3.2. Association of risk factors with occurrence of self-reported AGI among nondeployed active duty US Army service members.

	Univariable analysis			Multivariable analysis		
				Adjusted		
Risk Factors	OR	95% CI	*P* value	OR	95% CI	*P* value
Region*						
ERMC	1.79	(1.08-2.98)	0.024	1.73	(1.02-2.94)	0.043
NRMC	1.04	(0.74-1.46)	0.831	1.10	(0.78-1.55)	0.603
PRMC	1.04	(0.60-1.78)	0.896	0.90	(0.50-1.59)	0.711
SRMC	1.13	(0.84-1.52)	0.409	1.20	(0.89-1.62)	0.229
WRMC		Ref.			Ref.	
Location*						
United States		Ref.				
Overseas	1.29	(0.90-1.83)	0.168			
Gender*						
Male		Ref.			Ref.	
Female	1.08	(0.79-1.46)	0.629	1.08	(0.80-1.46)	0.607
Rank*						
Officer		Ref.				
Enlisted	1.18	(0.88-1.59)	0.275	0.933	(0.72-1.22)	0.609
Age*						
25 or younger	1.58	(1.01-2.46)	0.044			
26-30	1.60	(1.10-2.32)	0.013			
31-35	1.08	(0.74-1.56)	0.696			
36-40	1.36	(0.96-1.92)	0.085			
41 and Over		Ref.				
Race*						
White non-Hispanic	1.04	(0.78-1.39)	0.797	1.00	(0.74-1.36)	0.995
Black or African American	0.88	(0.61-1.28)	0.510	0.80	(0.55-1.18)	0.260
All other races		Ref.			Ref.	
Education*						
Associate/technical degree or less	1.03	(0.75-1.40)	0.870			
Bachelor's degree	0.79	(0.55-1.13)	0.201			
Advanced degree		Ref.				
Eating Habits/Food Procurement						
Eat at on-post dining facility (DFAC)						
Never		Ref.			Ref.	
At least once a week <2 times/day	0.82	(0.62-1.09)	0.177	0.77	(0.57-1.03)	0.080
Twice a day	1.45	(0.83-2.56)	0.196	1.32	(0.73-1.39)	0.352
More than twice a day	2.70	(1.32-5.48)	0.006	2.80	(1.30-6.02)	0.008

	Univariable analysis			Multivariable analysis		
				Adjusted		
Risk Factors (Continued)	OR	95% CI	*P* value	OR	95% CI	*P* value
Eat at other on-post establishments						
Never		Ref.			Ref.	
At least once a week <2 times/day	1.44	(1.13-1.85)	0.004	1.49	(1.15-1.93)	0.003
Twice a day	0.74	(0.22-2.50)	0.624	0.75	(0.22-2.63)	0.655
More than twice a day	1.08	(0.23-5.00)	0.921	0.84	(0.18-3.98)	0.825
Eat at home						
Never	1.13	(0.61-2.09)	0.704			
At least once a week <2 times/day	1.24	(0.93-1.65)	0.146			
Twice a day	1.06	(0.78-1.45)	0.709			
More than twice a day		Ref.				
Eat at off-post establishment						
Never		Ref.				
At least once a week <2 times/day	1.19	(0.85-1.66)	0.311			
Twice a day	1.26	(0.68-2.32)	0.466			
More than twice a day	1.28	(0.41-3.98)	0.675			
Fresh fruits & vegetables						
Purchase on-post	1.09	(0.85-1.38)	0.506			
Purchase off-post		Ref.				
Dairy						
Purchase on-post	1.24	(0.97-1.57)	0.083			
Purchase off-post		Ref.				
Eggs						
Purchase on-post	1.12	(0.88-1.42)	0.366			
Purchase off-post		Ref.				
Fresh Fish						
Purchase on-post	0.87	(0.66-1.14)	0.299			
Purchase off-post		Ref.				
Fresh Meat						
Purchase on-post	1.05	(0.82-1.33)	0.707			
Purchase off-post		Ref.				
Fresh Poultry						
Purchase on-post	1.13	(0.89-1.43)	0.317			
Purchase off-post		Ref.				
Dry grains and beans						
Purchase on-post	1.21	(0.96-1.54)	0.113			
Purchase off-post		Ref.				

*ORs weighted. Rank and gender also weighted by age, age also weighted by rank.

The installations with the highest annual incidence rates of AGI episodes per person-year were USAG Vicenza (4.21, 95% CI: 2.01-8.35), USAG Casey (3.41, 95% CI: 1.63-6.76), USAG Bavaria (3.16, 95% CI: 2.06-4.81), Fort Knox (3.16, 95% CI: 1.32-7.11), and Fort Belvoir (3.14, 95% CI: 1.72-5.64). Table 3.3 displays the odds ratios for procuring food items on-post and off-post for these five installations compared to all other installations that were selected during sampling. The odds ratios are significantly increased among those who purchase all categories of food products at establishments on the installations with the highest annual incidence rates of AGI per person-year.

Table 3.3. Association of food procurement location by installations with AGI incidence rates greater than 3 episodes/person-year, when compared with installations with AGI incidence rates less than 3 episodes/person-year.

	AGI >3 episodes/ person-year* *n*	AGI < 3 episodes/ person-year§ *n*	OR	95% CI	P-Value
Fresh fruits and vegetables					
Purchase on-post	164	677	2.83	(2.12-3.76)	<.0001
Purchase off-post	80	933		Ref.	
Dairy products					
Purchase on-post	173	740	2.87	(2.14-3.85)	<.0001
Purchase off-post	71	872		Ref.	
Shell eggs					
Purchase on-post	153	678	2.31	(1.75-3.06)	<.0001
Purchase off-post	90	923		Ref.	
Fresh fish					
Purchase on-post	122	458	2.62	(1.99-3.46)	<.0001
Purchase off-post	113	1113		Ref.	
Fresh meat					
Purchase on-post	169	739	2.78	(2.07-3.73)	<.0001
Purchase off-post	71	863		Ref.	
Fresh poultry					
Purchase on-post	174	760	2.89	(2.14-3.88)	<.0001
Purchase off-post	68	857		Ref.	
Dry grains and beans					
Purchase on-post	186	764	3.66	(2.68-5.00)	<.0001
Purchase off-post	57	856		Ref.	

* Installations with AGI incidence rates greater than 3 episodes per person-year: USAG Vicenza USAG Casey, USAG Bavaria, Fort Knox, and Fort Belvoir.
§ Installations with AGI incidence rates less than 3 episodes per person-yea: Fort Benning, Fort Wainwright, Fort Bliss, Fort Campbell, Fort Riley, Fort Sill, Fort Bragg, Fort Hood, USAG Hawaii, Fort Drum, Joint Base Lewis-McChord, USAG Japan, USAG Benelux.

Discussion

To our knowledge, this is the first worldwide survey conducted in the active duty US Army population with the goal of describing the risk factors for and the magnitude and distribution of AGI in this unique population. The findings from this study show that AGI among active duty service members is important. The overall estimated annual incidence AGI of 2.24 episodes per person-year (95% CI: 2.02-2.49) was much higher than estimates reported by studies in developed countries using the same case definition.[22-29] We excluded service members who recently deployed or traveled to other countries in the 30 days prior to responding to the survey in order to exclude those who may have increased risk of travel associated AGI. Despite this, the rate of AGI is alarmingly high in this study, especially considering the age groups most often associated with higher incidence of AGI are excluded due to military age restrictions.[30-33]

The self-reported AGI episodes/person-year ranged from 2.10 to 3.30 depending on the region where respondents reside. This corresponds to more than 1,075,922 (95% CI: 852,047-1,340,801) cases of AGI occurring per year among nondeployed active duty US Army service members, almost 90,000 cases per month. Enlisted service members who reported an episode of AGI in the previous 30 days missed an average of 3.67 days of work due to their illness. Officers missed an average of 2.61 days of work due to their illness. When taking into account the average base salary of enlisted service members ($18.25) and officers ($53.95), the cost to the government for missed workdays due to AGI is $847,451,629 (95% CI: $727,331,502-$978,720,151). Healthcare-associated costs would increase this estimate even more.

Survey respondents with self-reported AGI may also report concurrent respiratory symptoms. These symptoms may be due to primary respiratory infections, primary

gastrointestinal infections, or both.[16] Of the respondents that met the case definition for AGI, 31.8% also reported experiencing respiratory symptoms (sore throat, cough) during their illness. This percentage is less than seen in similar studies in the US (46.7%) and Canada (41.8%), and comparable to that seen in Australia (28.6%).[16] When excluding cases of AGI with concurrent respiratory symptoms, the overall average incidence rate decreased to 1.55 AGI episodes per person-year, a 31.7% reduction. This reduction is similar to the reductions seen in studies conducted in Australia (30% decrease), and less than reductions seen in the United States (>50% decrease) and Canada (40%).[16] The largest reduction in incidence of AGI after excluding cases with respiratory symptoms was seen in the European region. Because of the possibility of over-inflation of true primary AGI cases, we must carefully consider the differences we see here when estimating the burden of foodborne illness among nondeployed active duty Army service members.

Risk factors for AGI identified in this study included living in the Europe region, eating at the DFAC on average more than twice a day, and eating at other on-post establishments at least once a week, but less than twice per day. Similar AGI burden studies in Europe describe annual AGI incidence rates consistent with other developed countries but much lower than in our population,[26,28,34-37] so it is unlikely that living in Europe is the only factor contributing to the increased AGI in this population. Eating at higher risk establishments, or procuring food from unfamiliar, local sources could be contributing factors. The association could also be unrelated to consumption of contaminated food and should be investigated further.

The association between eating at the DFAC and other on-post food establishments and the occurrence of AGI could be due to a breakdown anywhere in the food protection program, including unsanitary conditions at these establishments, poor food worker education and

hygiene, procurement of unsafe food products, improper storage of food on-post, and improper/insufficient inspection procedures. Preventive medicine and veterinary services should perform through inspections of all on-post dining facilities to determine possible causes for the identified increased risk of AGI among those who eat at these facilities.

We also found that respondents assigned to the installations with the highest incidence rate of AGI per person-year procured all categories of food on-post more often than off-post when compared with respondents assigned to the installations with lower rates of AGI. Three of the installations (USAG Vicenza, USAG Casey, and USAG Bavaria) are located overseas, two in the Europe region. It is possible that respondents assigned to these installations feel more comfortable purchasing food items at establishments that are more "familiar" to them on the installation than at establishments in the local economy. Reasons respondents may be more likely to shop on-post at the two installations located in the US (Fort Knox and Fort Belvoir) are convenience and lower prices. Though these associations are ecological, it is certainly a concern that there is an association between purchasing food items on-post and living in a region where AGI incidence is higher. Further investigation of the installation food supply chain should be conducted to determine possible sources of food contamination. In addition, basic sanitation inspection reports of on-post food establishments at these installations should be reviewed and verified. An additional inspection by veterinary services and preventive medicine personnel also is warranted. Education of consumers regarding proper food handling and preparation techniques also can help to reduce illness.

The goal of the US Army's food protection program is to ensure the food prepared and consumed on-post, and the food items procured on-post are as safe as or safer than food prepared, consumed, and sold off-post. Our investigation shows this may not be the case, and a

thorough evaluation of the food protection program should be conducted. This ecological association also could be due to other factors that increase the risk of AGI not related to food safety, and should be explored further.

Previous studies report highest AGI incidences among children,[30-32] and among both children and the elderly.[33] Our study excludes these high-risk age groups due to military age requirements. Other similar studies found an increased tendency for women to develop AGI, citing increased food handling[18,27,34] and caring for their children[34,38,39] as a potential causes. In our study population, females did not have a statistically increased propensity for developing AGI. This could be due to female active duty US Army service members spending less time in the home preparing meals and caring for children. Our findings were consistent with similar studies conducted in Cuba[40], Malta[34], and Denmark[26] that cite cultural practices or study bias for their results. If our estimates are an accurate reflection of the true incidence of AGI among active duty nondeployed US Army service members, additional studies to determine more risk factors for AGI in the US Army are warranted so we can develop policies and intervention strategies to reduce AGI. The exceedingly high AGI incidence rates we found should be considered in future burden of illness studies in the United States and overseas, as they may influence the outcome.

As with any study, our estimates may have been biased by a number of factors. To our knowledge this is the first population-based AGI burden study to use a web-based survey for data collection. Problems with web-based surveys in general center around the fact that a limited percent of the population has access to the internet, and creating sampling frames that give complete coverage of the general population of interest are very difficult, if not impossible.[41] The military population is unique in that all service members are assigned an email address and have access to the Internet. There is a centralized Enterprise email system that allows us to create

sampling frames based on assigned installation. Because of this, we were able to randomly select US Army service members based on assigned installations. When a service members moves, retires, or is discharged from the military, the Enterprise email system does not instantly change the status or location of the service member. We found this to be the case in our study because we received responses from individuals stationed at installations we did not select for our survey, and we received approximately 1,400 non-deliverable or permanent out of office (retired, discharged) messages. We added 10% to our sample size to account for this.

Even though our response rate was higher than in previous online surveys of the military (N. Thompson [nicole.j.thompson14.civ@mail.mil], email, January 20, 2015), relative to population-based telephone surveys conducted in other countries, our response rate was extremely low. Though recent studies have demonstrated little to no relationship between nonresponse rates and nonresponse bias, the "low" response rates in these studies (36.0%) was much higher than our simple response rate of 3.4%, so nonresponse bias is certainly a concern in our study.[41] If those who received the email and chose not to respond (non-responders) were more or less likely to have experienced AGI in the previous 30 days, our results would be biased in favor of those who did respond. Our concern is that perhaps those who experienced AGI in the previous 30 days may have felt it was important to answer the survey (more so than those who did not), and therefore are over-represented in our responses. To prevent this from occurring, we attempted to structure the email and the questionnaire in a way that would not lead the survey recipients to believe the survey was about their experience with AGI. The email discussed food safety and the role of the US Army Veterinary Corps and US Army Public Health Command in keeping the military food supply safe. The initial survey questions were about where service members procure food items, and how often they eat at on-post establishments.

Questions about experience with AGI did not come until about half way through the survey. Also, an individual may be more willing to answer questions about their experience with unpleasant events such as diarrhea, vomiting, and bloody stool when answering a web-based survey, as opposed to a telephone interview with a real person. Web surveys may therefore result in a more accurate reflection of the burden of diarrheal illness. On the other hand, because this was an email survey, respondents had more time to read through the introduction and decide whether or not they wanted to take the survey (vs. receiving a telephone call). However, of the individuals that started the survey, 92.2% completed the survey, so very few non-responders opened the survey and chose to quit before completing the survey.

Misclassification of AGI due to a non-infectious, chronic cause could have inflated our estimates. In addition, our study over-represented and under-represented certain demographic subsets of the US Army population. If those who were under-represented had a tendency away from an episode of AGI, it would lead to an over estimation of AGI. Also, if those who were over-represented were more likely to experience an episode of AGI, that too would lead to an over estimation. We weighted our analyses in an attempt to overcome this source of bias.

Certain factors may have lead to an underestimation of AGI incidence as well. Due to time constraints and workload on respondents, we were only able to launch the survey once, so we cannot adjust results based on seasonal variation. This survey was launched on April 6, 2015, and respondents had until May 15, 2015 to respond. 868 surveys were completed by April 15, an additional 510 by April 30th, and the remaining 669 by the close of the survey, so the self-reported cases could have occurred anywhere from March 6th to May 15th. In general, rates of AGI are highest in winter months, and lower in the spring, so our survey may even further underestimate the incidence of AGI. We also used a 30-day recall period for this study. A US

study showed that recall period length has an impact on estimates of the prevalence of AGI.[42]. They found that annual rates of AGI estimated using a 7-day recall period were 1.8-3.4 times higher than when using a 1-month recall period.[42] Another study showed the opposite results, finding that a 3-week recall period incidence was almost three times higher than the rate estimated through active surveillance.[43] It is difficult to assess the impact our recall period had on calculated AGI prevalence and incidence data. Conducting another survey using more than one recall period, or a prospective study, could help to increase accuracy of these estimates.

Even though different sources of bias could have limited the accuracy of our burden estimates, this is a good first step to determining the true burden of AGI among nondeployed active duty service members in the US Army. The study certainly legitimizes the importance of AGI in the active duty population, and the potential failure of our food protection system to improve the safety of food sold on-post. The next chapter of this dissertation describes part two of this of this study: factors associated with nondeployed active duty US Army service members seeking medical care and submitting a stool sample.

References

1. United States Army Medical Service. *Preventive medicine in World War II.* Washington: Office of the Surgeon General, Dept. of the Army; 1955.

2. Hyams KC, Bourgeois AL, Merrell BR, et al. Diarrheal Disease during Operation Desert Shield. *New England Journal of Medicine.* 1991;325(20):1423-1428.

3. Armed Forces Health Surveillance Center. Gastrointestinal infections, active component, U.S. Armed Forces, 2002-2012. *MSMR.* 2013;20(10):7-11.

4. Sanders JW, Putnam SD, Riddle MS, et al. The epidemiology of self-reported diarrhea in operations Iraqi freedom and enduring freedom. *Diagnostic microbiology and infectious disease.* 2004;50(2):89-93.

5. M. Adams YM. Basic food safety for health workers. *Geneva: World Health Organization.* 1999:116.

6. Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. *Emerg Infect Dis.* 1999;5(5):607-625.

7. Scallan E, Hoekstra R, Angulo F, et al. Foodborne illness acquired in the United States--major pathogens. *Emerging infectious diseases.* 2011;17(1):7-15.

8. Roy SL, Scallan E, Beach MJ. The rate of acute gastrointestinal illness in developed countries. *Journal of water and health.* 2006;4 Suppl 2:31-69.

9. Armed Forces Health Surveillance Center. *Armed Forces Reportable Medical Events Guidelines and Case Definitions.* 2012. https://www.afhsc.mil/documents/pubs/documents/TriService_CaseDefDocs/ArmedForcesGuidlinesFinal14Mar12.pdf. Accessed January 2, 2016.

10. Levy PS. *Sampling for health professionals.* Belmont, Calif.: Lifetime Learning Publications; 1980.

11. Dean AG SK, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version 3.03a. 2015; http://www.openepi.com.

12. *Department of Defense Enterprise Email (DEE)* [computer program]. Fort Meade, Maryland: Defense Information Systems Agency (DISA); 2015.

13. *Microsoft Excel for Mac* [computer program]. Version 14.5.7. Redmond, Washington: Microsoft; 2011.

14. *Enterprise Feedback Management (EFM)* [computer program]. Melville, NY: Verint Systems Inc.; 2015.

15. Majowicz SE, Hall G, Scallan E, et al. A common, symptom-based case definition for gastroenteritis. *Epidemiol Infect.* 2008;136(7):886-894.

16. Hall G, McDonald L, Majowicz SE, et al. Respiratory symptoms and the case definition of gastroenteritis: an international analysis of the potential impact on burden estimates. *Epidemiol Infect.* 2010;138(1):117-124.

17. Baldi B. *The Practice of statistics in the life sciences.* New York: W.H. Freeman and Co.; 2012.

18. Majowicz SE, Dore K, Flint JA, et al. Magnitude and distribution of acute, self-reported gastrointestinal illness in a Canadian community. *Epidemiology and infection.* 2004;132(4):607-617.

19. *SAS* [computer program]. Version 9.3. Cary, NC: SAS Institute; 2000-2010.

20. Simple Interactive Statistical Analysis (SISA). Simple Interactive Statistical Analysis. 2004; http://www.quantitativeskills.com/sisa/calculations/casro.htm.

21. Office of the Deputy Assistent Secretary of Defense. 2013 Demographics Profile of the Military Community. *2013 Demographics Profile of the Military Community.* 2014. http://download.militaryonesource.mil/12038/MOS/Reports/2013-Demographics-Report.pdf. Accessed October 10, 2013.

22. Adlam SB, Perera S, Lake RJ, Campbell DM, Williman JA, Baker MG. Acute gastrointestinal illness in New Zealand: a community study. *Epidemiol Infect.* 2011;139(2):302-308.

23. Baumann-Popczyk A, Sadkowska-Todys M, Rogalska J, Stefanoff P. Incidence of self-reported acute gastrointestinal infections in the community in Poland: a population-based study. *Epidemiol Infect.* 2012;140(7):1173-1184.

24. Ho SC, Chau PH, Fung PK, Sham A, Nelson EA, Sung J. Acute gastroenteritis in Hong Kong: a population-based telephone survey. *Epidemiol Infect.* 2010;138(7):982-991.

25. Kubota K, Kasuga F, Iwasaki E, et al. Estimating the burden of acute gastroenteritis and foodborne illness caused by Campylobacter, Salmonella, and Vibrio parahaemolyticus by

using population-based telephone survey data, Miyagi Prefecture, Japan, 2005 to 2006. *Journal of food protection.* 2011;74(10):1592-1598.

26. Muller L, Korsgaard H, Ethelberg S. Burden of acute gastrointestinal illness in Denmark 2009: a population-based telephone survey. *Epidemiol Infection.* 2012;140(2):290-298.

27. Sargeant JM, Majowicz SE, Snelgrove J. The burden of acute gastrointestinal illness in Ontario, Canada, 2005-2006. *Epidemiol Infect.* 2008;136(4):451-460.

28. Scavia G, Baldinelli F, Busani L, Caprioli A. The burden of self-reported acute gastrointestinal illness in Italy: a retrospective survey, 2008-2009. *Epidemiol Infect.* 2012;140(7):1193-1206.

29. Wilking H, Spitznagel H, Werber D, Lange C, Jansen A, Stark K. Acute gastrointestinal illness in adults in Germany: a population-based telephone survey. *Epidemiology and infection.* 2013;141(11):2365-2375.

30. Herikstad H, Yang S, Van Gilder T, et al. A population-based estimate of the burden of diarrhoeal illness in the United States: FoodNet, 1996-7. *Epidemiology and Infection.* 2002;129(1):9-17.

31. de Wit MA, Koopmans M, Kortbeek L, et al. Sensor, a population-based cohort study on gastroenteritis in the Netherlands: incidence and etiology. *American journal of epidemiology.* 2001;154(7):666-674.

32. Palmer S, Houston H, Lervy B, Ribeiro D, Thomas P. Problems in the diagnosis of foodborne infection in general practice. *Epidemiology and Infection.* 1996;117(3):479-484.

33. Hoogenboom-Verdegaal A, De Jong J, During M, Hoogenveen R, Hoekstra J. Community-based study of the incidence of gastrointestinal diseases in The Netherlands. *Epidemiology and Infection.* 1994;112(03):481-487.

34. Gauci C, Gilles H, O'Brien S, et al. The magnitude and distribution of infectious intestinal disease in Malta: a population-based study. *Epidemiol Infect.* 2007;135(8):1282-1289.

35. Hansdotter FI, Magnusson M, Kuhlmann-Berenzon S, et al. The incidence of acute gastrointestinal illness in Sweden. *Scandinavian journal of public health.* 2015;43(5):540-547.

36. Hunter PR. Community study of infectious intestinal disease in England. Study underestimated morbidity due to specific pathogens. *BMJ (Clinical research ed.).* 1999;319(7204):258-259.

37. Kuusi M, Aavitsland P, Gondrosen B, Kapperud G. Incidence of gastroenteritis in Norway--a population-based survey. *Epidemiol Infect.* 2003;131(1):591-597.

38. Scallan E, Majowicz SE, Hall G, et al. Prevalence of diarrhoea in the community in Australia, Canada, Ireland, and the United States. *International journal of epidemiology.* 2005;34(2):454-460.

39. Thomas MK, Majowicz S, MacDougall L, et al. Population distribution and burden of acute gastrointestinal illness in British Columbia, Canada. *BMC public health.* 2006;6(1):307.

40. Aguiar Prieto P, Finley RL, Muchaal PK, et al. Burden of self-reported acute gastrointestinal illness in Cuba. *Journal of health, population, and nutrition.* 2009;27(3):345-357.

41. Tourangeau R. Survey research and societal change. *Annu. Rev. Psychol.* 2004;55:775-801.

42. Cantwell LB, Henao OL, Hoekstra RM, Scallan E. The effect of different recall periods on estimates of acute gastroenteritis in the United States, FoodNet Population Survey 2006-2007. *Foodborne pathogens and disease.* 2010;7(10):1225-1228.

43. Wheeler JG, Sethi D, Cowden JM, et al. Study of infectious intestinal disease in England: rates in the community, presenting to general practice, and reported to national surveillance. The Infectious Intestinal Disease Study Executive. *BMJ (Clinical research ed.).* 1999;318(7190):1046-1050.

Chapter 4 : Severity of Acute Gastrointestinal Illness and Factors Associated with Seeking Medical Care Among Nondeployed Active Duty US Army Service Members 2015

Introduction

Historically, acute gastrointestinal illness (AGI) has been a cause of morbidity and mortality among United States service members,[1] and continues to have an effect on modern day military operations.[2,3] In Chapter 3, we found the estimated incidence rate of AGI among nondeployed active duty US Army service members was 2.24 episodes/person-year (95% CI 2.04-2.49). This corresponds to more than 1 million cases of AGI occurring per year among nondeployed active duty US Army service members, almost 90,000 per month. Enlisted service members who reported an episode of AGI in the previous 30 days missed an average of 3.67 days of work due to their illness. Officers missed an average of 2.61 days of work due to their illness. When taking into account the average base salary of enlisted service members ($18.25) and officers ($53.95), the cost to the government for missed workdays due to AGI is $847,451,629 (95% CI: $727,331,502-$978,720,151). Determining the cause of AGI in the active duty US Army population is important for the development of intervention strategies to reduce AGI. This chapter is part two of a four-part study to estimate the burden of foodborne illness among nondeployed US Army active duty service members caused by five major pathogens (Figure 4.1). In part one of this study (Chapter 3), we used survey data to estimate the burden of AGI among nondeployed active duty US Army service members and to identify risk factors associated with the occurrence of AGI among service members. The aim of this chapter (part two) is to describe the severity of AGI among service members and determine the factors

associated with service members seeking medical care and submitting a stool sample. These are the necessary first steps to developing an estimate of the prevalence of AGI due to specific exposures such as foodborne illness.[4] Ultimately, the results of this study will be used to make recommendations for a DOD-wide foodborne illness surveillance system, identify strategies for foodborne illness intervention, and to modernize the current US Army food protection program (Chapter 7).

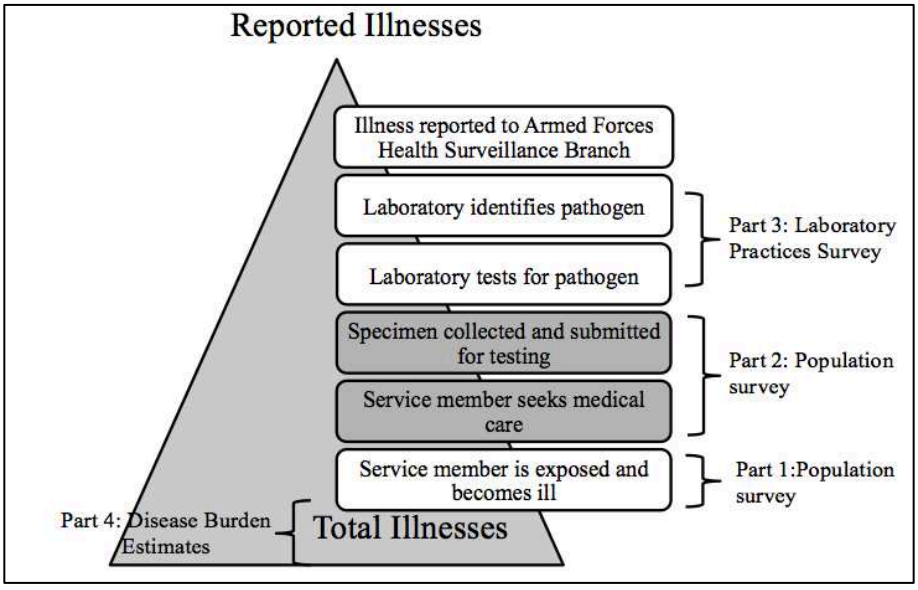


Figure 4.1. Burden of Illness pyramid illustrating the steps that must occur for an episode of illness in the active duty Army population to be reported through laboratory surveillance.

Ethics Statement

The Colorado State University Institutional Review Board (IRB) determined this project is exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b). The project qualifies for category 2 exemption (IRB ID# 131-15H). The United States US Army Public Health Command IRB determined that this project did not meet the definition of research as provided by 45 CFR46.102(d), and has approved this project as a Public Health Practice—surveillance (IRB# 14-316). The purpose of the study was explained to all participants, and participation was voluntary.

Methods

Study design and Data Collection

A geographically representative random sample of the active duty US Army population was selected using a two-stage stratified sampling strategy.[5] The sampling strategy and data collection is described in detail in Chapter 3.

Case Definition, Recall Period, and Inclusion/Exclusion Criteria

We used two different case definitions for AGI, the internationally recognized case definition, and the case definition used in a US Study by Scallan et al. (2006). The internationally recognized case definition is: three or more loose stools or any vomiting in a 24-hour period, but excluding those (a) with cancer of the bowel, irritable bowel syndrome, Crohn's disease, ulcerative colitis, cystic fibrosis, coeliac disease, or another chronic illness with symptoms of diarrhea or vomiting, or (b) who report their symptoms were due to drugs, alcohol, or pregnancy[6]. Individuals with (a) or (b) were counted as non-cases. The Scallan et al. case definition is: ≥3 loose stools in 24 hours with impairment of daily activities or ≥3 loose stools in 24 hours for a duration of >1 day.[7] Service members who deployed or travelled outside their country of residence within 30 days of completing the survey were excluded regardless of case definition. These two case definitions were chosen to allow for comparison of results between previously published studies.

Data Analyses

We used the same statistical methods for descriptive statistics, creating categorical variables, and for calculating estimated annual incidence rate as in Chapter 3 and the associated appendices. Univariable and multivariable logistic regression were used to construct two

univariable and two multivariable logistic regression models for each case definition. The first set of models (model 1-International Case Definition and model 3-Scallan (2006) Case Definition) compared nondeployed active duty US Army service members with self-reported AGI who sought medical care with those who did not seek medical care. The second set of models (model 2-International Case Definition and model 4-Scallan Case Definition) compared nondeployed active duty US Army service members with self-reported AGI who sought medical care and submitted a stool sample to those who sought medical care but did not submit a stool sample.

Independent variables were weighted to compensate for the under- and over-represented demographic factors including region of residence, age, sex, education, rank, and race. Gender and age also were weighted by rank. Weighting of these variables was outlined previously and in Appendix D-3. We assessed independent variables for high correlation with other variables, and excluded highly correlated variables from being included in the multivariable analysis. We identified these variables using statistical calculations as well as through logical analysis of how different independent variables might be related, such as region and location (in the US or overseas). We also identified variables that represented more specific information and therefore could not exist without another variable having an answer of 'yes'. For example, vomit must equal one (yes, a person experienced vomiting), in order for the number of days of vomiting experienced to have a value. If both the vomit and days vomiting variables are included in the same model, the model falls apart. We identified these variables using logic and through statistical calculations. Variables with high correlation included region of residence and location (US or overseas) and the number of days vomiting was experienced and number of days both vomiting and diarrhea were experienced. Sets of variables identified that could not exist without

the "success" of another variable included: maximum number of times vomited in 24 hours, number of days vomited, experiencing diarrhea and vomiting simultaneously, and number of days experiencing both diarrhea and vomiting with the variable vomit; experiencing both diarrhea and vomiting and days experiencing both diarrhea and vomiting; and missing work for illness with number of days work missed due to illness. Statistical outputs for correlation are displayed in Appendix A-4.

In the multivariable analysis, backward steps were applied by starting with the full model containing all variables with p-value <0.25 from the univariable analysis. Variables were removed in a step-wise fashion, starting with the highest p-value, until all variables with p-value >0.05 were removed. Independent variables were assessed for confounding by looking for a change in model coefficients of ≥ 10 percent as variables were removed and when adding variables back into the model. Independent variables were assessed for interaction by adding interaction terms back into the model and assessing for significance. The final model fit was assessed using the Pearson's chi-square goodness-of-fit and deviance test, or the Hosmer Lemeshow Goodness of Fit Test where applicable, with P≥0.05 indicating goodness of fit. Appendix B-4 displays SAS code inputs and outputs for all models.

Descriptive statistics were performed using Microsoft Excel for Mac 2010 (Microsoft Corporation, Redmond, WA, USA), StatCrunch (Pearson Education, 2007-2016), and the online statistical calculator, OpenEpi Version 3.03a 2015.[8,9] Statistical analysis was performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA) and StatCrunch (Pearson Education, 2007-2016).[10] The statistical significant level for these data was 0.05.

Results

Severity of AGI and Medical Care Seeking

Table 1 displays the characterization of illness by primary symptoms of self-reported AGI among nondeployed active duty US Army service members. A total of 337 (16.5%) respondents reported AGI as defined by the internationally recognized case definition in the month prior to completing the survey. Of the respondents who met the international case definition for AGI, 69.1% reported diarrhea, 10.4% reported vomiting, and 20.5% reported experiencing both symptoms simultaneously. Presence of blood in the stool was reported by 7.1% of cases. The median duration of illness was 2.0 days (range 1-10 days). Median illness duration was longest among those who experienced both vomiting and diarrhea and diarrhea only when compared vomiting only. Approximately one-third (30.9%) of ill respondents reported missing work because of their illness for a median length of 2 days (range, 1-30), and 20.2% of cases reported seeking medical care for their illness. Of the cases that visited a doctor, 13.2% were asked to submit a stool specimen, and 88.9% of those asked to submit a stool specimen did so. Doctors were more likely to ask for a stool sample in cases that experienced both vomiting and diarrhea (14.3%) than from cases who experienced diarrhea only (12.9%) or only vomiting (11.1%), though this difference was not statistically significant.

A total of 244 (11.9%) respondents reported AGI as defined by the Scallan et al. (2006) case definition in the month prior to completing the survey. Of the respondents who met the Scallan et al. (2006) case definition for AGI, 79.1% reported experiencing only diarrhea, and 20.9% reported experiencing both vomiting and diarrhea simultaneously (Table 4.1). Presence of blood in the stool was reported by 7.0% of cases. The median duration of illness was 3.0 days

(range 1-30 days). Median illness duration was the same for those experiencing both vomiting and diarrhea and diarrhea only. 34.4% of ill respondents reported missing work because of their illness for median length of 2 days (range 1-10) 21.7% of cases reported seeking medical care for their illness. Of the cases that visited a doctor, 15.9% were asked to submit a stool specimen, and 87.5% of those asked to submit a stool specimen did so. Under this case definition, doctors were more likely to request stool samples for those experiencing both vomiting and diarrhea (16.7%) than only diarrhea (13.8%). This difference was not statistically significant.

Table 4.1. Characterization of illness by primary symptoms of self-reported AGI as defined by the international AGI case definition, and the Scallan et al. (2006) case definition.

	Cases of AG, international case definition, by primary symptoms				Cases of AG, Scallan et al. (2006 case definition, by primary symptoms		
	Vomit Only (n=35)	Diarrhea Only (n=233)	Vomiting and Diarrhea (n=69)	All Cases (n=337)	Diarrhea Only (n=193)	Vomiting and Diarrhea (n=51)	All Cases (n=244)
Median duration of illness (days)	1	3	3	2	3	3	3
Median number of work days missed	1.5	2	2	2	2	2	2
	n(%)	n(%)	n(%)	n(%)	n (%)	n (%)	n (%)
Cases reporting							
Concurrent symptoms							
Blood in stool	1(2.9)	13(5.6)	10(14.5)	24(7.1)	10 (5.2)	7 (13.7)	17 (7.0)
Concurrent respiratory signs	11(31.4)	68(29.2)	28(40.6)	107(31.8)	59 (30.6)	20 (39.2)	79 (32.3)
Missed work	9(25.7)	48(20.6)	47(68.1)	104(30.9)	48 (24.8)	36 (70.6)	84 (34.4)
Visited doctor	9(25.7)	31(13.3)	28(40.6)	68(20.2)	29 (15.0)	24 (47.1)	53 (21.7)
Stool sample requested	1(11.1)	4(12.9)	4(14.3)	9(13.2)	4 (13.8)	4 (16.7)	8 (15.9)
Stool sample submitted	1(100)	4(100)	3(75)	8(88.9)	4 (100)	3 (75)	7 (87.5)

Majowicz et al. proposed the minimum set of results that should be reported for AGI studies to facilitate comparison between studies.[6] Table 4.2 displays these results by each regional location; all regions combined, and from other AGI burden studies for comparison.[6,11] Figure 4.2 displays the corresponding incidence per person-year and 95% confidence intervals in a graphical format. Overall, the annual incidence per person-year was significantly higher among US Army service members than in the U.S. Canada, Italy, and Ireland (95% confidence intervals for regional locations, and all service members do not overlap with the other 95% confidence intervals).

Table 4.2. Epidemiology of acute gastrointestinal illness under the international case definition (≥3 loose stool, or any vomiting, in 24 hours excluding those (a) with chronic illness with symptoms of diarrhea or vomiting, or (b) who report their symptoms were due to drugs, alcohol, or pregnancy) in non-deployed active duty Army service members (by regional location, and combined), the United States, Germany, Italy, Canada, and Malta.

	All Army Service Members	Pacific Region	Europe Region	Northern US Region	Southeast US Region	Western US Region	United States	Canada	Italy	Ireland	Malta
Incidence per person-year	2.2	2.2	3.3	2.2	2.3	2.1	0.83	0.91	1.08	0.64	0.37
(95%CI)	(2.04-2.49)	(1.39-3.23)	(2.25-4.72)	(1.7-2.71)	(1.94-2.76)	(1.73-2.53)	(0.78-0.89)	(0.80-1.02)	(0.90-1.14)	(0.59-0.70)	(0.36-1.89)
Incidence per person-year in males	2.2	2.1	3.2	2.1	2.4	2.1	0.78	0.78	0.89	0.51	0.31
Incidence per person-year in females	2.4	2.2	3.4	2.4	2.2	2.3	0.80	1.0	1.1	0.77	0.44
Mean age of cases (years)	35.2	31.4	32.7	36.6	35.4	35.3	28.4	36.0	-	24.2	34.8
Mean duration of illness (days)	2.0*	2.0*	2.0*	3.0*	2.0*	2.0*	3.1	4.2	3.2	2.9	4.2
Cases with bloody diarrhea (%)	7.1	15.8	8.0	4.5	10.1	3.0	2.3	3.2	0.3	0.9	5.1
Cases who saw physician (%)	20.2	31.6	28.0	19.4	15.1	23.8	18.1	21.0	36.1	25.5	39.4
Cases submitting stool sample for testing (%)	2.4	5.3	4	3.0	1.7	2.0	2.9	3.2	1.0	1.8	2.0
Cases with respiratory symptoms (%)	31.8	31.6	52.0	32.8	28.6	28.7	47.8	48.4	25.2	-	19.2
Cases with symptoms still ongoing	1.2	0.0	4.0	1.5	0.8	1.0	10.3	13.1	7.7	16.9	18.2

* Median Reported

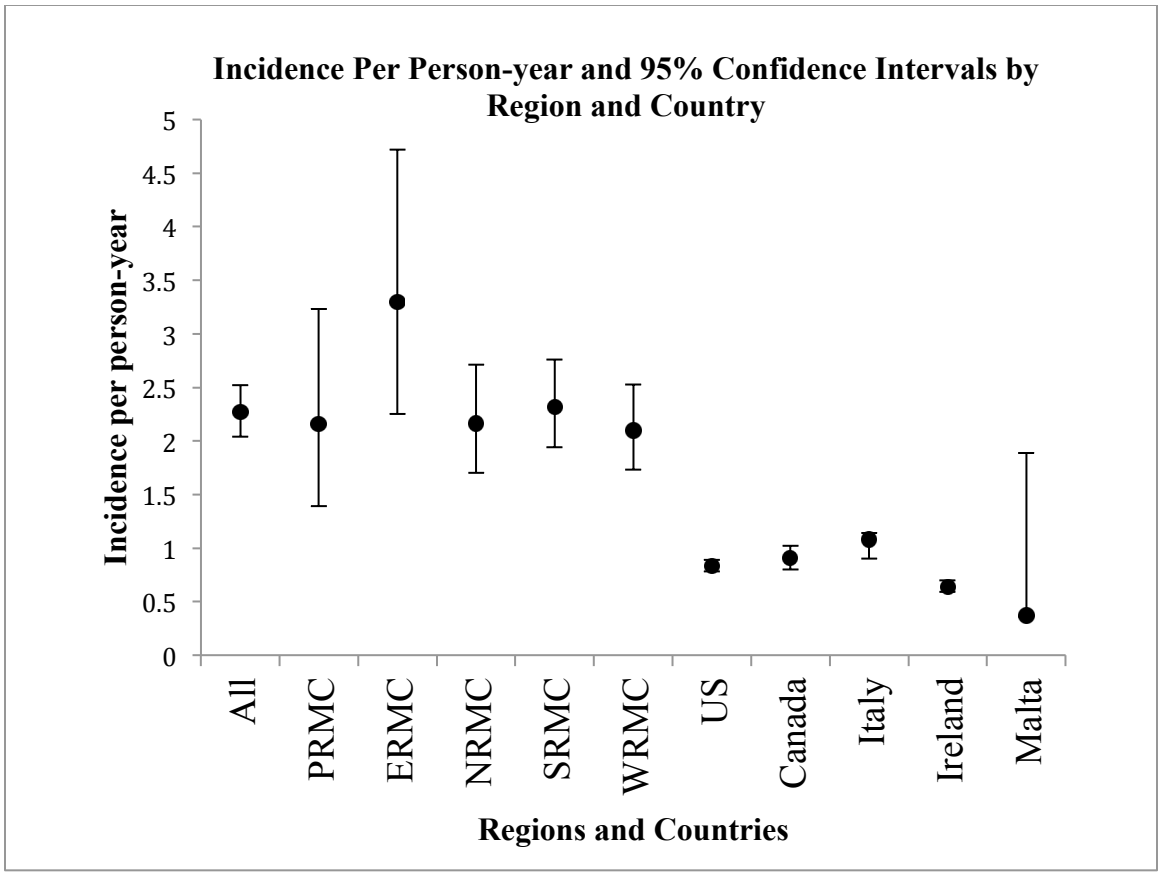


Figure 4.2. Graphical representation of point estimates and 95% confidence intervals for incidence of AGI episodes per person-year by region and country.

Among the cases reported by US Army service members, cases that reside in the Pacific and Europe regions were younger than those living in the other regions. Those residing in the Pacific region reported blood in their stool more often than those living in the other four regions, and this difference was significantly greater than those living in the Western US region. Service members with AGI who reside in the Pacific region also were more likely to visit a physician for their illness, though this difference was not statistically significant. Physicians in the Pacific region were more likely to submit stool samples for testing than in the other regions, but this difference was not statistically significant. Those residing in the Europe region reported concurrent respiratory symptoms significantly more often than those living in the four other regions combined. The 95% confidence intervals for AGI incidence per person-year for the

Western region, Northern US region, and the Pacific region, overlapped with the 95% confidence interval of Malta's AGI incidence per person-year.

When considering all self-reported AGI cases among nondeployed active duty US Army personnel, the average age of cases (35.2 years) were of similar age to cases in Canada (36.0 years), but older than all other countries listed in Table 4.2. US Army service members reported blood in their stool more often than all five-comparison countries, but sought medical care less than cases in Canada, Italy, Ireland, and Malta. The median duration of illness among US Army service members was less than the mean duration of illness reported by all other countries. The proportion of cases with respiratory symptoms was less than that reported in the US and Canada. The number of cases with illness on the date of interview/filling out the survey was less than all other comparison countries.

Factors Associated with Seeking Medical Care including Submitting a Stool Sample

International Case Definition

Table 4.3 displays the univariable analyses for Model 1 using the internationally recognized case definition for AGI. Factors associated with nondeployed active duty US Army service members seeking medical care for AGI (Model 1) included residing overseas, experiencing more than five loose stools in a 24 hour period, having diarrhea for three or more days, experiencing a sore throat or cough, vomiting, vomiting more than five times in 24 hours, having both vomiting and diarrhea for three or more days, and missing work for their illness. The most profound association was among those who experienced vomiting during their illness. When compared with those who did not experience vomiting, those who reported vomiting were 21.2 times more likely to visit a doctor (95%CI: 12.6-35.8).

Table 4.3. Univariable results for Model 1: factors associated with seeking medical care among non-deployed active duty Army service members with self-reported AGI using the internationally recognized case definition.

Variables	Care Seeking n (%)		Univariable Analysis For Model 1 OR	95%CI	p-value	Variables	Care Seeking n (%)		Univariable Analysis For Model 1 OR	95%CI	p-value
Region of residence* £						Blood in stool					
ERMC	19	(10.6)	1.93	(0.81-4.61)	0.139	Yes	24	(33.3)	1.95	(0.87-4.34)	0.104
NRMC	69	(5.4)	0.84	(0.42-1.67)	0.611	No	260	(17.7)		Ref.	
PRMC	21	(12.9)	1.39	(0.55-3.51)	0.484	Sore throat/cough					
SRMC	128	(3.6)	0.70	(0.37-1.3)	0.253	Yes	107	(32.7)	2.85	(1.71-4.76)	<.0001
WRMC	94	(4.8)		Ref.		No	222	(14.9)		Ref.	
Resides overseas*						Vomiting					
Yes	17	(29.5)	1.95	(1.04-3.64)	0.036	Yes	104	(35.6)	21.2	(12.6-35.8)	<.0001
No	300	(19.2)				No	232	(12.9)		Ref.	
Gender *						Max times vomit in 24 hrs					
Male	284	(18.0)		Ref.		≤5	91	(31.9)		Ref.	
Female	49	(27.0)	1.56	(0.92-2.67)	0.102	>5	11	(72.7)	3.27	(1.06-10.05	0.0390
Rank*						Vomit duration					
Officer	62	(17.5)		Ref.		<3 days	73	(27.4)		Ref.	
Enlisted	274	(21.9)	1.24	(0.73-2.08)	0.430	≥3 days	27	(55.6)	1.95	(0.85-4.5)	0.117
Age*						Both diarrhea and vomiting					
25 or Younger	150	(20)		Ref.		Yes	69	(40.6)	1.94	(0.81-4.65)	0.135
26-30	87	(23.9)	1.27	(0.53-3.04)	0.589	No	33	(27.3)		Ref.	
31-35	52	(23.4)	1.03	(0.43-2.49)	0.949	Days both diarrhea and vomiting					
36-40	40	(15.3)	0.76	(0.31-1.92)	0.557	<3 days	48	(31.3)		Ref.	
41 and Over	35	(19.1)	0.72	(0.31-1.7)	0.453	≥3 days	15	(66.7)	3.11	(1.02-9.47)	0.046
Race *						Missed Work					
White non-Hispanic	236	(18.8)		Ref.		Yes	104	(41.3)	7.88	(4.62-13.44	<.0001
Black or African American	64	(28.8)	1.34	(0.74-2.42)	0.330	No	229	(10.5)		Ref.	
All other races	36.0	(17.7)	0.93	(0.50-1.72)	0.814	Days missed work					
Education *						<2 days missed	35	(25.7)		Ref.	
Associate/technical degree or less	279	(19.2)	0.77	(0.43-1.39)	0.393	≥2 days missed	67	(49.3)	2.00	(0.84-4.74)	0.118
Bachelor's degree	41	(18.5)	0.61	(0.3-1.24)	0.174	Branch					
Advanced degree	26	(25.0)		Ref.		Special Operations Forces	6	(16.7)		Ref.	
Concurrent Symptoms						Force Sustainment Division	99	(21.2)	1.34	(0.17-10.39	0.780
Maximum number loose stools in 24 hrs						Health Services Division	79	(21.5)	1.23	(0.16-9.67)	0.842
≤5 loose stools	245	(18.4)		Ref.		Operations Divison	103	(20.4)	0.99	(0.13-7.69)	0.995
>5 loose stools	67	(28.4)	2.84	(1.58-5.12)	0.0005	Operations Support Division	45	(15.6)	0.82	(0.10-6.95)	0.856
Diarrhea duration						Chaplain	1	(0.0)	-	-	-
<3 Days	112	(17.0)		Ref.							
≥3 Days	175	(23.4)	2.19	(1.24-3.89)	0.007						

* Values weighted

£ ERMC:Europe Regional Medical Command, NRMC: Northeast Regional Medical Command, PRMC: Pacific Regional Medical Command, SRMC:Southeast Regional Medical Command, WRMC: Western Regional Medical Command

Table 4.4 displays the multivariable analysis for Model 1. The final variables for Model 1 included: rank, education, experiencing sore throat or cough, vomiting, and missing work. There was evidence of multiplicative interaction between missing work and rank. When controlling for other variables in the model, those who experienced a sore throat or cough were 3.2 times more likely to seek medical care than those who did not experience a sore throat or cough (95%CI: 1.79-5.75). Those experiencing vomiting were 4.03 times more likely to seek medical care (95%CI: 2.23-7.30). When controlling for other variables in the model, those with an advanced degree were 3.5 times more likely to seek medical care for AGI than those with an Associates or Technical degree or less (95%CI: 1.54-8.00). When comparing those with an advanced degree to those with a Bachelor's degree, those with an advanced degree were 2.22 times more likely to seek medical care, though these results were not statistically significant (95%CI: 0.91-5.43). There were three significant interactions between rank and missing work: enlisted service members missing work vs. not missing work (OR 3.20 95%CI:1.59-6.45) enlisted service members missing work vs. officers missing work (OR 3.66 95%CI:1.22-10.95) and enlisted service members missing work vs. officers not missing work (OR 11.71 95% CI: 3.82-35.86). The P value for deviance and Pearson Goodness-of-Fit tests were 0.9356 and 0.9912, respectively, indicating good model fit.

Table 4.4. Multivariable results for Model 1 factors associated with seeking medical care among nondeployed active duty Army service members with self-reported AGI using the internationally recognized case definition.

	Multivariable Model 1		
	OR§	95%CI	p-value
Rank*			
Officer		Ref.	
Enlisted	3.66	(1.22-10.95)	0.021
Education *			
Associate or Technical Degree or less		Ref.	
Bachelor's Degree	1.70	(0.74-3.87)	0.209
Advanced Degree	3.51	(1.54-8.00)	0.003
Concurrent symptoms			
Respiratory Symptoms (Sore throat/cough)			
Yes	3.2	(1.79-5.75)	<.0001
No		Ref.	
Vomiting			
Yes	4.03	(2.23-7.30)	<.0001
No		Ref.	
Missed Work			
Yes	3.2	(1.59-6.45)	0.001
No		Ref.	
Missed Work x Rank	3.97	(1.08-14.63)	0.038
Interaction Term			
Enlisted + miss work	3.20	(1.59-6.45)	0.001
Enlisted + not miss work		Ref.	
Interaction Term			
Enlisted + miss work	3.66	(1.22-10.95)	0.021
Officer + miss work		Ref.	
Interaction Term			
Enlisted + miss work	11.71	(3.82-35.86)	<.0001
Officer + not miss work		Ref.	

*Results weighted

Table 4.5 displays the univariable analyses for Model 2 using the internationally recognized case definition for AGI. The only factor associated with active duty US Army service members seeking medical care for AGI and submitting a stool sample was experiencing more than five loose stools in a 24 hour period. Those who experienced more than five loose stools in a 24-hour period were 5.0 (95%CI: 1.1-22.8) times as likely to submit a stool sample than respondents who experienced five or less loose stools in a 24-hour period. Though not statistically significant, those who did not experience a sore throat, and those who did not

experience vomiting, those who did not experience both diarrhea and vomiting, and those who had blood in their stool were more likely to submit a stool sample.

Table 4.6 displays the multivariable analysis for Model 2. The final variables for Model 2 included experiencing more than five loose stools in a 24-hour period and not experiencing a sore throat or cough. Gender and age also were included in the final model to adjust for possible confounding by these variables. When controlling for gender, age, and respiratory symptoms, those who experienced more than five loose stools in 24-hours were six times more likely to submit a stool sample than those who experienced five or less loose stools in 24 hours (95%CI: 1.36-28.26). When controlling for gender, age, and number of loose stools in 24 hours, those who did not experience a sore throat were 4.8 times as likely to submit a stool sample than those who did experience a sore throat (95%CI: 1.05-21.6). The P value Hosmer and Lemeshow Goodness of Fit Test was 0.814, indicating good model fit.

Table 4.5. Univariable results for Model 2: factors associated with submitting a stool sample among non-deployed active duty Army service member with self-reported AGI using the internationally recognized case definition who sought medical care.

Variables	Stool Sample Submission n (%)		Univariable Analysis For Model 2 OR§	95%CI	p-value
Region*£					
ERMC	5	(14.3)	1.83	(0.11-30.97)	0.674
NRMC	13	(15.4)	2.00	(0.28-14.3)	0.489
PRMC	7	(16.7)	2.20	(0.12-39.3)	0.592
SRMC	19	(11.1)	1.38	(0.15-12.9)	0.781
WRMC	22	(8.3)		Ref.	
Resides overseas*					
Yes	5	(15.4)	1.49	(0.24-9.4)	0.675
No	58	(10.9)			
Gender *					
Male	51	(12.8)	1.32	(0.25-6.98)	0.746
Female	13	(10.0)		Ref.	
Rank*					
Officer	11	(9.5)		Ref.	
Enlisted	60	(12.8)	1.39	(0.27-7.28)	0.697
Age*					
30 years and younger	54	(8.3)		Ref.	
31-35	12	(20.0)	2.75	(0.40-19.13)	0.306
36-40	6	(18.2)	2.44	(0.28-21.08)	0.416
41 and Over	7	(5.9)	0.69	(0.15-3.23)	0.635
Race *					
White non-Hispanic	44	(5.6)		Ref.	
Black or African American	18	(17.6)	3.64	(0.61-21.64)	0.155
All other races	6	(20.0)	4.25	(0.60-30.12)	0.148
Education *					
Associate/technical degree or less	54	(11.1)	0.94	(0.14-6.27)	0.947
Bachelor's degree	8	(13.3)	1.15	(0.17-7.73)	0.883
Advanced degree	6	(11.8)		Ref.	
Concurrent symptoms/severity					
Maximum number loose stools in 24 hrs					
≤5 loose stools	45	(6.7)		Ref.	
>5 loose stools	19	(26.3)	5.00	(1.1-22.83)	0.038
Diarrhea duration					
<3 Days	19	(5.3)		Ref.	
≥3 Days	41	(17.1)	3.71	(0.45-30.87)	0.256
Blood in stool					
Yes	8	(12.5)	1.50	(0.17-13.46)	0.717
No	46	(8.7)		Ref.	
Sore throat/cough					
Yes	35	(5.7)		Ref.	
No	33	(18.2)	3.67	(0.69-19.58)	0.129
Vomiting					
Yes	37	(10.8)		Ref.	
No	30	(13.3)	1.27	(0.32-5.12)	0.738
Max times vomit in 24 hrs					
≤5	29	(10.3)		Ref.	
>5	8	(12.5)	1.24	(0.11-13.92)	0.863
Vomit duration					
<3 days	20	(15.0)	2.47	(0.28-21.93)	0.417
≥3 days	15	(6.7)		Ref.	
Both diarrhea and vomiting					
Yes	28	(10.7)		Ref.	
No	9	(11.1)	1.04	(0.27-3.96)	0.952
Days both diarrhea and vomiting					
<3 days	15	(13.3)	1.39	(0.13-15.03)	0.789
≥3 days	10	(10.0)		Ref.	
Missed Work					
Yes	43	(11.6)	1.45	(0.27-7.88)	0.669
No	24	(8.3)		Ref.	
Days missed work					
<2 days missed	9	(22.2)	2.86	(0.67-12.18)	0.156
≥2 days missed	33	(9.1)		Ref.	
Branch					
Force Sustainment Division	21	(9.5)		Ref.	
Health Services Division	17	(11.8)	1.27	(0.19-8.56)	0.809
Operations Divison	21	(9.5)	1.00	(0.12-8.53)	1.000
Operations Support Division	7	(28.6)	3.80	(0.39-36.69)	0.250

* Results weighted

£ ERMC:Europe Regional Medical Command, PRMC:Pacific Regional Medical Command, NRMC: Northern Regional Medical Command, SRMC:Southeast Regional Medical Command, WRMC: Western Regional Medical Command

Table 4.6. Multivariable results for Model 2: factors associated with submitting a stool sample among nondeployed active duty Army service member with self-reported AGI using the internationally recognized case definition who sought medical care.

	Multivariable Model 2		
	OR§	95%CI	p-value
Gender *			
Male	1.72	(0.21-13.87)	0.611
Female		Ref.	
Age*			
30 years and younger	1.18	(0.13-9.21)	0.943
31-35	4.43	(0.77-25.65)	0.097
36-40	4.05	(0.72-22.68)	0.112
41 and Over		Ref.	
Concurrent symptoms			
Max number loose stools in 24 hrs			
≤5 loose stools		Ref.	
>5 loose stools	6.21	(1.36-28.26)	0.018
Respiratory Symptoms (Sore throat/cough)			
Yes		Ref.	
No	4.75	(1.05-21.6)	0.044

* Results weighted

Scallan et al. (2006) case definition

Table 4.7 displays the univariable analyses for Model 3 using the Scallan et al. (2006) case definition for AGI. Factors associated with nondeployed active duty US Army service members seeking medical care for AGI include experiencing a sore throat or cough, vomiting, and missing work for their illness. The most profound association was among those who missed work for their illness. When compared with those who did not miss work, those who did miss work were 6 times as likely to visit a doctor (95%CI: 3.08-11.54).

Table 4.7. Univariable results for Model 3 is factors associated with seeking medical care among non-deployed active duty Army service members with self-reported AGI, using the Scallan et al (2006) case definition.

	Care Seeking		Univariable Analysis For Model 3				Care Seeking		Univariable Analysis For Model 3		
Variables	n (%)		OR	95%CI	p-value	Variables	n (%)		OR	95%CI	p-value
Region*						Blood in stool					
ERMC	14	(27.8)	1.79	(0.53-6.07)	0.347	Yes	17	(35.3)	2.48	(0.89-6.82)	0.079
NRMC	54	(22.6)	1.37	(0.57-3.25)	0.481	No	203	(19.2)		Ref.	
PRMC	12	(45.5)	3.89	(0.95-15.85)	0.058	Sore throat/cough					
SRMC	92	(17.6)		Ref.		Yes	79	(36.7)	3.32	(1.76-6.27)	0.0002
WRMC	67	(22.2)	1.33	(0.60-2.97)	0.481	No	159	(15.1)		Ref.	
Resides overseas*						Vomiting					
Yes	11	(34.5)	2.04	(0.86-4.84)	0.104	Yes	51	(47.1)	5.05	(2.58-9.88)	<0.0001
No	220	(20.5)		Ref.		No	192	(14.6)		Ref.	
Gender *						Max times vomit in 24 hrs					
Male	208	(19.4)		Ref.		≤5	44	(40.91)		Ref.	
Female	34	(29.4)	1.68	(0.84-3.37)	0.146	>5	7	(85.7)	8.66	(0.96-77.90)	0.054
Rank*						Vomit duration					
Officer	43	(20.5)		Ref.		<3 days	35	(37.1)		Ref.	
Enlisted	204	(22.5)	1.12	(0.60-2.10)	0.724	≥3 days	15	(66.7)	3.38	(0.97-11.85)	0.060
Age*						Both diarrhea and vomiting					
25 or Younger	120	(21.9)	1.29	(0.44-3.79)	0.647	Yes	45	(46.7)		Ref.	
26-30	55	(23.8)	1.44	(0.53-3.87)	0.473	No	4	(75.0)	3.43	(0.34-34.93)	0.298
31-35	41	(28)	1.95	(0.78-4.91)	0.156	Days both diarrhea and vomiting					
36-40	32	(17.2)		Ref.		<3 days	30	(36.7)		Ref.	
41 and Over	23	(19)	1.08	(0.42-2.78)	0.879	≥3 days	12	(66.7)	3.45	(0.79-15.02)	0.098
Race *						Missed Work					
White non-Hispanic	172	(19.3)		Ref.		Yes	84	(41.7)	5.96	(3.08-11.54)	<0.0001
Black or African American	45	(31)	1.83	(0.83-4.02)	0.134	No	156	(10.9)		Ref.	
All other races	26	(21)	1.13	(0.54-2.37)	0.753	Days missed work					
Education *						<2 days missed	24	(25.0)		Ref.	
Associate/technical degree or less	206	(21.7)	1.41	(0.62-3.22)	0.410	≥2 days missed	58	(48.3)	3	(0.94-9.60)	0.064
Bachelor's degree	29	(15.8)		Ref.		Branch					
Advanced degree	18	(28.6)	2.00	(0.80-4.98)	0.137	Special Operations Forces	5	(20.0)	1.92	(0.15-24.30)	0.62
Concurrent symptoms/severity						Force Sustainment Division	75	(22.7)	1.78	(0.54-5.83)	0.34
Maximum number loose stools in 24 hrs						Health Services Division	54	(25.9)	2.01	(0.60-6.76)	0.26
≤5 loose stools	186	(18.8)		Ref.		Operations Divison	78	(20.5)	1.51	(0.44-5.19)	0.51
>5 loose stools	58	(31.0)	1.94	(1.00-3.77)	0.051	Operations Support Division	27	(14.8)		Ref.	
Diarrhea duration						Chaplain	1	(0.0)			
<3 Days	67	(19.4)		Ref.							
≥3 Days	171	(22.2)	1.14	(0.56-2.30)	0.720						

* Results weighted

£ ERMC:Europe Regional Medical Command, PRMC:Pacific Regional Medical Command, NRMC: Northern Regional Medical Command, SRMC:Southeast Regional Medical Command, WRMC: Western Regional Medical Command

Table 4.8 displays the multivariable analysis for Model 3. The final variables for Model 3 included: education, experiencing sore throat or cough, vomiting, and missing work. Gender, age, and race also were included in the final model to adjust for possible confounding by these variables. There was no evidence of multiplicative interaction between variables. When controlling for other variables in the model, those who experienced a sore throat or cough were 5.01 times as likely to seek medical care than those who did not experience a sore throat or cough (95%CI: 2.73-10.92). When controlling for other variables in the model, those experiencing vomiting were 3.8 times as likely to seek medical care (95%CI: 1.52-7.24). When controlling for other variables in the model, those who missed work for their illness were 4.3 times as likely to seek medical care for AGI than those who did not miss work for their illness (95%CI: 2.31-9.61). When controlling for other variables in the model, those with an advanced degree were 3.5 times as likely to seek medical care for AGI than those with bachelors degree (95%CI: 1.16-10.4). Those aged 31-35 were four times as likely to seek medical care than those in the 36-40 age group (95%CI: 1.34-12.65). When controlling for other variables in the model, those of African American heritage were 3.3 times as likely to seek medical care as non-Hispanic white individuals (95%CI: 1.29-8.56). The P value for the Hosmer and Lemeshow Goodness of Fit test was 0.852, indicating good fit.

Table 4.8. Multivariable results for Model 3: factors associated with seeking medical care among nondeployed active duty Army service members with self-reported AGI, using the Scallan et al. (2006) case definition.

	Multivariable Model 3		
	OR§	95%CI	p-value
Gender *			
Male		Ref.	
Female	1.09	(0.45-2.66)	0.846
Age*			
25 or Younger	1.84	(0.52-6.55)	0.348
26-30	2.04	(0.61-6.85)	0.250
31-35	4.12	(1.34-12.65)	0.014
36-40		Ref.	
41 and Over	1.89	(0.60-5.98)	0.278
Race *			
White non-Hispanic		Ref.	
Black or African American	3.33	(1.29-8.56)	0.013
All other races	1.35	(0.48-3.79)	0.572
Education *			
Associate or Technical Degree or less	1.37	(0.89-7.47)	0.484
Bachelor's Degree		Ref.	
Advanced Degree	3.53	(1.16-10.4)	0.020
Concurrent symptoms			
Sore throat/cough			
Yes	5.01	(2.73-10.92)	<0.0001
No		Ref.	
Vomiting			
Yes	3.79	(1.52-7.24)	0.0024
No		Ref.	
Missed Work			
Yes	4.30	(2.31-9.61)	0.0006
No			

*Results weighted

Table 4.9 displays the univariable analyses for Model 4 using the Scallan et al. (2006) case definition for AGI. The only significant factor associated with active duty US Army service members seeking medical care for AGI and submitting a stool sample was missing work for less than 2 days. Those who missed work for less than 2 days were 1.6 (95%CI: 1.12-32.02) times as likely to submit a stool sample than respondents who missed 2 or more days of work for their illness.

Table 4.9. Univariable results for Model 4 factors associated with submitting a stool sample among non-deployed active duty Army service members with self-reported AGI who sought medical care using Scallan et al. (2006) case definition.

	Stool Sample Submission n (%)		Univariable Analysis For Model 4 OR§	95%CI	p-value
Region*					
ERMC	4	(20.0)	1.75	(0.09-32.53)	0.707
NRMC	12	(25.0)	2.33	(0.36-14.94)	0.371
PRMC	6	(20.0)	1.75	(0.09-32.53)	0.707
SRMC	16	(20.0)	1.75	(0.25-12.05)	0.570
WRMC	15	(12.5)		Ref.	
Resides overseas*					
Yes	4	(25.0)	1.09	(0.17-7.24)	0.926
No	45	(18.6)		Ref.	
Gender *					
Male	40	(18.9)		Ref.	
Female	10	(20.0)	1.07	(0.24-4.71)	0.927
Rank*					
Officer	9	(11.1)		Ref.	
Enlisted	46	(19.1)	2.14	(0.37-12.59)	0.399
Age*					
25 or Younger	26	(14.3)	1.67	(0.16-17.67)	0.672
26-30	13	(20.0)	2.50	(0.44-14.37)	0.305
31-35	11	(21.4)	2.73	(0.64-11.66)	0.176
36-40	6	(30.0)	4.29	(0.92-20.03)	0.064
41 and Over	5	(9.1)		Ref.	
Race *					
White non-Hispanic	33	(14.8)		Ref.	
Black or African American	14	(23.1)	1.73	(0.41-7.28)	0.458
All other races	6	(23.1)	1.73	(0.33-9.02)	0.528
Education *					
Associate/technical degree or less	45	(20.0)	2.00	(0.65-6.17)	0.228
Bachelor's degree	5	(11.1)		Ref.	
Advanced degree	5	(21.4)	2.18	(0.55-8.61)	0.265
Concurrent symptoms/severity					
Maximum number loose stools in 24 hrs					
≤5 loose stools	35	(14.3)		Ref.	
>5 loose stools	18	(27.8)	2.31	(0.6-8.85)	0.223
Diarrhea duration					
<3 Days	13	(7.7)		Ref.	
≥3 Days	38	(18.4)	2.71	(0.29-25.49)	0.383
Blood in stool					
Yes	6	(0.0)	-	(-)	-
No	39	(17.9)		Ref.	
Sore throat/cough					
Yes	29	(10.3)		Ref.	
No	24	(29.2)	3.57	(0.79-16.2)	0.099
Vomiting					
Yes	24	(20.8)	1.21	(0.35-4.16)	0.762
No	28	(17.9)		Ref.	
Max times vomit in 24 hrs					
≤5	18	(22.2)	1.43	).099-20.5	0.793
>5	6	(16.7)		Ref.	
Vomit duration					
<3 days	13	(23.1)		Ref.	
≥3 days	10	(10.0)	2.70	0.34-21.58	0.349
Both diarrhea and vomiting					
Yes	21	(19.0)	2.13	0.30-14.87	0.448
No	3	(33.3)		Ref.	
Days both diarrhea and vomiting					
<3 days	11	(18.2)	1.56	0.18-13.78	0.692
≥3 days	8	(12.5)		Ref.	
Missed Work					
Yes	35	(20.0)	1.89	0.33-10.73	0.480
No	17	(11.8)		Ref.	
Days missed work					
<2 days missed	6	(50.0)	6.00	1.12-32.02	0.036
≥2 days missed	28	(14.3)		Ref.	
Branch					
Special Operations Forces	1	(0.0)	-		
Force Sustainment Division	17	(17.6)	1.50	0.18-12.38	0.707
Health Services Division	14	(21.4)	1.91	0.25-14.43	0.531
Operations Divison	16	(12.5)		Ref.	
Operations Support Divisio	4	(50.0)	7.00	0.48-101.9	0.154
Chaplain	0	(0.0)	-		

* Results weighted

£ ERMC:Europe Regional Medical Command, PRMC:Pacific Regional Medical Command, NRMC: Northern Regional Medical Command, SRMC:Southeast Regional Medical Command, WRMC: Western Regional Medical Command

Table 4.10 displays the multivariable analysis for Model 4. The final variables for Model 4 included not experiencing sore throat or cough and missing less than 2 days of work for their illness. Gender and age also were included in the final model to adjust for possible confounding by these variables. When controlling for other variables in the model, those who did not experienced sore throat or cough were 12.9 times as likely to submit a stool sample than those who did experience sore throat or cough (95%CI: 2.2-76.1). When controlling for other variables in the model, those who missed less than 2 days of work were 4.6 times as likely to submit a stool sample than those who did not missed more than 2 days of work for their illness (95%CI: 1.3-268.0). The P value for Hosmer and Lemeshow Goodness of Fit Test was 0.9796, indicating good fit.

Table 4.10. Multivariable results for Model 4: factors associated with submitting a stool sample among nondeployed active duty Army service member with self-reported AGI who sought medical care, using the Scallan et al. (2006) case definition.

	Multivariable Model 4		
	OR§	95%CI	p-value
Gender *			
Male	2.36	(0.06-89.55)	0.643
Female		Ref.	
Age*			
25 or Younger	3.98	(0.02-667.0)	0.597
26-30	3.26	(0.02-478.5)	0.642
31-35		Ref.	
36-40	4.38	(0.04-445.0)	0.531
41 and Over	1.84	(0.006-524.2)	0.832
Concurrent symptoms			
Sore throat/cough			
Yes		Ref.	
No	12.93	(2.20-76.11)	0.005
Days missed work			
<2 days missed	25.40	(1.30-268.0)	0.031
≥2 days missed			

*Results weighted

Discussion

To our knowledge, this is the first study to describe the severity of acute gastrointestinal illness and factors associated with seeking medical care and submitting a stool sample among nondeployed active duty US Army service members. According to Scallan et al., bloody diarrhea and duration of illness are indicators of AGI severity.[7] In general, our cases of AGI (under the internationally recognized case definition for AGI) were more severe (more reports of blood in stool), were shorter in duration (except in the Northern and Southeast regions) and had less reports of concurrent respiratory symptoms (Table 4.2). This could mean that our survey did a good job of capturing both severe (blood in stool) and mild (short duration) primary gastrointestinal disease (vs. primary respiratory disease with secondary gastrointestinal disease) in the US Army population. This could be a reason why our reported AGI incidence rate is so much higher than in other developed countries. Our respondents sought care more often than cases in the United States. This could be due to increased access to care. All active duty service members have access to free healthcare either on the installation where they are stationed, or through the military's medical insurance (Tri-Care) if stationed remotely. This is not true of the rest of the American population. Canada, Italy, and Ireland also have National healthcare services, and may explain why care seeking is higher in these countries. Though stool samples were only requested in 13.2%-15.9% (depending on case definition) of cases, almost all of those who were requested to submit a stool sample did (90%). Submitting whole stool, or experiencing a rectal swab sample can be conceived as somewhat embarrassing. In our population, however, it is evident that this embarrassment is not a hindrance to stool sample submission, likely because our population is accustomed to following orders from superiors.

This means educating physicians regarding the importance of collecting a stool sample for definitive diagnosis of illness caused by foodborne pathogens may, itself, result in increased stool sample submission and therefore improve detection by laboratory-based surveillance.

Similar studies report blood in the stool as a reason for seeking medical care more frequently.[7,12,13] This makes sense because, as previously described, blood in the stool is an indicator of severity, and people with more severe disease may be more likely to seek medical care. However, in our study, which had a higher proportion of bloody stools than other studies, blood in the stool was not associated with seeking medical care in the multivariable models, regardless of case definition. This means that active duty service members do not associate blood in the stool with the need to seek medical care. Regardless of the case definition for AGI, the surveyed population was more likely to seek medical care if they experienced the clinical symptoms of vomiting and a sore throat and/or cough. Noroviruses are the leading causes AGI among people seeking medical care and a common clinical sign of *Norovirus* is vomiting (which can lead to a sore throat) but non-bloody diarrhea.[14] It is possible that our study captured cases of *Norovirus* more than other causes of AGI that result in care seeking. The Europe region had significantly more cases of AGI with concurrent respiratory symptoms than any other region. This should be considered when estimating burden of specific illnesses in this region.

Duration of illness also was cited often as a factor associated with seeking medical care.[7,11] We found this to be the case during univariable analysis, but not during multivariable analysis. We repeated the analyses excluding cases that experienced sore throat or cough to see if additional risk factors for AGI could be identified. After excluding these cases, there was not enough power to detect any significant associations. Other published symptoms associated with

seeking medical care, but were not investigated in our study due to inadvertent oversight include abdominal cramps, fever, and nausea.[7]

Factors associated with seeking medical care and submitting a stool sample under the internationally recognized case definition included having more than five loose stools in 24 hours and absence of a sore throat or cough. This information helps us to determine what symptoms guide a physician's decision about whether or not to request a stool sample. In general, it appears that physicians do not request stool specimens from AGI cases that may be caused by primary respiratory illness. Frequency of diarrhea appears to be the biggest driving factor for physicians to request a stool sample from our population. The multivariable model for factors associated with seeking medical care and submitting a stool sample under the Scallan et al. (2006) case definition included absence of a sore throat and missing less than 2 days of work for illness. The confidence intervals are very wide for all variables in the model, likely due to low power, so results should be interpreted with caution. As discussed in previous chapters, it is important to note that a change in case definition can lead to different results.

The US Army's laboratory based surveillance relies on physicians requesting stool samples and other samples from patients for laboratory testing. Practice guidelines recommend that physicians request a stool culture from patients who report blood in their stool.[15] However, in our study, of the 24/17 (international and Scallan case definition, respectively) cases of bloody AGI, an estimated 33.3%/35.3% sought the care of a physician, and only 1/0 was asked to submit a stool sample by a physician. This finding further complicates whether or not a case of AGI in the population will be detected by laboratory surveillance. Educating our population about AGI and what symptoms should prompt them to seek medical care could help increase our ability to

detect foodborne illness through laboratory surveillance. A separate study to determine the factors associated with US Army physicians requesting stool samples is currently underway.

This study helps us to determine the difference between AGI cases detected by surveillance and the AGI cases not detected by surveillance. Our survey may over-represent cases with primary diarrheal illness, while underestimating cases with bloody diarrhea. Depending on case definition, we found that between 33.3% and 35.3% of cases with bloody diarrhea sought medical care, and of those between 0% and 12.5% submitted a stool sample. Therefore, we estimate there are between 17 and 23 nondeployed active duty service members with bloody AGI in the population for every one service member with bloody diarrhea who seeks medical care and submits a stool sample. Depending on case definition, we found that 19.2%-20.7% of our respondents with AGI that reported no blood in their stool sought medical care and, of these, between 11.7%-14.9% submitted a stool sample. We therefore estimate that for every stool sample submitted by a service member with non-bloody AGI, there are approximately 31 and 44 ill service members with non-bloody AGI in the community. When compared to results reported by Scallan et al. (2006), the number of service members in the community with non-bloody AGI for every submitted stool sample is the same as our results for the same case definition (31 individuals). However, Scallan et al. (2006) reported only 5 ill persons with bloody diarrhea in the community for every one person with bloody diarrhea that seeks medical care and submit a stool sample.[7] US Army service members with AGI (bloody) are less likely to seek care and submit a stool sample than that of the general US population, when using the same case definition for AGI. This is information will be used when developing multipliers to estimate the true burden of specific causes of foodborne illness in nondeployed active duty US Army service members (chapter 5, part four of this study).

Bias in this study that could have occurred due to low response rates was discussed in part one (chapter 3) of this study. Some symptoms such as experiencing fever, nausea or abdominal cramping were not investigated in this study, and these factors may be associated with healthcare seeking behavior in our population. Future studies that include these factors could help to gain a better overall picture of factors associated with care seeking behavior.

Having an understanding of the severity of AGI and the factors associated with nondeployed active duty US Army service members seeking care and submitting a stool sample (two steps in they burden of illness pyramid featured in Figure 4.1) is imperative to estimating the burden of foodborne AGI. Our laboratory based surveillance under-estimates service members with both bloody and non-bloody diarrhea, which means many cases AGI are going undetected. This is important knowledge for both US Army public health officials, and also for our burden of foodborne illness estimates. The next chapter of this dissertation describes US Army laboratory practices for stool-specimen testing for bacterial pathogens.

References

1. United States Army Medical Service. *Preventive medicine in World War II.* Washington: Office of the Surgeon General, Dept. of the Army; 1955.

2. Hyams KC, Bourgeois AL, Merrell BR, et al. Diarrheal Disease during Operation Desert Shield. *New England Journal of Medicine.* 1991;325(20):1423-1428.

3. Armed Forces Health Surveillance Center. Gastrointestinal infections, active component, U.S. Armed Forces, 2002-2012. *MSMR.* 2013;20(10):7-11.

4. Roy SL, Scallan E, Beach MJ. The rate of acute gastrointestinal illness in developed countries. *Journal of water and health.* 2006;4 Suppl 2:31-69.

5. Levy PS. *Sampling for health professionals.* Belmont, Calif.: Lifetime Learning Publications; 1980.

6. Majowicz SE, Hall G, Scallan E, et al. A common, symptom-based case definition for gastroenteritis. *Epidemiol Infect.* 2008;136(7):886-894.

7. Scallan E, Jones TF, Cronquist A, et al. Factors associated with seeking medical care and submitting a stool sample in estimating the burden of foodborne illness. *Foodborne pathogens and disease.* 2006;3(4):432-438.

8. *Microsoft Excel for Mac* [computer program]. Version 14.5.7. Redmond, Washington: Microsoft; 2011.

9. Dean AG SK, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version 3.03a. 2015; http://www.openepi.com.

10. *SAS* [computer program]. Version 9.3. Cary, NC: SAS Institute; 2000-2010.

11. Scavia G, Baldinelli F, Busani L, Caprioli A. The burden of self-reported acute gastrointestinal illness in Italy: a retrospective survey, 2008-2009. *Epidemiol Infect.* 2012;140(7):1193-1206.

12. Gurpreet K, Tee GH, Amal NM, Paramesarvathy R, Karuthan C. Incidence and determinants of acute diarrhoea in Malaysia: a population-based study. *Journal of health, population, and nutrition.* 2011;29(2):103-112.

13. Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. *Emerg Infect Dis.* 1999;5(5):607-625.

14. Hall AJ, Rosenthal M, Gregoricus N, et al. Incidence of acute gastroenteritis and role of norovirus, Georgia, USA, 2004-2005. *Emerg Infect Dis.* 2011;17(8):1381-1388.

15. Fenstemacher P. Practice Guidelines for the Management of Infectious Diarrhea. In: Skolnik N, Schneider D, Neill R, Kuritzky L, eds. *Essential Practice Guidelines in Primary Care*: Humana Press; 2007:183-209.

Chapter 5 : Laboratory Practices for Stool-Specimen Testing for Bacterial Pathogens in 13 US Army Clinical Laboratories, 2014

Introduction

Department of Defense Directive (DoD) 6490.2 states that comprehensive health surveillance is an important element of force health protection (FHP) programs to promote, protect, and restore the physical and mental health of DoD personnel.[1] Comprehensive, continuous, and consistent health surveillance shall be conducted by the Military Services to implement early intervention and control strategies using technologies, practices, and procedures in a consistent manner across the DoD [1]. This directive establishes the Armed Forces Health Surveillance Center (AFHSC), now named the Armed Forces Health Surveillance Branch (AFHSB) as the single source for DoD-level health surveillance information.[1]

In 2012, the AFHSB, in collaboration with the U.S. Air Force School of Aerospace Medicine, U.S. Navy and Marine Corps Public Health Center, and U.S. Army Public Health Command Army Institute of Public Health, published guidelines and case definitions for Reportable Medical Events (RME).[2] These RME represent an inherent, significant threat to public health and military operation.[2] These events have the potential to affect large numbers of people, to be widely transmitted within a population, to have severe/life threatening clinical manifestations, and to disrupt military training and deployment.[2] The reportable events were chosen based on consensus and recommendations from each of the military services about notifiable diseases from the Centers for Disease Control and Prevention, Council of State and Territorial Epidemiologists (CSTE), and events that military public health experts have identified as representing military threats that deserve additional emphasis for surveillance.[2] The list of

RME contains specific disease and environmental exposures that have clear case definitions and laboratory criteria for diagnosis. Though the AFHSB does not specifically monitor for foodborne illness, 17 of the 66 RMEs have the potential to be foodborne in origin (Appendix A-2).[2] The pathogens of interest in the present study (*Campylobacter* spp., *E. coli* O157:H7 and other STEC, *Salmonella* spp., and *Shigella*) are all RMEs. US Army surveillance for these pathogens uses passive data collection through the Defense Reporting System Internet (DRSi), which relies on clinical laboratories to report positive findings.

Laboratory-based surveillance systems rely on clinical laboratories to identify pathogens of public health importance through microbiological testing.[3,4] The Foodborne Diseases Active Surveillance Network (FoodNet) is an active laboratory-based surveillance system in the United States that tracks trends for infections commonly transmitted through food.[5] FoodNet collects data on laboratory culture-confirmed cases and cases diagnosed through culture-independent diagnostic testing (CIDT) methods from ten states.[5] These data, along with foodborne illness outbreak data, and surveys of laboratories, physicians, and the susceptible population are used to estimate burden of foodborne infections in the United States. Previous findings of the FoodNet active surveillance showed substantial variations in the incidence of laboratory-confirmed infection with bacterial foodborne pathogens between the different FoodNet sites.[6] A 2012 study found most of the surveyed FoodNet laboratories did not adhere to existing guidelines for the isolation of *Campylobacter* which likely resulted in underdiagnosis of this bacterial pathogen.[7] Another study compared the difference in testing practices for shiga toxin-producing *Escherichia coli* (STEC) over time to determine changes in practice that could impact surveillance data, and to compare current practices with published recommendations.[8] They found that most laboratories complied with recommendations for O157 STEC testing by culture, but not with

recommendations for detection of non-O157 STEC. Gaining a better understanding of the difference in laboratory testing procedures across laboratories can help to analyze trends in laboratory based surveillance data.[9]

This chapter is part three of the four-part study to estimate the burden of foodborne illness among nondeployed US Army active duty service members caused by five major pathogens (Figure 5.1). In chapter 3 (part one), we used population survey data to estimate the burden of acute gastrointestinal illness (AGI) among nondeployed active duty Army service members and to identify risk factors associated with the occurrence of AGI among service members. In Chapter 4 (part two), we described the severity of AGI among service members and determined the factors associated with service members seeking medical care and with submitting a stool sample.

There are 41 fixed US Army medical facilities with clinical microbiology laboratory capabilities. Each laboratory serves a varying number of patients, and each laboratory has different testing capabilities. The facilities are geographically dispersed worldwide, and provide services to all who have access to military healthcare including: active duty service members, reserve service members on active orders, military dependents (spouses, children), and military retirees. In this chapter, we describe the laboratory practices of US Army clinical laboratories including specimen handling, testing procedures for *Campylobacter* spp., *E. coli* O157:H7 and other STEC, *Salmonella* spp., and *Shigella* spp., and reporting procedures for these pathogens. Ultimately, the data help us to gain a baseline understanding of US Army clinical laboratory practices, and will be used with results from parts one and two to estimate the burden of foodborne illness among nondeployed US Army service members caused by five major pathogens.

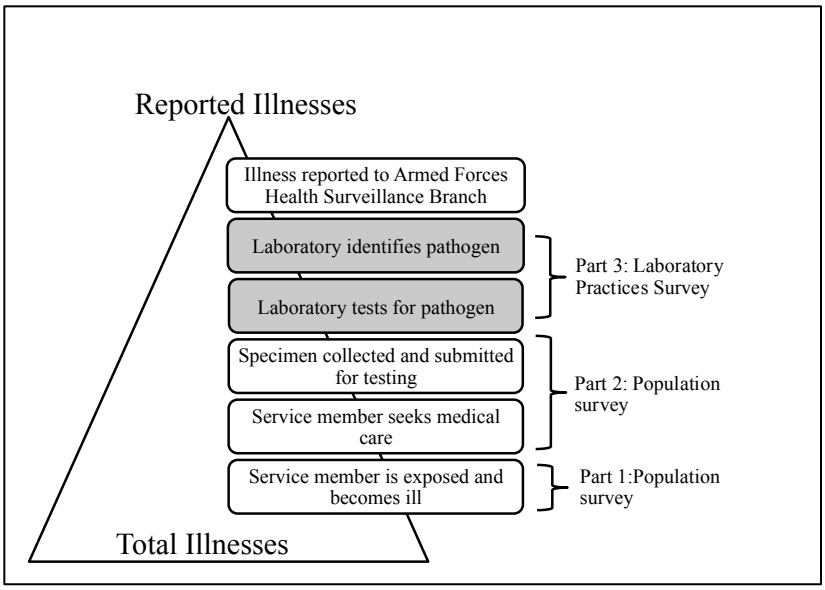


Figure 5.1. Burden of Illness pyramid illustrating the steps that must occur for an episode of illness in the active duty Army population to be reported through laboratory surveillance.

Methods

To capture differences in laboratory practices among US Army microbiology laboratories, we selected geographically dispersed laboratories across each of the five regional medical commands. The laboratories were selected based on size of population served, geographical location, and convenience. Figure 5.2 displays a map of the physical location of each of the 41 laboratories, as well as the laboratories we surveyed. An electronic questionnaire was sent to 15 different laboratories, serving a total population of approximately 200,000 active duty Army service members, or approximately 42.0% of the population assigned to the five regions. The questionnaire was based on the FoodNet Survey of Clinical Laboratory Practices, 2000 developed by the CDC's Emerging Infections Program, FoodNet, Active Bacterial Core Surveillance (Appendix A-5).[10] We asked about routine testing procedures for *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., and *E. coli* O157:H7 and other STEC, general sample

handling protocols, methods for pathogen detection, and reporting procedures. The total number of stool specimens tested in 2014 and total number positive in 2014 also were collected. The survey was conducted from May-October 2015. The estimated percent of positive samples for each pathogen was calculated from the number of stool specimens positive for *Salmonella* spp., *Shigella* spp., *Campylobacter* spp., *E. coli* O157:H7, and other STEC, divided by the total number of stool specimens tested for each laboratory that reported routinely testing for the pathogen in 2014. Rectal swabs that were collected and tested for *Clostridium difficile* only were excluded from denominator totals. Descriptive statistics were calculated using Microsoft Excel for Mac 2010 (Microsoft Corporation, Redmond, WA, USA). Maps were created using ZeeMaps free online mapping software (www.zeemaps.com, 2016).

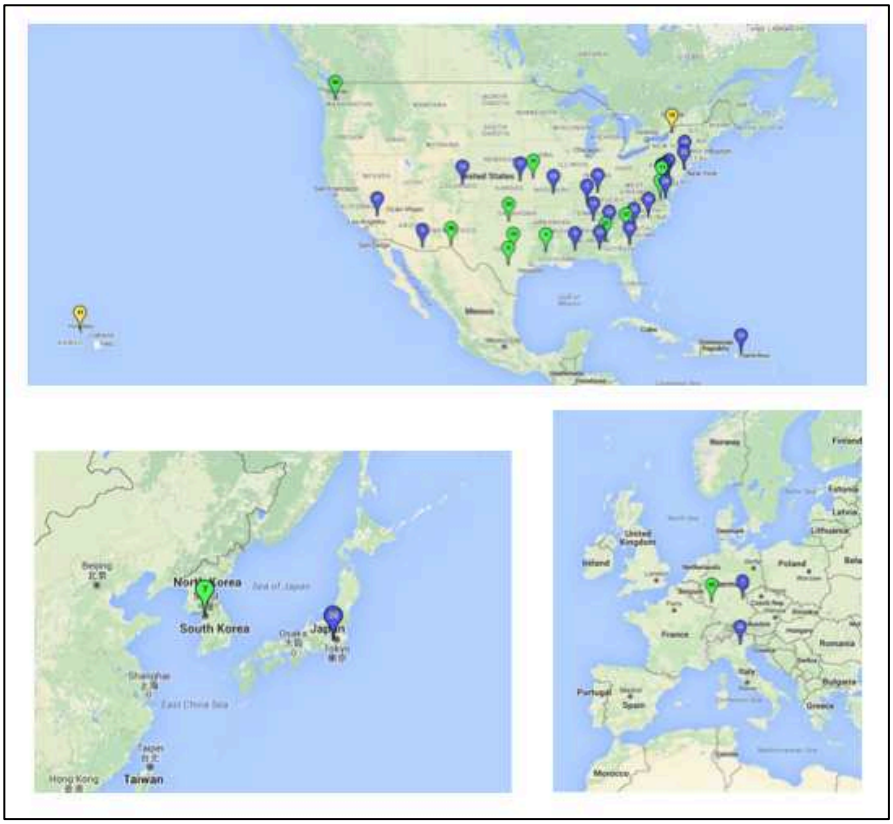


Figure 5.2. Map of clinical microbiology laboratory locations. Blue markers denote laboratories that were not selected for survey. Green markers denote laboratories that were selected and participated by completing surveys. Yellow markers denote laboratories that were selected but did not participate in the survey.

Results

Thirteen laboratories (86.7%) returned completed surveys. The 13 responding laboratories provided laboratory services covering approximately 41.6% of the active duty Army population. A summary of active duty Army service member population coverage by region is displayed in Table 5.1. At least one laboratory from each medical region responded to the survey. Regional US Army active duty population coverage ranged from 10.3% (Northern US Region) to 81.7% (Europe region). All thirteen laboratories provided an estimate of the number of stool specimens tested for bacterial pathogens in 2014. The median number of stool specimens processed per laboratory in 2014 was 482 (range, 95-18,525).

Table 5.1. Active duty (AD) population coverage by surveyed US Army laboratories and frequency of stool specimen testing at US Army laboratories that reported total number of stool specimens tested in 2014 survey.

Region	Estimated 2014 AD population	AD population served	Population coverage (%)	No. of laboratories surveyed	No. of laboratories reporting no. specimens tested	No. of specimens tested, median (range)	Total
Europe Region	27,451	22,441	81.7	1	1	642	642
Northern US Region	98,821	10,226	10.3	3	2	566 (95-1,037)	1,132
Pacific Region	37,822	16,380	43.3	2	1	205	205
Southern US Region	170,051	91,240	53.7	6	6	482 (215-18,525)	20,775
Western US Region	141,239	57,708	40.9	3	3	938 (106-1,995)	3039
All sites	475,384	197,995	41.6	15	13	482 (95-18,525)	25,793

Enteric Specimen Handling Practices

Three of the 13 (23.1%) laboratories were unable to determine from their records whether specimens were received as whole stools or rectal swabs, and whether the specimens included transport medium. Of the remaining ten laboratories, three (30.0%) reported receiving both whole stool and rectal swabs, and seven (70.0%) reported receiving only whole stool samples. All laboratories reported receiving whole stool specimens, and all laboratories received greater than 70.0% of their specimens as whole stools vs. rectal swabs. The reporting laboratories

processed a total of 26,371 stool specimens in 2014. One laboratory reported that 5,475 rectal swabs were PCR tested for *C. difficile* and no other pathogens, leaving a total of 20,896 specimens for routine fecal culture. Of the whole stool specimens, 96.7% were received without transport media, 2.2% were received with transport media, and 1.0% of samples were received on ice. Of the three laboratories who reported receiving rectal swabs, almost all (99.8%) were received without transport media. The reported average transit time for specimens to travel from the medical practitioner to the laboratory was two hours or less for 80% of the laboratories that responded to this question. Of the eleven laboratories that reported transit time for samples received, three laboratories (27.3%) reported an average transit time of 8 hour or more. Ten (76.9%) laboratories reported having rejection criteria for stool specimens received without transport media. Eight (80.0%) of these laboratories reported rejecting stool specimens without transport media if they were one to three hours old. Two (20.0%) laboratories reported rejecting these specimens if they were 24 or more hours old. The majority of laboratories (53.8%) process stool specimens immediately. Those laboratories that do not process samples immediately (46.2%), place the samples in the refrigerator without transport media until processing. Eleven of the responding laboratories (84.6%) reported receiving samples from hospitalized patients. Of these laboratories, 10 (90.9%) had specific rejection criteria for routine fecal testing of samples received from patients who have been hospitalized for a specific number of days. Nine (90.0%) of these laboratories rejected samples from patients hospitalized for 3 or more days, and 1 (10.0%) reported rejecting samples from patients hospitalized for 7 or more days. One (7.6%) laboratory had no policy for rejecting routine fecal culture samples from hospitalized patients.

Enteric Pathogen Testing Practices and Percent Positive Samples

***Salmonella* spp.**

All 13 laboratories that submitted a questionnaire reported testing stool specimens for *Salmonella* spp. on-site. All laboratories reported they routinely test all stool specimens for *Salmonella* as part of their routine enteric screening test. Four (30.8%) of the laboratories reported using both culture and CIDT methods to test for *Salmonella* spp. Nine (69.2%) reported using only culture-based method. For laboratories using CIDT methods, whether they also confirmed these results through culture was not reported. These laboratories tested an estimated 20,896 stool specimens for *Salmonella* spp. in 2014. Of these, 111 (0.53%) were positive.

***Shigella* spp.**

All 13 laboratories that submitted a questionnaire reported testing stool specimens for *Shigella* spp. on-site. All laboratories reported they routinely test all stool specimens for *Shigella* spp. as part of their routine enteric screening test. Four (30.8%) of the laboratories reported using both culture and CIDT methods to test for *Shigella* spp. Nine (69.2%) reported using only culture-based method. For laboratories using CIDT methods, whether they also confirmed these results through culture was not reported. These laboratories tested an estimated 20,896 stool specimens for *Shigella* spp. in 2014. Of these, 86 (0.41%) were positive.

***Campylobacter* spp.**

All 13 laboratories that submitted a questionnaire reported testing stool specimens for *Campylobacter* spp. on-site. Twelve laboratories (92.3%) reported they routinely test all stool specimens for *Campylobacter* spp. as part of their routine enteric screening test. Three (25.0%) of the laboratories reported using both culture and CIDT methods to test for *Campylobacter* spp. Seven (58.3%) reported using only culture-based methods, and three (25.0%) reported using only

CIDT methods to test for *Campylobacter* spp. For laboratories using CIDT methods, whether they also confirmed these results through culture was not reported. These laboratories tested an estimated 18,901 stool specimens for *Campylobacter* spp. in 2014. Of these, 80 (0.42%) were positive.

***E. coli* O157:H7 and other STEC**

Twelve laboratories (92.3%) that submitted a questionnaire reported testing stool specimens for *E. coli* O157:H7 and other STEC on-site. Eleven (91.7%) of these laboratories reported they routinely test all stool specimens for *E. coli* O157:H7 and other STEC as part of their routine enteric screening test. Eight (72.7%) of the laboratories reported using both culture and CIDT methods to test for *E. coli* O157:H7 and other STEC, the remaining three (27.2%) use culture-based methods only. Those laboratories that use CIDT methods all reported that they confirm the results by either performing culture on-site, and/or sending to the state public health lab for culture confirmation. These laboratories tested an estimated 18,401 stool specimens for *E. coli* O157:H7 and other STEC in 2014. Of these, 25 (0.14%) were positive, four of which were identified by non-culture methods and then were verified with culture.

Table 5.2 displays the percent of routine stool samples tested by US Army laboratories that were positive for *Salmonella*, *Shigella, Campylobacter,* and *E. coli* O157:H7 and other STEC listed by region and overall. In addition, the results from a 1999 FoodNet survey of civilian laboratories are included for comparison.[9] Overall, of these four pathogens, the most commonly isolated by US Army laboratories in 2014 was *Salmonella* (0.53%). When compared to the other regions, the Pacific Region had the highest percentage of samples positive for *Campylobacter* and *Salmonella* (4.88% and 2.44%, respectively), and the lowest percentage of samples positive for *Shigella* and STEC (0.0% for both). The Europe region had a high

percentage of samples positive for *E. coli* O157:H7 and other STEC (16.4%). When comparing all Army laboratories with the FoodNet sites surveyed in 1999, the percentage of samples positive for *Shigella* was slightly higher, but the percentage of samples positive for the other 3 pathogens were less. The percentage of samples positive for *Salmonella*, *E. coli* O157:H7/STEC, and *Campylobacter* were 1.7, 1.8, and 2.9 times lower, respectively. We were unable to determine whether these differences were statistically significant.

Table 5.2. 2014 percentage of positive stool samples processed by US Army laboratories that reported routinely testing for Salmonella, Shigella, Campylobacter, or STEC by pathogen and regional location.

	Percent of Routine Samples Testing Positive*			
	Salmonella	*Shigella*	*Campylobacter*	*E. coli* O157:H7/STEC
Europe Region	0	0.16	1.23	16.4
Northern US Region	1.24	0.71	0.88	0.09
Pacific Region	2.44	0	4.88	0
Southern US Region	0.53	0.49	0.29	0.02
Western US Region	0.36	0.03	0.20	0.07
All US Army laboratory sites	0.53	0.41	0.42	0.14
All FoodNet Sites (1999)	0.91	0.31	1.21	0.25

* reported number of specimens cultured that yielded the pathogen divided by the total no. of stool specimens tested by the laboratory

Reporting procedures

Twelve (92.3%) of laboratories reported positive samples to the Preventive Medicine department (PM) for input into DRSi. Methods of communication to PM varied. For some laboratories, PM physically collected positive results from the lab at least once daily. Others communicated to PM through electronic reports of RME logs. Some just simply called PM daily with RME reports. Eleven (84.6%) reported contacting the local state public health laboratory directly to report positive results. Six (50.0%) of the laboratories sent either isolates or the fecal sample itself to state public health laboratories for confirmation or additional testing including sero-typing, PFGE, or other post-identification characterization. All samples sent to the public

health laboratory are done so immediately, they are not held for "batching" with other samples. Results from samples sent off-site to public health laboratories or other civilian reference laboratories are entered manually into patient records.

Discussion

Enteric Specimen Handling Practices

Stool specimen and rectal swab handling guidelines for specific pathogens available at the time of this survey are described in the Manual of Clinical Microbiology, 10th Edition (2011).[11] Whole stool specimens are preferred for isolating *E. coli* O157:H7 and other STEC, *Shigella* spp., *Salmonella* spp., and *Campylobacter* spp. from patients with gastrointestinal infections, though rectal swabs also are acceptable for culture of *Campylobacter* and *Shigella.*[12,13] A single stool sample has a high sensitivity for routine culture requests, but two samples can improve recovery for *E. coli*, *Shigella*, and *Salmonella.*[12,13] Transport medium should always be used if a delay of 2 or more hours is anticipated, and for all rectal swabs.[12] Particularly delicate organisms like *Shigella* become non-detectable in samples within 30 minutes of collection, and should be immediately transferred to transport media.[11] A delay in transport of >2 hours of whole stools also can affect recovery of *Campylobacter.* Whole stool with transport media should be transported to the lab within 24 hours.[14] Specimens received in transport medium should be stored at 4°C if processing is not performed immediately. Transport and storage of fecal specimens at 4°C is especially important for *Campylobacter* and *Shigella* and transport of stool specimens at ambient temperature may have a deleterious effect on the ability to recover these organisms.[13]

There was variation in how the US Army laboratories handled specimens. Overall, laboratories followed most of the recommended guidelines for sample handling and transport. Laboratories received both whole stool and rectal swabs, but most received only whole stool samples, and most processed all specimens immediately. Those that did not process samples immediately stored specimens at refrigerator temperature. In addition, all but three laboratories discarded samples with no transport media if received more than 2 hours after collection. Most stool samples were received without transport media, so immediate processing or refrigeration is important for these specimens. For the laboratories that received rectal swabs, most were received without transport media, but the transit times reported for these laboratories were <2 hours. Though guidelines recommend all rectal swabs be placed in transport media, the short transit time for these specimens is encouraging. Most laboratories had rejection criteria for specimens received without transport media, but the criteria varied widely between laboratories. The variations in sample handling could have a negative effect on sensitivity for testing bacterial pathogens, especially *Campylobacter* and *Shigella*. Though it is difficult to quantify the impact the variation in specimen handling and transport has on incidence of positive samples, it likely has resulted in some level of underdiagnosis of these enteric bacterial pathogens. We recommend all US Army laboratories adopt policies that follow recommended guidelines for sample processing and transport.

It is recommended that stool samples from patients who have been hospitalized for more than three days should not be processed for enteric pathogens without justification from the physician.[14] The reason for this is that hospitalized patients who did not have diarrhea upon admission are unlikely to develop bacterial enterocolitis caused by agents other than *C. difficile.*[15,16] The majority of laboratories in our study population who receive samples from

hospitalized patients reject samples from patients that have been hospitalized for more than three days. One lab reported a rejection criterion of 7 days of hospitalization, which could lead to increased healthcare costs due to unnecessary testing. It is recommended that all US Army laboratories adopt a 3-day sample rejection policy.

Enteric Pathogen Testing Practices and Percent Positive Samples

We found that all laboratories routinely test all stool specimens for *Salmonella,* and *Shigella.* All but one laboratory routinely test all stool specimens for *Campylobacter*. This laboratory reported testing for *Campylobacter* only when requested specifically by a physician. All but two laboratories routinely test all stool specimens for *E. coli* O157:H7 and other STEC. One reported they do not perform any tests for *E. coli* O157:H7 and other STEC, and the other reported that they do test for *E. coli* O157 and other STEC when a physician specifically requests the test and/or when the specimen appears bloody. US Army surveillance of *E. coli* O157:H7 and other STEC and *Campylobacter* relies on clinical laboratory confirmation for these pathogens, so it is promising that the majority of surveyed laboratories either test for these pathogens routinely, when a physician requests the test, or if the stool is bloody. This means the majority of laboratories are following the CDCs recommendation that all stool specimens submitted for microbiological culture be tested for *E. coli* O157:H7 and *Campylobacter*.[9,17] The laboratory that reported testing *E. coli* only for bloody stools and *Campylobacter* when specifically requested by a physician tested approximately 2,000 stool specimens in 2014. The laboratory that reported not testing any stool specimens for *E. coli* O157:H7 receives approximately 500 stool specimens annually. It is important to keep this in mind when assessing regional percent isolation of *E. coli* O157:H7 and *Campylobacter* among service members, because testing procedures could potentially account for any geographical differences seen. For

example, the laboratory that reported not routinely testing for STEC and *Campylobacter* is located in the Western US Region, and low percent positive samples for *Campylobacter* and STEC in this region could be due to this laboratory not routinely testing for this pathogen.

The difference in the percentage of positive samples by US Army laboratories when compared to the FoodNet lab results could be due to a number of factors. The only FoodNet percentage of positive samples data available at the time of this study was from 1999, and the percent of samples positive for these pathogens today could be lower than in 2014. However, according to CDC, the number of culture-confirmed cases of *Campylobacter*, *Salmonella,* and all STEC has increased since 1999.[18] Not all laboratories had policies for rejecting routine stool specimen from patients who have been hospitalized for more than three days. This could lead to lower pathogen yield. Not all laboratories followed the recommended sample handling and transportation guidelines, which also could lead to lower test sensitivity. However, as previously discussed, *Shigella* spp. is especially sensitive to sampling handling, and the recovery success of this pathogen was slightly higher for US Army laboratories than FoodNet laboratories, which could be an indicator of good sample handling procedures. We did not ask specific questions about how samples are tested, what media is used for isolation, or the experience of microbiologists and technicians in the laboratories. If media and testing procedures are used that are not current, or lab personnel are not experienced in these procedures, this could lead to a lower percentage of positive samples as well. We also did not ask how often laboratories tested more than one patient sample, which can lead to higher yields for STEC, *Shigella,* and *Salmonella.* It also is possible that the percentage of positive samples is simply lower among those who seek care at military medical treatment facilities. Regardless of the reason for this lower percentage of positive samples, further research into these results is warranted.

Underdiagnosis of these pathogens due to laboratory practices is a concern and should be taken into account when determining true burden of disease caused by these pathogens.

Reporting Procedures

The surveillance for these enteric pathogens relies on passive data collection, meaning laboratories must report positive results to PM in order for the result to be captured by DRSi. According to Army Regulation 40-5, health care providers are required to inform the supporting PM of all incidences of diseases on the RME list.[19] From our survey, it appears as though the majority of laboratories are communicating RMEs to PM, but the method of communication varies across laboratories. Developing a system-wide reporting policy could help to improve reporting procedures and reduce missing cases in DRSi. Positive results received from outside laboratories must be hand-entered into the US Army laboratory database to be captured. This leaves room for human error in reporting. If results are miscoded, or simply aren't entered, DRSi will not capture them. This also can result in underreporting of results. A surveillance system that employs the active gathering of positive cases could help to reduce the amount of underreporting. It is difficult to determine the magnitude of underreporting in DRSi. Previous studies looking at *Chlamydia* and Lyme disease have used capture-recapture methods to compare cases captured by different US military databases, to determine the level of underreporting by individual databases, and to determine which combination of databases captures the most results.[20,21] In a study by Evans et al. (2014), they found that DRSi captured only 30% and 17% of human Lyme disease cases captured by two other military medical databases (HL7 and M2, respectively).[20] A study by Jordan, et al. (2014) found that DRSi captured 79% of *Chlamydia trachomatis* cases.[21] This data can be used to guide development of underreporting estimates to determine the true burden of disease.

PulseNet is a CDC surveillance tool that allows for early detection of outbreaks through the use of DNA fingerprinting of positive isolates by pulse-field gel electrophoresis (PFGE).[22] State public health laboratories upload the PFGE results into the PulseNet database for analysis by epidemiologists.[22] Clinical laboratories therefore are encouraged to forward isolates of bacteria that PulseNet tracks to their state public health laboratory. It is promising that the majority of laboratories send isolates to their local public health laboratories for confirmatory diagnosis and PFGE analysis. Having military isolates in the PulseNet system can help Army public health personnel link cases to possible foodborne illness outbreaks. A formal relationship with the CDC should be developed to enhance these capabilities. There were some military laboratories that use only CIDT methods for diagnosis of *Campylobacter*. We were unable to verify whether culture is used to confirm these results. Currently, PulseNet relies on bacterial isolates for PFGE analysis. The use of CIDT methods only would not allow for these positive cases to be uploaded into PulseNet, and would reduce the ability to link cases to outbreaks. Until other options are available for PulseNet tracking, we recommend culture for *Campylobacter* so isolates can be included in PulseNet data

Limitations

Limitations of this study include the difficulty in verifying the estimate of the number of stool specimens processed by each laboratory, and verifying how the stool specimens are received (with or without transport medium). Incorrect estimates of the number of stool specimens processed by each lab would have an effect on the calculated estimated percent isolated. It also is possible that counts could include multiple specimens from the same individual. Designing an active surveillance system using sentinel US Army laboratory sites (similar to FoodNet), and implementing a system that can more accurately track the number of

specimens received and tested could improve the accuracy of calculated percent positive test for each pathogen. This also could help to reduce underdiagnosis and underreporting of positive cases. Another limitation of this study is the selection of these laboratories for survey. The surveyed laboratories were not randomly selected. We selected laboratories based on geographic location and convenience. These laboratories have rigorous inspection and reporting requirements mandated by the DoD. At the time of the survey, influenza reporting was taking significant manpower for a number of the laboratories. We attempted to select laboratories that already had completed inspection requirements, and who were not burdened with influenza reporting to increase the likelihood of survey completion. Though we feel we selected a good variety of laboratories based on geographical location and the size of the population served, the fact that we did not randomly select laboratories could mean the results are not representative of all US Army laboratories.

Despite these limitations, the information obtained from these laboratory surveys is valuable as a baseline study for the evaluation of US Army laboratory practices for bacterial enteric pathogens. The results will serve to create underdiagnosis and underreporting multipliers used to estimate the burden of foodborne illness among US Army service members (part four, chapter 6). The results of the study also can be used to guide future surveys that evaluate more specific laboratory practices, and look for changes in testing procedures over time. The variation of adherence to available microbiology guidelines underscores the need to standardize best laboratory practices across all US Army laboratories through Army-wide laboratory regulations. Implementing standardized guidelines across all US Army clinical laboratories for testing enteric pathogens and submission of isolates to public health laboratories can enhance laboratory-based surveillance for these pathogens.

References

1. Department of Defense Directive (DODD) 6490.02E. Washington DC HeadquartersFebruary 8, 2012.

2. Armed Forces Health Surveillance Branch. Armed Forces Reportable Events Guidelines & Case Definitions. 2012; https://www.afhsc.mil/Home/ReportableEvents. Accessed January 18, 2016.

3. Thacker SB, Berkelman RL. Public Health Surveillance in the United States. *Epidemiologic Reviews.* 1988;10(1):164-190.

4. Vogt RL. Laboratory reporting and disease surveillance. *J public health management practice.* 1996;2(4):28-30.

5. Centers for Disease Control and Prevention. *FoodNet Surveillance: Active Laboratory Surveillance.* 2015. http://www.cdc.gov/foodnet/surveillance.html. Accessed December 7, 2015.

6. Centers for Disease Control and Prevention. Preliminary FoodNet data on the incidence of foodborne illnesses--selected sites, United States, 2001. *MMWR.* 2002;(51):325-329.

7. Hurd S, Patrick M, Hatch J, et al. Clinical laboratory practices for the isolation and identification of Campylobacter in Foodborne Diseases Active Surveillance Network (FoodNet) sites: baseline information for understanding changes in surveillance data. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America.* 54(Suppl 5):S440-S445.

8. Hoefer D, Hurd S, Medus C, et al. Laboratory practices for the identification of Shiga toxin-producing Escherichia coli in the United States, FoodNet sites, 2007. *Foodborne pathogens and disease.* 8(4):555-560.

9. Voetsch AC, Angulo FJ, Rabatsky-Ehr T, et al. Laboratory practices for stool-specimen culture for bacterial pathogens, including Escherichia coli O157:H7, in the FoodNet sites, 1995-2000. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America.* 2004;38 Suppl 3:S190-197.

10. FoodNet Survey of Clinical Laboratory Practices, 2000. 2000; http://www.cdc.gov/foodnet/surveys/lab.html. Accessed April 10, 2014, 2014.

11. Versalovic J, Carroll KC, Funke G, Jorgensen JH, Landry ML, Warnock DW. *Manual of Clinical Microbiology, 10th Edition.* American Society of Microbiology; 2011.

12. Fitzgerald C, Nachamkin I. *Campylobacter and Arcobacter*. *Manual of Clinical Microbiology, 10th Edition.* Vol 1. 10th ed: American Society of Microbiology; 2011:885-899.

13. Nataro J, Bopp C, Fields P, Kaper J, Strockbine N. *Escherichia, Shigella, and Salmonella*. *Manual of Clinical Microbiology, 10th Edition.* Vol 1. 10th ed: American Society of Microbiology; 2011:603-626.

14. Baron E, Thomson Jr. R. Specimen Collection, Transport, and Processing: Bacteriology. *Manual of Clinical Microbiology, 10th Edition.* Vol 1. 10th ed: American Society of Microbiology; 2011:228-271.

15. Morris AJ, Murray PR, Reller LB. Contemporary testing for enteric pathogens: the potential for cost, time, and health care savings. *Journal of clinical microbiology.* 1996;34(7):1776-1778.

16. Guerrant RL, Van Gilder T, Steiner TS, et al. Practice guidelines for the management of infectious diarrhea. *Clinical infectious diseases.* 2001;32(3):331-351.

17. Gould LH, Bopp C, Strockbine N, et al. Recommendations for Diagnosis of Shiga Toxin-Producing *Escherichia coli* infections by Clinical Laboratories. *MMWR.* 2009;(58):1-14.

18. Centers for Disease Control and Prevention. *Number and Incidence of Infections by Year, 1996-2014.* 2015. http://www.cdc.gov/foodnet/trends/2014/number-of-infections-by-year-1996-2014.html - table2a. Accessed February 4, 2016.

19. Army Regulation 40-5: Preventive Medicine. In: Army UDot, ed. Washington, DC2007.

20. Evans RI, Salman M, Lappin M, Hayne S, Peel J. *One health in the U.S. military : a review of existing systems and recommendations for the future*, Colorado State University. Libraries; 2014.

21. Jordan N, Clemmons N, Nowak G, Gaydos J. Estimating the Burden of Chlamydia Trachomatis in the US Army - Use of Three Passive Surveillance Systems and Capture-Recapture Methods to Identify Incident Cases. *Poster session presented at the 2014 STD Prevention Conference.* 2014.

22. Centers for Disease Control and Prevention. *PulseNet.* 2015. http://www.cdc.gov/pulsenet/. Accessed December 28, 2015.

Chapter 6 : Estimate of the Annual Burden of Foodborne Illness in Nondeployed Active Duty U.S. Army Service Members: Five Major Pathogens, 2010-2015.

Introduction

Throughout military history, acute gastrointestinal illness (AGI) has been a significant cause of morbidity and mortality among United States service members.[1] Despite advances in medicine and improvements in basic sanitation, modern day military operations still are affected by gastrointestinal illness. In 2012, diarrheal diseases were responsible for more than 17,000 healthcare encounters affecting over 15,000 U.S. service members.[2] AGI often is characterized by diarrhea, vomiting, fever, malaise, and/or weakness. If a large proportion of the military population is affected by AGI, military operational effectiveness can be degraded.[3]

One important preventable cause of AGI is foodborne illness. The WHO estimates that as much as 70% of diarrheal diseases worldwide can be attributed to foodborne pathogens.[4] Foodborne infections are an important cause of illness in the United States,[5] with more than 48 million Americans becoming ill from contaminated foods annually.[6] Members of the United States Army also are at risk for foodborne illness. The US Army is a unique population that is globally distributed, has its own food procurement system, and a food protection system dedicated to the prevention of both unintentional and intentional contamination of food. To our knowledge, the burden of foodborne illness caused by specific pathogens among the nondeployed active duty US Army military population has not been determined. Foodborne illness burden measures are necessary for directing policy and interventions aimed at reducing the incidence of foodborne disease.

Estimating the number of foodborne illnesses caused by specific pathogens among US Army service members can be very challenging for a number of reasons. One challenge is that food can be contaminated by a number of agents that can cause illness including viruses, bacteria, parasites, and chemicals.[6] Transmission of these agents can occur through nonfood routes such as consumption of contaminated water or contact with infected animals.[6] The amount of infection transmitted by food depends on the level of contamination in the food, the environment in which the food is prepared, the pathogen itself, and certain host factors such as immune status and age.[6] Finally, we generally rely on laboratory surveillance to detect cases of foodborne illness, which results in many cases going undetected.[7] For the US Army, these issues are compounded by the fact that the US Army does not have a foodborne illness-specific surveillance system in place.

In the US Army, foodborne disease is detected through the medical event reporting system (Disease Reporting System internet, DRSi), and only 17 of the 31 major causes of foodborne illness are included as reportable medical events (Appendix A-2).[6,8] This system relies on laboratory confirmation of illness etiology and is not an accurate reflection of the true burden of foodborne disease. For a reportable medical event to be documented, the ill service member must seek medical care and submit a stool specimen, the laboratory must isolate and identify the organism from the sample, and positive results must be entered into DRSi (Figure 6.1). If any one of these events does not occur, the illness is not recorded. To gain a more accurate estimate of the number of annual foodborne illnesses among US Army service members, we need to estimate the number of cases of disease that go unrecognized at each surveillance step. Scallan et al. (2011) calculated estimates of foodborne illness in the United States through the use of telephone surveys of the population, laboratory surveys, FoodNet surveillance data, and data

from outbreak investigations.[6] Our current study uses similar methods through a web-based survey of the active duty US Army population and of US Army clinical laboratories. This chapter is part four of a four-part study to estimate the burden of foodborne illness among nondeployed US Army active duty service members caused by five major pathogens. In chapter 3 of this dissertation, we used survey data to estimate the burden of AGI among nondeployed active duty US Army service members and identify risk factors associated with the occurrence of AGI among service members. In chapter 4, we described the severity of AGI among service members and determined the factors associated with service members seeking medical care and with submitting a stool sample. In chapter 5 we used the results of a survey to describe the laboratory practices of US Army clinical laboratories including specimen handling, reporting procedures, and testing procedures for *Campylobacter* spp., *E. coli* O157:H7 and other STEC, *Salmonella* spp., and *Shigella* spp.

In this chapter we use the results obtained from parts 1-3 to create pathogen-specific underreporting and underdiagnosis multipliers to estimate the true burden of disease caused by five major pathogens. Ultimately, the results of this study will be used to make recommendations for a DOD-wide foodborne illness surveillance system, identify strategies for foodborne illness intervention, and to modernize the current US Army food protection program (Chapter 7).

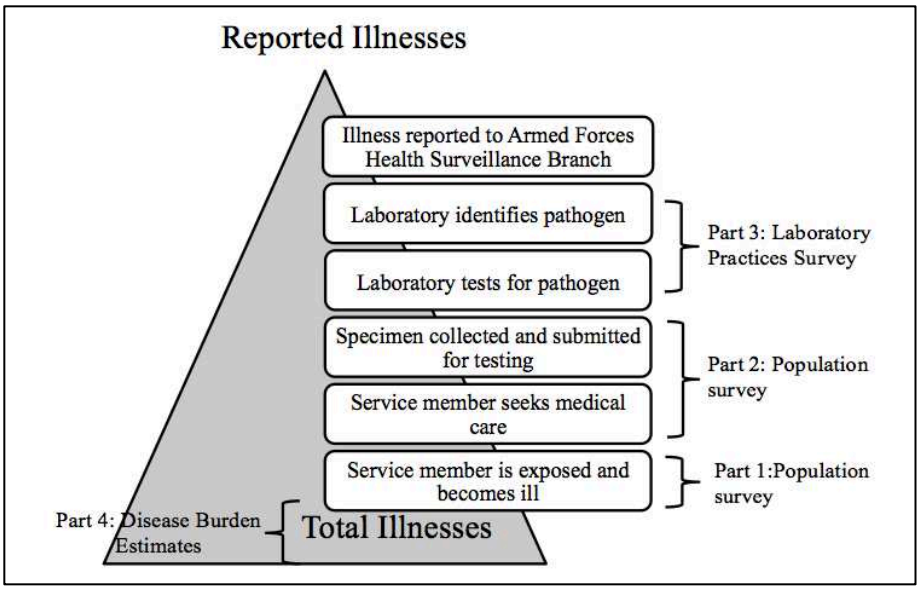


Figure 6.1. Burden of Illness pyramid illustrating the steps that must occur for an episode of illness in the active duty Army population to be reported through laboratory surveillance.

Methods

In 2011, the Centers for Disease Control and Prevention provided estimates of foodborne illnesses in the United States caused by 31 known major pathogens and unspecified agents.[6,9] We used a similar approach to estimate the annual number of foodborne illnesses among nondeployed active duty US Army service members for five major pathogens: *Campylobacter*, *Salmonella, Shigella,* non-O157 shiga-toxin-producing *Escherichia coli* (STEC), and *Norovirus*. We used two different model structures depending on the pathogen. For all bacterial pathogens, we used models that began with the laboratory-confirmed cases counts and then scaled them up through the use of a series of underreporting and underdiagnosis multipliers (model type 1). For *Norovirus*, the model began with the total 2014 nondeployed active duty US Army population and used acute gastrointestinal illness (AGI) incidence data to scale the population down to the estimated annual number of noroviral illnesses (model type 2).

For model type 1 we used a number of inputs, each with a measure of uncertainty. These inputs were derived from data obtained through surveys of the nondeployed active duty US Army population, US Army clinical laboratories (parts 1-3 of this project), and data from FoodNet and Scallan et al. (2011) [6]. We chose program evaluation and review technique (PERT) distributions for the majority of the model inputs. The PERT distribution is used exclusively for modeling expert estimates using the expert's minimum, most likely, and maximum estimates.[10] Like Scallan et al., we chose this distribution because it works well when you have many estimates and sources of uncertainty that need to be combined into one model.[6] The general structure for model type 1 is shown in Figure 6.1, followed by a general description of how each input was ascertained. Tables 6.1-6.4 display detailed model input data descriptions for each the bacterial pathogens.

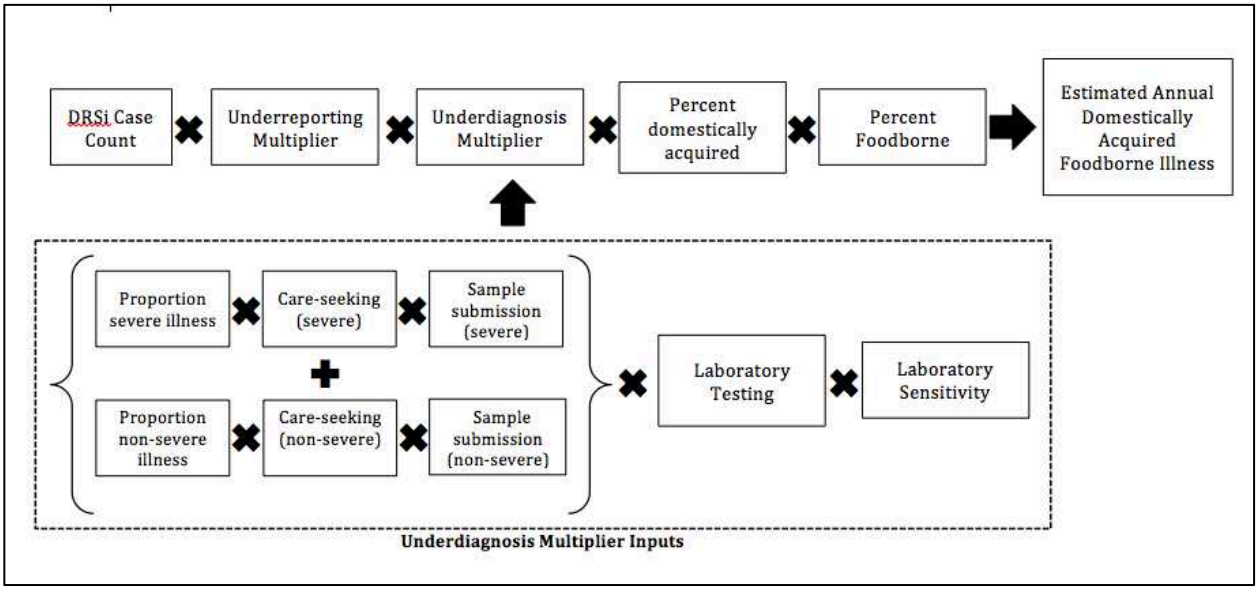


Figure 6.2. Basic model structure for model type 1.

DRSi Case Count

Laboratory-confirmed case counts were ascertained from the Disease Reporting System-internet (DRSi), which is a web-based reporting system for reportable medical events (RME). This system collects RME data for all individuals who receive care at military medical treatment

facilities (MTF) for all branches of service including active duty, reserve service members on active orders, dependents, and eligible retirees. The Army Institute of Public Health Epidemiology Service provided DRSi case counts of *Salmonella, Campylobacter,* STEC, and *Shigella* from 2010-2015 (Z. McCormic, S. Gosine [Zachary.d.mccormic.ctr@mail.mil], email, July 29, 2014). All non-active duty US Army cases and all deployed cases were excluded. All cases were culture-confirmed positive. The STEC cases were not identified specifically as STEC O157:H7, so it was assumed that they were all non-O157:H7 cases. Histograms were constructed for each of the four bacterial pathogens for entry into the model. A non-parametric distribution was used because of the flexibility associated with these types of distributions.[10] The data did not meet the assumptions of parametric count distributions, such as the Poisson distribution.[6,10] In particular, the annual case counts represented single count samples from distinct annual populations with different characteristics (not identically distributed).[6]

Underreporting multiplier

In Chapter 5, possible reasons for lab-confirmed diagnoses not being entered into the reportable events system were outlined. In a study by Jordan et al., they found that DRSi case capture for *Chlamydia trachomatis* was 79%.[11] A study by Evans et al. found that DRSi captured only 30% of Lyme disease cases.[12] Underreporting for the four bacterial pathogens of interest in this study likely falls somewhere between these two numbers, and a PERT distribution was constructed accordingly. The same underreporting PERT distribution was used for all four bacterial pathogens. Detailed information for the underreporting model inputs are displayed in Tables 6.1-6-4.

Underdiagnosis multiplier

The underdiagnosis multiplier is made up of eight different model inputs (Figure 6.2). PERT distributions were constructed for each of the eight inputs using the minimum, most likely, and maximum values.

Proportion severe illness and proportion non-severe illness

The data for proportion severe illness and non-severe illness was obtained from Scallan et al. (2011), Technical Appendix 3.[6] Depending on the pathogen, these data were based on FoodNet case-control studies or FoodNet surveillance data. Detailed information and model inputs for each pathogen are displayed in Tables 6.1-6-4.

Care seeking and stool specimen submission

To adjust for medical care seeking and specimen submission, results from the 2015 survey of nondeployed active duty US Army service members were used (Part 2, chapter 4 of this study). The proportion of respondents who reported acute diarrheal illness in the last thirty days and sought medical care and submitted a stool sample were calculated. People with more severe illness are more likely to seek care, and bloody diarrhea is an indicator of severe disease.[13] Therefore, medical care seeking and stool sample submission for bloody and non-bloody diarrhea as surrogates for medical care-seeking and stool sample submission for severe and mild cases of illness were used. These four inputs scale up mild and severe illness care-seekers to all mild and severe illnesses in the population, and scales up submitted samples from mild and severe illness care-seekers to all ill medical visits.[6] Detailed information and model inputs for each pathogen are displayed in Tables 6.1-6-4.

Laboratory Testing

The number of labs routinely testing for each of the 4 bacterial pathogens varied. PERT distributions for each of the pathogens based on the 2014 survey of US Army clinical laboratories were constructed. This factor scales tests performed up to samples submitted.[6] Detailed information and model inputs for each pathogen are displayed in Tables 6.1-6-4.

Laboratory Sensitivity

As described in Chapter 5, laboratory specimen handling and practices met most of the recommended guidelines. There were some practices that could result in decreased sensitivity, though quantification of the impact these variations in specimen handling and transport had on the number of positive samples was unable to be performed. The findings were similar to the 2004 survey of FoodNet laboratories, so the Scallan et al. (2011) data found in Technical Appendix 3 were used to construct the PERT distributions for this model input.[6,14] The data is based on studies of the laboratory test sensitivity rate of *Salmonella*. This model input scales up positive tests to true positive specimens.[6] Detailed information and model inputs for each pathogen are displayed in Tables 6.1-6.4.

Percent domestically acquired

This model input is a contractive factor to scale down case counts to those cases that are domestically acquired.[6] The data for this model input was obtained from Scallan et al (2011), Technical Appendix 3, and is based on FoodNet studies that looked at the number of infected individuals who reported travel outside of the United States within 7 days of illness to determine the number acquired during travel.[6] Those who reported no travel were considered to have domestically acquired foodborne illness. This data was not available for our population, the

assumption was made that our population is similar. Detailed information and model inputs for each pathogen are displayed in Tables 6.1-6-4.

Percent foodborne

This factor scales down overall illness counts to illness counts that are foodborne.[6] The data for this model input was obtained from Scallan et al. (2011) Technical Appendix 3, based on FoodNet case-control studies, outbreak data, and surveillance data, as outlined for each pathogen in Table 6.1-6-4.[6]

Table 6.1. Model inputs, data source, distribution, and distribution values for *Campylobacter.*

Pathogen: *Campylobacter* Model Input	Data Source	Distribution	Distribution Values
Reported Illnesses	Laboratory confirmed positive clinical specimens from non-deployed active duty Army service members reported by the Disease Reporting System-internet (DRSi), 2010-2015.	Histogram	2010, 2011, 2012, 2013, 2014, 2015 values: 15, 47, 52, 58, 52, 63
Underreporting	Reports that DRSi captures 30% of Lyme disease cases and 79% of *Chlamydia trachomatis* cases. Most likely value based on average.	PERT	min, most likely, max values: 1.21, 1.46, 1.70
Percent severe	Proportion of cases by site reporting bloody diarrhea from FoodNet case-control study of sporadic laboratory-confirmed *Campylobacter* infections.	PERT	min, most likely, max values: 0.36, 0.45, 0.52
Medical care seeking (severe)	Proportion (and 95% confidence interval (CI)) of survey respondents with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.14, 0.33, 0.52
Medical care seeking (mild)	Proportion (and 95%CI) of survey respondents with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.15, 0.19, 0.24
Specimen submission (severe)	Proportion (and 95% CI) of survey respondents who submitted a stool specimen among persons with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.10, 0.13, 0.35
Specimen submission (mild)	Proportion (and 95%CI) of survey respondents who submitted a stool specimen among persons with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.04, 0.12, 0.20
Laboratory testing	92.3% of clinical US Army clinical laboratories reported routinely testing stool samples for *Campylobacter* in the 2014 survey of Army clinical laboratories. Minimum value calculated based on if all other non-surveyed labs of same size do not routinely test. Max calculated based on if the one lab was the only lab that did not routinely test.	PERT	min, most likely, max values: 0.78, 0.92, 0.98
Test sensitivity	From the FoodNet study: they used a laboratory test sensitivity rate of 70% based on studies of *Salmonella*. They used a lower bound of 60% and an upper bound of 90%.	PERT	min, most likely, max values: 0.60, 0.70, 0.90
Proportion travel-related	From Scallan et al. (2011); proportion of FoodNet cases of *Campylobacter* who reported travel outside the US within 7 days of illness onset (2005-2008).	PERT	min, most likely, max values: 0.14, 0.20, 0.27
Proportion foodborne	From the FoodNet study: 1-total non-foodborne population attributable fractions from FoodNet case-control study.	PERT	min, most likely, max values: 0.73, 0.80, 0.86

Table 6.2. Model inputs, data source, distribution, and distribution values for *Salmonella enterica* non-typhoidal serotypes.

Pathogen: *Salmonella enterica* non-typhoidal serotypes			
Model Input	Data Source	Distribution	Distribution Values
Reported Illnesses	Laboratory confirmed positive clinical specimens from non-deployed active duty Army service members reported by the Disease Reporting System-internet (DRSi), 2010-2015.	Empirical	2010, 2011, 2012, 2013, 2014, 2015 values: 3, 38, 52, 45, 52, 50
Underreporting	Reports that DRSi captures 30% of Lyme disease cases and 79% of *Chlamydia trachomatis* cases. Most likely value based on average.	PERT	min, most likely, max values: 1.21, 1.46, 1.70
Percent severe	Proportion of cases by site reporting bloody diarrhea from FoodNet case-control study of sporadic laboratory-confirmed *Salmonella* infections.	PERT	min, most likely, max values: 0.35, 0.45, 0.71
Medical care seeking (severe)	Proportion (and 95% confidence interval (CI)) of survey respondents with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.14, 0.33, 0.52
Medical care seeking (mild)	Proportion (and 95%CI) of survey respondents with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.15, 0.19, 0.24
Specimen submission (severe)	Proportion (and 95% CI) of survey respondents who submitted a stool specimen among persons with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.10, 0.13, 0.35
Specimen submission (mild)	Proportion (and 95%CI) of survey respondents who submitted a stool specimen among persons with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.04, 0.12, 0.20
Laboratory testing	100% of clinical US Army clinical laboratories reported routinely testing stool samples for *Salmonella* in the 2014 survey of Army clinical laboratories. Based on expert opinion from US Army Laboratory personnel, assumed 94% and 97% min and most likely estimate.	PERT	min, most likely, max values: 0.94, 0.97, 1.00
Test sensitivity	From the FoodNet study: they used a laboratory test sensitivity rate of 70% based on studies of *Salmonella*. They used a lower bound of 60% and an upper bound of 90%.	PERT	min, most likely, max values: 0.60, 0.70, 0.90
Proportion travel-related	From Scallan et al. (2011); proportion of FoodNet cases of *Salmonella* who reported travel outside the US within 7 days of illness onset (2005-2008)	PERT	min, most likely, max values: 0.07, 0.11, 0.15
Proportion foodborne	From Scallan et al. (2011); 94% based on FoodNet case-control study of sporadic illness and on outbreaks reported to the CDC from 1996-2006.	PERT	min, most likely, max values: 0.91, 0.94, 0.96

Table 6.3. Model inputs, data source, distribution, and distribution values for *Shigella* spp.

Pathogen: *Shigella* spp.			
Model Input	Data Source	Distribution	Distribution Values
Reported Illnesses	Laboratory confirmed positive clinical specimens from non-deployed active duty Army service members reported by the Disease Reporting System-internet (DRSi), 2010-2015.	Empirical	2010, 2011, 2012, 2013, 2014, 2015 values: 2, 18, 8, 12, 13, 21
Underreporting	Reports that DRSi captures 30% of Lyme disease cases and 79% of *Chlamydia trachomatis* cases. Most likely value based on average.	PERT	min, most likely, max values: 1.21, 1.46, 1.70
Percent severe	Proportion of cases by site reporting bloody diarrhea from FoodNet case-control study of sporadic laboratory-confirmed *Salmonella* infections.	PERT	min, most likely, max values: 0.17, 0.35, 0.53
Medical care seeking (severe)	Proportion (and 95% confidence interval (CI)) of survey respondents with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.14, 0.33, 0.52
Medical care seeking (mild)	Proportion (and 95%CI) of survey respondents with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.15, 0.19, 0.24
Specimen submission (severe)	Proportion (and 95% CI) of survey respondents who submitted a stool specimen among persons with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.10, 0.13, 0.35
Specimen submission (mild)	Proportion (and 95%CI) of survey respondents who submitted a stool specimen among persons with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.04, 0.12, 0.20
Laboratory testing	100% of clinical US Army clinical laboratories reported routinely testing stool samples for *Shigella* in the 2014 survey of Army clinical laboratories. Based on expert opinion from US Army Laboratory personnel, assumed 94% and 97% min and most likely estimate.	PERT	min, most likely, max values: 0.94, 0.97, 1.00
Test sensitivity	From the FoodNet study: they used a laboratory test sensitivity rate of 70% based on studies of *Salmonella*. They used a lower bound of 60% and an upper bound of 90%.	PERT	min, most likely, max values: 0.60, 0.70, 0.90
Proportion travel-related	From Scallan et al. (2011); proportion of FoodNet cases of *Salmonella* who reported travel outside the US within 7 days of illness onset (2005-2008)	PERT	min, most likely, max values: 0.10, 0.15, 0.21
Proportion foodborne	From Scallan et al. (2011); 31% based on FoodNet enhanced surveillance.	PERT	min, most likely, max values: 0.23, 0.31, 0.40

Table 6.4. Model inputs, data source, distribution, and distribution values for non-O157 STEC.

Pathogen: Shiga-toxin producing *Escherichia coli,* non-O157			
Model Input	Data Source	Distribution	Distribution Values
Reported Illnesses	Laboratory confirmed positive clinical specimens from non-deployed active duty Army service members reported by the Disease Reporting System-internet (DRSi), 2010-2015.	Empirical	2010, 2011, 2012, 2013, 2014, 2015 values: 0, 0, 0, 1, 0, 3
Underreporting	Reports that DRSi captures 30% of Lyme disease cases and 79% of *Chlamydia trachomatis* cases. Most likely value based on average.	PERT	min, most likely, max values: 1.21, 1.46, 1.70
Percent severe	Proportion of cases by site reporting bloody diarrhea from FoodNet case-control study of sporadic laboratory-confirmed *Salmonella* infections.	PERT	min, most likely, max values: 0.44, 0.54, 0.64
Medical care seeking (severe)	Proportion (and 95% confidence interval (CI)) of survey respondents with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.14, 0.33, 0.52
Medical care seeking (mild)	Proportion (and 95%CI) of survey respondents with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.15, 0.19, 0.24
Specimen submission (severe)	Proportion (and 95% CI) of survey respondents who submitted a stool specimen among persons with bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.10, 0.13, 0.35
Specimen submission (mild)	Proportion (and 95%CI) of survey respondents who submitted a stool specimen among persons with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.04, 0.12, 0.20
Laboratory testing	84.6% of clinical US Army clinical laboratories reported routinely testing stool samples for SEC in the 2014 survey of Army clinical laboratories. Max value based on if the two labs not routinely testing were the only two out of 41. Minimum value based on if all laboratories of the same size did not test.	PERT	min, most likely, max values: 0.66, 0.85, 0.95
Test sensitivity	From the FoodNet study: they used a laboratory test sensitivity rate of 70% based on studies of *Salmonella*. They used a lower bound of 60% and an upper bound of 90%.	PERT	min, most likely, max values: 0.60, 0.70, 0.90
Proportion travel-related	From Scallan et al. (2011); proportion of FoodNet cases of non-O157 STEC who reported travel outside the US within 7 days of illness onset (2005-2008)	PERT	min, most likely, max values: 0.13, 0.18, 0.25
Proportion foodborne	From Scallan et al. (2011); proportion of non-O157 STEC outbreak-associated illnesses due to foodborne transmission from outbreaks reported to CDC (1990-2008)	PERT	min, most likely, max values: 0.75, 0.82, 0.87

Figure 6.3 illustrates the model structure for *Norovirus*. The annual incidence of acute gastrointestinal illness (AGI) among nondeployed US Army service members was estimated in chapter 3. The data showed variation in incidence among geographical US Army medical regions. Estimates of the region-level incidence for each of the five different regions were calculated. Using ModelRisk 5 (VOSE Software), normal distributions of AGI incidence from each site were overlaid using the point estimate and standard error as inputs to the distribution. The distributions were averaged for entry into the model as the annual incidence of AGI. The remaining model inputs and data sources are described in detail in Table 6.5.

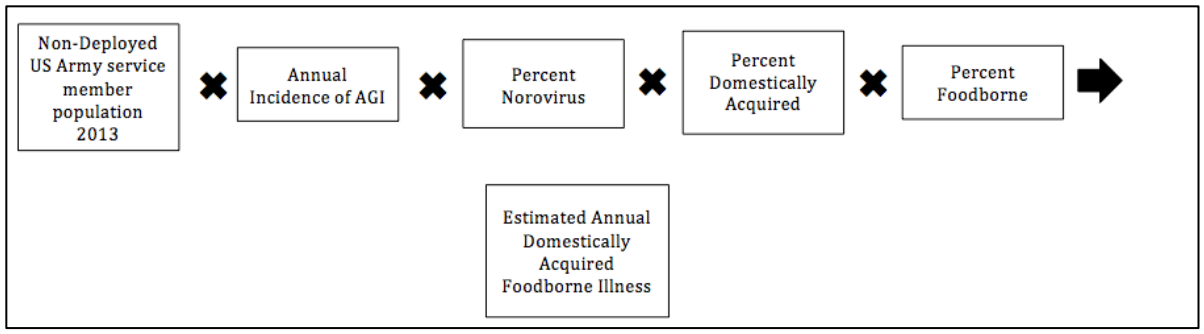


Figure 6.3. Basic model structure for *Norovirus*.

Table 6.5. Model inputs, data source, distribution, and distribution values for *Norovirus*.

Pathogen: Norovirus Model Input	Data Source	Distribution	Distribution Values
Population at risk	Estimated 2013 non deployed active duty US Army service member population	-	528,070
Norovirus fraction	From Scallan et al. (2011); the proportion of all acute gastroenteritis illnesses was estimated from published studies of the proportion of acute gastroenteritis illnesses due to Norovirus in the Netherlands, England and Wales, and Australia. The proportions from these studies were used to define min, most likely, and maximum values.	PERT	min, most likely, max values: 0.06, 0.11, 0.2
Norovirus illnesses	Norovirus fraction (above) applied to the estimated number of acute gastroenteritis illness (below)		
Acute Gastroenteritis Illnesses	Estimated rate per person year by US Army medical region using data from the 2015 survey of non-deployed active duty US Army service members. We assumed that site estimates were normally distributed with standard deviations equal to survey standard errors.	Normal Distributions	By US Army medial region: 3.3, 2.16, 2.16, 2.32, 2.1
Proportion travel-related	From Scallan et al. (2011); assumed to be low	PERT	0.00, 0.00, 0.02
Proportion foodborne	From Scallan et al. (2011); based on 179 Norovirus outbreaks examined by CDC from 2000-2005. Of 13,955 person ill, 3,628 (26%) were in foodborne outbreaks.	PERT	min, most likely, max values: 0.19, 0.26, 0.35
Specimen submission (mild)	Proportion (and 95%CI) of survey respondents who submitted a stool specimen among persons with a non-bloody diarrhea who sought medical care from the 2015 survey of nondeployed US Army service members	PERT	min, most likely, max values: 0.04, 0.12, 0.20

For both model types 1 and 2, once all model input distributions were constructed, Monte Carlo simulation was performed using ModelRisk 5 (Vose Software, 2013, Ghent, Belgium) with 100,000 iterations for each estimation. The results of each simulation were reported as a mean and range between the 5th and 95th percentile. All statistical analysis was performed using ModelRisk 5 (Vose Software, 2013, Ghent, Belgium).

Results

Distribution inputs and model outputs for each pathogen are displayed in Appendix 6-A. Estimated annual number of episodes of domestically acquired foodborne illness among nondeployed active duty Army service members caused by *Campylobacter jejuni*, *Shigella* spp., *Salmonella enterica* non-typhoidal, STEC non-O157 and *Norovirus* are presented in Table 6.6. Due to differences in care-seeking and stool sample submission behaviors among nondeployed active duty Army service members when compared to the general US population, our under-diagnosis multipliers were much higher for the four bacterial pathogens than in the Scallan et al. 2011 study.[6] Estimates are that these five major pathogens caused 158,478 (5%-95% range: 105,630-220,259) illnesses, of which 156,241 (5%-95% range: 103,618-217, 753) were domestically acquired, and 45,608 (5%-95% range: 30,338-64,193) were foodborne. Out of these pathogens, *Norovirus* (38,924, 85%) and *Campylobacter* (3,658, 8%) caused the most illness in this population.

Table 6.6. Estimated annual number of episodes of domestically acquired foodborne illnesses caused by 5 major pathogens among nondeployed active duty US Army service members.

		Multipliers				
Pathogen	Laboratory Confirmed	Under-reporting	Under-diagnosis	Travel Related, %	Foodborne, %	Estimated domestically acquired foodborne illnesses, mean (5%-95% range)
Bacteria						
Campylobacter jejuni	56	1.5	70.1	20	80	3,658 (2,110-5,802)
Shigella spp.	14	1.5	70	15	31	360 (111-727)
Salmonella enterica non-typhoidal	32	1.5	63.7	11	93.8	2,493 (862-4,793)
STEC non-O157	3	1.5	70.8	18	82	173 (87-286)
Subtotal						6,684 (4,221-9,745)
Virus						
Norovirus	NA	NA	NA	<1	26.3	38,924 (23,972-57,433)
Total						45,608 (30,338-64,193)

Discussion

To our knowledge, this is the first time the burden of foodborne illness caused by specific bacterial and viral pathogens has been estimated in the nondeployed active duty US Army population. Our study shows that underdiagnosis multipliers are higher in this population than in the general US population. In addition, DRSi data is collected passively, so underreporting multipliers were required for the four bacterial pathogens of interest. This should be considered in future burden of illness calculations for the US Army population. Similar to other studies, of the five pathogens assessed, *Norovirus* was the leading cause of foodborne illness in our population.[15] In the present study, of the four bacterial pathogens, *Campylobacter* and *Salmonella* caused the most illnesses. This finding is similar to studies in England, Wales, Australia, and the United States.[6,15,16] The estimated number of illnesses caused by these 5 major pathogens is alarming. Overall, these 5 pathogens cause an estimated 8,637 illness per 100,000 population (range: 5,745-12,157 per 100,000). The illnesses caused by these pathogens can vary in duration, severity, and post-infection complications (Table 6.7), and can minimize mission readiness if numerous individuals in a unit are affected, especially in outbreak situations.

Table 6.7. List of pathogens, incubation period, length of illness, clinical symptoms, and possible complications.

Pathogen	Incubation Period	Length of Illness	Clinical Symptoms	Post-infection Complications
Bacteria				
Campylobacter jejuni	2-5 days	2-10 days	Diarrhea (often bloody), abdominal pain, fever	Guillain-Barre syndrome, reactive arthritis
Shigella spp.	1-2 days	5-7 days	Diarrhea (often bloody), often accompained by fever and abdominal cramps	Post-infection arthritis
Salmonella enterica non-typhoidal	12-72 hours	4-7 days	Diarrhea, often with fever and abdominal cramps	Reactive arthritis
STEC non-O157	1-10 days	5-10 days	Diarrhea (often bloody), abdominal cramps (often severe), little or no fever	Hemolytic Uremic Syndrome (HUS)
Virus				
Norovirus	12-48 hours	1-3 days	Diarrhea, vomiting, nausea, abdominal cramps, low-grade fever	Rare complications due to severe dehydration

Limitations

The DRSi database system only captures individuals seeking care at military medical treatment facilities. If an ill service member sought care at a civilian location, DRSi will not capture the case. It is possible that cases of illness caused by the four bacterial pathogens were missed for this reason, resulting in lower burden estimates, which were not accounted for in the models. The data for this study came from a number of sources, including our own surveys, and from FoodNet surveillance and outbreak data. Limitations of our population and laboratory surveys are discussed in chapters 3 and 5, respectively. Limitations of the FoodNet data are discussed in the 2011 Scallan et al. burden of illness study.[6] Using the FoodNet data for the US Army population may have resulted in inaccurate estimates. However, the US Army does not have an active surveillance system in place (like FoodNet), so using the FoodNet data was the best option to provide estimates. One input in particular, percent domestically acquired, may have particularly affected the outcomes. The PERT distribution for this model input came directly from FoodNet studies of cases that reported travel outside the US within 7 days of illness onset.[6] There was no access to patient records where travel history may (or may not) have been recorded. The US Army population is located worldwide, and may be more likely than the general US population to travel to countries where risk of foodborne disease is higher. They also may live in overseas locations where the risk of foodborne disease is higher or even lower. That means the actual percent domestically acquired input for the US Army population could either be higher or lower than the FoodNet estimates. Regardless of these limitations, this data serves as an important baseline of the estimate of foodborne illness caused by five major pathogens. This study also shows that the military population is unique with respect to care-seeking for AGI, stool sample submission, and exposure risk, so calculating military-specific underdiagnosis and

underreporting multipliers to make foodborne illness burden estimates for the military population is a worthwhile undertaking.

There are more than 200 known diseases transmitted through food.[5] Foodborne illness can be attributed to viruses, bacteria, parasites, toxins, metals, and prions.[5] Estimating the burden of foodborne illness for all causes of foodborne illness was beyond the scope of this present study. Future studies to estimate the burden of illness for all causes of foodborne illness would be helpful to get a better idea of the total burden in the US Army population. Before this lofty undertaking is performed, however, limitations of the current study should be addressed so the most accurate data is produced. Chapter 7 contains recommendations to address many of the limitations outlined throughout the preceding chapters. Recommendations include: a Department of Defense (DoD)-sponsored survey of active duty service members across all branches of the military; a DoD-wide active laboratory-based foodborne illness surveillance system that can monitor trends in the burden of specific foodborne illnesses in the military over time, detect foodborne illness outbreaks in the military, and attribute the burden of foodborne illness in the military to specific foods and settings; cohort and case-control studies to provide military-specific data for disease burden model inputs; and specific foodborne illness interventions to modernize the current US Army food protection program aimed at preventing foodborne illness among members of the military.

References

1. United States Army Medical Service. *Preventive medicine in World War II.* Washington: Office of the Surgeon General, Dept. of the Army; 1955.

2. Armed Forces Health Surveillance Center. Gastrointestinal infections, active component, U.S. Armed Forces, 2002-2012. *MSMR.* 2013;20(10):7-11.

3. Sanders JW, Putnam SD, Riddle MS, et al. The epidemiology of self-reported diarrhea in operations Iraqi freedom and enduring freedom. *Diagnostic microbiology and infectious disease.* 2004;50(2):89-93.

4. M. Adams YM. Basic food safety for health workers. *Geneva: World Health Organization.* 1999:116.

5. Mead PS, Slutsker L, Dietz V, et al. Food-related illness and death in the United States. *Emerg Infect Dis.* 1999;5(5):607-625.

6. Scallan E, Hoekstra R, Angulo F, et al. Foodborne illness acquired in the United States--major pathogens. *Emerging infectious diseases.* 2011;17(1):7-15.

7. Roy SL, Scallan E, Beach MJ. The rate of acute gastrointestinal illness in developed countries. *Journal of water and health.* 2006;4 Suppl 2:31-69.

8. Armed Forces Health Surveillance Center. *Armed Forces Reportable Medical Events Guidelines and Case Definitions.* 2012. https://www.afhsc.mil/documents/pubs/documents/TriService_CaseDefDocs/ArmedForcesGuidlinesFinal14Mar12.pdf. Accessed January 2, 2016.

9. Scallan E, Griffin PM, Angulo FJ, Tauxe RV, Hoekstra RM. Foodborne illness acquired in the United States--unspecified agents. *Emerg Infect Dis.* 2011;17(1):16-22.

10. Hauwemeiren MV, Vose D, Bossche SV. A Compendium of Distributions second ed: Vose Software, Ghent, Belgium; 2012: http://www.vosesoftware.com. Accessed February 5, 2016.

11. Jordan N, Clemmons N, Nowak G, Gaydos J. Estimating the Burden of Chlamydia Trachomatis in the US Army - Use of Three Passive Surveillance Systems and Capture-Recapture Methods to Identify Incident Cases. *Poster session presented at the 2014 STD Prevention Conference.* 2014.

12. Evans RI, Salman M, Lappin M, Hayne S, Peel J. *One health in the U.S. military : a review of existing systems and recommendations for the future*, Colorado State University. Libraries; 2014.

13. Scallan E, Jones TF, Cronquist A, et al. Factors associated with seeking medical care and submitting a stool sample in estimating the burden of foodborne illness. *Foodborne pathogens and disease.* 2006;3(4):432-438.

14. Voetsch AC, Angulo FJ, Rabatsky-Ehr T, et al. Laboratory practices for stool-specimen culture for bacterial pathogens, including Escherichia coli O157:H7, in the FoodNet sites, 1995-2000. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America.* 2004;38 Suppl 3:S190-197.

15. Hall G, Kirk MD, Becker N, et al. Estimating foodborne gastroenteritis, Australia. *Emerg Infect Dis.* 2005;11(8):1257-1264.

16. Adak GK, Meakins SM, Yip H, Lopman BA, O'Brien SJ. Disease risks from foods, England and Wales, 1996-2000. *Emerg Infect Dis.* 2005;11(3):365-372.

Chapter 7 : An Integrated and Comprehensive Surveillance Foodborne Illness System For the US Military: Recommendations

Introduction

Foodborne disease surveillance systems provide critical information for the development and evaluation of interventions aimed at preventing foodborne disease.[1] The Army Public Health Center (Provisional) (APHC) provides food safety and defense for the United States Army and other Department of Defense (DoD) customers.[2] As described in previous chapters of this dissertation, the US Army Food Protection Program is a robust program that assesses food safety and defense of food items from production to consumption. However, there is no specific foodborne disease surveillance system in the DoD to evaluate the effectiveness of the US Army Food Protection Program's intervention strategies, or to aid in developing more modern intervention strategies. In chapters 3-6 of this dissertation, it was shown that acute gastrointestinal illness (AGI) and foodborne disease are important public health problems in the nondeployed US Army active duty population. Care-seeking and stool sample submission practices are different among service members when compared to the general US population. In addition, the DoD's globally dispersed and unique service member population has risk factors for AGI that differ from the general US population. A DoD foodborne disease surveillance system would address a number of the limitations identified in the previous chapters, and allow for more accurate foodborne disease burden estimates in the future. Foodborne disease surveillance is essential to efforts to measure, control, and prevent foodborne disease among DoD service members.[1] Once implemented, a foodborne disease surveillance system would, for the first time, allow us to objectively evaluate the current US Army Food Protection Program.

This chapter discusses the advantages, disadvantages, and relevance of different foodborne disease surveillance approaches in general, and makes a recommendation for a DoD-wide comprehensive and integrated foodborne disease surveillance system that incorporates collaboration between the APHC (Provisional), the Armed Forces Health Surveillance Branch (AFHSB), the Army Medical Department (AMEDD), other service branch medical departments and personnel, and outside agencies such as the Centers for Disease Control and Prevention (CDC), United States Department of Agriculture (USDA), and the Food and Drug Administration (FDA). A foodborne disease surveillance system for the DoD is integral to achieving the ultimate goal of reducing the burden of foodborne disease, which can have serious consequences in the DoD service member population.

Objectives for Foodborne Disease Surveillance System

According to CDC, surveillance is the systematic ongoing collection, analysis, interpretation and dissemination for public health action.[3] A foodborne disease surveillance system should meet a number of objectives. Information on incidence, trends, and high-risk populations can assist policy-makers in prioritizing, monitoring, and evaluating foodborne disease prevention strategies.[1] Early detection of foodborne outbreaks and their source allows for prompt removal of contaminated products from consumer markets, therefore preventing further spread. [1] In addition, a system that allows epidemiologic investigations to identify gaps in knowledge and identification of new hazards or unsafe practices can lead to the development of new prevention strategies.[1] Finally, there must be a system in place that allows monitoring and evaluation of the effectiveness of implemented prevention strategies.

Methods for Foodborne Disease Surveillance Systems

General foodborne disease surveillance system methods include syndromic surveillance, laboratory-based surveillance, and integrated food chain surveillance.[1] A syndromic surveillance system tracks clinical symptoms common in foodborne disease such as acute gastroenteritis.[1] Syndromic surveillance systems can be useful to identify large localized outbreaks, but are not specific since they do not involve definitive diagnosis of the illness.[1] A laboratory-based surveillance system relies on laboratory diagnosis of cases and provides higher quality data than a syndromic surveillance system because it allows for identification of the pathogen responsible for clinical symptoms.[1] A laboratory-based surveillance system, however, underestimates the true number of cases of foodborne illness in the community because in order to detect a positive sample, the ill person must seek care, an appropriate sample (usually stool) must be submitted, the sample must be tested for the pathogen using proper techniques, and results must be reported. Integrated food chain surveillance includes data collection from both animals and food.[1] This method of surveillance facilitates investigation of the source of human illness and guides estimates of the burden of foodborne disease due to specific pathogen-commodity combinations, for example, *Campylobacter* and raw poultry.[1]

Approaches for Foodborne Disease Surveillance System

There are a number of approaches to meet the objectives of foodborne disease surveillance. These approaches include: routine surveillance systems for notifiable diseases, laboratory subtyping of pathogens, sentinel site surveillance systems, hospital discharge records and death registration, foodborne disease complaint systems, and outbreak reports.[1] These approaches can be used alone or in combination, and some approaches meet specific surveillance objectives better than others. A routine surveillance system for notifiable disease can provide

data that describe disease trends, high-risk populations, and how intervention strategies impact disease burden.[1] This type of surveillance also can identify potential foodborne illness outbreaks. Laboratory subtyping (described in more detail in Chapter 2, PulseNet) can detect outbreaks caused by common strains of bacteria, and can recognize very small or geographically dispersed outbreaks.[1] A sentinel site surveillance system can provide useful data when obtaining national data from every laboratory is not feasible. One disadvantage of a sentinel site surveillance system is that it can only detect foodborne disease outbreaks that occur within the surveillance area.[1] Death registration and hospital discharge records can help to identify cases of foodborne disease that result in hospitalization or death.[1] Surveillance for these severe outcomes is important because it can help to identify the impact these infections have on a population, and in turn help direct intervention policies.[1] Foodborne disease complaint systems collect reports from the public about possible foodborne illnesses. Complaints are recorded in a complaint log, which are reviewed to assess trends that might identify clusters of foodborne disease.[1] Complaint systems do not rely on laboratory diagnosis or medical examination so they can detect outbreaks earlier, but the lack of detailed exposure and diagnostic information limits the ability of this system to link related cases and detect dispersed and low-level outbreaks.[1] Finally, reports of outbreaks rely on outbreak surveillance data.[1] Outbreak surveillance can provide information on foods most often associated with illness, associate specific pathogens with specific foods, and identify risk factors for outbreaks.[1] Under this system, foodborne disease outbreaks may go unrecognized and be classified as sporadic.[1] The advantages and disadvantages of each of these surveillance approaches are summarized in Table 7.1.

Table 7.1. Advantages and disadvantages of different surveillance approaches.

Foodborne Disease Surveillance Approach	Advantages	Disadvantages
Routine notifiable disease surveillance	• describes disease trends • identifies high risk populations • describes how interventions impact disease burden • identifies potential outbreaks	• only captures infections in persons who seek medical attention and receive a diagnosis • misses pathogens not routinely tested • reporting delays and under-notification
Laboratory subtyping of pathogens	• detects outbreaks caused by common bacterial strains • identifies very small or geographically dispersed outbreaks	• requires affected individuals to seek medical care, have a positive diagnosis, and positive isolate submitted to PulseNet • relies on culture, culture-independent tested positive samples not captured
Sentinel site surveillance system	• provides useful data when obtaining data from all laboratories not feasible	• only detects outbreaks occurring within the surveillance area
Hospital discharge and death records	• identifies the impact of severe foodborne disease	• coverage limited to those admitted to hospital or death medically certified • must be coded specifically for foodborne disease as cause of illness or death
Foodborne disease complaint system	• can identify clusters of foodborne disease • do not depend on medical provider contact, can detect outbreaks earlier	• lack of detailed exposure information • no agent-specific diagnosis • limited ability to link related cases and detect dispersed or low-level outbreaks
Outbreak reports	• provides information on foods most frequently associated with illness and the association of specific pathogens with specific foods	• under-reporting • outbreaks may go unrecognized

A Foodborne Disease Surveillance System for the DoD, DoDFoodNet:

To meet the surveillance objectives outlined above, we recommend the implementation of the United States Department of Defense Foodborne Disease Integrated Surveillance Network (DoDFoodNet). Named after CDC's primary foodborne illness surveillance system, FoodNet, DoDFoodNet should be a comprehensive and integrated foodborne disease surveillance system that uses multiple surveillance approaches. DoDFoodNet will allow the Army Public Health Center (Provisional) to more accurately estimate the number of foodborne illnesses in the US military population, monitor trends in incidence of specific foodborne illnesses over time, attribute illnesses to specific foods and settings, detect outbreaks in the military population, and disseminate the information to DoD stakeholders.[4] DoDFoodNet will integrate both existing and new military and civilian data streams, and incorporate numerous surveillance approaches to provide comprehensive and integrated food chain surveillance for the DoD. Figure 1 is a schematic outline that summarizes the proposed DoDFoodNet structure, and how the

surveillance streams will be integrated to meet the objectives of a DoD-wide foodborne illness surveillance system.

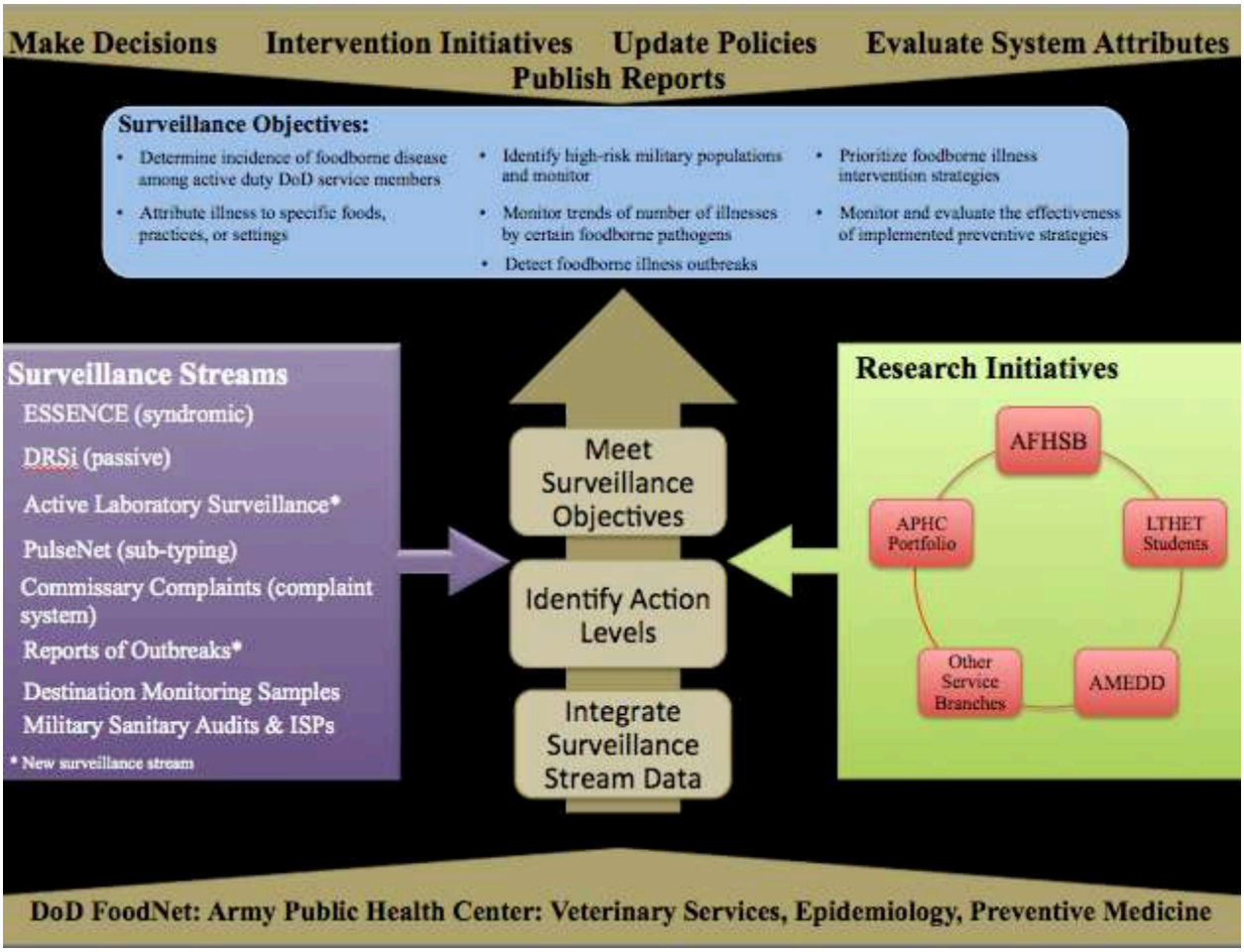


Figure 7.1. DoDFoodNet proposal in graphic form.

Surveillance Data Streams

Though the US military does not have a formal foodborne disease surveillance system in place, it does have a number of non-foodborne illness specific data streams that can be integrated and modified to meet surveillance objectives. Existing surveillance streams that will be integrated, in a comprehensive and synthesized fashion, include the Defense Health Services Systems (DHSS) Electronic Surveillance System for Early Notification of Community-Based Epidemics (ESSENCE), Disease Reporting System internet (DRSi), the commissary complaint reporting system, the US Army Destination Monitoring System, the US Army Veterinary

Services military sanitary audit and installation support plan inspection program, and PulseNet. New surveillance streams to be integrated include an active DoD laboratory surveillance network, and foodborne illness/outbreak reporting system. These surveillance streams use different approaches for foodborne disease surveillance and can be used together in a comprehensive and integrated foodborne disease surveillance system.

ESSENCE is a syndromic surveillance system for capturing and organizing clinical data from the Military Health System (MHS) into disease syndrome groupings intended to promote early detection of disease outbreaks.[5] ESSENCE monitors and provides alerts for rapid or unusual increases in the occurrence of infectious diseases and biological outbreaks.[5] Once baseline disease levels have been established, threshold levels for foodborne illness symptoms can be set to alert DoD public health officials of possible outbreaks.

DRSi is a web-based reporting system for Reportable Medical Events (RME). All RMEs are reviewed by hospital preventive medicine staff before they are converted to Medical Event Reports and formally entered into the DRSi system.[6] Data in DRSi can be used to track disease outbreaks and perform RME trend analysis at the installation or regional level.

The commissary complaint reporting system allows customers to submit complaints about food items procured from the installation commissary. This information could be used as an early detection system for placing retail food items on medical hold and to drive destination monitoring sampling plans, which can increase the overall sensitivity of the surveillance system.

The Destination Monitoring System tests samples of food items (usually potentially hazardous foods) collected from commissaries, military exchange activities, MWR activities, and prime vendor/troop feeding facilities. Isolates from positive samples are submitted to PulseNet for DNA fingerprinting via pulsed field gel electrophoresis (PFGE). Together, these systems

allow for the early detection of outbreaks and can connect seemingly isolated outbreaks. The military sanitary audit program and installation support program can help to identify critical production, processing, storage, and food handling concerns to allow for early intervention that can prevent foodborne illness.

New surveillance streams that we recommend include an active laboratory-based surveillance system and an illness/outbreak reporting system that can help improve early detection of outbreaks. We recommend an active laboratory-based surveillance system that can conduct active sentinel surveillance for the following pathogens: *Cryptosporidium, Cyclospora, Listeria, Salmonella, Shigella,* Shiga toxin-producing *Escherichia coli* (STEC) O157 and non-O157, *Vibrio*, and *Yersinia*. These pathogens are the same pathogens tracked by CDC's FoodNet. Pathogens for laboratory-based surveillance usually are chosen based on our ability to detect them, prevalence, severity of illness, and ability to prevent infection.[7] This recommended list of pathogens could change as needed by consensus of the AFHSB personnel. The active laboratory-based surveillance system will be under the AFHSB control. Personnel from the AFHSB will regularly contact geographically dispersed US Army clinical laboratories to record reports of infections caused by the listed pathogens and diagnosed in patients with access to care at the corresponding medical treatment facility. Clinical laboratories from nine Army Medical Centers (AMC) will be included as sentinel sites: Madigan Army Medical Center, William Beaumont AMC, Darnall AMC, Eisenhower AMC, Womack AMC, Walter Reed AMC, Tripler AMC, Landstuhl Regional Medical Center, and Brian Allgood Army Community Hospital (Figure 7.2). These sentinel sites provide coverage to approximately 15% of the active duty US military population, similar to the coverage by sentinel labs in FoodNet. A communicable disease report form (similar to that in Appendix A-7) will be completed for each case and include

name, age, gender, race, ethnicity, address, phone number, provider contact information, and laboratory test/specimen information.[8] These data can be used to determine trends in infections over time, detect outbreaks, and instigate individual case investigations for the source and possible spread.[7] This system will complement the DRSi surveillance system, which passively collects case information on RMEs and historically has been shown to underreport cases.[9,10] The active laboratory-based surveillance will decrease underreporting and allow the APHC (Provisional) to focus on specific diseases of interest and make more accurate estimates of the overall burden of foodborne disease caused by specific pathogens.

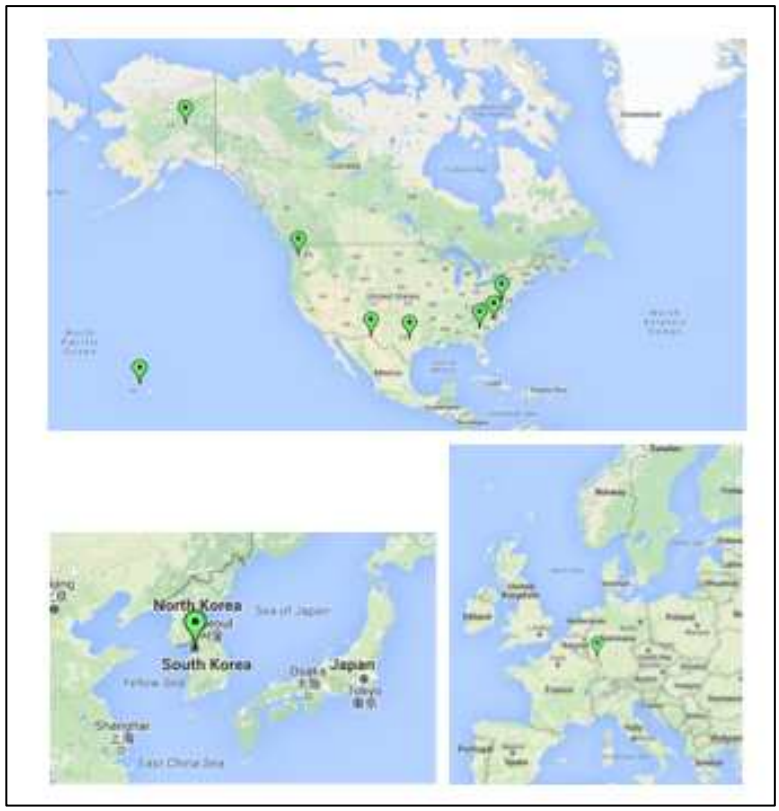


Figure 7.2. Map of suggested clinical laboratories for active sentinel site surveillance through DoDFoodNet.

Another new surveillance stream to integrate into DoDFoodNet is a foodborne illness and/or outbreak reporting system. We propose an online system that is easily accessed by DoD service members and their families where they can report illness they think might be caused by

something they ate. The system will allow for input of food and water consumption history, symptoms experienced, other possible routes of exposures, etc.[11] If clusters of individuals with similar signs and food histories are detected, this can prompt an epidemiological investigation by preventive medicine and/or APHC (Provisional) staff. In addition, paper complaint forms will be available for individuals who seek medical care for acute gastrointestinal illness. These forms will have the same information as the online system, but will be available upon check-in at military treatment facilities for patients to fill out while waiting for their appointment. Appendix A-7 has an example foodborne illness complaint form currently used by CDC.[11]

Research Directives

One of the greatest benefits of a formal foodborne illness surveillance system for the DoD is that it opens lines of communication between veterinary services, medical services, preventive medicine services, the AFHSB, and all branches of the military. This allows for leveraging of existing assets to work together to streamline system processes. One group of assets to integrate into this system is Long Term Health Education Training (LTHET) participants. Army Medical Department (AMEDD) officers have the opportunity to be selected for LTHET. LTHET allows officers from the Nurse Corps, Medical Service Corps, and Veterinary Corps to participate in advanced educational training in a specialty. One of the specialties offered by LTHET is a Master's degree or PhD in public health/epidemiology. Students generally are able to choose the subject of their thesis/dissertation, and there is no requirement that the results of their study are directly related to their work in the Army. DoDFoodNet will leverage these assets by providing research topics to LTHET students that meet the specific goals of foodborne disease surveillance. The APHC (Provisional) will maintain a list of current research topics that are updated annually and disseminated to LTHET

students pursuing a Master's or PhD in Public Health. APHC (Provisional) sponsors will help guide the students' research and serve as points of contact throughout the educational process. DoDFoodNet also will provide suggested topics to the Uniformed Services University of Health Sciences (USUHS), which trains many LTHET students.

In the previous chapters of this dissertation, we identified areas that need further research. One of the limitations of the current project was the survey was disseminated only to active duty nondeployed Army service members. Gaining DoD approval for a DoD-wide survey with dissemination similar to the DoD Survey of Health Related Behaviors would improve our estimates and allow for extrapolation to the entire DoD service member population.[12] Periodic surveys can be used to make more accurate estimates of the number of service members who experience diarrheal illness, the severity of their illness, frequency of medical care seeking, and stool sample submission. Additional questions about food consumption, food procurement, and food-handling practices also should be included in future surveys. Another population that warrants specific investigation is the deployed population. Similar surveys should be disseminated to deployed service members to identify their specific AGI risk factors and care seeking behaviors, as well as specific foodborne illness intervention strategies for this unique subset of the military population. In addition, surveys should be disseminated to deployed clinical laboratory assets to assess their capabilities and general specimen handling and testing practices. One limitation of using population surveys to estimate the burden of AGI is their retrospective nature (discussed in Chapter 2). We recommend that the DoD also conduct prospective studies to attain a potentially more accurate estimate of AGI burden. Studies would focus on specific cohorts of individuals based on demographics and geographic location and track daily self-reported AGI and medical care seeking behaviors. For example, in chapter 3, we

identified an association between AGI and living in the Europe region and being in the 26-30 year old age group. Conducting prospective studies comparing these cohorts of individuals to other cohorts would help to determine specific risk factors and interventions for AGI in these individuals. Case-control studies also could be implemented to identify risk factors for AGI.

Reporting Outputs

DoDFoodNet will provide data for a number of reporting outputs for dissemination throughout the DoD. We have identified baseline estimates of foodborne illness among nondeployed active duty service members for 5 major pathogens. As part of the Healthy People 2020 initiative, the US Department of Health and Human Services Office of Disease Prevention and Health Promotion outlined food safety objectives to be met by 2020.[13] A snapshot of these objectives are in Appendix B-7.[13] The APHC (Provisional) Veterinary Services Portfolio, in collaboration with other applicable APHC Portfolio representatives should set food safety goals that correspond with the 2020 initiative. The APHC (Provisional), in conjunction with AFHSB, also should create annual DoDFoodNet surveillance reports showing trends in foodborne illness data, and annual progress reports showing how the DoD is contributing to the 2020 initiative. As more research is conducted, results should be published in peer-reviewed journals. Outbreak reporting and suggestions for future interventions should be continually updated.

Evaluation of the Surveillance System

Any time a surveillance system is developed, there also must be a way to evaluate the success of the system. According to CDC, a surveillance system should have, and be evaluated on the following attributes: simplicity, flexibility, data quality, acceptability, sensitivity, predictive value positive, representativeness, timeliness, and stability.[14] Below, we provide an initial assessment of these attributes specifically for DoDFoodNet.

Simplicity

A foodborne disease surveillance system should be as simple as possible while still meeting the outlined objectives.[14] DoDFoodNet will accomplish this by leveraging current assets including clinical laboratories, APHC (Provisional) staff, veterinary personnel, preventive medicine personnel, AFHSB personnel, and Long Term Health and Education Training (LTHET) students to create an integrated surveillance system that can meet all surveillance objectives. In addition, APHC (Provisional) has direct access to ESSENCE and DRSi data. While preparing the current manuscript, we had difficulty accessing data from other branches of the service in a timely manner (or at all), so using easily accessed data sources increases simplicity.

Flexibility

DoDFoodNet can adapt to changing information needs or operating conditions with little additional time, personnel, or allocated funds.[14] The system will be able to accommodate changes in clinical case definitions, changes in testing technology (such as culture-independent testing methods), and variations in man-power that come with PCS-moves and changing personnel. Most of the integrated surveillance streams have been in existence for many years, so there already are allocated personnel and operational funds available. Further assessment as to whether additional funding and manpower is required for final integration is necessary.

Data Quality

Data quality completeness and validity will be improved by using active data collection for case counts.[14] Also, standardizing all report forms for foodborne illness, reportable medical events, and clinical laboratory results across all DoD laboratories will facilitate improved data

quality. Future studies can focus on assessing the completeness and validity of the obtained data once the system is in place.

Acceptability

Acceptability is the willingness of persons and organizations to participate in the surveillance system.[14] Because most of these data streams already are in existence, there should be no added workload that would make individuals reluctant to implement this system. After evaluation, if we discover additional workload is needed, funding and manpower requests could be necessary.

Sensitivity

The sensitivity of a surveillance system can be considered on two levels.[14] First, at the level of case reporting, sensitivity refers to the proportion of cases of a disease (or other health-related event) detected by the surveillance system.[14] Second, sensitivity can refer to the ability to detect outbreaks, including the ability to monitor changes in the number of cases over time.[14] The measurement of the sensitivity of a public health surveillance system is affected by the likelihood that certain diseases or other health-related events are occurring in the population under surveillance; cases of certain health-related events are under medical care, receive laboratory testing, or are otherwise coming to the attention of institutions subject to reporting requirements; the health-related events will be diagnosed/identified, reflecting the skill of health-care providers and the sensitivity of screening and diagnostic tests (i.e., the case definition); and the case will be reported to the system.[14] As part of this dissertation, we found that care-seeking stool submission for AGI is lower than in the general population, resulting less cases being reported by surveillance (requiring larger underdiagnosis multipliers). Laboratory specimen handling practices also varied among Army laboratories. Education of physicians, updating the

guidelines for stool sample submission, and ensuring laboratory specimen handling policies are the same across laboratories can help to increase the sensitivity of DoDFoodNet. Sensitivity also can be assessed through capture-recapture studies to see how case-capture differs between DoDFoodNet and other surveillance systems not specifically designed for foodborne illness detection.[9,10]

Predictive Value Positive

This attribute is the proportion of reported cases that actually have the health-related event under surveillance.[14] Predictive value positive (PVP) is important because a low value means that non cases might be investigated, and outbreaks might be identified that are not real, which is a waste of time and resources.[14] False positive reports can lead to unnecessary interventions, and falsely detected outbreaks can lead to costly investigations and undue concern in the population under surveillance.[14] A public health surveillance system with a high PVP will lead to fewer misdirected resources [14]. DoDFoodNet case definitions will include the RME definitions, which includes culture-confirmed positive laboratory specimens. A benefit of culture-confirmation is that culture rarely leads to false-positive results, especially for these pathogens of interest. As culture-independent testing (CIDT) methods become more commonplace, we will have to re-evaluate the PVP of this system and suggest testing protocols to increase PVP.

Representativeness

DoDFoodNet will accurately describe the occurrence of foodborne disease events over time and it's distribution in the military population by place and purpose.[14] One of the limitations of the current manuscript survey was possible selection bias and response bias in the survey (see

chapter 3). As previously discussed, a DoD-wide survey supported by upper echelons of the military might increase the response rate and representativeness of future surveys.

Timeliness

Timeliness reflects the speed between steps in a public health surveillance system.[14] Some of the surveillance streams are designed to detect illness and outbreaks faster than others, at the cost of specificity. These faster systems (outbreak reporting, complaint systems) offset the active and passive systems that rely on laboratory-confirmed culture. The laboratory-based surveillance requires the service member to ingest a contaminated food item, develop illness (incubation period can vary, hours to days), seek medical care (appointments can be hard to obtain quickly), have a stool sample collected and the pathogen isolated (can take days to ship and then isolate bacteria) before being reported through active or passive surveillance. The time from ingestion to laboratory detection can take days to months depending on the pathogen. This inherently is one of the disadvantages of laboratory-based surveillance, which in DoDFoodNet is offset by the high specificity of laboratory surveillance. DoDFoodNet will use a combination of both fast/non-specific and slower/specific systems that results in a balanced timely foodborne illness surveillance system.

Stability

Stability is the reliability, and availability of the system. In the current study, there were no issues in the reliability and availability of the DRSi system. We were able to obtain case data within hours of requesting it through a source with primary access (after gaining permission for access through the IRB committee). The other surveillance streams should be similar and supply data as requested to those with access. System outages can occur, especially with Internet based

systems. Future studies to evaluate the reliability of these systems should be conducted to fully evaluate stability of DoDFoodNet.

Identified Limitations

Initially, we selected Army laboratories as sentinel sites for simplicity. In the future we would like to integrate laboratories from other branches of the military (Navy, Marines, Air Force) to ensure DoD-wide coverage. However, memorandum of understanding (MOU) and agreement (MOA) would need to be developed and approved before such data could be integrated. Currently, US Army laboratory data is easily accessed by APHC (Provisional). Additionally, there may be initial issues with manpower and funding requirements, and determining the command hierarchies for DoDFoodNet. It may take months to years to develop the regulations, policies, and directives needed to build a formal system. In the meantime, APHC (Provisional) staff can use current systems along with collaboration with AFHSB to begin initial foodborne disease surveillance in the DoD. Truly, this proposed system will open formal lines of communication between all medial service branches, veterinary services, public health services, AFHSB, and preventive medicine services. The goal is to integrate what each service already is doing into a system that can leverage assets together and meet the surveillance objectives.

One Health Approach to Food Safety

The ultimate goal of DoDFoodNet is to reduce the burden of foodborne illness in the military by creating a comprehensive and integrated foodborne disease surveillance program that incorporates numerous data streams from many sources. The DoD has a great potential and unique ability to be able to link food inspection data to patient cases. Under DoDFoodNet,

communication between Veterinary Services and Public Health personnel will be two way: human cases will drive food sampling procedures and policies and food sampling results will drive patient testing. Figure 3 displays a schematic of a One Health Approach to food safety in the military that engages veterinary services, medical services, public health/epidemiology services, and preventive medicine services.

This schematic can appear confusing at first, but ultimately it shows how intimately the different missions across the AMEDD overlap and complement each other. The red boxes and arrows of the schematic represent medical disease surveillance. The burden of illness pyramid represents the steps required for foodborne illness to be detected by surveillance. Active and passive surveillance for foodborne illnesses can help to fulfill a number of surveillance objectives including identifying high risk populations, determining incidence of foodborne illness in the military population, and monitoring trends of numbers of foodborne illnesses. Meeting these objectives in turn helps the DoD to prioritize intervention strategies and monitor and evaluate the effectiveness of these strategies. Standardizing laboratory policies, food history forms, and stool specimen collection guidelines can improve foodborne illness burden estimates across the DoD. All positive isolates identified through surveillance will be sent to PulseNet, which in turn helps with outbreak detection. Positive samples obtained through the destination sampling program also are sent to PulseNet, which can help ultimately tie specific foods to outbreaks. The commissary complaint system also potentially can help to detect outbreaks sooner and also can drive which products are tested during destination sampling.

The blue boxes and arrows represent the DoD food chain from farm to table. The brown boxes and arrows represent areas where veterinary services and preventive medicine play a role in intervention through the US Army Food Protection Program. The US Army Food Protection

Program identifies food safety concerns from farm to table. For example, at the farm level, mushroom and sprout growing facilities undergo sanitation audits by veterinary services personnel. Processing facilities and distribution and storage facilities also are audited by veterinary services personnel. Some processing facilities are exempt from veterinary services inspections (see chapter 2); these facilities undergo inspection by the USDA or FDA. Before food products can enter the military food supply, they must be listed in the Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement (or be exempt).[15]

To be listed in this directory, food establishments must undergo and pass the above-described inspections by veterinary services personnel. Before an approved food item is delivered to an installation, veterinary inspectors meet the delivery vehicles and conduct inspections to ensure food safety and food defense measures were met during transport. Once food is delivered to on-post food establishments and the commissary, additional storage and sanitation inspections are conducted periodically by veterinary services personnel. If food items are recalled, veterinary services personnel conduct ALFOODACT inspections to ensure recalled items are removed from shelves. In addition, preventive medicine specialists conduct inspections of food preparation and handling practices in facilities that serve food items. Not pictured in this schematic are the role environmental health specialists play in rodent, insect, and other pest control in on-post food establishments.

Figure 7.3 also displays current interventions in place along the food supply chain. The main intervention strategy for veterinary services audits is the ability to de-list facilities that do not pass inspections. Once a facility is de-listed, they cannot provide products to the DoD until they meet inspection requirements. In the past, veterinary services inspectors de-listed a facility after finding critical issues during inspection. This same plant was later involved in a nationwide

recall due to an outbreak caused by one of their products.[16] This is one example where DoD inspection practices helped prevent foodborne infections through the military food supply chain. When commissary complaints and ALFOODACT recalls occur, veterinary services personnel have the authority to place items on medical hold until final disposition is determined. Preventive medicine and veterinary services personnel can work with food establishment workers and managers and provide education regarding proper storage, sanitation, preparation, and handling of food. This is the primary intervention at on-post eating establishments. Once consumers take home food from the commissary for home meal preparation, the food protection system begins to lose control of the food safety process. This is an area where consumer food safety education can be very beneficial. This education also is beneficial to reduce foodborne illness from contaminated food purchased at non-military facilities. Consumer education is an area the DoD can excel in and make a real impact on the burden of foodborne illness in the military. We recommend the development of a robust consumer food education initiative that includes educational displays and presentations by preventive medicine and food safety personnel at the commissary and installation events, educational poster displays in food establishments and across installations, and specific consumer food safety training during in-processing, especially in overseas locations with higher risk off-post dining establishments. Education through the commander's channel, the Armed Forces Network, and installation newspapers also can be very helpful. One successful food safety education campaign in the United States is the FightBac!® Partnership for Food Safety Education campaign that supports consumers to prevent food poisoning.[17] This initiative provides information about foodborne illness, food safety education, education targeted specifically at children, and free resources such as brochures, posters, and webinars. Appendix C-7 displays some of the flyers available on

their website. These messages can be altered and updated to target high-risk populations in the military and meet the needs of the DoD.

Conclusion

We have shown that acute gastroenteritis and foodborne illness is a burden in the US Army, and presumably across the DoD as a whole. Implementation of a comprehensive and integrated DoD foodborne disease surveillance system like DoDFoodNet will not only allow for the DoD to make more accurate estimates of the burden of foodborne illness in the entire population, but also be able to track and monitor foodborne illness trends, detect outbreaks, attribute illness to specific foods, prioritize interventions, and monitor and evaluate the effectiveness of preventive strategies. Though there is a robust US Army Food Protection Program in place, there is no way to objectively evaluate the effectiveness of this system. Integrating DoDFoodNet and a One Health approach to food safety in the military that creates a formal network between veterinary services personnel, public health personnel, medical personnel, AFHSB, and environmental health personnel across all branches of the military is the best way to prevent foodborne illness in the DoD service member population, and to ensure the US military and their families have access to the safest food supply in the world.

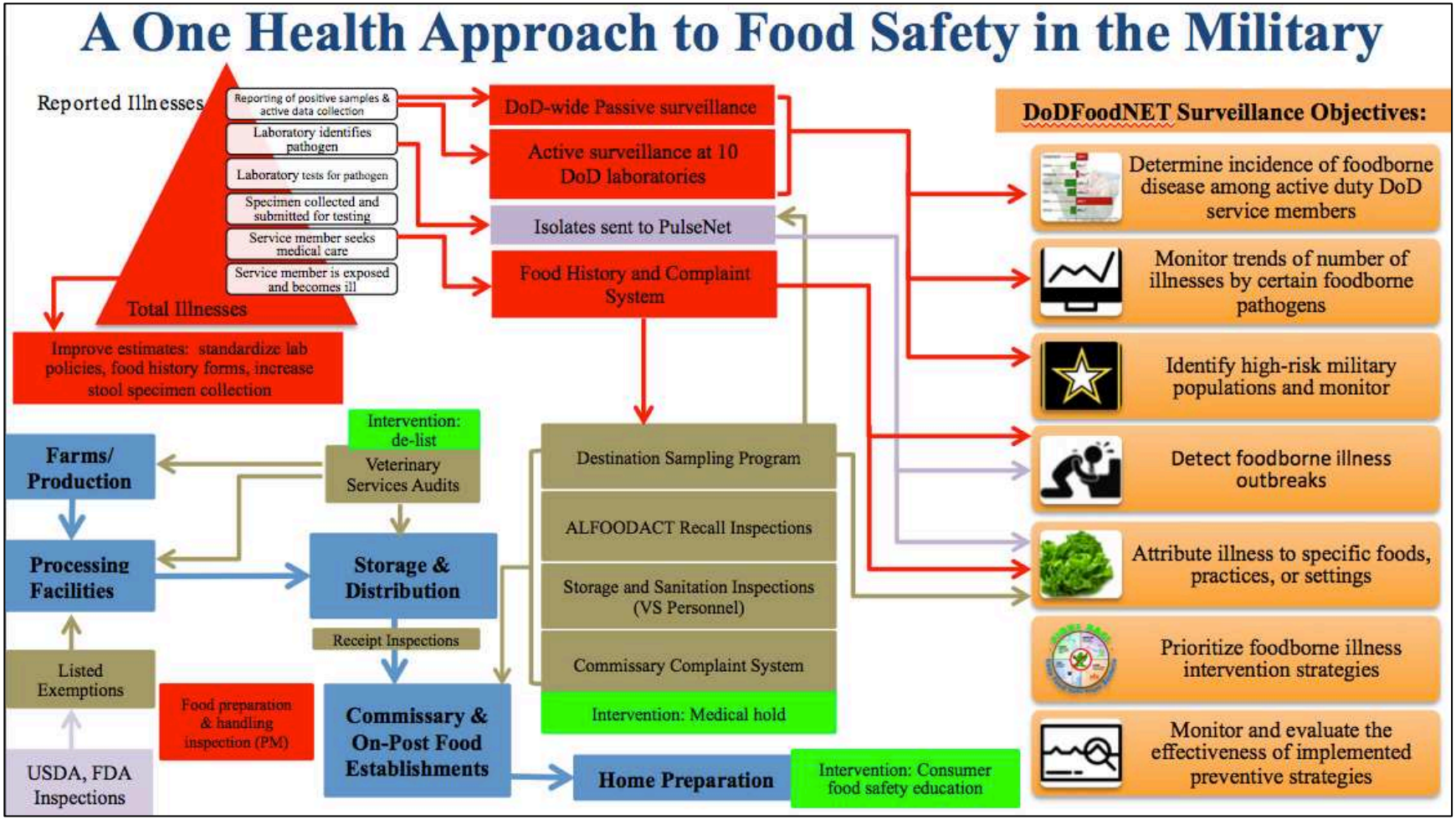


Figure 7.3. A One Health Approach to Food Safety in the Military. Boxes and arrows shaded red represent medical disease surveillance. Boxes and arrows shaded blue represent the military food supply chain. Boxes and arrows shaded brown represent veterinary services surveillance and inspections. Bright green boxes represent interventions. Boxes shaded orange represent DoDFoodNet surveillance objectives.

References

1. Scallan E, Mahon B, Wong DLF. Surveillance for foodborne disease. In: M'Ikanatha NM, ed. *Infectious disease surveillance*. Chicester: Wiley-Blackwell; 2013.

2. United States Army Public Health Center (Provisional). Food and Drinking Water Protection. 2016; https://phc.amedd.army.mil/topics/foodwater/Pages/default.aspx. Accessed February 16, 2016.

3. Thacker SB, Qualters JR, Lee LM. Public Health Surveillance in the United States: Evolution and Challenges. *MMWR*. 2012;61(3):3-9.

4. Foodborne Diseases Active Surveillance Network (FoodNet). 2015; http://www.cdc.gov/foodnet/about.html. Accessed February 16, 2016, 2014.

5. Electronic Surveillance System for Early Notification of Community based Epidemics. http://www.health.mil/Military-Health-Topics/Technology/Clinical-Support/Centralized-Credentials-Quality-Assurance-System/Decision-Support/Electronic-Surveillance-System-for-the-Early-Notification-of-Community-based-Epidemics. Accessed January 18, 2016.

6. McCormic Z. Disease Reporting System internet (DRSi). 2014.

7. Scallan E. Surveillance for Foodborne and Diarrheal Diseases. *EPID 6641*. 2015;University of Colorado Denver.

8. Colorado Department of Public Health & Environment. *Report a Disease: General communicable disease reporting form*. 2016. https://www.colorado.gov/pacific/cdphe/report-a-disease. Accessed February 18, 2016.

9. Evans RI, Salman M, Lappin M, Hayne S, Peel J. *One health in the U.S. military : a review of existing systems and recommendations for the future*, Colorado State University. Libraries; 2014.

10. Jordan N, Clemmons N, Nowak G, Gaydos J. Estimating the Burden of Chlamydia Trachomatis in the US Army - Use of Three Passive Surveillance Systems and Capture-Recapture Methods to Identify Incident Cases. *Poster session presented at the 2014 STD Prevention Conference*. 2014.

11. Centers for Disease Control and Prevention. *Environmental Health Services Resources: Consumer Foodborne Illness Complaint Form.* http://www.cdc.gov/nceh/ehs/ehsnet/resources/index.htm. Accessed February 18, 2016.

12. Military Health System and Defense Health Agency. Survey of Health Related Behaviors. 2015; http://www.health.mil/Military-Health-Topics/Access-Cost-Quality-and-Safety/Health-Care-Program-Evaluation/TRICARE-Patient-Satisfaction-Surveys/Survey-of-Health-Related-Behaviors. Accessed February 18, 2016.

13. Office of Disease Prevention and Health Promotion. Healthy Poeple 2020: Food Safety. 2016; http://www.healthypeople.gov/2020/topics-objectives/topic/food-safety/objectives. Accessed February 18, 2016.

14. Center for Disease Control and Prevention. Updated Guidelines for Evaluating Public Health Surveillance Systems: Recommendations from the Guidelines Working Group *MMWR.* 2001;50(RR13):1-35.

15. USAPHC Circular 40-1: Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement. In: Army Dot, ed. Aberdeen Proving Ground, MD: US Army Publich Health Command; June 2012.

16. Marx de Salcedo A. *Combat-ready kitchen : how the U.S. military shapes the way you eat.* 2015.

17. Partnership for Food Safety Education. *Fight Bac! (R) Supporting consumers to prevent food poisoning.* 2016. http://www.fightbac.org. Accessed February 18, 2016.

Appendix A-2:

Table A.2.1. Listing of Armed Forces Health Surveillance Branch Reportable Medical Events, 12 March 2012.

Pathogen/Disease	Foodborne Origin?	Proportion Foodborne
Amebiasis	NO	N/A
Anthrax	NO	N/A
Botulism, Infant*	YES	N/A*
Brucellosis	YES	50%
Campylobacter	YES	80%
Chlamydia trachomatis	NO	N/A
Cholera	YES	100%
Coccidioidomycosis	NO	N/A
Cold Weather Injuries	NO	N/A
Cryptosporidiosis	YES	8%
Cyclospora	YES	99%
Dengue Fever	NO	N/A
Diptheria	NO	N/A
E.coli, Shiga Toxin-producing	YES	68%
Ehrlichiosis	NO	N/A
Encephalitis, Arboviral	NO	N/A
Filariasis	NO	N/A
Giardiasis	YES	7%
Gonorrhea	NO	N/A
Haemophilus influenzae	NO	N/A
Hanta Virus	NO	N/A
Heat Illness	NO	N/A
Hemorrhagic Fever	NO	N/A
Hepatitis A	YES	41%
Hepatitis B	NO	N/A
Hepatitis C	NO	N/A
Influenza-Associated Hospitalization	NO	N/A
Legionellosis	NO	N/A
Leishmanisasis	NO	N/A
Leprosy	NO	N/A
Leptospirosis	NO	N/A
Listeriosis	YES	100%
Lyme Disease	NO	N/A
Malaria (ALL)	NO	N/A

Table A.2.1. Continued.

Pathogen/Disease	Foodborne Origin?	Proportion Foodborne
Measles	NO	N/A
Meningococcal Disease	NO	N/A
Mumps	NO	N/A
Norovirus	YES	26%
Outbreak or Disease Cluster	NO**	N/A
Pertussis	NO	N/A
Plague	NO	N/A
Poliomyelitis	NO	N/A
Q Fever	NO	N/A
Rabies, Human	NO	N/A
Relapsing Fever	NO	N/A
Pneumatic Fever (Acute)	NO	N/A
Rift Valley Fever	NO	N/A
Rocky Mountain Spotted Fever	NO	N/A
Rubella	NO	N/A
Salmonellosis	YES	94%
Schistosomiasis	NO	N/A
Sever Acute Respiratory Syndrome	NO	N/A
Shigellosis	YES	N/A
Smallpox	NO	N/A
Streptococcus, Group A, Invasive	YES	100%
Syphilis	NO	N/A
Tetanus	NO	N/A
Toxic Shock Syndrome	NO	N/A
Trichinosis	YES	100%
Trypanosomiasis	NO	N/A
Tuberculosis, Pulmonary	NO	N/A
Tularemia	YES	Rare
Typhoid Fever	YES	76%
Typhus Fever	NO	N/A
Varicella	NO	N/A
Yellow Fever	NO	N/A

* Only infant Botulism is RME, not adult foodborne illness Botulism (different ICD-9 Code), study is only active duty SM, so infant Botulism not of interest in this study.
**Not specific outbreaks of foodborne illness.

Appendix A-3

Table A.3.1. Active duty Army population by regional medical command, number of installations, estimated population, and number of Soldiers to select in each region. The total population differs slightly from the total active Army population because some service members are not assigned to these regions (deployment, etc.).

Region	Number of installations	Estimated population	Number to survey*
ERMC	9	27451	3222
NRMC	12	98821	11600
PRMC	9	37822	4439
SRMC	11	170051	19960
WRMC	11	141239	16578
		475383	55800

*calculation: region population x (55800/465,383)

Table A.3.2. Final number to survey by installation.

Region	Installation	Estimated population	Number to survey	Plus 10%*
ERMC	USAG Bavaria	8527	2385	2623
ERMC	USAG Benelux	5670	159	175
ERMC	USAG Vicenza	2425	678	746
NRMC	Fort Knox	8565	1291	1421
NRMC	Fort Sill	3418	515	567
NRMC	Fort Bragg	47638	7183	7901
NRMC	Fort Drum	17313	2610	2871
PRMC	USAG Casey	5189	843	928
PRMC	Camp Zama	1345	219	240
PRMC	USAG Hawaii	20782	3378	3715
SRMC	Fort Benning	23175	4310	4742
SRMC	Fort Campbell	30979	5762	6338
SRMC	Fort Hood	41514	7722	8494
SRMC	Fort Sill	11647	2166	2383
WRMC	Fort Wainwright	6224	1225	1347
WRMC	Fort Bliss	27128	5338	5872
WRMC	Fort Riley	17653	3474	3821
WRMC	Fort Lewis	33247	6542	7196
		Total	55800	61380

Installation selection and proportional allocation calculations for ERMC:

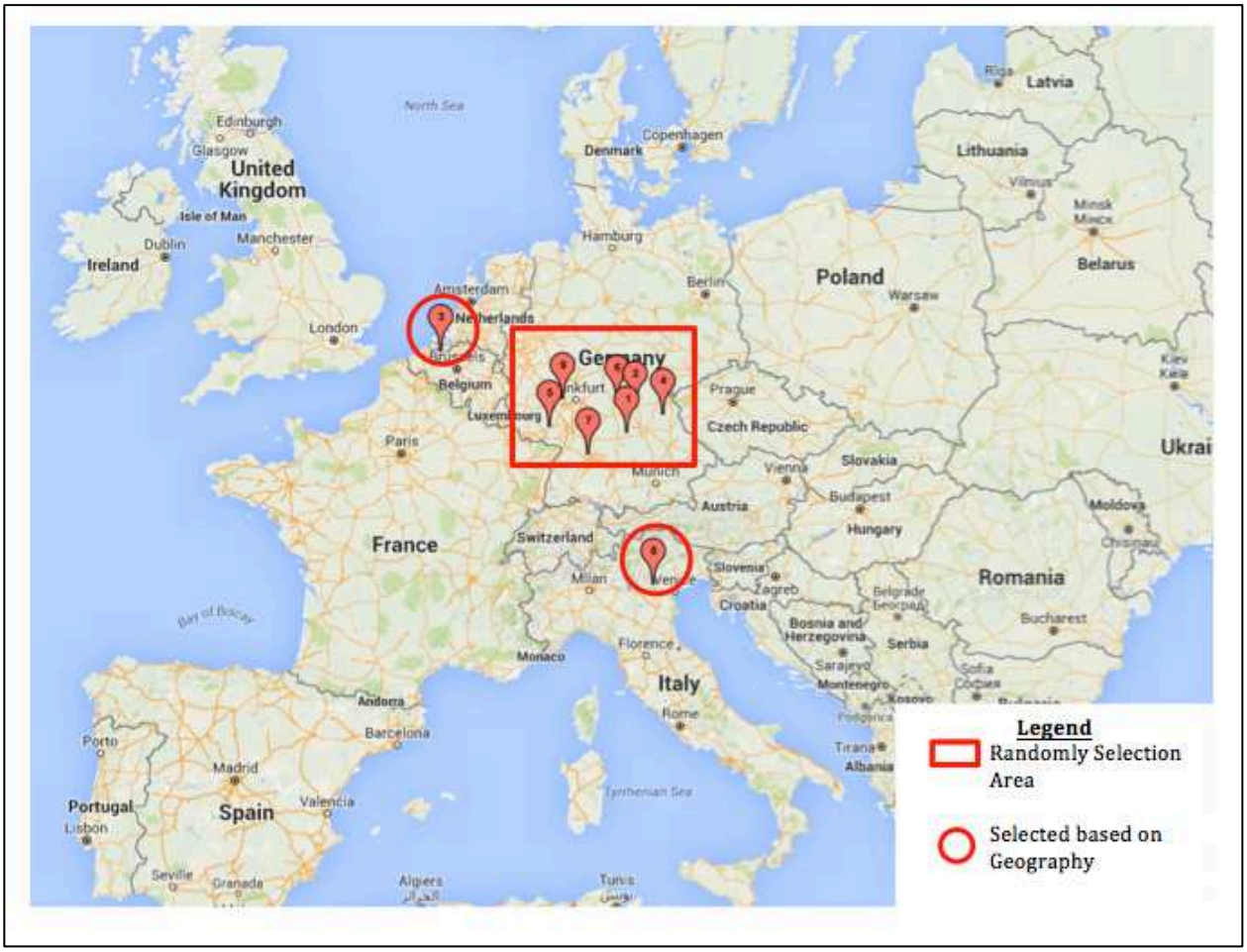


Figure A.3.1. Map of Army installations in ERMC.

Table A.3.3. ERMC installations, how selected, installation population, number to survey, number to survey after adding 10%.

Map Number	Installation Name	Selected (Y/N)	Selection method	Selected installation population	Number to survey*	Plus 10%
1	Ansbach	N		N/A		
2	Bamberg	N		N/A		
3	Benelux	Y	Geographic	570	159	175
4	Grafenwoehr	Y	Random	8527	2385	2623
5	Kaiserlautern	N		N/A		
6	Schweinfurt	N		N/A		
7	Stuttgart	N		N/A		
8	Vicenza	Y	Geographic	2425	678	746
9	Wiesbaden	N		N/A		
Total population of selected installations				11522	3222	3544

$$*\#\ \boldsymbol{To\ Survey = Selected\ installation\ pop.x}\ \frac{\boldsymbol{total\ needed\ to\ survey\ from\ region\ (table1)}}{\boldsymbol{total\ pop.of installations\ selected\ in\ region}}$$

Installation selection and proportional allocation calculations for NRMC:

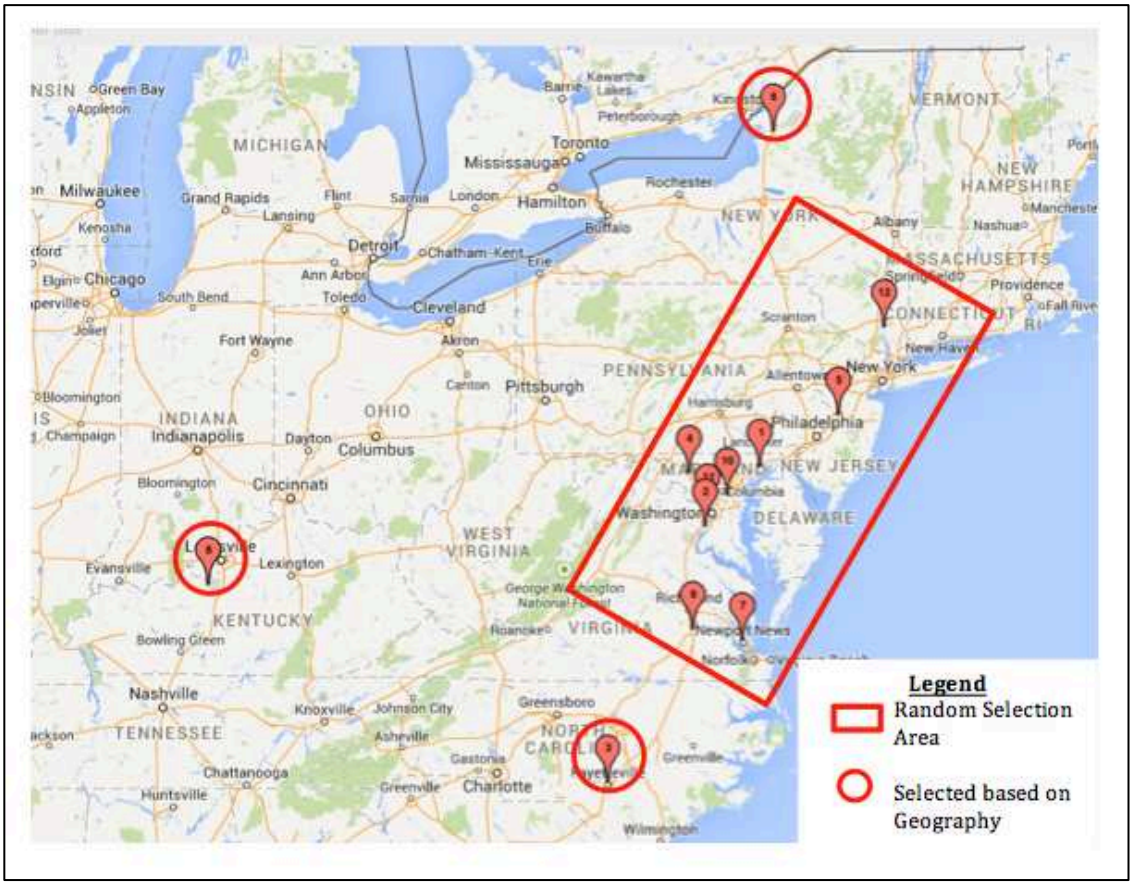


Figure A.3.2. Map of Army installations in NRMC

Table A.3.4. NRMC installations, how selected, installation population, number to survey, number to survey after adding 10%.

Map Number	Installation Name	Selected (Y/N)	Selection method	Selected installation population	Number to survey*	Plus 10%
1	Aberdeen Proving Grds	N		N/A		
2	Fort Belvoir	Y	Random	3418	515	567
3	Fort Bragg	Y	Geographic	47638	7183	7901
4	Fort Detrick	N		N/A		
5	Fort Dix	N		N/A		
6	Fort Drum	Y	Geographic	17313	2610	2871
7	Fort Eustis	N		N/A		
8	Fort Knox	Y	Geographic	8565	1291	1421
9	Fort Lee	N		N/A		
10	Fort Meade	N		N/A		
11	Fort Myer	N		N/A		
12	West Point	N		N/A		
	Total			76934	11600	12760

$$*\#\ \textbf{To Survey} = \textbf{Selected installation pop.}\ x\ \frac{\textbf{total needed to survey from region (table1)}}{\textbf{total pop. of installations selected in region}}$$

Installation selection and proportional allocation calculations for PRMC:

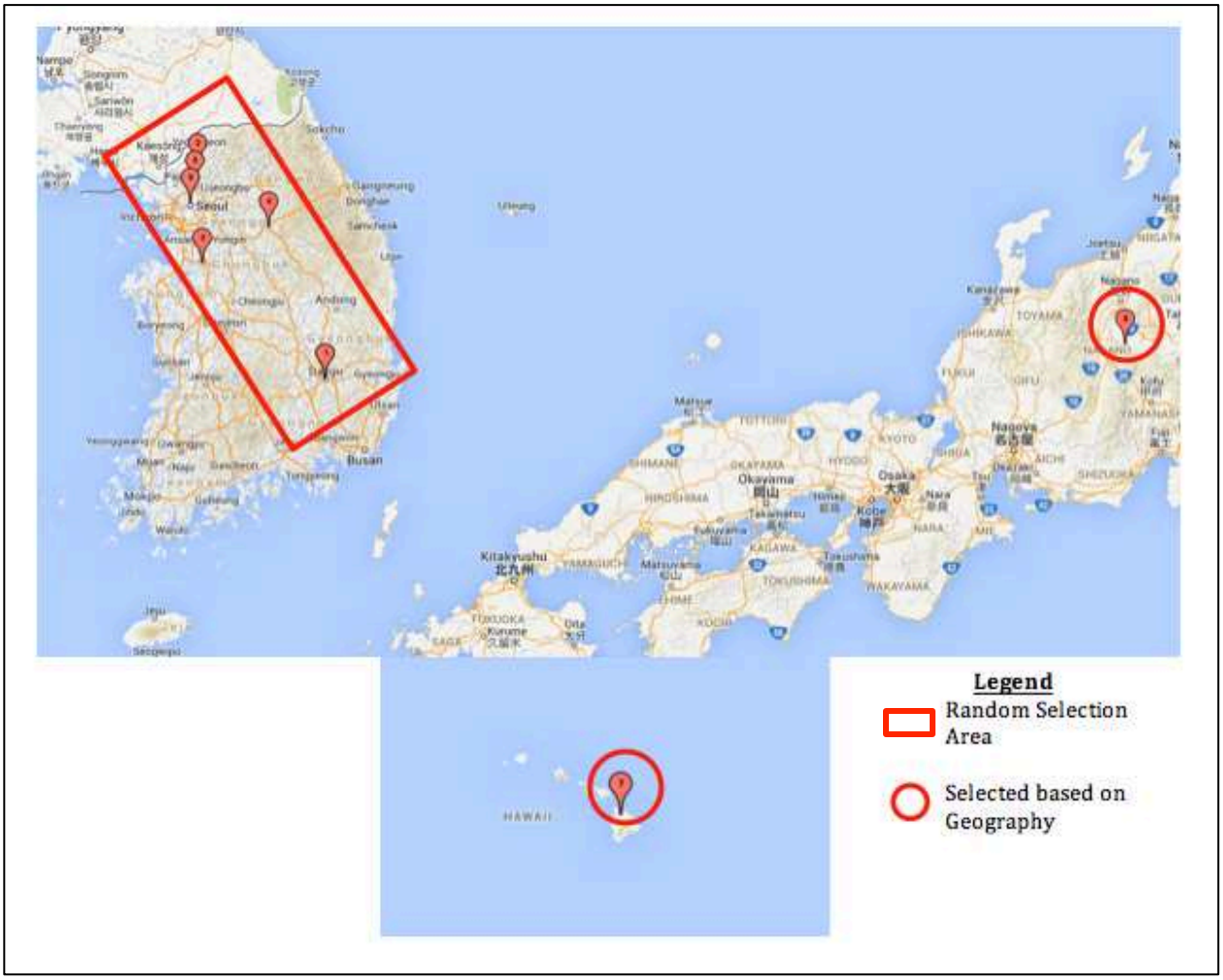


Figure A.3.3. Map of Army installations in PRMC.

Table A.3.5. PRMC installations, how selected, installation population, number to survey, number to survey after adding 10%.

Map Number	Installation Name	Selected (Y/N)	Selection method	Selected installation population	Number to survey*	Plus 10%
1	Camp Carroll	N		N/A		
2	Camp Casey	Y	Random	5189	843	928
3	Camp Humphreys	N		N/A		
4	Camp Long	N		N/A		
5	Camp Stanley/CRC	N		N/A		
6	Camp Walker	N		N/A		
7	USAG Hawaii	Y	Geographic	20782	3378	3715
8	Camp Zama	Y	Geographic	1345	219	240
	Total			27316	4439	4883

$$*\#\ \textbf{To Survey} = \textbf{Selected installation pop.} \times \frac{\textbf{total needed to survey from region (table1)}}{\textbf{total pop. of installations selected in region}}$$

Installation selection and proportional allocation calculations for SRMC:

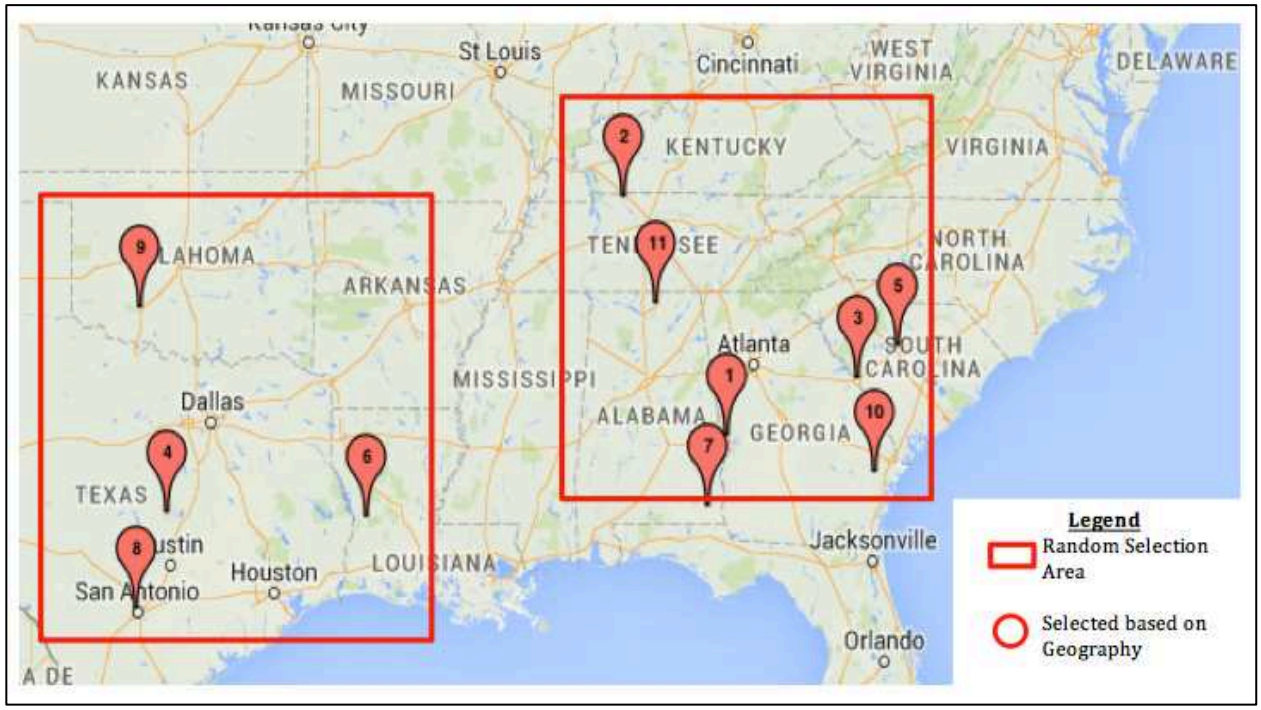


Figure A.3.4. Map of Army installations in SRMC.

Table A.3.6. SRMC installations, how selected, installation population, number to survey, number to survey after adding 10%.

Map Number	Installation Name	Selected (Y/N)	Selection method	Selected installation population	Number to survey*	Plus 10%
1	Fort Benning	Y	Random East	23175	4310	4742
2	Fort Campbell	Y	Random East	30979	5762	6388
3	Fort Gordon	N		N/A		
4	Fort Hood	Y	Random West	41514	7722	8494
5	Fort Jackson	N		N/A		
6	Fort Polk	N		N/A		
7	Fort Rucker	N		N/A		
8	Fort Sam Houston	N		N/A		
9	Fort Sill	Y	Random West	11647	2166	2383
10	Fort Stewart	N		N/A		
11	Redstone Arsenal	N		N/A		
	Total			107315	19960	21957

$$*\#\ \boldsymbol{To\ Survey = Selected\ installation\ pop.\ x\ \frac{total\ needed\ to\ survey\ from\ region\ (table1)}{total\ pop.of installations\ selected\ in\ region}}$$

Installation selection and proportional allocation calculations for WRMC:

Figure A.3.5. Map of Army installations in WRMC.

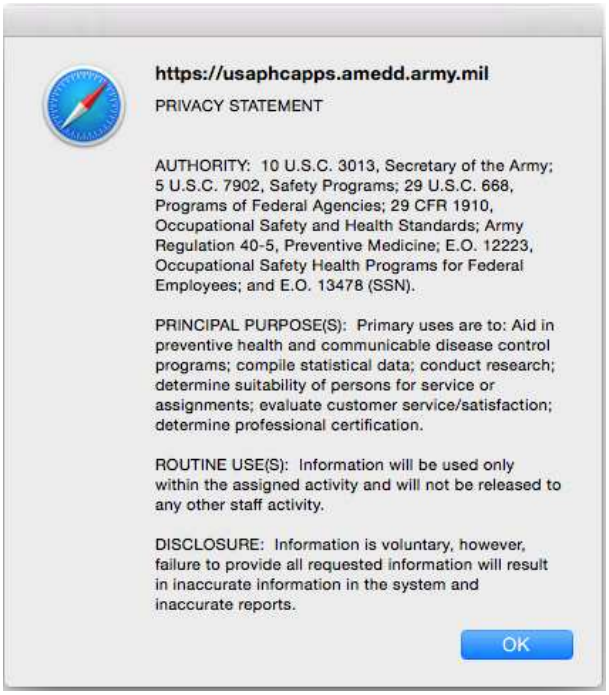
Table A.3.7. WRMC installations, how selected, installation population, number to survey, number to survey after adding 10%.

Map Number	Installation Name	Selected (Y/N)	Selection method	Selected installation population	Number to survey*	Plus 10%
1	Fort Leavenworth	N		N/A		
2	Fort Lewis	Y	Geographic	33247	6542	7196
3	Fort Richardson	N		N/A		
4	Fort Bliss	Y	Random Southwest	27128	5338	5872
5	Fort Carson	N		N/A		
6	Fort Huachuca	N		N/A		
7	Fort Irwin	N		N/A		
8	Fort Leonard Wood	N		N/A		
9	Fort Riley	Y	Random Central	17652	3474	3821
10	Fort Wainwright	Y	Random Central	6224	1225	1347
11	Presidio	N		N/A		
	Total			84252	16578	18236

$$*\#\ \textbf{To Survey} = \textbf{Selected installation pop.} \times \frac{\textbf{total needed to survey from region (table1)}}{\textbf{total pop.of installations selected in region}}$$

Appendix B-3

Privacy Statement, Email to Military Members, and Survey



Greetings,

Did you know that according to the Centers for Disease Control and Prevention, 1 in 6 Americans (48 million people) get sick from foodborne disease each year? The U.S. Army Public Health Command Veterinary Services Portfolio is committed to ensuring the food you and your family purchase and consume is wholesome and safe. In order to continue to expand the capacity and capabilities of our food protection program, we would like to gain more knowledge about the occurrence of foodborne illness among active duty service members. You can play a direct role by completing an anonymous online survey we have developed.

The survey will take approximately five minutes to complete, and your responses to the survey will be completely anonymous. To complete the survey, please either click on the following link:

https://usaphcapps.amedd.army.mil/Survey/se.ashx?s=25113745612B8008

The survey will be accessible until May 15, 2015.

If you have any questions about this public health project, please contact MAJ Sara Mullaney at sara.b.mullaney.mil@mail.mil <mailto:sara.b.mullaney.mil@mail.mil> .

The Public Health Command and Veterinary Corps look forward to continuing to ensure you and your families have access to safe and wholesome food.

SURVEY APPROVAL AUTHORITY: U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

SURVEY CONTROL NUMBER: DAPE-ARI-AO-15-22

RCS: MILPB-3

EXPIRES: 03/02/16

Dear Active Duty Service Member,

Thank you for your service. The U.S. Army Public Health Command, in coordination with Colorado State University, is conducting a survey of service members, and you have been randomly selected to participate in this survey. By completing this survey, you can play a direct role in reducing the risk of service members and their families being affected by foodborne illness. The information you provide will help the Public Health Command leadership enhance the military's food protection program. Ultimately, the survey results will be used to estimate the overall burden of acute gastroenteritis and foodborne illness in the military. The principal U.S. Army Public Health Command investigator for this project: Estimating Annual Foodborne Illness in the Military is MAJ Sara B. Mullaney, and the Public Health Command Sponsor is LTC Rebecca I. Evans. The Colorado State University Sponsor/PI is Dr. Mo Salman.

We would like for you to complete an anonymous online survey. Participation will take approximately five minutes. Your participation in this research is voluntary, and there are no correct or incorrect responses. If you decide not to participate in the study, you may withdraw your consent and stop participation at any time without penalty.

We will not collect your name or personal identifiers. When we report and share the data to others, we will combine the data from all participants, so there will be no way to trace the data back to you. While there are no direct compensation benefits to you for completing the survey, we do hope to gain more knowledge about foodborne illness in the military, in order to improve our food safety program and keep you and your family safe from foodborne illness.

There are no known risks associated with completing this survey. It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any known and potential (but unknown) risks.

To indicate your consent to participate in this public health project and to continue on to the survey, simply click "Next" at the bottom of the screen.

If you have any questions about this public health project, please contact MAJ Sara Mullaney at sara.b.mullaney.mil@mail.mil. If you have any questions about your rights as a volunteer in this project, contact the CSU IRB at: RICRO_IRB@mail.colostate.edu; 970-491-1553. Thank you for your assistance. The Public Health Command looks forward to continuing to ensure you and your families have access to safe and wholesome food.

Sara Mullaney
MAJ, VC
Clinical Sciences Graduate Student
Sara.b.mullaney.mil@mail.mil

Rebecca Evans
LTC, VC
Public Health Command Sponsor
Rebecca.i.evans.mil@mail.mil

1a. Are you an active duty military member serving in the United States Army?

1 Yes [if Q1a=Yes, then proceed to Q1]
2 No [if Q1a=No, then end survey]

Section I: Foodborne Illness Study: Eating Habits

This section of the survey focuses on your general eating habits. You will be asked about where you usually eat your meals, and where you obtain certain food items consumed at home (including barracks, dormitory, etc.). Your answers to these questions will help the Public Health Command target food safety inspection and education efforts. Please answer each question to the best of your ability; there are no right or wrong answers.

1. In the last 7 days (1 week), how many meals did you eat that were served at the on-post Dining Facility (DFAC)? [drop down list, individual numbers 1-21, and >21]

2. In the last 7 days (1 week), how many meals did you eat at on-post establishments other than the DFAC? [drop down list, individual numbers 1-21, and >21]

3. In the last 7 days (1 week), how many meals did you eat at home, or someone else's home that were prepared at home by yourself or others? [drop down list, individual numbers 1-21, and >21]

4. In the last 7 days (1 week), how many meals did you eat away from home, at off-post establishments/restaurants? [drop down list, individual numbers 1-21, and >21]

5. Where do you obtain most of the fresh fruits and vegetables that are consumed in your home? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or Community Supported Agriculture (CSA)
4 My own garden
5 Other_____
6 Fresh fruit and vegetables are not consumed in my home
7 I do not know where these items are obtained

6. Where do you obtain most of the dairy products (milk, cheese, yogurt) consumed in your home? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or CSA
4 Other_____
5 Dairy products are not consumed in my home
6 I do not know where these items are obtained

7. Where do you obtain most of the fresh eggs (eggs in a shell, not egg products as Egg Beaters) consumed in your home obtained? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or CSA
4 Other_____
5 My own chickens
6 Eggs are not consumed in my home
7 I do not know where these items are obtained

8. Where do you obtain most of the fresh fish (not pre-cooked) and seafood consumed in your home? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or CSA
4 Other_____
5 Fresh fish and seafood are not consumed in my home
6 I do not know where these items are obtained

9. Where do you obtain most of the fresh meat (not pre-cooked beef or pork) consumed in your home? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or CSA
4 Other_____
5 Fresh beef or pork are not consumed in my home
6 I do not know where these items are obtained

10. Where do you obtain most of the fresh poultry (not pre-cooked chicken, turkey, duck, etc.) consumed in your home? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or CSA
4 Other_____
5 Fresh poultry is not consumed in my home
6 I do not know where these items are obtained

11. Where do you obtain most of the dry (not canned) grains, rice, beans, lentils, and peas consumed in your home? (Please choose only answer)

1 On-post: Commissary, Shoppette, Post Exchange, etc.
2 Grocery Store (not on-post)
3 Farmer's Market or CSA
4 Other_____
5 Dry grains and beans are not consumed in my home
6 I do not know where these items are obtained

Section II: Foodborne Illness Study: Care Seeking Questions

This portion of the survey asks questions about past history of illness. These questions will help the Public Health Command better estimate the number of service members affected by foodborne illness each year. Please answer these questions to the best of your ability by recalling specific symptoms you may have experienced in the last 30 days (1 month). If you experienced more than one episode of illness during the last 30 days, please answer the question about the most recent illness you experienced.

12. In the last 30 days (1 month), did you have diarrhea (loose stools/loose bowel movements)?

1 Yes
2 No [If Q12=No then Go to Q16]
3 I don't remember

13. In the last 30 days, in any one 24-hour period, what was the maximum number of loose stools/loose bowel movements you had?

1 0-2
2 3-5
3 More than 5
4 I don't remember

14. In the last 30 days, how many days in total did you have diarrhea?

__ __ [drop down list: I don't remember followed by individual numbers 1–30]

15. When you had loose stools or bowel movements during the last 30 days, did you have blood in your stool at any time?

1 Yes
2 No
3 I don't remember

16. In the last 30 days (1 month), did you have vomiting?

1 Yes
2 No [If Q16=NO and Q12=NO then Go To Q28, if Q16=NO and Q12=YES then Go to Q22]
3 I don't remember

17. During the last 30 days, in any one 24-hour period, what was the maximum number of times you vomited?

1 0
2 1
3 2-4
4 More than 5
5 I don't remember

18. During the last 30 days, for how many days altogether did you have vomiting?

__ __ drop down list: I don't remember followed by individual numbers 1–30] *

19. During the last 30 days, did you ever have both diarrhea and vomiting within the same 24-hour period?

1 Yes
2 No [If Q19=No then Go to Q22]
3 I don't remember

20. During the last 30 days, for how many days altogether did you have both diarrhea and vomiting?

__ __ [Enter Number 00–30]
1 I don't remember

21. Are you still having diarrhea and/or vomiting today?

1 Yes
2 No
3 I Don't Know

22. During the illness you experienced in the last 30 days, did you have a sore throat, cough, nasal discharge, or sneezing?

1 Yes
2 No
3 I don't remember

23. Did you visit a doctor, nurse, or other health professional for symptoms you experienced in the last 30 days? (By "other health professional" we mean a nurse practitioner, a physician's assistant, or other licensed health professional.)

1 Yes
2 No [If Q23=No then Go to Q25]
3 I don't remember

24. During this visit, did your doctor or other health professional ask you to provide a stool sample?

1 No
2 Yes, and I did provide a stool sample
3 Yes, but I did NOT provide a stool sample
4 I don't remember

25. Did the symptoms you experienced keep you from your usual/planned activities? By "usual/planned activities" we mean attending work, Unit Physical Readiness Training, assigned duty, or social events.

1 Yes
2 No [If Q25=No then Go to Q27]
3 I Don't Know

26. In the last 30 days, how many days of usual/planned activities did you miss because of the symptoms you experienced? [Drop down list individual numbers 1-30]

27. Do you think the symptoms you experienced were due to a chronic illness (Inflammatory Bowel Disease, Celiac, etc.), a medication, alcohol consumption, or pregnancy?

1 Yes
2 No
3 I Don't Know

Section III: Foodborne Illness Study: About You

This section asks for general information about you. Your responses will remain confidential and will in no way be used to identify you. You may choose not to respond to any of these questions.

28. What is your Gender?

1 Male
2 Female
3 Prefer not to respond

29. What is your rank?

1 E1-E4
2 E5-E6
3 E7-E9
4 WO1-CW2
5 CW3-CW5
6 O1-O3
7 O4-O6
8 O7-O9

30. What is your age? _____ [Manually Enter]

31. Select your Branch/Corps.

1 Acquisition
2 Adjutant General
3 Air Defense Artillery
4 Armor
5 Aviation
6 Chaplain
7 Chemical
8 Engineer
9 Field Artillery
10 Finance
11 Infantry
12 Judge Advocate General

13 Logistics
14 Medical/Veterinary/Nurse/Dental
15 Medical Service
16 Military Intelligence
17 Military Police
18 Ordnance
19 Public Affairs
20 Quartermaster
21 Signal
22 Special Forces
23 Transportation
24 Other, please specify _____

32. Were you deployed or did you travel to or visit an out of country location in the last 30 days (1 month)?

1 Yes
2 No

33. To which racial or ethnic group(s) do you *most* identify? [Select one or more]

1 American Indian or Alaska Native
2 Asian
3 Black or African American
4 Hispanic or Latino
5 Native Hawaiian or Other Pacific Islander
6 White

34. What is the highest level of school you completed or the highest degree received?

1 High School Graduate: high school diploma or equivalent [GED]
2 Some college but no degree
3 Associate degree in college
4 Bachelor's degree [i.e.: BA, AB, BS]
5 Master's degree [i.e.: MA, MS, MBA]
6 Doctorate degree [i.e.: MD, DVM, PhD, JD]
7 Technical Degree _____
8 Other_____

35. What is your assigned duty installation?

1 Benelux
2 Camp Casey
3 Fort Belvoir
4 Fort Benning
5 Fort Bliss
6 Fort Bragg
7 Fort Campbell
8 Fort Drum
9 Fort Hood
10 Fort Knox

11 Joint Base Lewis-McChord
12 Fort Riley
13 Fort Sill
14 Fort Wainwright
15 Hawaii (any location)
16 Japan (any location)
17 USAG Bavaria
18 Vicenza
19 Other (please specify)_____

36. Please use this space to share any thoughts you have about food safety in the military or your experiences with foodborne illness. Please do NOT include personally identifiable or operationally sensitive information.

Text box

This concludes the survey. Please click the submit button to submit your survey.

Your survey has been submitted. Thank you for taking the time to participate in this important survey.

Appendix C-3

SAS Code for Descriptive Statistics and Chi-Square Test of Categorical Variables

```
proc surveyfreq data=surveydata4; tables FF_V/CL chisq; run;
proc surveyfreq data=surveydata4; tables Dairy/CL chisq; run;
proc surveyfreq data=surveydata4; tables eggs/CL chisq; run;
proc surveyfreq data=surveydata4; tables fish/CL chisq; run;
proc surveyfreq data=surveydata4; tables poultry/CL chisq; run;
proc surveyfreq data=surveydata4; tables grains/CL chisq; run;

proc surveyfreq data=surveydata4; tables diarrhea/CL chisq; run;
proc surveyfreq data=surveydata4; tables max_diarrhea/CL chisq; run;
proc surveyfreq data=surveydata4; tables blood/CL chisq; run;
proc surveyfreq data=surveydata4; tables vomit/CL chisq; run;
proc surveyfreq data=surveydata4; tables max_vomit/CL chisq; run;
proc surveyfreq data=surveydata4; tables D_V/CL chisq; run;
proc surveyfreq data=surveydata4; tables sick_today/CL chisq; run;
proc surveyfreq data=surveydata4; tables Sore_Throat/CL chisq; run;
proc surveyfreq data=surveydata4; tables doctor/CL chisq; run;
proc surveyfreq data=surveydata4; tables Stool/CL chisq; run;
proc surveyfreq data=surveydata4; tables miss_work/CL chisq; run;
proc surveyfreq data=surveydata4; tables chronic_illness/CL chisq; run;
proc surveyfreq data=surveydata4; tables gender/CL chisq; run;
proc surveyfreq data=surveydata4; tables rank/CL chisq; run;
proc surveyfreq data=surveydata4; tables branch/CL chisq; run;
proc surveyfreq data=surveydata4; tables deployed/CL chisq; run;
proc surveyfreq data=surveydata4; tables race/CL chisq; run;
proc surveyfreq data=surveydata4; tables education/CL chisq; run;
proc surveyfreq data=surveydata4; tables installation/CL chisq; run;
```

SAS Output for Descriptive Statistics and Chi-Square Test of Categorical Variables

Table C.3.1. Frequency, percent, 95% confidence interval (CI), and chi-square test p-value for categorical variables obtained from the survey of the active duty US Army population. These data are before collapsing various categories.

Survey Question #	Variable Description		Answer Choices	Frequency	%	95% CI		p-value*
						LL	UL	
5	Procurement of fresh fruits and vegetables	0	Blank	1	0.1	0.0	0.1	<0.0001
		1	On Post: Commissary, Shoppette, Post Exchange, etc.	902	44.1	41.9	46.2	
		2	Grocery Store (not on post)	936	45.7	43.6	47.9	
		3	Farmer's Market or Community Supported Agriculture (CSA)	87	4.3	3.4	5.1	
		4	My Own Garden	9	0.4	0.2	0.7	
		5	Other	73	3.6	2.8	4.4	
		6	Fresh fruit and vegetables are not consumed in my home	28	1.4	0.9	1.9	
		7	I do not know where these items are obtained	11	0.5	0.2	0.9	
			Total	2047	100			
6	Procurement of dairy	0	Blank	3	0.1	0.0	0.3	<0.0001
		1	On Post: Commissary, Shoppette, Post Exchange, etc.	974	47.6	45.4	49.7	
		2	Grocery Store (not on post)	912	44.6	42.4	46.7	
		3	Farmer's Market or Community Supported Agriculture (CSA)	23	1.1	0.7	1.6	
		4	Other	84	4.1	3.2	5.0	
		5	Dariy products are not consumed in my home	43	2.1	1.5	2.7	
		6	I do not know where these items are obtained	8	0.4	0.1	0.7	
			Total	2047	100			
7	Procurement of eggs	0	Blank	12	0.6	0.3	0.9	<0.0001
		1	On Post: Commissary, Shoppette, Post Exchange, etc.	888	43.4	41.2	45.5	
		2	Grocery Store (not on post)	909	44.4	42.3	46.6	
		3	Farmer's Market or Community Supported Agriculture (CSA)	53	2.6	1.9	3.3	
		4	Other	22	1.1	0.6	1.5	
		5	My Own chickens	98	4.8	3.9	5.7	
		6	Eggs are not consumed in my home	54	2.6	1.9	3.3	
		7	I do not know where these items are obtained	11	0.5	0.2	0.9	
				2047	100			
8	Procurement of fresh fish	0	Blank	20	1.0	0.6	1.4	<0.0001
		1	On Post: Commissary, Shoppette, Post Exchange, etc.	621	30.3	28.3	32.3	
		2	Grocery Store (not on post)	900	44.0	41.8	46.1	
		3	Farmer's Market or Community Supported Agriculture (CSA)	58	2.8	2.1	3.6	
		4	Other	139	6.8	5.7	7.9	
		5	Fresh fish and seafood are not consumed in my home	263	12.8	11.4	14.3	
		6	I do not know where these items are obtained	46	2.2	1.6	2.9	
			Total	2047	100			
9	Procurement of fresh poultry	0	Blank	9	0.4	0.2	0.7	<0.0001
		1	On Post: Commissary, Shoppette, Post Exchange, etc.	997	48.7	46.5	50.9	
		2	Grocery Store (not on post)	870	42.5	40.4	44.6	
		3	Farmer's Market or Community Supported Agriculture (CSA)	23	1.1	0.7	1.6	
		4	Other	76	3.7	2.9	4.5	
		5	Fresh poultry are not consumed in my home	57	2.8	2.1	3.5	
		6	I do not know where these items are obtained	15	0.7	0.4	1.1	
			Total	2047	100			
10	Procurement of dry grains	0	Blank	2	0.1	0.0	0.2	<0.0001
		1	On Post: Commissary, Shoppette, Post Exchange, etc.	1015	49.6	47.4	51.8	
		2	Grocery Store (not on post)	896	43.8	41.6	45.9	
		3	Farmer's Market or Community Supported Agriculture (CSA)	12	0.6	0.3	0.9	
		4	Other	61	3.0	2.2	3.7	
		5	Dry grains and beans are not consumed in my home	49	2.4	1.7	3.1	
		6	I do not know where these items are obtained	12	0.6	0.3	0.9	
			Total	2047	100			
12	Diarrhea in last 30 days	1	Yes	739	36.1	34.0	38.2	<0.0001
		2	No	1240	60.6	58.5	62.7	
		3	I don't remember	68	3.3	2.5	4.1	
			Total	2047	100			

Table C.3.1. Continued.

Survey Question	Variable Description		Answer Choices	Frequency	%	95% CI		p-value*
						LL	UL	
13	Maximum # loose stools in 24 hours	0	Blank	3	0.4	0.0	0.9	<0.0001
		1	0-2	293	40.0	36.4	43.5	
		2	3-5	310	42.3	38.7	45.9	
		3	More than 5	107	14.6	12.0	17.2	
		4	I don't remember	20	2.7	1.5	3.9	
			Total	733	100			
15	Blood in Stool	0	Blank/No Response	1	0.1	0.0	0.4	<0.0001
		1	Yes	61	8.3	6.3	10.3	
		2	No	623	85.0	82.4	87.6	
		3	I don't remember	48	6.5	4.8	8.3	
			Total	733	100			
16	Vomiting in last 30 days	0	Blank/No Response	3	0.1	0.0	0.3	<0.0001
		1	Yes	150	7.3	6.2	8.5	
		2	No	1888	92.2	91.1	93.4	
		3	I don't remember	6	0.3	0.1	0.5	
			Total	2047	100			
17	Max # of times vomited in 24 hours	1	0	1	0.7	0.0	2.0	<0.0001
		2	1	54	36.0	28.2	43.8	
		3	2-4	76	50.7	42.6	58.8	
		4	More than 5	16	10.7	5.7	15.7	
		5	I don't remember	3	2.0	0.0	4.3	
			Total	150	100			
19	Experienced Both diarrhea and vomiting	1	Yes	95	63.3	55.5	71.1	<0.0001
		2	No	51	34.0	26.3	41.7	
		3	I don't remember	4	2.7	0.1	5.3	
			Total	150	100			
21	Still experiencing illness today	1	Yes	9	8.1	3.0	13.3	<0.0001
		2	No	98	88.3	82.2	94.4	
		3	I don't know	4	3.6	0.1	7.1	
			Total	111	100			
22	Experienced respiratory symptoms	0	Blank/No Response	2	0.3	0.0	0.6	<0.0001
		1	Yes	222	28.8	25.6	32.0	
		2	No	531	68.8	65.5	72.1	
		3	I don't remember	17	2.2	1.2	3.2	
		Total	Total	772	100			
23	Sought medical care for illness	0	Blank/No Response	2	0.3	0.0	0.6	<0.0001
		1	Yes	124	16.1	13.5	18.7	
		2	No	641	83.0	80.4	85.7	
		3	I don't remember	5	0.6	0.1	1.2	
			Total	772	100			
24	Doctor requested stool sample	1	No	107	84.9	78.6	91.3	<0.0001
		2	Yes, and I did provide one	16	12.7	6.8	18.6	
		3	Yes, but I did NOT provide one	3	2.4	0.0	5.1	
		4	I don't remember	0	0.0	0.0	0.0	
			Total	126	100			
25	Missed work for illness	1	Yes	175	22.7	19.7	25.7	<0.0001
		2	No	589	76.4	73.4	79.4	
		3	I don't remember	7	0.9	0.2	1.6	
			Total	771	100			
27	Symptoms due to a chronic illness	0	Blank/No Response	9	1.2	0.4	1.9	<0.0001
		1	Yes	134	17.4	14.7	20.0	
		2	No	521	67.5	64.2	70.8	
		3	I don't know	108	14.0	11.5	16.4	
			Total	772	100.0			
28	Gender	0	Blank/No Response	4	0.2	0.0	0.4	<0.0001
		1	Male	1612	78.7	77.0	80.5	
		2	Female	417	20.4	18.6	22.1	
		3	Prefer not to respond	14	0.7	0.3	1.0	
			Total	2047	100			

Table C.3.1. Continued.

Survey Question	Variable Description		Answer Choices	Frequency	%	95% CI		p-value*
						LL	UL	
29	Rank	0	Blank/No Response	10	0.5	0.2	0.8	<0.0001
		1	E1-E4	245	12.0	10.6	13.4	
		2	E5-E6	580	28.3	26.4	30.3	
		3	E7-E9	472	23.1	21.2	24.9	
		4	WO1-CW2	55	2.7	2.0	3.4	
		5	CW3-CW5	62	3.0	2.3	3.8	
		6	O1-O3	372	18.2	16.5	19.8	
		7	O4-O6	248	12.1	10.7	13.5	
		8	O7-O9	3	0.1	0.0	0.3	
			Total	2047	100			
31	Branch/Corps	1	Acquisition	11	0.5	0.2	0.9	<0.0001
		2	Adjutant General	86	4.2	3.3	5.1	
		3	Air Defense Artillery	36	1.8	1.2	2.3	
		4	Armor	88	4.3	3.4	5.2	
		5	Aviation	125	6.1	5.1	7.1	
		6	Chaplain	25	1.2	0.7	1.7	
		7	Chemical	47	2.3	1.6	2.9	
		8	Engineer	95	4.6	3.7	5.6	
		9	Field Artillery	110	5.4	4.4	6.4	
		10	Finance	17	0.8	0.4	1.2	
		11	Infantry	166	8.1	6.9	9.3	
		12	Judge Advocate General	31	1.5	1.0	2.0	
		13	Logistics	70	3.4	2.6	4.2	
		14	Medical/Veterinary/Nurse Dental	224	10.9	9.6	12.3	
		15	Medical Service	209	10.2	8.9	11.5	
		16	Military Intelligence	134	6.5	5.5	7.6	
		17	Military Police	54	2.6	1.9	3.3	
		18	Ordnance	141	6.9	5.8	8.0	
		19	Public Affiars	9	0.4	0.2	0.7	
		20	Quartermaster	147	7.2	6.1	8.3	
		21	Signal	128	6.3	5.2	7.3	
		22	Special Operations Forces	34	1.7	1.1	2.2	
		23	Transportation	33	1.6	1.1	2.2	
		24	Cyber Branch	6	0.3	0.1	0.5	
		25	Functional Area Branch	5	0.2	0.0	0.5	
		26	General Officer	2	0.1	0.0	0.2	
		27	Recruiting	6	0.3	0.1	0.5	
		28	Uknown	8	0.4	0.1	0.7	
			Total	2047	100			
32	Deployed or traveled in last 30 days	0	Blank	12	0.6	0.3	0.9	<0.0001
		1	Yes	241	11.8	10.4	13.2	
		2	No	1794	87.6	86.2	89.1	
			Total	2047	100			
33	Race	1	American Indian or Alaska Native	49	2.4	1.7	3.1	<0.0001
		2	Asian	102	5.0	4.0	5.9	
		3	Black or African American	393	19.2	17.5	20.9	
		4	Hispanic or Latino	263	12.8	11.4	14.3	
		5	Native Hawaiian or Other Pacific Islander	47	2.3	1.6	2.9	
		6	White	1129	55.2	53.0	57.3	
		7	Multi-racial	39	1.9	1.3	2.5	
		8	Uknown/Blank	25	1.2	0.7	1.7	
			Total	2047	100			
34	Education Level	1	High school/GED	129	6.3	5.2	7.4	<0.0001
		2	Some college, no degree	617	30.1	28.2	32.1	
		3	Associates	305	14.9	13.4	16.4	
		4	Bachelor's	578	28.2	26.3	30.2	
		5	Master's	288	14.1	12.6	15.6	
		6	Doctorate	109	5.3	4.4	6.3	
		7	Technical	14	0.7	0.3	1.0	
		8	Other/Uknown	7	0.3	0.1	0.6	
			Total	2047	100			

Table C.3.1. Continued.

Survey Question	Variable Description		Answer Choices	Frequency	%	95% CI		p-value*
						LL	UL	
35	Duty Location	1	Benelux	8	0.4	0.1	0.7	<0.0001
		2	Casey	45	2.2	1.6	2.8	
		3	Belvoir	38	1.9	1.3	2.4	
		4	Benning	160	7.8	6.7	9.0	
		5	Bliss	162	7.9	6.7	9.1	
		6	Bragg	239	11.7	10.3	13.1	
		7	Campbell	134	6.5	5.5	7.6	
		8	Drum	78	3.8	3.0	4.6	
		9	Hood	251	12.3	10.8	13.7	
		10	Knox	15	0.7	0.4	1.1	
		11	JBLM	279	13.6	12.1	15.1	
		12	Riley	93	4.5	3.6	5.4	
		13	Sill	72	3.5	2.7	4.3	
		14	Wainwright	49	2.4	1.7	3.1	
		15	Hawaii	83	4.1	3.2	4.9	
		16	Japan	13	0.6	0.3	1.0	
		17	Bavaria	117	5.7	4.7	6.7	
		18	Vicenza	29	1.4	0.9	1.9	
		19	Uknown	6	0.3	0.1	0.5	
		20	Other	176	8.6	7.4	9.8	
			Total	2047	100			

*Chi-square test: null hypothesis is that all classification levels have the same frequency. If p-value is <0.05, then reject the null and

Descriptive Statistics of Continuous Variables

Continuous variables include: age, number of days diarrhea, number of days vomiting, number of days both diarrhea and vomiting, and number of days of work missed.

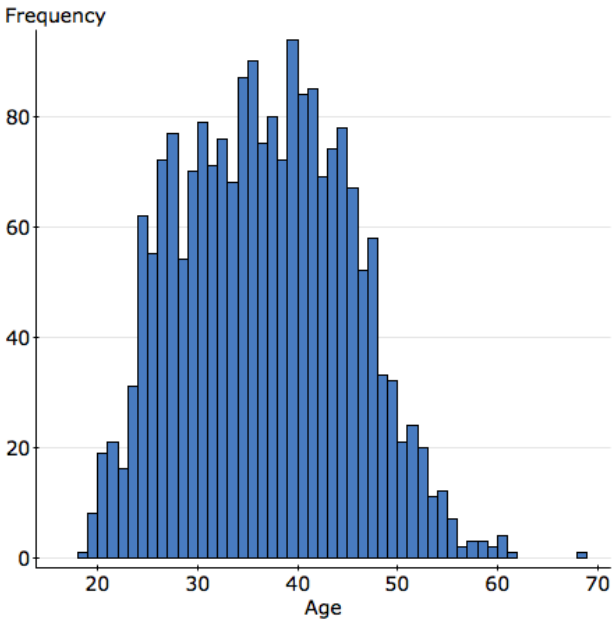


Figure C.3.1. Histogram of the distribution of the continuous variable age.

The continuous variable age is normally distributed. The appropriate descriptive statistics include mean and standard deviation.

Table C.3.2. Summary statistics for continuous variable age.

Variable	n	Mean	Standard Deviation
Age (years)	2021	36.29	8.31

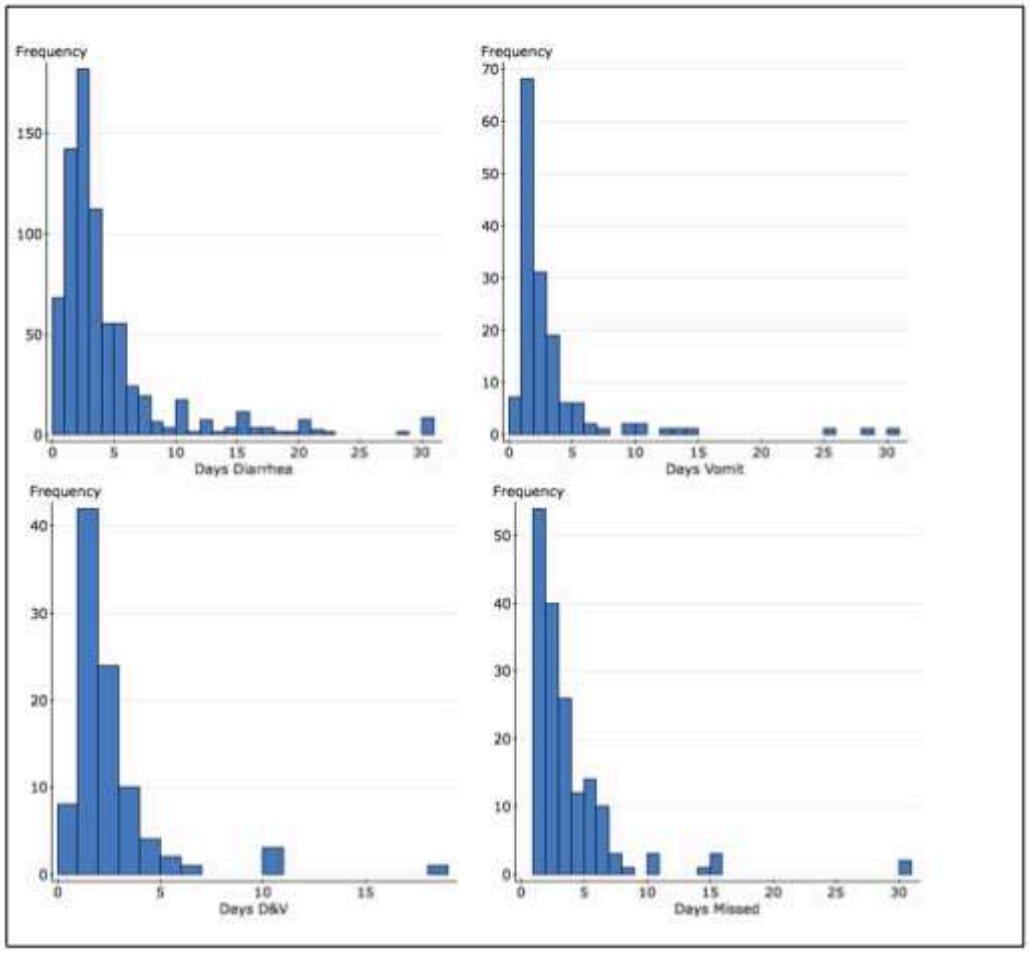


Figure C.3.2. Histograms displaying the distribution of continuous variables duration of diarrhea (days diarrhea), duration of vomiting (days vomit), duration of diarrhea and vomiting (days D&V), and number of days of missed work (days missed).

All histograms display distributions that are right skewed. The appropriate descriptive statistics for these data are median and range.

Table C.3.3. Summary statistics for continuous variables duration of diarrhea, duration of vomiting, duration of diarrhea and vomiting, and number of days of missed.

Variable	n	Median	Minimum	Maximum
Diarrhea duration	733	2	0	30
Vomiting duration	150	1.5	0	30
Vomiting & diarrhea duration	95	1	0	18
Days of missed work	771	2	1	3

Statistical Tests of Continuous Variables

Analysis of Variance results:
Responses: Age
Factors: Region

Response statistics by factor

Region	n	Mean	Std. Dev.	Std. Error
ERMC	154	35.194805	7.9162924	0.63791302
NRMC	402	37.365672	8.3180611	0.41486718
PRMC	138	33.992754	8.2493055	0.70222752
SRMC	651	36.462366	7.97012	0.31237363
WRMC	630	36.030159	8.7039661	0.34677431

ANOVA table

Source	DF	SS	MS	F-Stat	P-value
Region	4	1434.452	358.61299	5.2099899	0.0004
Error	1970	135598.65	68.831802		
Total	1974	137033.1			

Figure C.3.3. One-way analysis of variance (ANOVA) results comparing age of respondents between regions.

The null hypothesis for the ANOVA test is that there is no difference in mean age of respondents across the different geographical regions. ANOVA test p-value is 0.004, therefore we reject the null and conclude that at least one of the regional mean ages is significantly different. To test this, we used a post-hoc test, the Tukey's Honest Significant Difference Test (HSD).

Tukey HSD results (95% level)

ERMC subtracted from

	Difference	Lower	Upper	P-value
NRMC	2.1708664	0.024175283	4.3175576	0.0459
PRMC	-1.2020516	-3.8572506	1.4531475	0.7302
SRMC	1.2675604	-0.76223679	3.2973576	0.431
WRMC	0.83535354	-1.2009052	2.8716123	0.796

NRMC subtracted from

	Difference	Lower	Upper	P-value
PRMC	-3.372918	-5.6077757	-1.1380603	0.0004
SRMC	-0.90330605	-2.3401719	0.53355981	0.424
WRMC	-1.3355129	-2.7814923	0.11046649	0.0862

PRMC subtracted from

	Difference	Lower	Upper	P-value
SRMC	2.469612	0.3467878	4.5924361	0.0131
WRMC	2.0374051	-0.091598278	4.1664085	0.0684

SRMC subtracted from

	Difference	Lower	Upper	P-value
WRMC	-0.43220686	-1.698165	0.83375131	0.8844

Figure C.3.4. Results of Tukey's HSD. Significant differences in mean age include the following: PRMC mean age is significantly lower than NRMC (3.4 years) and SRMC (2.5 years).

Table C.3.4. Results of the Kruskal-Wallis test.

	Region of Residence					
Variable (days)	ERMC	NRMC	PRMC	SRMC	WRMC	P-value
Median Diarrhea duration	2	3	2	2	2	0.149
Median Vomiting duration	2	2	1.5	2	1	0.716
Median Vomiting & diarrhea duration	1	1.5	1.5	2	1	0.956
Median Days of missed work	3	2	2	2	2	0.985

The four continuous variables described by median and range were compared by region using the Kruskal-Wallis test. The null hypothesis is that there is no difference in median for each variable when compared between regions. All p-values are greater than 0.05, so we fail to reject the null hypothesis and conclude the median diarrhea duration, vomiting duration, vomiting and diarrhea duration, and number of days missed work are not significant different by region of residence.

SAS Code and Output to Assess Independent Variables by Outcome Variable (AGI case). Contingency tables below display each independent variable by the outcome variable (AGI case). Assessment of these tables helped to see initial associations and to identify blank or sparse cells that could affect the analysis. This helped to guide collapsing of variables. Cells with values of 10 are left are highlighted.

Table C.3.5. Contingency tables of each independent variable by the outcome variable (AGI case).

Variable	Case (AGI)	Non-Case	Total
Region of residence			
ERMC	25	67	92
NRMC	67	310	377
PRMC	19	88	107
SRMC	119	505	624
WRMC	101	485	586
Middle East/Africa	0	0	0
Unknown/Blank	6	14	20
Total	337	1469	1806
Gender			
Male	261	1143	1404
Female	74	310	384
Blank/No Response	0	4	4
Prefer Not To Respond	2	12	14
Total	337	1469	1806
Rank			
E1-E4	53	178	231
E5-E6	100	415	515
E7-E9	62	353	415
WO1-CW2	12	35	47
CW3-CW5	7	39	46
O1-O3	52	274	326
O4-O6	49	165	214
O7-O9	0	3	3
Blank/No Response	2	7	9
Total	337	1469	1806
Race			
American Indian or Alaska Native	9	32	41
Asian	13	70	83
Black or African American	59	292	351
Hispanic or Latino	47	191	238
Native Hawaiian or Other Pacific Islander	10	34	44
White	192	797	989
Multi-racial	6	31	37
Unknown/Blank	1	22	23
Total	337	1469	1806

Table C.3.5. Continued.

Variable	Case (AGI)	Non-Case	Total
Education			
High school/GED	21	95	116
Some college, no degree	111	438	549
Associates	53	215	268
Bachelor's	81	419	500
Master's	45	206	251
Doctorate	23	78	101
Technical	2	12	14
Other/Unknown	1	6	7
Total	337	1469	1806
Concurrent symptoms/severity			
Maximum number loose stools in 24 hrs.			
Blank	0	3	3
0-2	23	230	253
3-5	222	54	276
More than 5	67	24	91
I don't remember	1	19	20
Total	313	330	643
Blood in stool			
Blank/No Response	0	1	1
Yes	24	29	53
No	260	284	544
I don't remember	29	16	45
Total	313	330	643
Respiratory Symptoms (Sore throat/cough)			
Blank/No Response	0	2	2
Yes	107	90	197
No	222	241	463
I don't remember	8	8	16
Total	337	341	678
Vomiting			
Blank/No Response	0	3	3
Yes	104	28	132
No	232	1433	1665
I don't remember	1	5	6
Total	337	1469	1806

Table C.3.5. Continued.

Variable	Case (AGI)	Non-Case	Total
Max times vomit in 24 hrs.			
0	0	1	1
1	35	9	44
2-4	56	13	69
More than 5	11	4	15
I don't remember	2	1	3
Total	104	28	132
Both diarrhea and vomiting			
Yes	69	15	84
No	33	12	45
I don't remember	2	1	3
Total	104	28	132
Missed Work			
Yes	104	51	155
No	229	286	515
I don't remember	3	4	7
Total	336	341	677
Branch			
Acquisition	2	5	7
Adjutant General	20	54	74
Air Defense Artillery	4	25	29
Armor	13	68	81
Aviation	17	83	100
Chaplain	1	20	21
Chemical	9	36	45
Engineer	13	69	82
Field Artillery	19	74	93
Finance	1	14	15
Infantry	24	121	145
Judge Advocate General	9	19	28
Logistics	13	46	59
Medical/Veterinary/Nurse Dental	38	175	213
Medical Service	41	149	190
Military Intelligence	21	98	119
Military Police	4	42	46
Ordnance	28	98	126
Public Affairs	1	6	7
Quartermaster	20	110	130
Signal	22	91	113

Table C.3.5. Continued.

Variable	Case (AGI)	Non-Case	Total
Special Operations Forces	6	24	30
Transportation	6	22	28
Cyber Branch	0	5	5
Functional Area Branch	1	3	4
General Officer	0	2	2
Recruiting	3	3	6
Unknown	1	7	8
Total	337	1469	1806

```
/*contingency tables to look for sparse or blank cells*/
proc free data=surveydata;tables region*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables gender*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables rank*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables race*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables education*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables Max_diarrhea*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables blood*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables sore_throat*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables vomit*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables max_vomit*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables D_V*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables days_D_V*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables miss_work*MAGE2/nocol norow nopercent;run;
proc freq data=surveydata;tables branch*MAGE2/nocol norow nopercent;run;
```

Creating Categorical Variables from Continuous Variables and Collapsing of Categorical Variables

In this analysis, all continuous variables were converted to categorical variables. In addition, some categorical variables were collapsed. The decision to collapse certain variables was based on initial descriptive statistic evaluation. Some variables included sparse or blank cells. Collapsing of variables was only performed when the resultant collapsed variable made sense.

SAS Code for creating categorical variables from continuous variables and collapsing of categorical variables

Below is the SAS code used to create/collapse categorical variables. The boxes to the right provide a description of the new variables.

The continuous variable age was categorized to match the published military demographics report: 25 or younger, 26 to 30, 31 to 35, 36 to 40, 41 or older. This method for categorizing age was chosen to allow for comparison of our respondent population to the US Army population.

```
if region=1 then region2=1;
if region=2 then region2=2;
if region=3 then region2=3;
if region=4 then region2=4;
if region=5 then region2=5;
```

The Region category was created in the original Excel data file. Each installation is in one of five regional medical commands (RMC). This code removes blank responses and installations located in outside the RMCs (deployed locations. 1=ERMC, 2=NRMC, 3=PRMC, 4=SRMC, 5=WRMC

```
if rankcat=1 then rankcat2=1;
if rankcat=2 then rankcat2=2;
```

The rank category was created in the original Excel data file to create 2 ranks (officer/enlisted), assigning all enlisted ranks to rankcat=2 and all officers to rankcat=1. Rankcat2 was created to remove blank responses.

```
if race=6 then race2=1;
if race=3 then race2=2;
if race=1 then race2=3;
if race=2 then race2=3;
if race=4 then race2=3;
if race=5 then race2=3;
if race=7 then race2=3;
```

The race category was collapsed into a three-category variable as follows: race2=1=White/non-Hispanic, race2=2=Black or African American, race2=4=all other races.

```
if education=1 then education2=1;
if education=2 then education2=1;
if education=3 then education2=1;
if education=4 then education2=2;
if education=5 then education2=3;
if education=6 then education2=3;
if education=7 then education2=1;
```

The education variable was collapsed into a three-category variable as follows:
education2=1=Associate/technical degree or less
education2=2=Bachelor's degree,
education2=3=advanced degree

```
if max_diarrhea=1 then max_diarrhea2=1;
if max_diarrhea=2 then max_diarrhea2=1;
if max_diarrhea=3 then max_diarrhea2=2;
```

The maximum number of loose stools in 24 hours variable (max_diarrhea) was collapsed into a 2 category variable where
max_diarrhea2=1=≤5 loose stools and
diarrhea2=2= >5 loose stools

```
if blood=1 then blood2=1;
if blood=2 then blood2=2
```

The blood2 category removes blank and I don't know responses to the question about presence of blood in stool.

```
if sore_throat=1 then sore_throat2=1;
if sore_throat=2 then sore_throat2=2;
```

The sore_throat2 category removes blank and I don't know responses to the question about concurrent respiratory symptoms.

```
if vomit=1 then vomit2=1;
if vomit=2 then vomit2=2;
```

The sore_throat2 category gets rid of blank and I don't know responses to the question about concurrent respiratory symptoms.

```
if max_vomit=2 then max_vomit3=1;
if max_vomit=3 then max_vomit3=1;
if max_vomit=4 then max_vomit3=2;
```

The maximum number of times vomited variable was collapsed into two-category variable where max_vomit3=1=≤5 and max_vomit3=2=>5.

```
if days_vomit=1 then days_vomit3=1;
if days_vomit=2 then days_vomit3=1;
if days_vomit>2 then days_vomit3=2;
```

The continuous variable duration of vomiting was converted to a two-category variable where days_vomit3=1=<3 days and days_vomit3=2=≥3 days.

```
if days_diarrhea=1 then days_diarrhea3=1;
if days_diarrhea=2 then days_diarrhea3=1;
if days_diarrhea>2 then days_diarrhea3=2;
```

The continuous variable duration of diarrhea was converted to a two-category variable where days_diarrhea3=1=<3 days and days_diarrhea3=2=≥3 days.

```
if miss_work=1 then miss_work2=1;
if miss_work=2 then miss_work2=2;
```

The miss_work2 category removes blank and I don't know responses to the question about whether respondents missed work for their illness.

```
if days_missed=1 then days_missed2=1;
if days_missed=2 then days_missed2=2;
if days_missed>2 then days_missed2=2;
```

The days_missed2 category collapses the continuous variable duration of work missed into a two-category variable where days_missed2=1=<2 days and days_missed2=2≥2 days

```
if deployed=1 then deployed2=1;
if deployed=2 then deployed2=2;
```

The deployed2 category removes blank and I don't know responses to the question about whether respondents were deployed or traveled in the last 30 days.

```
if branch=1 then branch2=2;
if branch=23 then branch2=2;
if branch=18 then branch2=2;
if branch=20 then branch2=2;
if branch=2 then branch2=2;
if branch=10 then branch2=2;
if branch=12 then branch2=2;
if branch=13 then branch2=2;
if branch=22 then branch2=1;
if branch=14 then branch2=3;
if branch=15 then branch2=3;
if branch=11 then branch2=4;
if branch=5 then branch2=4;
if branch=4 then branch2=4;
if branch=8 then branch2=4;
if branch=17 then branch2=4;
if branch=7 then branch2=4;
if branch=9 then branch2=4;
if branch=3 then branch2=4;
if branch=21 then branch2=5;
if branch=16 then branch2=5;
if branch=19 then branch2=5;
if branch=25 then branch2=5;
if branch=24 then branch2=5;
if branch=6 then branch2=6;
```

The branch of service category was collapsed into a six-category variable as follows: branch2=1=Special Operations Forces, branch2=2=Force Sustainment Division; branch2=3=Health Services Division, branch2=4=Operations Division, branch2=5=Operations Support Division, and branch3=6=Chaplain

```
if D_V=1 then D_V2=1;
if D_V=2 then D_V2=2;
```

The D_V2 category removes blank and I don't know responses to the question about whether respondents experienced both diarrhea and vomiting simultaneously.

```
if Days_D_V=1 then Days_D_V2=1;
if Days_D_V=2 then Days_D_V2=1;
if Days_D_V=>3 then Days_D_V2=2;
```

The duration of diarrhea and vomiting continuous variable was converted into a two-category variable where Days_D_V2=1=<3 days and Days_D_V2=2≥3 days.

```
if Region2=1 then Overseas=1;
if Region2=2 then Overseas=2;
If region2=3 then Overseas=1;
if region2=4 then overseas=2;
if region2=5 then overseas=2;
```

The Overseas category collapses region2 into those regions located in the US vs. overseas. Overseas1=overseas location, oversease2=located in the United States.

```
if installation=2 then post=0;
if installation=18 then post=0;
if installation=17 then post=0;
if installation=3 then post=0;
if installation=10 then post=0;
if installation=1 then post=1;
if installation=4 then post=1;
if installation=5 then post=1;
if installation=6 then post=1;
if installation=7 then post=1;
if installation=8 then post=1;
if installation=9 then post=1;
if installation=11 then post=1;
if installation=12 then post=1;
if installation=13 then post=1;
if installation=14 then post=1;
if installation=15 then post=1;
if installation=16 then post=1;
```

The post variable categorizes installations as a two-category variable where post=0 is installations with the AGI incidence of >3 episodes/person year, and post=1 is installations with AGI incidence of < 3 episodes per person-year.

```
if FF_V=1 then FFV2=1;
if FF_V=2 then FFV2=2;
if FF_V=3 then FFV2=2;
if FF_V=4 then FFV2=2;
if FF_V=5 then FFV2=2;
if FF_V=6 then FFV2=2;
if FF_V=7 then FFV2=.;

if dairy=1 then D2=1;
if dairy=2 then D2=2;
if dairy=3 then D2=2;
if dairy=4 then D2=2;
if dairy=5 then D2=2;
if dairy=6 then D2=.;

if eggs=1 then E2=1;
if eggs=2 then E2=2;
if eggs=3 then E2=2;
```

All of these codes collapse the variables about where seven different food commodities are procured into 2-category variables. For each commodity, 1=Purchase on-post and 2=Purchase off-post

```
if eggs=4 then E2=2;
if eggs=5 then E2=2;
if eggs=6 then E2=2;
if eggs=7 then E2=.;

if fish=1 then F2=1;
if fish=2 then F2=2;
if fish=3 then F2=2;
if fish=4 then F2=2;
if fish=5 then F2=2;
if fish=6 then F2=.;

if meat=1 then M2=1;
if meat=2 then M2=2;
if meat=3 then M2=2;
if meat=4 then M2=2;
if meat=5 then M2=2;
if meat=6 then M2=2;

if poultry=1 then P2=1;
if poultry=2 then P2=2;
if poultry=3 then P2=2;
if poultry=4 then P2=2;
if poultry=5 then P2=2;
if poultry=6 then P2=2;

if grains=1 then G2=1;
if grains=2 then G2=2;
if grains=3 then G2=2;
if grains=4 then G2=2;
if grains=5 then G2=2;
if grains=6 then G2=2;

run;
```

Appendix D-3

Weights for known differences between respondent demographics and population demographics were calculated by calculating the percent difference for rank, age, region of residence, and gender. Gender and age also were weighted by rank and rank was weighted by age.

Table D.3.1. Calculations for weights of known demographic differences.

Education:	Army Population		Survey Respondents		Weight
	#	%	#	%	
Less than Bachelor's	410572	77.7%	1065	52.2%	1.489
Bachelor's Degree	74974	14.2%	578	28.3%	0.501
Advanced Degree	38555	7.3%	397	19.5%	0.375
Gender:	Army Population		Survey Respondents		Weight
	#	%	#	%	
Male	456165	86.4%	1612	79.4%	1.087
Female	71905	13.6%	417	20.6%	0.663
Race:	Army Population		Survey Respondents		Weight
	#	%	#	%	
Total White	361877	68.5%	1129	55.8%	1.227
Black	110854	21.0%	393	19.4%	1.080
Total other	55339	10.5%	500	24.7%	0.424
Location:	Army Population		Survey Respondents		Weight
	#	%	#	%	
United States	470743	89.1%	1705	85.3%	1.046
Overseas	30343	5.7%	295	14.8%	0.390
Age:	Army Population		Survey Respondents		Weight
	#	%	#	%	
25 or Younger	208880	39.6%	213	10.5%	3.753
26-30	119362	22.6%	352	17.4%	1.298
31-35	83159	15.7%	392	19.4%	0.812
36-40	58266	11.0%	405	20.0%	0.551
41 or Older	68403	13.0%	659	32.6%	0.397

Table D.3.1. Continued.

Region:	Army Population		Survey Respondents		Weight
	#	%	#	%	
ERMC	27451	5.8%	154	7.7%	0.750
NRMC	98821	20.8%	406	20.3%	1.024
PRMC	37822	8.0%	141	7.1%	1.129
SRMC	170051	35.8%	663	33.2%	1.079
WRMC	141239	29.7%	636	31.8%	0.934
Rank:	Army Population		Survey Respondents		Weight
	#	%	#	%	
Officer	98967	18.7%	740	36.3%	0.516
Enlisted	429103	81.3%	1297	63.7%	1.276
Rank by Gender:	Army Population		Survey Respondents		Weight
	#	%	#	%	
Male Officer	82743	15.7%	571	28.2%	0.555
Male Enlisted	373422	70.7%	1037	51.3%	1.380
Female Officer	16224	3.1%	164	8.1%	0.379
Female Enlisted	55681	10.5%	251	12.4%	0.850
Rank by Gender:	Army Population		Survey Respondents		Weight
	#	%	#	%	
Enlisted 25 or Younger	196143	37.1%	152	7.4%	5.002
Enlisted 26-30	98358	18.6%	215	10.5%	1.773
Enlisted 31-35	62666	11.9%	237	11.6%	1.025
Enlisted 36-40	39681	7.5%	275	13.4%	0.559
Enlisted 41 or Older	32255	6.1%	405	19.8%	0.309
Officer 25 or Younger	12737	2.4%	60	2.9%	0.823
Officer 26-30	21004	4.0%	136	6.6%	0.599
Officer 31-35	20493	3.9%	153	7.5%	0.519
Officer 36-40	18585	3.5%	130	6.4%	0.554
Officer 41 or Older	26148	5.0%	254	12.4%	0.399

SAS Code for Crude Survey Response Data for Table D.3.1 (above).

```
proc freq data=surveydata;tables region2/nocol norow nopercent;run;
proc freq data=surveydata;tables gender1/nocol norow nopercent;run;
proc freq data=surveydata;tables rankcat2/nocol norow nopercent;run;
proc freq data=surveydata;tables agecat/nocol norow nopercent;run;
proc freq data=surveydata;tables race2/nocol norow nopercent;run;
proc freq data=surveydata;tables education2/nocol norow nopercent;run;
```

```
proc freq data=surveydata;tables /nocol norow nopercent;run;
```

SAS Code for Weighting of Variables

```
if region2=1 then wgtreg=0.7499;
if region2=2 then wgtreg=1.0240;
if region2=3 then wgtreg=1.1285;
if region2=4 then wgtreg=1.0791;
if region2=5 then wgtreg=0.9343;

if overseas=1 then wgtloc=0.3896;
if overseas=2 then wgtloc=1.0457;

if gender1=1 then wgtgen=1.0873;
if gender1=2 then wgtgen=0.6625;

if rankcat2=1 then wgtrank=0.5159;
if rankcat2=2 then wgtrank=1.2762;

if agecat=1 then wgtage=3.7531;
if agecat=2 then wgtage=1.2978;
if agecat=3 then wgtage=0.8119;
if agecat=4 then wgtage=0.5506;
if agecat=5 then wgtage=0.3973;

if race2=1 then wgtrace=1.2273;
if race2=2 then wgtrace=1.0801;
if race2=3 then wgtrace=0.4238;

if education2=1 then wgtedu=1.4893;
if education2=2 then wgtedu=0.5011;
if education2=3 then wgtedu=0.3752;

if gender1=1 and rankcat2=1 then wgtrankgen=0.56;
if gender1=1 and rankcat2=2 then wgtrankgen=1.38;
if gender1=2 and rankcat2=1 then wgtrankgen=0.38;
if gender1=2 and rankcat2=2 then wgtrankgen=0.85;

if rankcat2=1 and agecat=1 then wgtrankage=0.8229;
if rankcat2=1 and agecat=2 then wgtrankage=0.5987;
if rankcat2=1 and agecat=3 then wgtrankage=0.5192;
if rankcat2=1 and agecat=4 then wgtrankage=0.5542;
if rankcat2=1 and agecat=5 then wgtrankage=0.3991;

if rankcat2=2 and agecat=1 then wgtrankage=5.0021;
if rankcat2=2 and agecat=2 then wgtrankage=1.7734;
if rankcat2=2 and agecat=3 then wgtrankage=1.0250;
if rankcat2=2 and agecat=4 then wgtrankage=0.5593;
```

```
if rankcat2=2 and agecat=5 then wgtrankage=0.3087;
```

SAS Code to Verify Correct Weighting of Variables:

```
proc freq data=surveydata;tables region2 wgtreg region2*wgtreg/nocol norow nopercent;run;
proc freq data=surveydata;tables overseas wgtloc overseas*wgtloc/nocol norow nopercent;run;
proc freq data=surveydata;tables overseas wgtgen gender1*wgtgen/nocol norow nopercent;run;
proc freq data=surveydata;tables rankcat2 wgtrank rankcat2*wgtrank/nocol norow
nopercent;run;
proc freq data=surveydata;tables agecat wgtage agecat*wgtage/nocol norow nopercent;run;
proc freq data=surveydata;tables race2 wgtrace race2*wgtrace/nocol norow nopercent;run;
proc freq data=surveydata;tables education2 wgtedu education2*wgtedu/nocol norow
nopercent;run;
```

SAS Output Verifying Weighting is Correct:

Contingency tables were created ensure each variable only received on weight. The tables are below showing that each variable is assigned only one weight (zeros in all other cells).

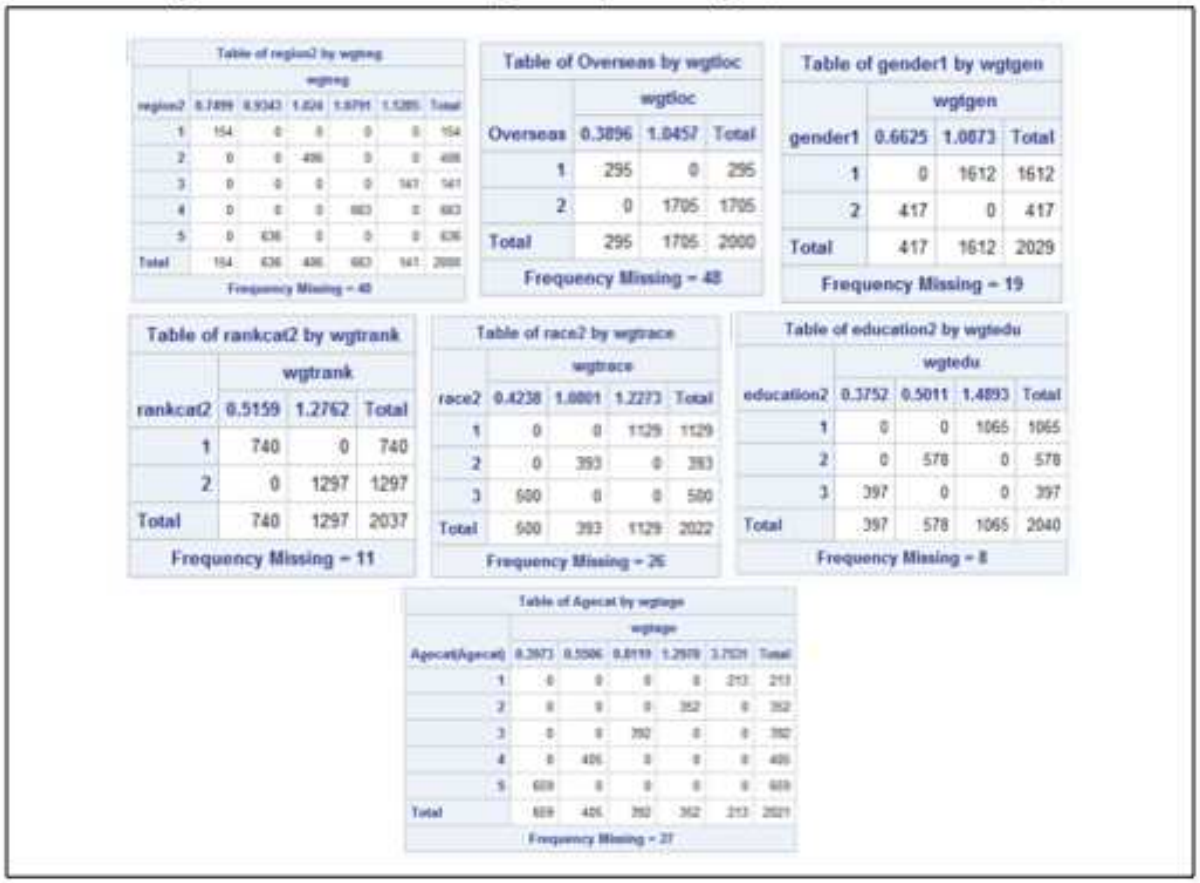


Table of Overseas by wgtloc

Overseas	wgtloc 0.3896	1.0457	Total
1	295	0	295
2	0	1705	1705
Total	295	1705	2000

Frequency Missing = 48

Table of gender1 by wgtgen

gender1	wgtgen 0.6625	1.0873	Total
1	0	1612	1612
2	417	0	417
Total	417	1612	2029

Frequency Missing = 19

Table of rankcat2 by wgtrank

rankcat2	wgtrank 0.5159	1.2762	Total
1	740	0	740
2	0	1297	1297
Total	740	1297	2037

Frequency Missing = 11

Table of race2 by wgtrace

race2	wgtrace 0.4238	1.0801	1.2273	Total
1	0	0	1129	1129
2	0	393	0	393
3	500	0	0	500
Total	500	393	1129	2022

Frequency Missing = 26

Table of education2 by wgtedu

education2	wgtedu 0.3752	0.5011	1.4893	Total
1	0	0	1065	1065
2	0	578	0	578
3	397	0	0	397
Total	397	578	1065	2040

Frequency Missing = 8

Figure D.3.1. Contingency tables of weighted variables by weight. These tables were created to ensure the different levels of each variable were assigned only one weight. Each table shows only one weight value for each variable.

Appendix E-3

SAS Code and Output For Survey Weighted Data in Formulas to Calculate Estimated AGI Prevalence and Incidence (See Chapter 3 Table 1 n*).

Not Excluding Respiratory Disease

```
proc surveyfreq data=surveydata;tables region2 mage2 region2*mage2/nopercent; strata
installation; weight wgtreg; run;
proc surveyfreq data=surveydata;tables overseas mage2 overseas*mage2/nopercent; weight
wgtloc; strata region2 installation; run;
proc surveyfreq data=surveydata;tables gender1 mage2 gender1*mage2/nopercent; weight
wgtrankgen; strata region2
installation; run;
proc surveyfreq data=surveydata;tables rankcat2 mage2 rankcat2*mage2/nopercent; weight
wgtrankage; strata region2
installation;run;
proc surveyfreq data=surveydata;tables agecat mage2 agecat*mage2/nopercent; weight
wgtrankage;strata region2
installation; run;
proc surveyfreq data=surveydata;tables race2 mage2 race2*mage2/nopercent; weight wgtrace;
strata region2
installation;run;
proc surveyfreq data=surveydata;tables education2 mage2 education2*mage2/nopercent; weight
wgtedu;strata region2
installation; run;
proc surveyfreq data=surveydata;tables mage2/nopercent;strata region2 installation; weight
wgtreg;run;
```

Excluding Respiratory Disease:

```
proc surveyfreq data=surveydata2;table mage2NST/nopercent;strata region2 installation;weight
wgtreg;run;
proc surveyfreq data=surveydata2;tables region2 mage2NST region2*mage2NST/nopercent;
strata installation; weight wgtreg; run;
proc surveyfreq data=surveydata2;tables overseas mage2NST overseas*mage2NST/nopercent;
weight wgtloc; strata region2 installation; run;
proc surveyfreq data=surveydata2;tables gender1 mage2NST gender1*mage2NST/nopercent;
weight wgtrankgen; strata region2 installation; run;
proc surveyfreq data=surveydata2;tables rankcat2 mage2NST rankcat2*mage2NST/nopercent;
weight wgtrankage; strata region2 installation;run;
proc surveyfreq data=surveydata2;tables agecat mage2NST agecat*mage2NST/nopercent;
weight wgtrankage;strata region2 installation; run;
proc surveyfreq data=surveydata2;tables race2 mage2NST race2*mage2NST/nopercent; weight
wgtrace; strata region2 installation;run;
proc surveylogistic data=surveydata2; class race2/param=ref ref=last;
```

proc surveyfreq data=surveydata2;tables education2 mage2NST
education2*mage2NST/nopercent; weight wgtedu;strata region2 installation; run;
SAS Output:
Table E.3.1. SAS output of crude and weighted data for number of AGI cases and AGI cases excluding respiratory symptoms by demographic categories. Inputs for formulas are highlighted (lighter highlight=weighted AGI cases, darker highlight=number at risk).

All Responses	AGI Case	Crude Number	Weighted	AGI Case Excluding Respiratory	Crude Number	Weighted
	Yes	331	332	Yes	227	229
	No	1455	1465	No	1559	1568
	Total	1786	1797	Total	1786	1797
Region	**AGI Case**	**Crude Number**	**Weighted**	**AGI Case Excluding Respiratory**	**Crude Number**	**Weighted**
ERMC	Yes	25	19	Yes	12	9
	No	67	50	No	80	60
	Total	92	69	Total	92	69
NRMC	Yes	67	69	Yes	45	46
	No	310	317	No	332	340
	Total	377	386	Total	377	386
PRMC	Yes	19	21	Yes	13	15
	No	88	99	No	94	106
	Total	107	121	Total	107	121
SRMC	Yes	119	128	Yes	85	92
	No	505	545	No	539	582
	Total	624	673	Total	624	674
WRMC	Yes	101	94	Yes	72	67
	No	485	453	No	514	480
	Total	586	547	Total	586	547
Location	**AGI Case**	**Crude Number**	**Weighted**	**AGI Case Excluding Respiratory**	**Crude Number**	**Weighted**
Overseas	Yes	44	17	Yes	25	10
	No	155	60	No	174	68
	Total	199	78	Total	199	78
United States	Yes	287	301	Yes	202	212
	No	1300	1359	No	1385	1448
	Total	1578	1660	Total	1578	1660

Table E.3.1. Continued.

Gender	AGI Case	Crude Number	Weighted	AGI Case Excluding Respiratory	Crude Number	Weighted
Male	Yes	254	277	Yes	173	187
	No	1128	1241	No	1209	1331
	Total	1382	1518	Total	1382	1518
Female	Yes	73	50	Yes	50	32
	No	309	205	No	332	223
	Total	382	255	Total	382	255
Rank	AGI Case	Crude Number	Weighted	AGI Case Excluding Respiratory	Crude Number	Weighted
Officer	Yes	116	61	Yes	85	44
	No	506	267	No	537	284
	Total	622	328	Total	622	328
Enlisted	Yes	209	317	Yes	137	198
	No	928	1172	No	1000	1291
	Total	1137	1489	Total	1137	1489
Age (Years)	AGI Case	Crude Number	Weighted	AGI Case Excluding Respiratory	Crude Number	Weighted
25 or Younger	Yes	39	166	Yes	23	98
	No	153	565	No	169	632
	Total	192	731	Total	192	730
26-30	Yes	67	94	Yes	46	60
	No	240	317	No	261	350
	Total	307	411	Total	307	410
31-35	Yes	61	48	Yes	43	35
	No	289	242	No	307	255
	Total	350	290	Total	350	290
36-40	Yes	70	39	Yes	43	24
	No	277	155	No	304	170
	Total	347	194	Total	347	194
41 and Over	Yes	88	30	Yes	67	23
	No	475	162	No	496	169
	Total	563	192	Total	563	192

Table E.3.1. Continued.

Race	AGI Case	Crude Number	Weighted	AGI Case Excluding Respiratory	Crude Number	Weighted
White/Non-Hispanic	Yes	189	232	Yes	127	156
	No	790	970	No	852	1046
	Total	979	1202	Total	979	1202
Black or African American	Yes	59	64	Yes	36	39
	No	290	313	No	313	338
	Total	349	377	Total	349	377
All Other Races	Yes	82	35	Yes	63	27
	No	356	151	No	375	159
	Total	438	186	Total	438	186
Education	AGI Case	Crude Number	Weighted	AGI Case Excluding Respiratory	Crude Number	Weighted
Associates or Technical or Less	Yes	185	275	Yes	121	180
	No	756	1126	No	820	1221
	Total	941	1401	Total	941	1401
Bachelor's	Yes	78	39	Yes	49	25
	No	414	208	No	443	222
	Total	492	247	Total	492	247
Advanced	Yes	67	25	Yes	56	21
	No	281	106	No	292	110
	Total	348	131	Total	348	131

Formulas for Estimated Prevalence, Point Prevalence, Annual AGI Incidence, Adjustment Factor for Incidence, and 95% Confidence Intervals.

$$\text{Prevalence}=\frac{\textbf{no.of cases}}{\textbf{total no.at risk}}$$

$$\text{Point prevalence}=\frac{\text{no.of cases with symptoms on they day of the survey}}{\text{total no.at risk}}$$

$$\text{Annual AGI incidence}=\frac{\text{no.of cases}-\text{adjustment factor}}{\text{total no.at risk}-\text{adjustment factor}}*\frac{365}{30}$$

$$\text{Adjustment factor (proportion of pre-existing cases)}=\frac{x-1}{30+(x-1)}$$

x= mean duration of illness

Upper and lower 95% confidence limit for incidence:

$$\left(\frac{1}{2n}\right) * \chi^2_{2x,0.025} * \left(\frac{365}{30}\right), \left(\frac{1}{2n}\right) * \chi^2_{2x+2,0.975} * \left(\frac{365}{30}\right),$$

$\chi^2_{v,\alpha}$ = the chi-square deviate with lower tail area α on *v* degrees of freedom,

n = the population at risk

x = the number of cases

These formulas were placed into an Excel spreadsheet and the outputs in Table 3-1 were entered to calculate outcomes of interest.

Appendix F-3

SAS Code and Outputs For Univariable and Multivariable Analysis
Univariable Analysis:
Region

```
proc surveylogistic data=surveydata; class region2/param=ref ref=last;
model mage2=region2;strata installation;weight wgtreg;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.5690	0.1096	204.8793	<.0001
region2	1	1	0.5832	0.2596	5.0486	0.0246
region2	2	1	0.0371	0.1740	0.0456	0.8310
region2	3	1	0.0361	0.2770	0.0170	0.8962
region2	4	1	0.1236	0.1499	0.6795	0.4098

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 1 vs 5	1.792	1.077	2.980
region2 2 vs 5	1.038	0.738	1.460
region2 3 vs 5	1.037	0.602	1.784
region2 4 vs 5	1.132	0.843	1.518

Location

```
proc surveylogistic data=surveydata; class overseas/param=ref ref=last;
model mage2=overseas;strata region2 installation; weight wgtloc;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.5106	0.0654	534.0515	<.0001
Overseas	1	1	0.2515	0.1825	1.8997	0.1681

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.286	0.899	1.839

Gender

```
proc surveylogistic data=surveydata; class gender1/param=ref ref=first;
model mage2=gender1;weight wgtrankgen;strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.5006	0.0739	412.4406	<.0001
gender1	2	1	0.0752	0.1559	0.2330	0.6293

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 2 vs 1	1.078	0.794	1.463

Rank

```
proc surveylogistic data=surveydata2; class rankcat2/param=ref ref=last; model
mage2NST=rankcat2;weight wgtrank;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4763	0.1049	197.9100	<.0001
rankcat2	2	1	0.1669	0.1528	1.1929	0.2747

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
rankcat2 2 vs 1	1.182	0.876	1.594

Age

```
proc surveylogistic data=surveydata; class agecat/param=ref ref=last;
model mage2=agecat;weight wgtrankage;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.6822	0.1171	206.3748	<.0001
Agecat	1	1	0.4568	0.2268	4.0581	0.0440
Agecat	2	1	0.4702	0.1899	6.1295	0.0133
Agecat	3	1	0.0738	0.1888	0.1527	0.6960
Agecat	4	1	0.3059	0.1778	2.9620	0.0852

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Agecat 1 vs 5	1.579	1.012	2.463
Agecat 2 vs 5	1.600	1.103	2.322
Agecat 3 vs 5	1.077	0.744	1.559
Agecat 4 vs 5	1.358	0.958	1.924

Race

```
proc surveylogistic data=surveydata; class race2/param=ref ref=last;
model mage2=race2;weight wgtrace;strata region2 installation; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4682	0.1228	142.9321	<.0001
race2	1	1	0.0379	0.1471	0.0665	0.7965
race2	2	1	-0.1241	0.1886	0.4332	0.5104

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 1 vs 3	1.039	0.779	1.386
race2 2 vs 3	0.883	0.610	1.278

Education

```
proc surveylogistic data=surveydata; class education2/param=ref ref=last;
model mage2=education2;weight wgtedu; strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4337	0.1364	110.5482	<.0001
education2	1	1	0.0260	0.1592	0.0266	0.8704
education2	2	1	-0.2354	0.1841	1.6350	0.2010

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
education2 1 vs 3	1.026	0.751	1.402
education2 2 vs 3	0.790	0.551	1.134

```
/*DFAC*/
proc surveyfreq data=surveydata;tables DFAC_code mage2 DFAC_code*mage2/nopercent;
strata region2
installation;run;
proc surveylogistic data=surveydata; class DFAC_code/param=ref ref=first;
model mage2=DFAC_code;strata region2 installation; run;
/*on-post*/
proc surveyfreq data=surveydata;tables On_Post_Code mage2
On_Post_Code*mage2/nopercent;strata region2 installation;run;
proc surveylogistic data=surveydata; class On_Post_Code/param=ref ref=first;
model mage2=On_Post_Code;strata region2 installation;run;
/*At Home*/
proc surveyfreq data=surveydata;tables At_Home_code mage2
At_Home_code*mage2/nopercent;strata region2 installation;run;
proc surveylogistic data=surveydata; class At_Home_code/param=ref ref=last;
model mage2=At_Home_code;strata region2 installation;run;
/*Off-post Establishments*/
proc surveyfreq data=surveydata;tables Off_Post_Code mage2
Off_Post_Code*mage2/nopercent;strata region2
installation;run;
proc surveylogistic data=surveydata; class Off_Post_Code/param=ref ref=first;
model mage2=Off_Post_Code;strata region2 installation;run;
/*FF&V*/
proc surveyfreq data=surveydata;tables FFV2 mage2 FFV2*mage2/nopercent;strata region2
installation;run;
proc surveylogistic data=surveydata; class FFV2/param=ref ref=last;
model mage2=FFV2;strata region2 installation;run;
/*Dairy*/
proc surveyfreq data=surveydata;tables d2 mage2 d2*mage2/nopercent;strata region2
installation;run;
proc surveylogistic data=surveydata; class d2/param=ref ref=last;
model mage2=d2;strata region2 installation;run;
/*eggs*/
proc surveyfreq data=surveydata;tables e2 mage2 e2*mage2/nopercent;strata region2
installation;run;
proc surveylogistic data=surveydata; class e2/param=ref ref=last;
model mage2=e2;strata region2 installation;run;
/*Fish*/
proc surveyfreq data=surveydata;tables f2 mage2 f2*mage2/nopercent;strata region2
installation;run;
proc surveylogistic data=surveydata; class f2/param=ref ref=last;
model mage2=f2;strata region2 installation;run;
/*Meat*/
proc surveyfreq data=surveydata;tables M2 mage2 M2*mage2/nopercent; strata region2
installation;run;
proc surveylogistic data=surveydata; class M2/param=ref ref=last;
```

```
model mage2=M2;strata region2 installation;run;
/*Poultry*/
proc surveyfreq data=surveydata;tables P2 mage2 P2*mage2/nopercent; strata region2
installation;run;
proc surveylogistic data=surveydata; class P2/param=ref ref=last;
model mage2=P2;strata region2 installation;run;
/*Grains*/
proc surveyfreq data=surveydata;tables G2 mage2 G2*mage2/nopercent; strata region2
installation;run;
proc surveylogistic data=surveydata; class G2/param=ref ref=last;
model mage2=G2;strata region2 installation;run;
```

SAS Output

Table G.3.1. Summary of SAS output used obtain 'n' and AGI % for Chapter 3 Table 3.

Variable	AGI	No AGI	Total	% AGI
Eat at on-post dining facility (DFAC)				
Never	226	985	1211	18.7%
At least once a week <2 times/day	75	398	473	15.9%
Twice a day	17	51	68	25.0%
More than twice a day	13	21	34	38.2%
Total	331	1455	1786	
Eat at other on-post establishments				
Never	122	659	781	15.6%
At least once a week <2 times/day	204	764	968	21.1%
Twice a day	3	22	25	12.0%
More than twice a day	2	10	12	16.7%
Total	331	1455	1786	
Eat at home				
Never	14	60	74	18.9%
At least once a week <2 times/day	120	468	588	20.4%
Twice a day	90	410	500	18.0%
More than twice a day	107	517	624	17.1%
Total	331	1455	1786	
Eat at off-post establishment				
Never	49	250	299	16.4%
At least once a week <2 times/day	261	1120	1381	18.9%
Twice a day	17	69	86	19.8%
More than twice a day	4	16	20	20.0%
Total	331	1455	1786	
Fresh fruits & vegetables				
Purchase on-post	151	631	782	19.3%
Purchase off-post	180	816	996	18.1%
Total	331	1447	1778	

Dairy				
Purchase on-post	169	665	834	20.3%
Purchase off-post	161	783	944	17.1%
Total	330	1448	1778	
Eggs				
Purchase on-post	150	619	769	19.5%
Purchase off-post	178	821	999	17.8%
Total	328	1440	1768	
Fresh Fish				
Purchase on-post	90	436	526	17.1%
Purchase off-post	232	975	1207	19.2%
Total	322	1411	1733	
Fresh Meat				
Purchase on-post	157	672	829	18.9%
Purchase off-post	170	762	932	18.2%
Total	327	1434	1761	
Fresh Poultry				
Purchase on-post	167	686	853	19.6%
Purchase off-post	164	761	925	17.7%
Total	331	1447	1778	
Dry grains and beans				
Purchase on-post	175	698	873	20.0%
Purchase off-post	156	755	911	17.1%

Multivariable Analysis:

Full Model with all variables with p<0.25 from Univariable Analysis:
proc surveylogistic data=surveydata; class region2 agecat education2 DFAC_code On_post_code at_home_code D2 G2/param=ref ref=first;
model mage2=region2 agecat education2 DFAC_code On_post_code at_home_code D2 G2 ;strata region2 installation

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.2637	0.4547	7.7235	0.0055
region2	2	1	-0.3882	0.2867	1.8337	0.1757
region2	3	1	-0.7244	0.3656	3.9266	0.0475
region2	4	1	-0.2703	0.2731	0.9795	0.3223
region2	5	1	-0.4567	0.2740	2.7783	0.0955
Agecat	2	1	0.1756	0.2305	0.5802	0.4462
Agecat	3	1	-0.1924	0.2361	0.6635	0.4153

Agecat	4	1	0.0166	0.2313	0.0051	0.9428
Agecat	5	1	-0.3317	0.2239	2.1954	0.1384
education2	2	1	-0.1777	0.1557	1.3034	0.2536
education2	3	1	0.1909	0.1703	1.2567	0.2623
DFAC_Code	1	1	-0.3233	0.1553	4.3314	0.0374
DFAC_Code	2	1	0.3199	0.3052	1.0985	0.2946
DFAC_Code	3	1	0.8377	0.4370	3.6749	0.0552
On_Post_Code	1	1	0.3375	0.1353	6.2226	0.0126
On_Post_Code	2	1	-0.4567	0.6400	0.5093	0.4755
On_Post_Code	3	1	-0.2525	0.7909	0.1019	0.7495
At_Home_Code	1	1	0.3334	0.3419	0.9505	0.3296
At_Home_Code	2	1	0.1793	0.3488	0.2641	0.6073
At_Home_Code	3	1	0.1614	0.3516	0.2108	0.6461
D2	2	1	-0.1560	0.2140	0.5309	0.4662
G2	2	1	-0.0419	0.2155	0.0378	0.8458

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
region2 2 vs 1	0.678	0.387	1.190
region2 3 vs 1	0.485	0.237	0.992
region2 4 vs 1	0.763	0.447	1.303
region2 5 vs 1	0.633	0.370	1.084
Agecat 2 vs 1	1.192	0.759	1.873
Agecat 3 vs 1	0.825	0.519	1.311
Agecat 4 vs 1	1.017	0.646	1.600
Agecat 5 vs 1	0.718	0.463	1.113
education2 2 vs 1	0.837	0.617	1.136
education2 3 vs 1	1.210	0.867	1.690
DFAC_Code 1 vs 0	0.724	0.534	0.981
DFAC_Code 2 vs 0	1.377	0.757	2.505
DFAC_Code 3 vs 0	2.311	0.981	5.442
On_Post_Code 1 vs 0	1.401	1.075	1.827
On_Post_Code 2 vs 0	0.633	0.181	2.220
On_Post_Code 3 vs 0	0.777	0.165	3.660
At_Home_Code 1 vs 0	1.396	0.714	2.728
At_Home_Code 2 vs 0	1.196	0.604	2.370
At_Home_Code 3 vs 0	1.175	0.590	2.341
D2 2 vs 1	0.856	0.562	1.302
G2 2 vs 1	0.959	0.629	1.463

Remove G2 (Dried Grains)

```
proc surveylogistic  data=surveydata; class region2 agecat education2 DFAC_code
On_post_code at_home_code D2 G2/param=ref ref=first;model mage2=region2 agecat
education2 DFAC_code On_post_code at_home_code D2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.2639	0.4545	7.7334	0.0054
region2	2	1	-0.3945	0.2853	1.9118	0.1668
region2	3	1	-0.7281	0.3651	3.9771	0.0461
region2	4	1	-0.2763	0.2719	1.0330	0.3095
region2	5	1	-0.4629	0.2725	2.8864	0.0893
Agecat	2	1	0.1740	0.2309	0.5684	0.4509
Agecat	3	1	-0.1934	0.2362	0.6704	0.4129
Agecat	4	1	0.0170	0.2312	0.0054	0.9414
Agecat	5	1	-0.3303	0.2231	2.1908	0.1388
education2	2	1	-0.1784	0.1555	1.3159	0.2513
education2	3	1	0.1910	0.1702	1.2593	0.2618
DFAC_Code	1	1	-0.3236	0.1553	4.3451	0.0371
DFAC_Code	2	1	0.3201	0.3057	1.0962	0.2951
DFAC_Code	3	1	0.8368	0.4368	3.6696	0.0554
On_Post_Code	1	1	0.3382	0.1351	6.2705	0.0123
On_Post_Code	2	1	-0.4563	0.6415	0.5059	0.4769
On_Post_Code	3	1	-0.2541	0.7921	0.1029	0.7484
At_Home_Code	1	1	0.3349	0.3419	0.9593	0.3274
At_Home_Code	2	1	0.1810	0.3488	0.2692	0.6039
At_Home_Code	3	1	0.1644	0.3514	0.2189	0.6399
D2	2	1	-0.1892	0.1309	2.0872	0.1485

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 2 vs 1	0.674	0.385	1.179
region2 3 vs 1	0.483	0.236	0.988
region2 4 vs 1	0.759	0.445	1.292
region2 5 vs 1	0.629	0.369	1.074
Agecat 2 vs 1	1.190	0.757	1.871
Agecat 3 vs 1	0.824	0.519	1.309
Agecat 4 vs 1	1.017	0.647	1.600
Agecat 5 vs 1	0.719	0.464	1.113
education2 2 vs 1	0.837	0.617	1.135
education2 3 vs 1	1.210	0.867	1.690
DFAC_Code 1 vs 0	0.724	0.534	0.981
DFAC_Code 2 vs 0	1.377	0.756	2.507
DFAC_Code 3 vs 0	2.309	0.981	5.435
On_Post_Code 1 vs 0	1.402	1.076	1.828
On_Post_Code 2 vs 0	0.634	0.180	2.228
On_Post_Code 3 vs 0	0.776	0.164	3.663
At_Home_Code 1 vs 0	1.398	0.715	2.732
At_Home_Code 2 vs 0	1.198	0.605	2.374

At_Home_Code 3 vs 0	1.179	0.592	2.347
D2 2 vs 1	0.828	0.640	1.070

No change >10% in odds ratios between full and reduce model, no evidence of confounding by dried grains.

Remove at home

```
proc surveylogistic  data=surveydata; class region2 agecat education2 DFAC_code
On_post_code at_home_code D2 G2/param=ref ref=first;
model mage2=region2 agecat education2 DFAC_code On_post_code D2;strata region2
installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.0499	0.3142	11.1660	0.0008
region2	2	1	-0.3925	0.2844	1.9043	0.1676
region2	3	1	-0.7324	0.3646	4.0344	0.0446
region2	4	1	-0.2705	0.2711	0.9953	0.3184
region2	5	1	-0.4633	0.2716	2.9091	0.0881
Agecat	2	1	0.1716	0.2305	0.5546	0.4564
Agecat	3	1	-0.1869	0.2350	0.6323	0.4265
Agecat	4	1	0.0203	0.2298	0.0078	0.9295
Agecat	5	1	-0.3220	0.2225	2.0952	0.1478
education2	2	1	-0.1984	0.1539	1.6608	0.1975
education2	3	1	0.1625	0.1678	0.9375	0.3329
DFAC_Code	1	1	-0.3070	0.1531	4.0195	0.0450
DFAC_Code	2	1	0.3158	0.2957	1.1411	0.2854
DFAC_Code	3	1	0.7859	0.4028	3.8071	0.0510
On_Post_Code	1	1	0.3497	0.1322	6.9972	0.0082
On_Post_Code	2	1	-0.4197	0.6272	0.4476	0.5035
On_Post_Code	3	1	-0.2158	0.7909	0.0744	0.7850
D2	2	1	-0.1885	0.1305	2.0866	0.1486

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 2 vs 1	0.675	0.387	1.179
region2 3 vs 1	0.481	0.235	0.982
region2 4 vs 1	0.763	0.448	1.298
region2 5 vs 1	0.629	0.369	1.072
Agecat 2 vs 1	1.187	0.756	1.865
Agecat 3 vs 1	0.830	0.523	1.315
Agecat 4 vs 1	1.021	0.650	1.601
Agecat 5 vs 1	0.725	0.469	1.121
education2 2 vs 1	0.820	0.606	1.109
education2 3 vs 1	1.176	0.847	1.635
DFAC_Code 1 vs 0	0.736	0.545	0.993

DFAC_Code 2 vs 0	1.371	0.768	2.448
DFAC_Code 3 vs 0	2.194	0.996	4.833
On_Post_Code 1 vs 0	1.419	1.095	1.838
On_Post_Code 2 vs 0	0.657	0.192	2.247
On_Post_Code 3 vs 0	0.806	0.171	3.798
D2 2 vs 1	0.828	0.641	1.070

No change >10% in odds ratios between full and reduce model, no evidence of confounding by eating at home.

Remove Education

proc surveylogistic data=surveydata; class region2 agecat DFAC_code On_post_code at_home_code D2 G2/param=ref ref=first;

model mage2=region2 agecat DFAC_code On_post_code D2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.1067	0.3108	12.6839	0.0004
region2	2	1	-0.3963	0.2831	1.9596	0.1616
region2	3	1	-0.7585	0.3643	4.3360	0.0373
region2	4	1	-0.2709	0.2700	1.0067	0.3157
region2	5	1	-0.4539	0.2700	2.8261	0.0927
Agecat	2	1	0.1668	0.2290	0.5306	0.4664
Agecat	3	1	-0.1476	0.2322	0.4038	0.5251
Agecat	4	1	0.0688	0.2263	0.0925	0.7610
Agecat	5	1	-0.2474	0.2164	1.3065	0.2530
DFAC_Code	1	1	-0.3137	0.1532	4.1925	0.0406
DFAC_Code	2	1	0.3272	0.2962	1.2201	0.2694
DFAC_Code	3	1	0.7792	0.4033	3.7325	0.0534
On_Post_Code	1	1	0.3592	0.1319	7.4182	0.0065
On_Post_Code	2	1	-0.4271	0.6261	0.4654	0.4951
On_Post_Code	3	1	-0.2465	0.7949	0.0961	0.7565
D2	2	1	-0.1968	0.1296	2.3079	0.1287

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
region2 2 vs 1	0.673	0.386	1.172
region2 3 vs 1	0.468	0.229	0.956
region2 4 vs 1	0.763	0.449	1.295
region2 5 vs 1	0.635	0.374	1.078
Agecat 2 vs 1	1.182	0.754	1.851
Agecat 3 vs 1	0.863	0.547	1.360
Agecat 4 vs 1	1.071	0.687	1.669
Agecat 5 vs 1	0.781	0.511	1.193
DFAC_Code 1 vs 0	0.731	0.541	0.987
DFAC_Code 2 vs 0	1.387	0.776	2.479
DFAC_Code 3 vs 0	2.180	0.989	4.805

On_Post_Code 1 vs 0	1.432	1.106	1.855
On_Post_Code 2 vs 0	0.652	0.191	2.226
On_Post_Code 3 vs 0	0.782	0.165	3.712
D2 2 vs 1	0.821	0.637	1.059

No change >10% in odds ratios between full and reduce model, no evidence of confounding by education.

Remove Agecat

```
proc surveylogistic  data=surveydata; class region2 agecat DFAC_code On_post_code
at_home_code D2 G2/param=ref ref=first;model mage2=region2 DFAC_code On_post_code
D2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.1664	0.2602	20.0936	<.0001
region2	2	1	-0.4081	0.2831	2.0775	0.1495
region2	3	1	-0.7295	0.3661	3.9694	0.0463
region2	4	1	-0.2943	0.2707	1.1826	0.2768
region2	5	1	-0.4781	0.2709	3.1157	0.0775
DFAC_Code	1	1	-0.2924	0.1513	3.7365	0.0532
DFAC_Code	2	1	0.3514	0.2955	1.4142	0.2344
DFAC_Code	3	1	0.8743	0.3954	4.8894	0.0270
On_Post_Code	1	1	0.3609	0.1315	7.5291	0.0061
On_Post_Code	2	1	-0.3865	0.6356	0.3698	0.5431
On_Post_Code	3	1	-0.1378	0.7903	0.0304	0.8616
D2	2	1	-0.1805	0.1289	1.9606	0.1615

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 2 vs 1	0.665	0.382	1.158
region2 3 vs 1	0.482	0.235	0.988
region2 4 vs 1	0.745	0.438	1.266
region2 5 vs 1	0.620	0.365	1.054
DFAC_Code 1 vs 0	0.746	0.555	1.004
DFAC_Code 2 vs 0	1.421	0.796	2.536
DFAC_Code 3 vs 0	2.397	1.104	5.203
On_Post_Code 1 vs 0	1.435	1.109	1.856
On_Post_Code 2 vs 0	0.679	0.196	2.361
On_Post_Code 3 vs 0	0.871	0.185	4.100
D2 2 vs 1	0.835	0.648	1.075

No change >10% in odds ratios between full and reduce model, no evidence of confounding by

age category.
Remove D2

```
proc surveylogistic  data=surveydata; class region2 agecat DFAC_code On_post_code
at_home_code D2 G2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.2108	0.2576	22.0993	<.0001
region2	2	1	-0.4673	0.2779	2.8271	0.0927
region2	3	1	-0.7299	0.3656	3.9856	0.0459
region2	4	1	-0.3688	0.2633	1.9622	0.1613
region2	5	1	-0.5380	0.2654	4.1090	0.0427
DFAC_Code	1	1	-0.2856	0.1510	3.5774	0.0586
DFAC_Code	2	1	0.3651	0.2941	1.5408	0.2145
DFAC_Code	3	1	0.8923	0.3943	5.1209	0.0236
On_Post_Code	1	1	0.3742	0.1310	8.1519	0.0043
On_Post_Code	2	1	-0.3911	0.6358	0.3784	0.5385
On_Post_Code	3	1	-0.1323	0.7835	0.0285	0.8659

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 2 vs 1	0.627	0.363	1.080
region2 3 vs 1	0.482	0.235	0.987
region2 4 vs 1	0.692	0.413	1.159
region2 5 vs 1	0.584	0.347	0.982
DFAC_Code 1 vs 0	0.752	0.559	1.010
DFAC_Code 2 vs 0	1.441	0.809	2.564
DFAC_Code 3 vs 0	2.441	1.127	5.287
On_Post_Code 1 vs 0	1.454	1.124	1.880
On_Post_Code 2 vs 0	0.676	0.195	2.351
On_Post_Code 3 vs 0	0.876	0.189	4.069

No change >10% in odds ratios between full and reduce model, no evidence of confounding by D2 (dairy procurement)

SAS Code and Output to Check Other Variables For Evidence of Confounding:

Added other variables back into the model to check for evidence of confounding.

```
/*check other variables for confounding*/
/*gender (yes)*/
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code
gender1/param=ref ref=first;
```

```
model mage2=region2 DFAC_code On_post_code gender1;strata region2 installation;run;
/*rank (yes)*/
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code
rankcat2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code rankcat2;strata region2 installation;run;
/*race (yes)*/
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code race2/param=ref
ref=first;
model mage2=region2 DFAC_code On_post_code race2;strata region2 installation;run;
```

Table F.3.1. Summary of the SAS output for odds ratios (ORs) and change in odds ratios before and after adding potential confounders back into the mode. Evidence of confounding by gender, rank, and race. Keep all three in the model.

Variables	Pre-Final Model OR Outputs	OR After Add Gender	% Change	OR After Add Rank	% Change	OR After Add Race	% Change
region2 2 vs 1	0.665	0.648	2.56%	0.615	-7.52%	0.621	6.62%
region2 3 vs 1	0.482	0.563	-16.80%	0.525	8.92%	0.551	-14.32%
region2 4 vs 1	0.745	0.712	4.43%	0.681	-8.59%	0.671	9.93%
region2 5 vs 1	0.62	0.602	2.90%	0.568	-8.39%	0.568	8.39%
DFAC 1 vs 0	0.746	0.766	-2.68%	0.771	3.35%	0.768	-2.95%
DFAC 2 vs 0	1.421	1.402	1.34%	1.326	-6.69%	1.386	2.46%
DFAC 3 vs 0	2.397	2.639	-10.10%	2.976	24.16%	2.931	-22.28%
OnPost 1 vs 0	1.435	1.499	-4.46%	1.494	4.11%	1.485	-3.48%
OnPost 2 vs 0	0.679	0.69	-1.62%	0.694	2.21%	0.712	-4.86%
OnPost 3 vs 0	0.871	0.846	2.87%	0.836	-4.02%	0.832	4.48%

SAS Code and Output to Check For Evidence of Multiplicative Interaction:

```
*Check for multiplicative interaction*/
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
region2*DFAC_Code;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
region2*On_post_code;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
region2*gender1;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
```

```
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
region2*rankcat2;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2 region2*race2;strata
region2 installation;run;

proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
DFAC_Code*On_Post_code;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
DFAC_Code*gender1;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
DFAC_Code*rankcat2;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
DFAC_Code*race2;strata region2 installation;run;

proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
On_post_code*gender1;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
On_post_code*rankcat2;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
On_post_code*race2;strata region2 installation;run;

proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2
gender1*rankcat2;strata region2 installation;run;
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2 gender1*race2;strata
region2 installation;run;
```

```
proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2 rankcat2*race2;strata
region2 installation;run;/*no evidence of multiplicative interaction*/
```

Table F.3.2. Summary of SAS output after adding interaction terms back into the model to look for evidence of multiplicative interaction. Table displays the interaction terms and associated P-values.

Interaction Term	P-value	Interaction Term	P-Value
region2*DFAC_Code	0.2262	region2*gender1	0.9043
region2*DFAC_Code	0.7433	region2*gender1	0.6515
region2*DFAC_Code	0.6095	region2*gender1	0.6414
region2*DFAC_Code	0.1322	region2*gender1	0.9780
region2*DFAC_Code	0.3920	region2*rankcat2	0.4702
region2*DFAC_Code	0.7881	region2*rankcat2	0.3546
region2*DFAC_Code	0.1027	region2*rankcat2	0.7579
region2*DFAC_Code	0.2451	region2*rankcat2	0.9296
region2*DFAC_Code	0.6095	region2*race2	0.9108
region2*DFAC_Code	0.1322	region2*race2	0.7737
region2*DFAC_Code	0.3920	region2*race2	0.9865
region2*DFAC_Code	0.7881	region2*race2	0.9343
region2*On_Post_Code	0.3605	region2*race2	0.6977
region2*On_Post_Code	0.7080	region2*race2	0.9240
region2*On_Post_Code	0.8583	region2*race2	0.5091
region2*On_Post_Code	0.9428	region2*race2	0.7924
region2*On_Post_Code	0.6631	DFAC_Code*On_Post_	0.6791
region2*On_Post_Code	0.2766	DFAC_Code*On_Post_	0.5091
region2*On_Post_Code	0.1907	DFAC_Code*On_Post_	0.7924
region2*On_Post_Code	0.8583	DFAC_Code*On_Post_	0.6791
region2*On_Post_Code	0.9428	DFAC_Code*On_Post_	0.3503
region2*On_Post_Code	0.6631	DFAC_Code*On_Post_	.
region2*On_Post_Code	0.2766	DFAC_Code*On_Post_	0.3213
region2*On_Post_Code	0.1907	DFAC_Code*On_Post_	0.6095
On_Post_Code*gender1	0.2332	DFAC_Code*On_Post_	0.1322
On_Post_Code*gender1	0.5091	DFAC_Code*gender1	0.3920
On_Post_Code*gender1	0.7924	DFAC_Code*gender1	0.7881
On_Post_Cod*rankcat2	0.6791	DFAC_Code*gender1	0.6515
On_Post_Cod*rankcat2	0.9357	DFAC_Code*rankcat2	0.6414
On_Post_Cod*rankcat2	0.4388	DFAC_Code*rankcat2	0.9780
On_Post_Code*race2	0.8837	DFAC_Code*rankcat2	0.4702
On_Post_Code*race2	0.2619	DFAC_Code*race2	0.3546
On_Post_Code*race2	0.6515	DFAC_Code*race2	0.7579

On_Post_Code*race2	0.6414	DFAC_Code*race2	0.9296
On_Post_Code*race2	0.9780	DFAC_Code*race2	0.8837
On_Post_Code*race2	0.4702	DFAC_Code*race2	0.2619
gender1*rankcat2	0.3546	DFAC_Code*race2	0.5484
gender1*race2	0.7579	rankcat2*race2	0.6198
gender1*race2	0.9296	rankcat2*race2	0.0177

No statistically significant interaction terms. No evidence of multiplicative interaction.

SAS Code and Outputs For Model Fit Tests

```
/*model fit tests*/
proc logistic data=surveydata;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2/scale=n aggregate
lackfit;run;
```

There were 281 unique profiles/covariate patterns (J) and 1751 observations (p). $J \ll n$, so Pearson Chi-Square goodness of fit and Deviance tests can be used to assess model fit. If $p \leq 0.05$ there is evidence of lack of model fit. If $p > 0.05$, there is evidence of model fit. The SAS output for both of these tests is below. Both show evidence of model fit.

Deviance and Pearson Goodness-of-Fit Statistics

Criterion	Value	DF	Value/DF	Pr > ChiSq
Deviance	311.6180	274	1.1373	0.0586
Pearson	280.3507	274	1.0232	0.3830

```
/*FINAL MODEL FOR TABLE 2*/

proc surveylogistic  data=surveydata; class region2 DFAC_code On_post_code gender1 rankcat2
race2/param=ref ref=first;
model mage2=region2 DFAC_code On_post_code gender1 rankcat2 race2;strata region2
installation;
contrast '1v5' region2 0 0 0 -1/estimate=exp;
contrast '2v5' region2 1 0 0 -1/estimate=exp;
contrast '3v5' region2 0 1 0 -1/estimate=exp;
contrast '4v5' region2 0 0 1 -1/estimate=exp;
contrast 'officer v enlisted' rankcat2 -1 0/estimate=exp;
contrast 'race 1 v 3' race2 0 -1/estimate=exp;
contrast 'race 2 v 3' race2 1 -1/estimate=exp;
run;
```

Appendix A-4

SAS Input and Output to Identify Highly Correlated Variables

Table A-4-1. Results of the proc corr procedure in SAS. Pearson correlation coefficient of 1 means perfect positive correlation, and correspond to the same variables being compared in the matrix. The highlight "." shows where variables rely on the 'success' of another variable. Correlation coefficients greater than 0.5 are highlighted as well.

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	region2	gender1	rankcat2	Agecat	race2	education2	max_diarrhea 2	days_diarrhea 3	blood2	sore_throat2	vomit2	max_vomit3	days_vomit3	D_V2	Days_D_V2	miss_work2	days_missed2	branch2	Overseas
region2	1	-0.01	0.007	-0.02	-0.01	0.001	-0.06	-0.03	0.037	0.068	0.011	0.017	-0.03	0.219	0.026	0.046	0.008	0.013	0.521
		0.699	0.747	0.327	0.659	0.958	0.094	0.517	0.34	0.065	0.612	0.837	0.712	0.009	0.81	0.213	0.919	0.548	<.000
	2000	1983	1991	1975	1979	1995	695	650	671	735	1991	142	139	142	85	746	163	1986	2000
gender1	-0.01	1	-0.03	-0.12	0.056	0.051	0.018	-0.02	0.037	0.028	-0.07	0.157	0.308	0.037	0.053	-0.11	0.061	-0.16	0.005
	0.699		0.13	<.000	0.012	0.021	0.64	0.665	0.333	0.443	0.003	0.06	2E-04	0.662	0.626	0.003	0.433	<.000	0.809
	1983	2029	2023	2008	2010	2024	707	661	681	750	2022	145	142	145	86	761	167	2015	1983
rankcat2	0.007	-0.03	1	-0.03	0.176	-0.68	-0.01	0.098	-0.06	-0.06	-0.05	-0.07	0.024	0.046	0.151	-0.04	0.126	-0.04	-0.06
	0.747	0.13		0.206	<.000	<.000	0.805	0.012	0.112	0.092	0.03	0.428	0.78	0.586	0.165	0.223	0.104	0.109	0.008
	1991	2023	2037	2017	2019	2032	705	660	679	747	2030	145	142	145	86	758	168	2025	1991
Agecat	-0.02	-0.12	-0.03	1	0.097	0.187	-0.01	-0.06	-0.08	0.05	0.069	-0.18	-0.03	-0.03	0.066	0.046	0.064	-0.06	0.079
	0.327	<.000	0.206		<.000	<.000	0.707	0.141	0.049	0.175	0.002	0.032	0.703	0.749	0.548	0.203	0.416	0.007	5E-04
Agecat	1975	2008	2017	2021	2001	2016	700	655	674	742	2015	145	142	145	86	753	166	2010	1975
race2	-0.01	0.056	0.176	0.097	1	-0.13	0.006	-0.03	-0.1	-0	0.013	-0.04	-0.01	0.175	0.117	-0.03	-0.07	-0.11	-0.02
	0.659	0.012	<.000	<.000		<.000	0.884	0.447	0.008	0.961	0.552	0.646	0.869	0.035	0.284	0.367	0.39	<.000	0.354
	1979	2010	2019	2001	2022	2019	699	653	674	741	2015	144	141	145	86	752	167	2011	1979
education2	0.001	0.051	-0.68	0.187	-0.13	1	-0.01	-0.05	0.031	0.089	0.031	-0.01	-0.04	-0.01	-0.09	0.052	-0.09	-0.02	0.083
	0.958	0.021	<.000	<.000	<.000		0.804	0.195	0.416	0.015	0.161	0.863	0.649	0.934	0.41	0.152	0.241	0.494	2E-04
	1995	2024	2032	2016	2019	2040	706	661	680	749	2031	146	143	146	87	760	169	2026	1995
max_diarrhea2	-0.06	0.018	-0.01	-0.01	0.006	-0.01	1	0.26	-0.1	0.006	-0.2	0.014	0.236	-0.21	0.165	-0.23	0.091	-0.02	-0.07
	0.094	0.64	0.805	0.707	0.884	0.804		<.000	0.007	0.867	<.000	0.885	0.015	0.032	0.143	<.000	0.262	0.675	0.064
	695	707	705	700	699	706	710	652	667	695	707	108	106	106	80	705	155	701	695
days_diarrhea3	-0.03	-0.02	0.098	-0.06	-0.03	-0.05	0.26	1	-0.07	-0.11	-0.08	0.045	0.32	-0.19	0.328	-0.18	0.337	-0.04	0.051
	0.517	0.665	0.012	0.141	0.447	0.195	<.000		0.083	0.004	0.033	0.65	0.001	0.053	0.003	<.000	<.000	0.32	0.191
	650	661	660	655	653	661	652	665	622	649	661	104	103	101	80	659	144	656	650
blood2	0.037	0.037	-0.06	-0.08	-0.1	0.031	-0.1	-0.07	1	0.086	0.151	-0.09	-0.32	0.162	-0.06	0.134	-0.02	0.031	0.074
	0.34	0.333	0.112	0.049	0.008	0.416	0.007	0.083		0.026	<.000	0.386	0.001	0.115	0.61	5E-04	0.831	0.419	0.054
	671	681	679	674	674	680	667	622	684	668	682	97	94	96	73	680	139	676	671
sore_throat2	0.068	0.028	-0.06	0.05	-0	0.089	0.006	-0.11	0.086	1	0.066	-0.01	-0.14	0.159	-0.19	0.1	-0.2	-0.07	0.121
	0.065	0.443	0.092	0.175	0.961	0.015	0.867	0.004	0.026		0.072	0.886	0.086	0.056	0.083	0.006	0.009	0.062	0.001
	735	750	747	742	741	749	695	649	668	753	748	145	142	145	86	748	167	743	735
vomit2	0.011	-0.07	-0.05	0.069	0.013	0.031	-0.2	-0.08	0.151	0.066	1	.	.	.	.	0.359	0.165	0.017	0.03
	0.612	0.003	0.03	0.002	0.552	0.161	<.000	0.033	<.000	0.072		.	.	.	.	<.000	0.033	0.457	0.188
	1991	2022	2030	2015	2015	2031	707	661	682	748	2038	146	143	146	87	759	167	2023	1991
max_vomit3	0.017	0.157	-0.07	-0.18	-0.04	-0.01	0.014	0.045	-0.09	-0.01	.	1	0.338	-0.16	0.338	-0.23	0.17	-0	0.002
	0.837	0.06	0.428	0.032	0.646	0.863	0.885	0.65	0.386	0.886	.		<.000	0.05	0.001	0.005	0.149	0.985	0.977
	142	145	145	145	144	146	108	104	97	145	146	146	141	142	87	144	73	145	142
days_vomit3	-0.03	0.308	0.024	-0.03	-0.01	-0.04	0.236	0.32	-0.32	-0.14	.	0.338	1	-0.14	0.682	-0.21	0.43	-0.13	0.121
	0.712	2E-04	0.78	0.703	0.869	0.649	0.015	0.001	0.001	0.086	.	<.000		0.112	<.000	0.012	1E-04	0.135	0.154
	139	142	142	142	141	143	106	103	94	142	143	141	143	139	86	141	73	142	139
D_V2	0.219	0.037	0.046	-0.03	0.175	-0.01	-0.21	-0.19	0.162	0.159	.	-0.16	-0.14	1	.	0.299	-0.03	-0.02	0.125
	0.009	0.662	0.586	0.749	0.035	0.934	0.032	0.053	0.115	0.056	.	0.05	0.112		.	3E-04	0.828	0.855	0.138
	142	145	145	145	145	146	106	101	96	145	146	142	139	146	87	144	75	145	142
Days_D_V2	0.026	0.053	0.151	0.066	0.117	-0.09	0.165	0.328	-0.06	-0.19	.	0.338	0.682	.	1	-0.13	0.352	-0.04	0.098
	0.81	0.626	0.165	0.548	0.284	0.41	0.143	0.003	0.61	0.083	.	0.001	<.000	.		0.228	0.01	0.706	0.373
	85	86	86	86	86	87	80	80	73	86	87	87	86	87	87	85	53	86	85
miss_work2	0.046	-0.11	-0.04	0.046	-0.03	0.052	-0.23	-0.18	0.134	0.1	0.359	-0.23	-0.21	0.299	-0.13	1	.	0.022	0.013
	0.213	0.003	0.223	0.203	0.367	0.152	<.000	<.000	5E-04	0.006	<.000	0.005	0.012	3E-04	0.228		.	0.543	0.72
	746	761	758	753	752	760	705	659	680	748	759	144	141	144	85	764	169	754	746
days_missed2	0.008	0.061	0.126	0.064	-0.07	-0.09	0.091	0.337	-0.02	-0.2	0.165	0.17	0.43	-0.03	0.352	.	1	-0.01	0.037
	0.919	0.433	0.104	0.416	0.39	0.241	0.262	<.000	0.831	0.009	0.033	0.149	1E-04	0.828	0.01	.		0.886	0.637
	163	167	168	166	167	169	155	144	139	167	167	73	73	75	53	169	169	168	163
branch2	0.013	-0.16	-0.04	-0.06	-0.11	-0.02	-0.02	-0.04	0.031	-0.07	0.017	-0	-0.13	-0.02	-0.04	0.022	-0.01	1	-0.02
	0.548	<.000	0.109	0.007	<.000	0.494	0.675	0.32	0.419	0.062	0.457	0.985	0.135	0.855	0.706	0.543	0.886		0.282
	1986	2015	2025	2010	2011	2026	701	656	676	743	2023	145	142	145	86	754	168	2031	1986
Overseas	0.521	0.005	-0.06	0.079	-0.02	0.083	-0.07	0.051	0.074	0.121	0.03	0.002	0.121	0.125	0.098	0.013	0.037	-0.02	1
	<.000	0.809	0.008	5E-04	0.354	2E-04	0.064	0.191	0.054	0.001	0.188	0.977	0.154	0.138	0.373	0.72	0.637	0.282	
	2000	1983	1991	1975	1979	1995	695	650	671	735	1991	142	139	142	85	746	163	1986	2000

```
proc corr data=surveydata6; var region2 gender1 rankcat2 agecat race2 education2
max_diarrhea2 days_diarrhea3 blood2 sore_throat2 vomit2 max_vomit3 days_vomit3 d_v2
days_d_v2 miss_work2 days_missed2 branch2 overseas;run;
```

Appendix B-4

SAS Code for Univariable Analysis for Model 1: International case definition for AGI; factors associated with service members seeking medical care for AGI.

SAS Code for AGI cases and medical care seeking data used to create Chapter 4 Table 3.

```
/*Region*/
proc surveyfreq data=surveydata;tables region2 mage2 region2*mage2;weight wgtreg; run;
proc surveyfreq data=surveydata;tables region2 mage2doc region2*mage2doc; weight wgtreg;
run;
/*Overseas*/
proc surveyfreq data=surveydata;tables overseas mage2 overseas*mage2; weight wgtloc; run;
proc surveyfreq data=surveydata;tables overseas mage2doc overseas*mage2doc; weight wgtloc;
run;
/*Gender*/
proc surveyfreq data=surveydata;tables gender1 mage2 gender1*mage2;weight wgtgen;run;
proc surveyfreq data=surveydata;tables gender1 mage2doc gender1*mage2doc; weight
wgtgen;run;
/*rank*/
proc surveyfreq data=surveydata;tables rankcat2 mage2 rankcat2*mage2;weight wgtrank;run;
proc surveyfreq data=surveydata;tables rankcat2 mage2doc rankcat2*mage2doc; weight
wgtrank;run;
/*Age*/
proc surveyfreq data=surveydata;tables agecat mage2 agecat*mage2;weight wgtage;run;
proc surveyfreq data=surveydata;tables agecat mage2doc agecat*mage2doc;weight wgtage;run;
/*race collapsed*/
proc surveyfreq data=surveydata;tables race2 mage2 race2*mage2; weight wgtrace; run;
proc surveyfreq data=surveydata;tables race2 mage2doc race2*mage2doc; weight wgtrace; run;
/*education*/
proc surveyfreq data=surveydata;tables education2 mage2 education2*mage2; weight wgtedu;
run;
proc surveyfreq data=surveydata;tables education2 mage2doc education2*mage2doc;weight
wgtedu;run;
/*max diarrhea*/
proc surveyfreq data=surveydata; tables max_diarrhea2 mage2 max_diarrhea2*mage2;run;
proc surveyfreq data=surveydata; tables max_diarrhea2 mage2doc
max_diarrhea2*mage2doc;run;
/*Days Diarrhea Collapsed*/
proc surveyfreq data=surveydata; tables days_diarrhea3 mage2 days_diarrhea3*mage2;run;
proc surveyfreq data=surveydata; tables days_diarrhea3 mage2doc
days_diarrhea3*mage2doc;run;
/*blood*/
proc surveyfreq data=surveydata;tables blood2 mage2 blood2*mage2;run;
proc surveyfreq data=surveydata;tables blood2 mage2doc blood2*mage2doc;run;
```

```
/*Sore Throat*/
proc surveyfreq data=surveydata;tables sore_throat2 mage2 sore_throat2*mage2;run;
proc surveyfreq data=surveydata;tables sore_throat2 mage2doc sore_throat2*mage2doc;run;
/*Vomit*/
proc surveyfreq data=surveydata;tables vomit2 mage2 vomit2*mage2;run;
proc surveyfreq data=surveydata;tables vomit2 mage2doc vomit2*mage2doc;run;
/*Max Vomit Collapsed*/
proc surveyfreq data=surveydata;tables max_vomit3 mage2 max_vomit3*mage2;run;
proc surveyfreq data=surveydata;tables max_vomit3 mage2doc max_vomit3*mage2doc;run;
/*Days Vomit Collapsed */
proc surveyfreq data=surveydata;tables days_vomit3 mage2 days_vomit3*mage2;run;
proc surveyfreq data=surveydata;tables days_vomit3 mage2doc days_vomit3*mage2doc;run;
/*Diarrhea and Vomiting*/
proc surveyfreq data=surveydata;tables D_V2 mage2 D_V2*mage2;run;
proc surveyfreq data=surveydata;tables D_V2 mage2doc D_V2*mage2doc;run;
/*Days diarrhea and vomiting*/
proc surveyfreq data=surveydata; tables Days_D_V2 mage2 Days_D_V2*mage2;run;
proc surveyfreq data=surveydata; tables Days_D_V2 mage2doc Days_D_V2*mage2doc;run;
/*Miss Work*/
proc surveyfreq data=surveydata;tables miss_work2 mage2 miss_work2*mage2;run;
proc surveyfreq data=surveydata;tables miss_work2 mage2doc miss_work2*mage2doc;run;
/*Days Missed*/
proc surveyfreq data=surveydata;tables days_missed2 mage2 days_missed2*mage2;run;
proc surveyfreq data=surveydata;tables days_missed2 mage2doc days_missed2*mage2doc;run;
/*Branch*/
proc surveyfreq data=surveydata;tables branch2 mage2 branch2*mage2;run;
proc surveyfreq data=surveydata;tables branch2 mage2doc branch2*mage2doc;run;
```

Table B.4.1. Summary of SAS outputs of crude and weighted data for weighted variables used to create Chapter 4 table 3 for model 1.

Variable	Crude # AGI Cases	Crude # AGI Cases Seeking Care	Crude % AGI Cases Seeking Care	Weighted # AGI Cases	Weighted # AGI Cases Seeking Care	% AGI Cases Seeking Care
Region						
ERMC	25	7	28.0	18.75	5.25	28.0
NRMC	67	13	19.4	68.61	13.31	19.4
PRMC	19	6	31.6	21.44	6.77	31.6
SRMC	119	18	15.1	128.41	19.42	15.1
WRMC	101	24	23.8	94.36	22.42	23.8
Overseas						
Yes	44	13	29.5	17.14	5.06	29.5
No	287	55	19.2	300.12	57.51	19.2
Gender						
Male	261	47	18.0	283.8	51.1	18.0
Female	74	20	27.0	49.03	13.25	27.0
Rank						
Officer	120	21	17.5	61.9	10.83	17.5
Enlisted	215	47	21.9	274.4	59.98	21.9
Age						
25 or Younger	40	8	20.0	150.12	30.02	20.0
26-30	67	16	23.9	86.95	20.76	23.9
31-35	64	15	23.4	51.96	12.18	23.4
36-40	72	11	15.3	39.64	6.06	15.3
41 and Over	89	17	19.1	35.36	6.75	19.1
Race						
White non-Hispanic	192	36	18.8	235.6	44.2	18.8
Black or African American	59	17	28.8	63.726	18.36	28.8
All other races	85	15	17.6	36.02	6.36	17.7
Education						
Associate or Technical Degree or less	187	36	19.3	278.5	53.6	19.2
Bachelor's Degree	91	15	16.5	40.59	7.52	18.5
Advanced Degree	68	17	25.0	25.51	6.38	25.0

Table B.4.2. Summary of SAS outputs of data for non-weighted variables used to create Chapter 4 table 3 for model 1.

Variable	# AGI Cases	# AGI Cases Seeking Care	% AGI Cases Seeking Care
Concurrent symptoms			
Max number loose stools in 24 hrs			
≤5 loose stools	245	45	18.4
>5 loose stools	67	19	28.4
Diarrhea duration			
<3 Days	112	19	17.0
≥3 Days	175	41	23.4
Blood in Stool			
Yes	24	8	33.3
No	260	46	17.7
Sore throat/cough			
Yes	107	35	32.7
No	222	33	14.9
Vomiting			
Yes	104	37	35.6
No	232	30	12.9
Max times vomit in 24 hrs			
≤5	91	29	31.9
>5	11	8	72.7
Vomit Duration			
<3 Days	73	20	27.4
≥3 Days	27	15	55.6
Both Diarrhea and Vomiting			
Yes	69	28	40.6
No	33	9	27.3
Days both diarrhea and vomiting			
<3 Days	48	15	31.3
≥3 Days	15	10	66.7
Missed Work			
Yes	104	43	41.3
No	229	24	10.5
Days Missed Work			
<2 Days Missed	35	9	25.7
≥2 Days missed	67	33	49.3

Table B.4.2. Summary of SAS outputs of data for non-weighted variables used to create Chapter 4 table 3 for model 1.

Variable	# AGI Cases	# AGI Cases Seeking Care	% AGI Cases Seeking Care
Branch			
Army SOF	6	1	16.7
FSD	99	21	21.2
HSD	79	17	21.5
OD	103	21	20.4
OSD	45	7	15.6
Chaplain	1	0	0

SAS Code and Output for Univariable Analysis Represented in Chapter 4 Table 3.

```
proc surveylogistic data=surveydata; class region2/param=ref ref=last;
model mage2doc=region2;weight wgtreg; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.1534	0.2078	230.2026	<.0001
region2	1	1	0.6573	0.4447	2.1854	0.1393
region2	2	1	-0.1788	0.3512	0.2591	0.6108
region2	3	1	0.3301	0.4718	0.4895	0.4842
region2	4	1	-0.3631	0.3174	1.3086	0.2527

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 1 vs 5	1.930	0.807	4.613
region2 2 vs 5	0.836	0.420	1.665
region2 3 vs 5	1.391	0.552	3.507
region2 4 vs 5	0.696	0.373	1.296

```
proc surveylogistic data=surveydata;class overseas/param=ref ref=last;
model mage2doc=overseas;weight wgtloc; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.3270	0.1371	588.6972	<.0001
Overseas	1	1	0.6664	0.3185	4.3770	0.0364

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.947	1.043	3.635

```
proc surveylogistic data=surveydata; class gender1/param=ref ref=first;
model mage2doc=gender1; weight wgtgen; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.3488	0.1485	508.8181	<.0001
gender1	2	1	0.4474	0.2733	2.6801	0.1016

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 2 vs 1	1.564	0.916	2.672

```
proc surveylogistic data=surveydata; class rankcat2/param=ref ref=first;
model mage2doc=rankcat2;weight wgtrank;strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.3656	0.2218	230.2230	<.0001
rankcat2	2	1	0.2108	0.2669	0.6241	0.4295

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
rankcat2 2 vs 1	1.235	0.732	2.083

```
proc surveylogistic data=surveydata; class agecat/param=ref ref=first;
model mage2doc=agecat;weight wgtage;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.1409	0.3622	75.2044	<.0001
Agecat	2	1	0.2402	0.4440	0.2926	0.5886
Agecat	3	1	0.0289	0.4496	0.0041	0.9488
Agecat	4	1	-0.2783	0.4742	0.3444	0.5573
Agecat	5	1	-0.3285	0.4373	0.5642	0.4526

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Agecat 2 vs 1	1.271	0.533	3.036
Agecat 3 vs 1	1.029	0.426	2.485
Agecat 4 vs 1	0.757	0.299	1.918
Agecat 5 vs 1	0.720	0.306	1.697

proc surveylogistic data=surveydata; class race2/param=ref ref=first;
model mage2doc=race2; weight wgtrace;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.2655	0.1699	369.2820	<.0001
race2	2	1	0.2939	0.3016	0.9500	0.3297
race2	3	1	-0.0737	0.3136	0.0553	0.8141

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	1.342	0.743	2.423
race2 3 vs 1	0.929	0.502	1.717

proc surveylogistic data=surveydata; class education2/param=ref ref=last;
model mage2doc=education2;weight wgtedu;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.9684	0.2479	143.3400	<.0001
education2	1	1	-0.2560	0.2998	0.7295	0.3930
education2	2	1	-0.4909	0.3611	1.8479	0.1740

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
education2 1 vs 3	0.774	0.430	1.393
education2 2 vs 3	0.612	0.302	1.242

proc surveylogistic data=surveydata; class max_diarrhea2/param=ref ref=first; model mage2doc=max_diarrhea2; strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3609	0.1549	232.3955	<.0001
max_diarrhea2	2	1	1.0428	0.3007	12.0241	0.0005

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_diarrhea2 2 vs 1	2.837	1.574	5.115

proc surveylogistic data=surveydata; class days_diarrhea3/param=ref ref=First; model mage2doc=days_diarrhea3;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.6085	0.2376	120.5395	<.0001
days_diarrhea3	2	1	0.7848	0.2923	7.2064	0.0073

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_diarrhea3 2 vs 1	2.192	1.236	3.887

proc surveylogistic data=surveydata; class blood2/param=ref ref=last; model mage2doc=blood2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3698	0.1531	239.5468	<.0001
blood2	1	1	0.6651	0.4092	2.6417	0.1041

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
blood2 1 vs 2	1.945	0.872	4.337

proc surveylogistic data=surveydata; class sore_throat2/param=ref ref=last; model mage2doc=sore_throat2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.5556	0.1806	200.3232	<.0001
sore_throat2	1	1	1.0484	0.2606	16.1795	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
sore_throat2 1 vs 2	2.853	1.712	4.755

proc surveylogistic data=surveydata; class vomit2/param=ref ref=last; model mage2doc=vomit2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.9864	0.1838	470.1960	<.0001
vomit2	1	1	3.0540	0.2666	131.1900	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
vomit2 1 vs 2	21.201	12.572	35.753

```
proc surveylogistic data=surveydata; class max_vomit3/param=ref ref=first;
model mage2doc=max_vomit3;strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.0515	0.2146	24.0180	<.0001
max_vomit3	2	1	1.1851	0.5729	4.2792	0.0386

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_vomit3 2 vs 1	3.271	1.064	10.053

```
proc surveylogistic data=surveydata; class days_vomit3/param=ref ref=first;
model mage2doc=days_vomit3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.1786	0.2521	21.8623	<.0001
days_vomit3	2	1	0.6680	0.4266	2.4521	0.1174

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_vomit3 2 vs 1	1.950	0.845	4.500

```
proc surveylogistic data=surveydata; class D_V2/param=ref ref=last;
model mage2doc=D_V2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.3581	0.3710	13.4009	0.0003
D_V2	1	1	0.6650	0.4449	2.2338	0.1350

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
D_V2 1 vs 2	1.944	0.813	4.651

```
proc surveylogistic data=surveydata; class Days_D_V2/param=ref ref=fist; model
mage2doc=Days_D_V2;strata region2 installation; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.0295	0.3033	11.5216	0.0007
Days_D_V2	2	1	1.1347	0.5681	3.9889	0.0458

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Days_D_V2 2 vs 1	3.110	1.021	9.470

```
proc surveylogistic data=surveydata; class miss_work2/param=ref ref=last;
model mage2doc=miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.0040	0.2081	208.4294	<.0001
miss_work2	1	1	2.0648	0.2724	57.4720	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
miss_work2 1 vs 2	7.883	4.623	13.444

```
proc surveylogistic data=surveydata; class days_missed2/param=ref ref=first;
model mage2doc=days_missed2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4137	0.3825	13.6629	0.0002
days_missed2	2	1	0.6907	0.4413	2.4495	0.1176

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_missed2 2 vs 1	1.995	0.840	4.738

```
proc surveylogistic data=surveydata; class branch2/param=ref ref=first;
model mage2doc=branch2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.3322	1.0208	10.6562	0.0011
branch2	2	1	0.2922	1.0453	0.0782	0.7798
branch2	3	1	0.2096	1.0508	0.0398	0.8419
branch2	4	1	-0.00678	1.0444	0.0000	0.9948
branch2	5	1	-0.1983	1.0905	0.0331	0.8557
branch2	6	1	-12.9656	1.0438	154.3057	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
branch2 2 vs 1	1.339	0.173	10.391
branch2 3 vs 1	1.233	0.157	9.671
branch2 4 vs 1	0.993	0.128	7.691
branch2 5 vs 1	0.820	0.097	6.952
branch2 6 vs 1	<0.001	<0.001	<0.001

SAS Code for Multivariable Analysis for Model 1: International case definition for AGI; factors associated with service members seeking medical care for AGI, Chapter 4 Table 4.

Variables with p-values <0.25 from univariable analysis include: region2, overseas, gender1, education2, max_diarrhea2, days_diarrhea3, blood2, sore_throat2, vomit2, max_vomit3, days_vomit3, d_v2, days_d_v2, miss_work2, and days_missed_2.
We chose to leave region2 out of the model (and keep overseas). We chose to keep vomit2 but leave out max_vomit3, days_vomit3, d_v2, and days_d_v2. We chose to keep miss_work2, but keep days_missed_2. (See appendix A-4).

Full model therefore contains 9 variables: overseas, gender1, education2, max_diarrhea2, days_diarrhea3, blood2, sore_throat2, vomit2, miss_work2

Full Model:

```
proc surveylogistic data=surveydata;class overseas gender1 education2 max  diarrhea2
days_diarrhea3 blood2 sore_throat2 vomit2 miss_work2/param=ref ref=last; model
mage2doc=overseas gender1 education2 max_diarrhea2 days_diarrhea3 blood2 sore_throat2
vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.4282	0.5895	16.9679	<.0001
Overseas	1	1	0.2114	0.4818	0.1925	0.6609
gender1	1	1	-0.2189	0.4123	0.2819	0.5954
education2	1	1	-1.0516	0.4118	6.5233	0.0106
education2	2	1	-0.7409	0.4464	2.7549	0.0970
max_diarrhea2	1	1	-0.3508	0.4240	0.6847	0.4080
days_diarrhea3	1	1	-0.1745	0.3752	0.2163	0.6419
blood2	1	1	-0.3178	0.6058	0.2751	0.5999
sore_throat2	1	1	1.2198	0.3833	10.1288	0.0015
vomit2	1	1	1.5517	0.3773	16.9157	<.0001
miss_work2	1	1	1.4207	0.3802	13.9673	0.0002

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.235	0.481	3.176
gender1 1 vs 2	0.803	0.358	1.803
education2 1 vs 3	0.349	0.156	0.783
education2 2 vs 3	0.477	0.199	1.143
max_diarrhea2 1 vs 2	0.704	0.307	1.616
days_diarrhea3 1 vs 2	0.840	0.403	1.752
blood2 1 vs 2	0.728	0.222	2.386
sore_throat2 1 vs 2	3.387	1.598	7.178
vomit2 1 vs 2	4.720	2.253	9.886
miss_work2 1 vs 2	4.140	1.965	8.722

Remove the variable overseas:

```
proc surveylogistic data=surveydata;class gender1 education2 max_diarrhea2 days_diarrhea3
blood2 sore_throat2 vomit2 miss_work2/param=ref ref=last;
model mage2doc=gender1 education2 max_diarrhea2 days_diarrhea3 blood2 sore_throat2
vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3945	0.5921	16.3552	<.0001
gender1	1	1	-0.2229	0.4121	0.2927	0.5885
education2	1	1	-1.0432	0.4129	6.3827	0.0115
education2	2	1	-0.7404	0.4459	2.7576	0.0968
max_diarrhea2	1	1	-0.3739	0.4214	0.7873	0.3749
days_diarrhea3	1	1	-0.1650	0.3686	0.2003	0.6544
blood2	1	1	-0.3236	0.6076	0.2837	0.5943
sore_throat2	1	1	1.2441	0.3673	11.4695	0.0007
vomit2	1	1	1.5540	0.3792	16.7909	<.0001
miss_work2	1	1	1.4184	0.3809	13.8639	0.0002

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 1 vs 2	0.800	0.357	1.794
education2 1 vs 3	0.352	0.157	0.791
education2 2 vs 3	0.477	0.199	1.143
max_diarrhea2 1 vs 2	0.688	0.301	1.571
days_diarrhea3 1 vs 2	0.848	0.412	1.746
blood2 1 vs 2	0.724	0.220	2.380
sore_throat2 1 vs 2	3.470	1.689	7.128
vomit2 1 vs 2	4.730	2.249	9.947
miss_work2 1 vs 2	4.130	1.958	8.715

No change in odds ratio >10%. No evidence of confounding by overseas, remove days_diarrhea3 next.

proc surveylogistic data=surveydata;class gender1 education2 max_diarrhea2 blood2 sore_throat2 vomit2 miss_work2/param=ref ref=last; model mage2doc=gender1 education2 max_diarrhea2 blood2 sore_throat2 vomit2 miss_work2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3964	0.5780	17.1903	<.0001
gender1	1	1	-0.2283	0.3987	0.3279	0.5669
education2	1	1	-0.9569	0.4004	5.7117	0.0169
education2	2	1	-0.6661	0.4350	2.3451	0.1257
max_diarrhea2	1	1	-0.4932	0.3905	1.5951	0.2066
blood2	1	1	-0.3074	0.5691	0.2917	0.5891
sore_throat2	1	1	1.1378	0.3467	10.7686	0.0010
vomit2	1	1	1.5055	0.3569	17.7928	<.0001
miss_work2	1	1	1.4507	0.3622	16.0400	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 1 vs 2	0.796	0.364	1.739
education2 1 vs 3	0.384	0.175	0.842
education2 2 vs 3	0.514	0.219	1.205
max_diarrhea2 1 vs 2	0.611	0.284	1.313
blood2 1 vs 2	0.735	0.241	2.244
sore_throat2 1 vs 2	3.120	1.581	6.155
vomit2 1 vs 2	4.506	2.239	9.071
miss_work2 1 vs 2	4.266	2.098	8.677

Odds ratio for max_diarrhea2 changes by 11.2%. When check contingency table of days_diarrhea3 by max_diarrhea2 by outcome variable, there are sparse cells which likely accounts for this subtle change. Decide to keep days_diarrhea3 out of model, remove blood2 next.

Table of max_diarrhea2 by days_diarrhea3				
Controlling for MAGE2DOC=1				
max_diarrhea2	days_diarrhea3	Frequency	Percent	Std Err of Percent
1	1	17	28.3333	5.8226
	2	25	41.6667	6.3703
	Total	42	70.0000	5.9213
2	1	2	3.3333	2.3195
	2	16	26.6667	5.7140
	Total	18	30.0000	5.9213
Total	1	19	31.6667	6.0107
	2	41	68.3333	6.0107
	Total	60	100.000	

proc surveylogistic data=surveydata;class gender1 education2 max_diarrhea2 sore_throat2 vomit2 miss_work2/param=ref ref=last;model mage2doc=gender1 education2 max_diarrhea2 sore_throat2 vomit2 miss_work2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.4527	0.5615	19.0836	<.0001
gender1	1	1	-0.3002	0.3698	0.6592	0.4168
education2	1	1	-0.9016	0.3821	5.5676	0.0183
education2	2	1	-0.6235	0.4158	2.2493	0.1337
max_diarrhea2	1	1	-0.4029	0.3786	1.1325	0.2873
sore_throat2	1	1	1.0026	0.3177	9.9574	0.0016
vomit2	1	1	1.5082	0.3330	20.5097	<.0001
miss_work2	1	1	1.6070	0.3396	22.3877	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 1 vs 2	0.741	0.359	1.529
education2 1 vs 3	0.406	0.192	0.858
education2 2 vs 3	0.536	0.237	1.211
max_diarrhea2 1 vs 2	0.668	0.318	1.404
sore_throat2 1 vs 2	2.725	1.462	5.081
vomit2 1 vs 2	4.518	2.352	8.679
miss_work2 1 vs 2	4.988	2.563	9.706

Sore_throat2 and miss_work change by >10%, but when look at contingency tables of blood on sore_throat2 and miss_work to by the outcome variable, there are some very sparse cells which could account for these changes. Variable does not make sense as confounder, we decided to keep blood2 out of model, remove gender1 next.

Table of blood2 by sore_throat2
Controlling for MAGE2DOC=1

blood2	sore_throat2	Frequency	Percent	Std Err of Percent
1	1	4	7.4074	3.5670
	2	4	7.4074	3.5670
	Total	8	14.8148	4.8385
2	1	25	46.2963	6.7913
	2	21	38.8889	6.6397
	Total	46	85.1852	4.8385
Total	1	29	53.7037	6.7913
	2	25	46.2963	6.7913
	Total	54	100.000	

Table of blood2 by miss_work2
Controlling for MAGE2DOC=1

blood2	miss_work2	Frequency	Percent	Std Err of Percent
1	1	6	11.1111	4.2803
	2	2	3.7037	2.5721
	Total	8	14.8148	4.8384
2	1	27	50.0000	6.8099
	2	19	35.1852	6.5041
	Total	46	85.1852	4.8384
Total	1	33	61.1111	6.6396
	2	21	38.8889	6.6396
	Total	54	100.000	

proc surveylogistic data=surveydata;class education2 max_diarrhea2 sore_throat2 vomit2 miss_work2/param=ref ref=last; model mage2doc=education2 max_diarrhea2 sore_throat2 vomit2 miss_work2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.7021	0.4647	33.8046	<.0001
education2	1	1	-0.9426	0.3766	6.2641	0.0123
education2	2	1	-0.6427	0.4140	2.4096	0.1206
max_diarrhea2	1	1	-0.3639	0.3743	0.9451	0.3310
sore_throat2	1	1	1.0047	0.3104	10.4757	0.0012
vomit2	1	1	1.4994	0.3322	20.3740	<.0001
miss_work2	1	1	1.6454	0.3240	25.7924	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
education2 1 vs 3	0.390	0.186	0.815
education2 2 vs 3	0.526	0.234	1.184
max_diarrhea2 1 vs 2	0.695	0.334	1.447
sore_throat2 1 vs 2	2.731	1.486	5.018
vomit2 1 vs 2	4.479	2.336	8.589
miss_work2 1 vs 2	5.183	2.747	9.781

No change in odds ratio >10%. No evidence of confounding by gender1, next remove max_diarrhea2.

```
proc surveylogistic data=surveydata;class overseas gender1 education2 days_diarrhea3 blood2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.9823	0.3382	77.7690	<.0001
education2	1	1	-1.0647	0.4071	6.8409	0.0089
education2	2	1	-0.7934	0.4350	3.3269	0.0682
sore_throat2	1	1	1.2322	0.3359	13.4574	0.0002
vomit2	1	1	1.5979	0.3509	20.7415	<.0001
miss_work2	1	1	1.4909	0.3437	18.8143	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
education2 1 vs 3	0.345	0.155	0.766
education2 2 vs 3	0.452	0.193	1.061
sore_throat2 1 vs 2	3.429	1.775	6.623
vomit2 1 vs 2	4.943	2.485	9.832
miss_work2 1 vs 2	4.441	2.264	8.711

Table B.4.3. Summary of the SAS output for odds ratios (ORs) and change in odds ratios before and after adding potential confounders back into the model. Evidence of confounding by rank, keep in model.

Variables	Pre-Final Model OR Outputs	OR After Add Rank	% Change	OR After Add Race	% Change	OR After Add age	% Change
education2 1 vs 3	0.345	0.302	12.5%	0.298	1.3%	0.283	6.3%
education2 2 vs 3	0.452	0.567	-25.4%	0.553	2.5%	0.529	6.7%
sore_throat2 1 vs 2	3.429	3.287	4.1%	3.242	1.4%	3.53	-7.4%
vomit2 1 vs 2	4.943	4.115	16.8%	4.128	-0.3%	3.792	7.8%
miss_work2 1 vs 2	4.441	4.856	-9.3%	4.762	1.9%	5.327	-9.7%

SAS Code and Output to Check For Evidence of Multiplicative Interaction:

```
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore  throat2 vomit2 miss_work2 rankcat2
education2*sore_throat2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
education2*vomit2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
education2*miss_work2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
education2*rankcat2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
sore_throat2*vomit2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
sore_throat2*miss_work2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
sore_throat2*rankcat2;strata region2 installation;run;
```

```
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
vomit2*miss_work2;strata region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2 vomit2*rankcat2;strata
region2 installation;run;
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 gender1 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
rankcat2*miss_work2;strata region2 installation;run;
```

Table B.4.4. Summary of SAS output after adding interaction terms back into the model to look for evidence of multiplicative interaction. Table displays the interaction terms and associated p-values when added to the model.

Interaction Term	P-value
education*sore_throa	0.5637
education*sore_throa	0.3237
education2*vomit2	0.7738
education2*vomit2	0.2315
education*miss_work2	0.1705
education*miss_work2	0.5771
education2*rankcat2	0.3548
education2*rankcat2	0.2457
sore_throat2*vomit2	0.5071
sore_thro*miss_work2	0.2498
sore_throat*rankcat2	0.9694
vomit2*miss_work2	0.7087
vomit2*rankcat2	0.1861
miss_work2*rankcat2	0.0403

Evidence of multiplicative interaction between miss_work2 and rankcat2.

SAS Code and Outputs For Model Fit Tests

```
/*model fit tests*/
proc logistic data=surveydata;model mage2doc=education2 sore_throat2 vomit2 miss_work2
rankcat2 miss_work2*rankcat2/scale=n aggregate lackfit;run;
```

There were 43 unique profiles/covariate patterns (J) and 643 observations (p). $J \ll n$, so Pearson Chi-Square goodness of fit and Deviance tests can be used to assess model fit. If $p \leq 0.05$ there is evidence of lack of model fit. If $p > 0.05$, there is evidence of model fit. The SAS output for both of these tests is below. Both show evidence of model fit.

Deviance and Pearson Goodness-of-Fit Statistics				
Criterion	Value	DF	Value/DF	Pr > ChiSq
Deviance	24.0724	36	0.6687	0.9356
Pearson	18.9752	36	0.5271	0.9912

SAS Code For Final Multivariable Model 1

```
proc surveylogistic data=surveydata;class education2 sore_throat2 vomit2 miss_work2
rankcat2/param=ref ref=last;
model mage2doc=education2 sore_throat2 vomit2 miss_work2 rankcat2
miss  work2*rankcat2;strata region2 installation;
contrast 'misswork' miss_work2 1/estimate=exp;
contrast 'rankcat' rankcat2 -1/estimate=exp;
contrast 'gender' gender1 -1/estimate=exp;
contrast 'miss_work2*rankcat2' miss_work2*rankcat2 1/estimate=exp;
contrast 'adv. vs ass.' education2 -1 0/estimate=exp;
contrast 'bach. vs. ass' education2 -1 1/estimate=exp;
contrast 'bach. vs. adv.' education2 0 1/estimate=exp;
contrast 'adv. vs. bach.' education2 0 -1/estimate=exp;
contrast 'Enlisted Miss Work vs. Enlisted Not Miss Work'rankcat2 0 miss_work2
1/estimate=exp;
contrast 'Enlisted Miss Work vs. Officer Miss Work'rankcat2 -1 miss_work2 0/estimate=exp;
contrast 'Enlisted Miss Work vs. Officer Not Miss Work'rankcat2 -1 miss_work2
1/estimate=exp;
contrast 'Enlisted Not Miss Work vs. Officer Miss Work'rankcat2 -1 miss_work2 -
1/estimate=exp;
run;
```

SAS Code for Univariable Analysis for Model 2: International case definition for AGI; factors associated with service members seeking medical care for AGI and submitting a stool sample.

SAS Code for AGI cases that sought medical care and submitted a stool sample data used to create Chapter 4 Table 5.

```
/*Region*/
proc surveyfreq data=surveydata2;tables region2 mage2doc region2*mage2doc;weight wgtreg;
run;
proc surveyfreq data=surveydata2;tables region2 mage2stool region2*mage2stool;weight
wgtreg; run;
/*Overseas*/
proc surveyfreq data=surveydata2;tables overseas mage2doc overseas*mage2doc;weight wgtloc;
run;
proc surveyfreq data=surveydata2;tables overseas mage2stool overseas*mage2stool; weight
wgtloc; run;
/*Gender*/
```

```
proc surveyfreq data=surveydata2;tables gender1 mage2doc gender1*mage2doc;weight
wgtgen;run;
proc surveyfreq data=surveydata2;tables gender1 mage2stool gender1*mage2stool;weight
wgtgen;run;
/*rank*/
proc surveyfreq data=surveydata2;tables rankcat2 mage2doc rankcat2*mage2doc;weight
wgtrank;run;
proc surveyfreq data=surveydata2;tables rankcat2 mage2stool rankcat2*mage2stool;weight
wgtrank;run;
/*Age*/
proc surveyfreq data=surveydata2;tables agecat mage2doc agecat*mage2doc;weight
wgtage2;run;
proc surveyfreq data=surveydata2;tables agecat mage2stool agecat*mage2stool;weight
wgtage2;run;
/*race collapsed*/
proc surveyfreq data=surveydata2;tables race2 mage2doc race2*mage2doc; weight wgtrace; run;
proc surveyfreq data=surveydata2;tables race2 mage2stool race2*mage2stool; weight wgtrace;
run;
/*education*/
proc surveyfreq data=surveydata2;tables education2 mage2doc education2*mage2doc;weight
wgtedu; run;
proc surveyfreq data=surveydata2;tables education2 mage2stool education2*mage2stool;weight
wgtedu;run;
/*max diarrhea*/
proc surveyfreq data=surveydata2; tables max_diarrhea2 mage2doc
max_diarrhea2*mage2doc;run;
proc surveyfreq data=surveydata2; tables max_diarrhea2 mage2stool
max_diarrhea2*mage2stool;run;
/*Days Diarrhea Collapsed*/
proc surveyfreq data=surveydata2; tables days_diarrhea3 mage2doc
days_diarrhea3*mage2doc;run;
proc surveyfreq data=surveydata2; tables days_diarrhea3 mage2stool
days_diarrhea3*mage2stool;run;
/*blood*/
proc surveyfreq data=surveydata2;tables blood2 mage2doc blood2*mage2doc;run;
proc surveyfreq data=surveydata2;tables blood2 mage2stool blood2*mage2stool;run;
/*Sore Throat*/
proc surveyfreq data=surveydata2;tables sore_throat2 mage2doc sore_throat2*mage2doc;run;
proc surveyfreq data=surveydata2;tables sore_throat2 mage2stool sore_throat2*mage2stool;run;
/*Vomit*/
proc surveyfreq data=surveydata2;tables vomit2 mage2doc vomit2*mage2doc;run;
proc surveyfreq data=surveydata2;tables vomit2 mage2stool vomit2*mage2stool;run;
/*Max Vomit Collapsed*/
proc surveyfreq data=surveydata2;tables max_vomit3 mage2doc max_vomit3*mage2doc;run;
proc surveyfreq data=surveydata2;tables max_vomit3 mage2stool max_vomit3*mage2stool;run;
/*Days Vomit Collapsed */
```

```
proc surveyfreq data=surveydata2;tables days_vomit3 mage2doc days_vomit3*mage2doc;run;
proc surveyfreq data=surveydata2;tables days_vomit3 mage2stool days_vomit3*mage2stool;run;
/*Diarrhea and Vomiting*/
proc surveyfreq data=surveydata2;tables D_V2 mage2doc D_V2*mage2doc;run;
proc surveyfreq data=surveydata2;tables D_V2 mage2stool D_V2*mage2stool;run;
/*Days diarrhea and vomiting*/
proc surveyfreq data=surveydata2; tables Days_D_V2 mage2doc Days_D_V2*mage2doc;run;
proc surveyfreq data=surveydata2; tables Days_D_V2 mage2stool Days_D_V2*mage2stool;run;
/*Miss Work*/
proc surveyfreq data=surveydata2;tables miss_work2 mage2doc miss_work2*mage2doc;run;
proc surveyfreq data=surveydata2;tables miss_work2 mage2stool miss_work2*mage2stool;run;
/*Days Missed*/
proc surveyfreq data=surveydata2;tables days_missed2 mage2doc days_missed2*mage2doc;run;
proc surveyfreq data=surveydata2;tables days_missed2 mage2stool
days_missed2*mage2stool;run;
/*Branch*/
proc surveyfreq data=surveydata2;tables branch2 mage2doc branch2*mage2doc;run;
proc surveyfreq data=surveydata2;tables branch2 mage2stool branch2*mage2stool;run;
proc surveylogistic data=surveydata2; class region2/param=ref ref=last;
model mage2stool=region2;weight wgtreg; strata region2 installation;
run;
```

Table B.4.5. Summary of SAS outputs of crude and weighted data for weighted variables used to create Chapter 4 table 5 for model 2.

Variable	Crude # AGI Cases Seeking Care	Crude # Care Seekers Submitting Stool	Crude % Care Seekers Submitting Stool	Weighted # AGI Cases Seeking Care	Weighted # Care Seekers Submitting Stool	Weighted % Care Seekers Submitting Stool
Region						
ERMC	7	1	14.3	5.25	0.7499	14.3
NRMC	13	2	15.4	13.31	2.048	15.4
PRMC	6	1	16.7	6.77	1.13	16.7
SRMC	18	2	11.1	19.42	1.51	7.8
WRMC	24	2	8.3	22.42	1.87	8.3
Overseas						
Yes	13	2	15.4	5.06	0.779	15.4
No	55	6	10.9	57.51	6.27	10.9
Gender						
Male	47	6	12.8	51.1	6.52	12.8
Female	20	2	10.0	13.25	1.33	10.0
Rank						
Officer	21	2	9.5	10.83	1.03	9.5
Enlisted	47	6	12.8	59.98	7.67	12.8
Age						
25 or Younger	8	0	0.0	17.8	0	0.0
26-30	16	2	12.5	35.6	4.45	12.5
31-35	15	3	20.0	12.2	2.44	20.0
36-40	11	2	18.2	6.06	1.1	18.2
41 and Over	17	1	5.9	6.75	0.397	5.9
Race						
White non-Hispanic	36	2	5.6	44.2	2.455	5.6
Black or African American	17	3	17.6	18.36	3.24	17.6
All other races	15	3	20.0	6.36	1.27	20.0
Education						
Associate or Technical Degree or less	36	4	11.1	53.6	5.96	11.1
Bachelor's	15	2	13.3	7.52	1.002	13.3
Advanced	17	2	11.8	6.38	0.75	11.8

Table B.4.6. Summary of SAS outputs of data for non-weighted variables used to create Chapter 4 table 5 for model 2.

Variable	# AGI Cases Seeking Care	# Care Seekers Submitting Stool	% Care Seekers Submitting Stool
Concurrent symptoms			
Max number loose stools in 24 hrs			
≤5 loose stools	45	3	6.7
>5 loose stools	19	5	26.3
Diarrhea duration			
<3 Days	19	1	5.3
≥3 Days	41	7	17.1
Blood in Stool			
Yes	8	1	12.5
No	46	4	8.7
Sore throat/cough			
Yes	35	2	5.7
No	33	6	18.2
Vomiting			
Yes	37	4	10.8
No	30	4	13.3
Max times vomit in 24 hrs			
≤5	29	3	10.3
>5	8	1	12.5
Vomit Duration			
<3 Days	20	3	15.0
≥3 Days	15	1	6.7
Both Diarrhea and Vomiting			
Yes	28	3	10.7
No	9	1	11.1
Days both diarrhea and vomiting			
<3 Days	15	2	13.3
≥3 Days	10	1	10.0
Missed Work			
Yes	43	5	11.6
No	24	2	8.3
Days Missed Work			
<2 Days Missed	9	2	22.2
≥2 Days missed	33	3	9.1

Table B.4.6. Continued.

Variable	# AGI Cases Seeking Care	# Care Seekers Submitting Stool	% Care Seekers Submitting Stool
Branch			
Army SOF	1	0	0.0
FSD	21	2	9.5
HSD	17	2	11.8
OD	21	2	9.5
OSD	7	2	28.6
Chaplain	0	0	-

SAS Code and Output for Univariable Analysis in Represented in Chapter 4Table 5

```
proc surveylogistic data=surveydata2; class region2/param=ref ref=last;
model mage2stool=region2;weight wgtreg; strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3979	0.7955	9.0861	0.0026
region2	1	1	0.6061	1.4423	0.1766	0.6743
region2	2	1	0.6931	1.0021	0.4785	0.4891
region2	3	1	0.7885	1.4711	0.2872	0.5920
region2	4	1	0.3185	1.1427	0.0777	0.7805

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
region2 1 vs 5	1.833	0.109	30.972
region2 2 vs 5	2.000	0.281	14.256
region2 3 vs 5	2.200	0.123	39.324
region2 4 vs 5	1.375	0.146	12.912

```
proc surveylogistic data=surveydata2;class overseas/param=ref ref=last;
model mage2stool=overseas;weight wgtloc; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1001	0.4215	24.8275	<.0001
Overseas	1	1	0.3953	0.9416	0.1763	0.6746

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.485	0.235	9.401

proc surveylogistic data=surveydata2; class gender1/param=ref ref=first;
model mage2stool=gender1; weight wgtgen; strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1971	0.7534	8.5052	0.0035
gender1	1	1	0.2753	0.8510	0.1046	0.7463

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 1 vs 2	1.317	0.248	6.981

proc surveylogistic data=surveydata2; class rankcat2/param=ref ref=first;
model mage2stool=rankcat2;weight wgtrank;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.2510	0.7536	8.9227	0.0028
rankcat2	2	1	0.3291	0.8446	0.1518	0.6968

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
rankcat2 2 vs 1	1.390	0.265	7.276

proc surveylogistic data=surveydata2; class agecat2/param=ref ref=first;
model mage2stool=agecat2;weight wgtage2;strata region2 installation;run;

Collapsed the Age variable because 25 and younger contained no cases that submitted stool.
Made a new four category variable:
if agecat=1 then agecat2=1;
if agecat=2 then agecat2=1;
if agecat=3 then agecat2=2;
if agecat=4 then agecat2=3;
if agecat=5 then agecat2=4;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3979	0.7721	9.6465	0.0019
agecat2	2	1	1.0117	0.9895	1.0453	0.3066
agecat2	3	1	0.8938	1.0992	0.6612	0.4161
agecat2	4	1	-0.3747	0.7895	0.2252	0.6351

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
agecat2 2 vs 1	2.750	0.395	19.126
agecat2 3 vs 1	2.444	0.283	21.079
agecat2 4 vs 1	0.688	0.146	3.231

```
proc surveylogistic data=surveydata2; class race2/param=ref ref=first;
model mage2stool=race2; weight wgtrace;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.8332	0.7574	13.9943	0.0002
race2	2	1	1.2928	0.9092	2.0218	0.1551
race2	3	1	1.4470	0.9990	2.0980	0.1475

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	3.643	0.613	21.644
race2 3 vs 1	4.250	0.600	30.116

```
proc surveylogistic data=surveydata2; class education2/param=ref ref=last;
model mage2stool=education2;weight wgtedu;strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.0149	0.7881	6.5367	0.0106
education2	1	1	-0.0645	0.9693	0.0044	0.9469
education2	2	1	0.1432	0.9701	0.0218	0.8827

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
education2 1 vs 3	0.937	0.140	6.266
education2 2 vs 3	1.154	0.172	7.725

```
proc surveylogistic data=surveydata2; class max_diarrhea2/param=ref ref=first; model
mage2stool=max_diarrhea2;strata region2 installation; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.6390	0.6242	17.8731	<.0001
max_diarrhea2	2	1	1.6095	0.7749	4.3144	0.0378

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_diarrhea2 2 vs 1	5.000	1.095	22.834

proc surveylogistic data=surveydata2; class days_diarrhea3/param=ref ref=First; model mage2stool=days_diarrhea3;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.8904	1.0252	7.9486	0.0048
days_diarrhea3	2	1	1.3099	1.0816	1.4666	0.2559

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_diarrhea3 2 vs 1	3.706	0.445	30.874

proc surveylogistic data=surveydata2; class blood2/param=ref ref=last; model mage2stool=blood2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3514	0.4745	24.5518	<.0001
blood2	1	1	0.4055	1.1194	0.1312	0.7172

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
blood2 1 vs 2	1.500	0.167	13.457

proc surveylogistic data=surveydata2; class sore_throat2/param=ref ref=first; model mage2stool=sore_throat2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.8032	0.7548	13.7928	0.0002
sore_throat2	2	1	1.2992	0.8548	2.3096	0.1286

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
sore_throat2 2 vs 1	3.666	0.686	19.582

proc surveylogistic data=surveydata2; class vomit2/param=ref ref=first; model mage2stool=vomit2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1102	0.4928	18.3353	<.0001
vomit2	2	1	0.2384	0.7118	0.1122	0.7377

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
vomit2 2 vs 1	1.269	0.315	5.122

```
proc surveylogistic data=surveydata2; class max_vomit3/param=ref ref=first;
model mage2stool=max_vomit3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1595	0.5408	15.9444	<.0001
max_vomit3	2	1	0.2136	1.2345	0.0299	0.8626

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_vomit3 2 vs 1	1.238	0.110	13.917

```
proc surveylogistic data=surveydata2; class days_vomit3/param=ref ref=last;
model mage2stool=days_vomit3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.6390	1.0321	6.5375	0.0106
days_vomit3	1	1	0.9044	1.1139	0.6593	0.4168

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_vomit3 1 vs 2	2.471	0.278	21.926

```
proc surveylogistic data=surveydata2; class D_V2/param=ref ref=first;
model mage2stool=D_V2;strata region2 installation;run;
```

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1203	0.6424	10.8927	0.0010
D_V2	2	1	0.0408	0.6815	0.0036	0.9522

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
D_V2 2 vs 1	1.042	0.274	3.961

```
proc surveylogistic data=surveydata2; class Days_D_V2/param=ref ref=last;
model mage2stool=Days_D_V2;strata region2 installation; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1971	1.0422	4.4441	0.0350
Days_D_V2	1	1	0.3253	1.2166	0.0715	0.7892

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Days_D_V2 1 vs 2	1.385	0.128	15.027

```
proc surveylogistic data=surveydata2; class miss_work2/param=ref ref=last;
model mage2stool=miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3977	0.7588	9.9835	0.0016
miss_work2	1	1	0.3695	0.8647	0.1826	0.6691

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
miss_work2 1 vs 2	1.447	0.266	7.880

```
proc surveylogistic data=surveydata2; class days_missed2/param=ref ref=last;
model mage2stool=days_missed2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3026	0.5098	20.4032	<.0001
days_missed2	1	1	1.0499	0.7397	2.0146	0.1558

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_missed2 1 vs 2	2.857	0.670	12.178

```
proc surveylogistic data=surveydata2; class branch2/param=ref ref=last;
model mage2stool=branch2;strata region2 installation;run;
```
Two of the branch categories contain 0 cells, so collapsed into a four category variable, branch3.
```
if branch2=1 then branch3=.;
if branch2=2 then branch3=1;
if branch2=3 then branch3=2;
if branch2=4 then branch3=3;
if branch2=5 then branch3=4;
if branch2=6 then branch3=.;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.2513	0.7780	8.3737	0.0038
branch3	2	1	0.2364	0.9751	0.0588	0.8085
branch3	3	1	4.7E-16	1.0935	0.0000	1.0000
branch3	4	1	1.3352	1.1568	1.3323	0.2484

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
branch3 2 vs 1	1.267	0.187	8.564
branch3 3 vs 1	1.000	0.117	8.527
branch3 4 vs 1	3.801	0.394	36.686

SAS Code and Output for Multivariable Analysis, Model 2: International case definition for AGI; factors associated with service member seeking medical care and submitting a stool sample, Chapter 4, Table 6

Variables with p-values <0.25 from univariable analysis include: race2, max_diarrhea2, sore_throat2, and days_missed.

Full Model:
```
proc surveylogistic data=surveydata2; class race2 max_diarrhea2 sore_throat2
days_missed2/param=ref ref=first;
model mage2stool= race2 max_diarrhea2 sore_throat2 days_missed2;strata region2 installation;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-4.3478	2.1836	3.9646	0.0465
race2	2	1	2.0085	1.6769	1.4346	0.2310
race2	3	1	2.1983	2.2118	0.9877	0.3203
max_diarrhea2	2	1	2.1568	1.6948	1.6195	0.2032
sore_throat2	2	1	1.5588	0.9726	2.5686	0.1090
days_missed2	2	1	-1.3886	1.2363	1.2614	0.2614

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	7.452	0.279	199.382
race2 3 vs 1	9.009	0.118	687.729
max_diarrhea2 2 vs 1	8.643	0.312	239.488
sore_throat2 2 vs 1	4.753	0.706	31.981
days_missed2 2 vs 1	0.249	0.022	2.814

Remove days_missed2 first.

proc surveylogistic data=surveydata2; class race2 max_diarrhea2 sore_throat2/param=ref ref=first; model mage2stool= race2 max_diarrhea2 sore_throat2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-4.3697	1.2796	11.6622	0.0006
race2	2	1	1.2673	1.1437	1.2278	0.2678
race2	3	1	1.6292	1.1458	2.0218	0.1551
max_diarrhea2	2	1	1.8398	0.8839	4.3322	0.0374
sore_throat2	2	1	1.2160	0.9064	1.8000	0.1797

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	3.551	0.377	33.413
race2 3 vs 1	5.100	0.540	48.177
max_diarrhea2 2 vs 1	6.295	1.113	35.595
sore_throat2 2 vs 1	3.374	0.571	19.935

Odds ratios change quite a bit, that is expected because there are so many sparse cells (low power) making the model unstable. Will have to choose confounders that make sense and add them back into the model.

Remove sore_throat2 next.

proc surveylogistic data=surveydata2; class race2 max_diarrhea2/param=ref ref=first; model mage2stool= race2 max_diarrhea2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-3.6260	1.1287	10.3206	0.0013
race2	2	1	1.2369	1.0173	1.4784	0.2240
race2	3	1	1.7276	1.1430	2.2847	0.1307
max_diarrhea2	2	1	1.8137	0.9179	3.9041	0.0482

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	3.445	0.469	25.299
race2 3 vs 1	5.627	0.599	52.867
max_diarrhea2 2 vs 1	6.133	1.015	37.068

Remove race and try gender and age as possible confounders.

proc surveylogistic data=surveydata2; class gender1 agecat2 max_diarrhea2 /param=ref ref=first; model mage2stool= agecat2 gender1 max_diarrhea2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.8773	1.0652	7.2970	0.0069
agecat2	2	1	0.9381	1.1374	0.6802	0.4095
agecat2	3	1	0.9535	1.0600	0.8091	0.3684
agecat2	4	1	-0.2152	0.8894	0.0586	0.8088
gender1	2	1	-0.4137	0.9963	0.1724	0.6780
max_diarrhea2	2	1	1.4998	0.8367	3.2127	0.0731

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
agecat2 2 vs 1	2.555	0.275	23.741
agecat2 3 vs 1	2.595	0.325	20.719
agecat2 4 vs 1	0.806	0.141	4.609
gender1 2 vs 1	0.661	0.094	4.660
max_diarrhea2 2 vs 1	4.481	0.869	23.098

No variables are significant. Try putting sore_throat2 back into the model.

proc surveylogistic data=surveydata2; class max_diarrhea2 agecat2 sore_throat2 gender1/param=ref ref=first; model mage2stool=max_diarrhea2 gender1 agecat2 sore_throat2; weight wgtgen;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-4.2250	1.3464	9.8470	0.0017
max_diarrhea2	2	1	1.8259	0.7732	5.5763	0.0182
gender1	2	1	-0.5417	1.0652	0.2586	0.6111
agecat2	2	1	1.4099	1.2286	1.3169	0.2511
agecat2	3	1	1.3189	1.2383	1.1343	0.2869
agecat2	4	1	-0.0787	1.0929	0.0052	0.9426
sore_throat2	2	1	1.5577	0.7721	4.0699	0.0437

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_diarrhea2 2 vs 1	6.209	1.364	28.260
gender1 2 vs 1	0.582	0.072	4.693
agecat2 2 vs 1	4.095	0.369	45.508
agecat2 3 vs 1	3.739	0.330	42.351
agecat2 4 vs 1	0.924	0.109	7.872
sore_throat2 2 vs 1	4.748	1.045	21.562

SAS Code and Output to Check For Evidence of Multiplicative Interaction:

Checked for evidence of multiplicative interaction. When adding interaction terms into the model, the model fell apart, (due to low power) so no interaction terms.

SAS Code and Outputs For Model Fit Tests

```
/*model fit tests*/
proc logistic data=surveydata2;model mage2stool=max_diarrhea2 gender1 agecat2
sore_throat2/scale=n aggregate lackfit;run;
```

There were 26 unique profiles/covariate patterns (J) and 63 observations (p). J is not < < than n, so use Hosmer and Lemeshow Goodness of Fit Test. If $p \leq 0.05$ there is evidence of lack of model fit. If $p > 0.05$, there is evidence of model fit. The SAS output for both of this test is below and shows evidence of model fit.

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
4.4582	8	0.8136

SAS Code For Final Multivariable Model 2

```
proc surveylogistic data=surveydata2; class max_diarrhea2 agecat2 sore_throat2
gender1/param=ref ref=first;
model mage2stool=max_diarrhea2 gender1 agecat2 sore_throat2; weight wgtgen;strata region2
installation;
contrast 'gender male vs. female' gender1 -1/estimate=exp;
contrast 'age 1 v 4' agecat2 0 0 -1/estimate=exp;
contrast 'age 2 v 4' agecat2 1 0 -1/estimate=exp;
contrast 'age 2 v 4' agecat2 0 1 -1/estimate=exp;
run;
```

SAS Code for Univariable Analysis for Model 3: Scallan et al. (2006) case definition for AGI; factors associated with service members seeking medical care for AGI.

SAS Code for AGI cases and medical care seeking used to create Chapter 4 Table 7

```
/*Region*/
proc surveyfreq data=surveydata6;tables region2 sage region2*sage;weight wgtreg; run;
proc surveyfreq data=surveydata6;tables region2 sagedoc region2*sagedoc;weight wgtreg; run;
/*Overseas*/
proc surveyfreq data=surveydata6;tables overseas sage overseas*sage; weight wgtloc; run;
proc surveyfreq data=surveydata6;tables overseas sagedoc overseas*sagedoc;weight wgtloc; run;
/*Gender*/
proc surveyfreq data=surveydata6;tables gender1 sage gender1*sage;weight wgtgen;run;
proc surveyfreq data=surveydata6;tables gender1 sagedoc gender1*sagedoc;weight wgtgen;run;
proc surveylogistic data=surveydata6; class gender1/param=ref ref=first;
model sagedoc=gender1; weight wgtgen; strata region2 installation;run;
/*rank*/
proc surveyfreq data=surveydata6;tables rankcat2 sage rankcat2*sage;weight wgtrank;run;
proc surveyfreq data=surveydata6;tables rankcat2 sagedoc rankcat2*sagedoc;weight
wgtrank;run;
/*Age*/
proc surveyfreq data=surveydata6;tables agecat sage agecat*sage;weight wgtage;run;
proc surveyfreq data=surveydata6;tables agecat sagedoc agecat*sagedoc;weight wgtage;run;
/*race collapsed*/
proc surveyfreq data=surveydata6;tables race2 sage race2*sage; weight wgtrace; run;
proc surveyfreq data=surveydata6;tables race2 sagedoc race2*sagedoc; weight wgtrace; run;
/*education*/
proc surveyfreq data=surveydata6;tables education2 sage education2*sage;weight wgtedu; run;
proc surveyfreq data=surveydata6;tables education2 sagedoc education2*sagedoc;weight
wgtedu;run;
/*max diarrhea*/
proc surveyfreq data=surveydata6; tables max_diarrhea2 sage max_diarrhea2*sage;run;
proc surveyfreq data=surveydata6; tables max_diarrhea2 sagedoc max_diarrhea2*sagedoc;run;
/*Days Diarrhea Collapsed*/
proc surveyfreq data=surveydata6; tables days_diarrhea3 sage days_diarrhea3*sage;run;
proc surveyfreq data=surveydata6; tables days_diarrhea3 sagedoc days_diarrhea3*sagedoc;run;
/*blood*/
proc surveyfreq data=surveydata6;tables blood2 sage blood2*sage;run;
proc surveyfreq data=surveydata6;tables blood2 sagedoc blood2*sagedoc;run;
/*Sore Throat*/
proc surveyfreq data=surveydata6;tables sore_throat2 sage sore_throat2*sage;run;
proc surveyfreq data=surveydata6;tables sore_throat2 sagedoc sore_throat2*sagedoc;run;
/*Vomit*/
proc surveyfreq data=surveydata6;tables vomit2 sage vomit2*sage;run;
proc surveyfreq data=surveydata6;tables vomit2 sagedoc vomit2*sagedoc;run;
/*Max Vomit Collapsed*/
```

```
proc surveyfreq data=surveydata6;tables max_vomit3 sage max_vomit3*sage;run;
proc surveyfreq data=surveydata6;tables max_vomit3 sagedoc max_vomit3*sagedoc;run;
proc surveylogistic data=surveydata6; class max_vomit3/param=ref ref=first;
model sagedoc=max_vomit3;strata region2 installation;run;
/*Days Vomit Collapsed */
proc surveyfreq data=surveydata6;tables days_vomit3 sage days_vomit3*sage;run;
proc surveyfreq data=surveydata6;tables days_vomit3 sagedoc days_vomit3*sagedoc;run;
/*Diarrhea and Vomiting*/
proc surveyfreq data=surveydata6;tables D_V2 sage D_V2*sage;run;
proc surveyfreq data=surveydata6;tables D_V2 sagedoc D_V2*sagedoc;run;
/*Days diarrhea and vomiting*/
proc surveyfreq data=surveydata6; tables Days_D_V2 sage Days_D_V2*sage;run;
proc surveyfreq data=surveydata6; tables Days_D_V2 sagedoc Days_D_V2*sagedoc;run;
/*Miss Work*/
proc surveyfreq data=surveydata6;tables miss_work2 sage miss_work2*sage;run;
proc surveyfreq data=surveydata6;tables miss_work2 sagedoc miss_work2*sagedoc;run;
/*Days Missed*/
proc surveyfreq data=surveydata6;tables days_missed2 sage days_missed2*sage;run;
proc surveyfreq data=surveydata6;tables days_missed2 sagedoc days_missed2*sagedoc;run;
/*Branch*/
proc surveyfreq data=surveydata6;tables branch2 sage branch2*sage;run;
proc surveyfreq data=surveydata6;tables branch2 sagedoc branch2*sagedoc;run;
```

Table B.4.7. Summary of SAS outputs of crude and weighted data for weighted variables used to create Chapter 4 table 7 for model 3.

Variable	Crude # AGI Cases	Crude # AGI Cases Seeking Care	Crude % AGI Cases Seeking Care	Weighted # AGI Cases	Weighted # AGI Cases Seeking Care	% AGI Cases Seeking Care
Region						
ERMC	18	5	27.8	13.5	3.75	27.8
NRMC	53	12	22.6	54.27	12.29	22.6
PRMC	11	5	45.5	12.41	6.77	54.6
SRMC	85	15	17.6	91.72	75.54	82.4
WRMC	72	16	22.2	67.27	52.32	77.8
Overseas						
Yes	29	10	34.5	11.3	3.896	34.5
No	210	43	20.5	219.6	44.97	20.5
Gender						
Male	191	37	19.4	207.67	40.23	19.4
Female	51	15	29.4	33.79	9.94	29.4

Table B.4.7. Continued.

Variable	Crude	Crude #	Crude %	Weighted	Weighted	% AGI

	# AGI Cases	AGI Cases Seeking Care	AGI Cases Seeking Care	# AGI Cases	# AGI Cases Seeking Care	Cases Seeking Care
Rank						
Officer	83	17	20.5	42.82	8.77	20.5
Enlisted	160	36	22.5	204.19	45.94	22.5
Age						
25 or Younger	32	7	21.9	120.099	26.27	21.9
26-30	42	10	23.8	54.51	12.98	23.8
31-35	50	14	28.0	40.595	11.37	28.0
36-40	58	10	17.2	31.93	5.506	17.2
41 and Over	58	11	19.0	23.04	4.37	19.0
Race						
White non-Hispanic	140	27	19.3	171.82	33.14	19.3
Black or African American	42	13	31.0	45.36	14.04	31.0
All other races	62	13	21.0	26.28	5.51	21.0
Education						
Associate or Technical Degree or less	138	30	21.7	205.52	44.68	21.7
Bachelor's Degree	57	9	15.8	28.56	4.51	15.8
Advanced Degree	49	14	28.6	18.38	5.25	28.6

Table B.4.8. Summary of SAS outputs of data for non-weighted variables used to create Chapter 4 table 7 for model 3.

Variable	# AGI Cases	# AGI Cases Seeking Care	% AGI Cases Seeking Care
Concurrent symptoms			
Max number loose stools in 24 hrs			
≤5 loose stools	186	35	18.8
>5 loose stools	58	18	31.0
Diarrhea duration			
<3 Days	67	13	19.4
≥3 Days	171	38	22.2
Blood in Stool			
Yes	17	6	35.3
No	203	39	19.2

Table B.4.8. Continued.

Variable	# AGI Cases	# AGI Cases Seeking Care	% AGI Cases Seeking Care
Sore throat/cough			
Yes	79	29	36.7
No	159	24	15.1
Vomiting			
Yes	51	24	47.1
No	192	28	14.6
Max times vomit in 24 hrs			
≤5	44	18	40.9
>5	7	6	85.7
Vomit Duration			
<3 Days	35	13	37.1
≥3 Days	15	10	66.7
Both Diarrhea and Vomiting			
Yes	45	21	46.7
No	4	3	75.0
Days both diarrhea and vomiting			
<3 Days	30	11	36.7
≥3 Days	12	8	66.7
Missed Work			
Yes	84	35	41.7
No	156	17	10.9
Days Missed Work			
<2 Days Missed	24	6	25.0
≥2 Days missed	58	28	48.3
Branch			
Army SOF	5	1	20.0
FSD	75	17	22.7
HSD	54	14	25.9
OD	78	16	20.5
OSD	27	4	14.8
Chaplain	1	0	0

SAS Code and Output for Univariable Analysis Represented in Chapter 4 Table 7

```
proc surveylogistic data=surveydata6; class region2/param=ref ref=last;
model sagedoc=region2;weight wgtreg; strata region2 installation;
Contrast 'ERMC v SRMC' region2 1 0 0 -1/estimate=exp;
Contrast 'NRMC v SRMC' region2 0 1 0 -1/estimate=exp;
Contrast 'PRMC v SRMC' region2 0 0 1 -1/estimate=exp;
Contrast 'WRMC v SRMC' region2 0 0 0 -1/estimate=exp;
```

run;

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.2528	0.2861	19.1690	<.0001
region2	1	1	0.2974	0.6195	0.2304	0.6312
region2	2	1	0.0241	0.4391	0.0030	0.9562
region2	3	1	1.0704	0.7153	2.2392	0.1346
region2	4	1	-0.2875	0.4079	0.4970	0.4808

Contrast Estimation and Testing Results by Row

Contrast	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
ERMC v SRMC	1.7949	1.1157	0.05	0.5308	6.0696	0.8854	0.3467
NRMC v SRMC	1.3656	0.6037	0.05	0.5742	3.2482	0.4969	0.4809
PRMC v SRMC	3.8880	2.7881	0.05	0.9535	15.8535	3.5856	0.0583
WRMC v SRMC	1.3331	0.5437	0.05	0.5994	2.9651	0.4970	0.4808

```
proc surveylogistic data=surveydata6;class overseas/param=ref ref=last;
model sagedoc=overseas;weight wgtloc; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.3568	0.1722	62.0523	<.0001
Overseas	1	1	0.7149	0.4402	2.6378	0.1043

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	2.044	0.863	4.844

```
proc surveylogistic data=surveydata6; class gender1/param=ref ref=first;
model sagedoc=gender1; weight wgtgen; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.3930	0.1859	56.1773	<.0001
gender1	2	1	0.5176	0.3558	2.1158	0.1458

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 2 vs 1	1.678	0.835	3.370

```
proc surveylogistic data=surveydata6; class rankcat2/param=ref ref=first;
model sagedoc=rankcat2;weight wgtrank;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.3257	0.2694	24.2112	<.0001
rankcat2	2	1	0.1134	0.3208	0.1249	0.7237

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
rankcat2 2 vs 1	1.120	0.597	2.101

```
proc surveylogistic data=surveydata6; class agecat/param=ref ref=first;
model sagedoc=agecat;weight wgtage;strata region2 installation;
Contrast '25 and less v 36-40' agecat 0 0 -1 0/estimate=exp;
Contrast '26-30 v 36-40' agecat 1 0 -1 0/estimate=exp;
Contrast '31-35 v 36-40' agecat 0 1 -1 0/estimate=exp;
Contrast '41 and up v 36-40' agecat 0 0 -1 1/estimate=exp; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.2730	0.4334	8.6272	0.0033
Agecat	2	1	0.1098	0.5650	0.0378	0.8459
Agecat	3	1	0.4158	0.5379	0.5976	0.4395
Agecat	4	1	-0.2529	0.5514	0.2103	0.6465
Agecat	5	1	-0.1792	0.5481	0.1069	0.7437

Contrast Estimation and Testing Results by Row							
Contrast	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
25 and less v 36-40	1.2878	0.7101	0.05	0.4370	3.7949	0.2103	0.6465
26-30 v 36-40	1.4372	0.7260	0.05	0.5340	3.8681	0.5156	0.4727
31-35 v 36-40	1.9516	0.9192	0.05	0.7754	4.9123	2.0158	0.1557
41 and up v 36-40	1.0765	0.5217	0.05	0.4163	2.7833	0.0231	0.8792

```
proc surveylogistic data=surveydata6; class race2/param=ref ref=first;
model sagedoc=race2; weight wgtrace;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4046	0.2193	41.0268	<.0001
race2	2	1	0.6023	0.4024	2.2404	0.1344
race2	3	1	0.1194	0.3794	0.0991	0.7529

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	1.826	0.830	4.019
race2 3 vs 1	1.127	0.536	2.371

```
proc surveylogistic data=surveydata6; class education2/param=ref ref=last;
model sagedoc=education2;weight wgtedu;strata region2 installation;
contrast 'associates vs. bachelors' education2 1 -1/estimate=exp;
contrast 'advanced vs. bachelors'       education2 0 -1/estimate=exp;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.9160	0.3023	9.1837	0.0024
education2	1	1	-0.3462	0.3578	0.9360	0.3333
education2	2	1	-0.6930	0.4655	2.2169	0.1365

Contrast Estimation and Testing Results by Row							
Contrast	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
associates vs. bachelors	1.4146	0.5927	0.05	0.6223	3.2158	0.6852	0.4078
advanced vs. bachelors	1.9998	0.9308	0.05	0.8031	4.9795	2.2169	0.1365

proc surveylogistic data=surveydata6; class max_diarrhea2/param=ref ref=first; model sagedoc=max_diarrhea2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4351	0.1851	60.1199	<.0001
max_diarrhea2	2	1	0.6619	0.3389	3.8141	0.0508

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_diarrhea2 2 vs 1	1.938	0.998	3.767

proc surveylogistic data=surveydata6; class days_diarrhea3/param=ref ref=First; model sagedoc=days_diarrhea3;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.3669	0.3087	19.6031	<.0001
days_diarrhea3	2	1	0.1293	0.3589	0.1297	0.7187

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_diarrhea3 2 vs 1	1.138	0.563	2.300

proc surveylogistic data=surveydata6; class blood2/param=ref ref=last;
model sagedoc=blood2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4178	0.1788	62.8542	<.0001
blood2	1	1	0.9070	0.5169	3.0788	0.0793

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
blood2 1 vs 2	2.477	0.899	6.822

proc surveylogistic data=surveydata6; class sore_throat2/param=ref ref=last;
model sagedoc=sore_throat2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.7047	0.2218	59.0767	<.0001
sore_throat2	1	1	1.2008	0.3243	13.7142	0.0002

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
sore_throat2 1 vs 2	3.323	1.760	6.274

```
proc surveylogistic data=surveydata6; class vomit2/param=ref ref=last;
model sagedoc=vomit2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.7367	0.2027	73.4234	<.0001
vomit2	1	1	1.6189	0.3428	22.3026	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
vomit2 1 vs 2	5.048	2.578	9.883

```
proc surveylogistic data=surveydata6; class max_vomit3/param=ref ref=first;
model sagedoc=max_vomit3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.3677	0.2933	1.5715	0.2100
max_vomit3	2	1	2.1590	1.1207	3.7113	0.0540

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_vomit3 2 vs 1	8.662	0.963	77.902

```
proc surveylogistic data=surveydata6; class days_vomit3/param=ref ref=first;
model sagedoc=days_vomit3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.5261	0.3380	2.4227	0.1196
days_vomit3	2	1	1.2192	0.6394	3.6359	0.0565

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_vomit3 2 vs 1	3.384	0.967	11.850

proc surveylogistic data=surveydata6; class D_V2/param=ref ref=first;
model sagedoc=D_V2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.1335	0.3007	0.1971	0.6570
D_V2	2	1	1.2321	1.1843	1.0825	0.2981

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
D_V2 2 vs 1	3.429	0.337	34.927

proc surveylogistic data=surveydata6; class Days_D_V2/param=ref ref=fist; model sagedoc=Days_D_V2;strata region2 installation; run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.5465	0.3953	1.9114	0.1668
Days_D_V2	2	1	1.2396	0.7499	2.7324	0.0983

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Days_D_V2 2 vs 1	3.454	0.794	15.021

proc surveylogistic data=surveydata6; class miss work2/param=ref ref=last;
model sagedoc=miss_work2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.0794	0.2565	65.7193	<.0001
miss_work2	1	1	1.7846	0.3374	27.9716	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
miss_work2 1 vs 2	5.957	3.075	11.541

proc surveylogistic data=surveydata6; class days_missed2/param=ref ref=first;
model sagedoc=days_missed2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.0986	0.5168	4.5186	0.0335
days_missed2	2	1	1.0986	0.5934	3.4276	0.0641

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_missed2 2 vs 1	3.000	0.938	9.599

```
proc surveylogistic data=surveydata6; class branch2/param=ref ref=first;
model sagedoc=branch2;strata region2 installation;
contrast 'SOF vs. OSD' branch2 0 0 0 -1 0/estimate=exp;
contrast 'FSD vs. OSD'          branch2 1 0 0 -1 0/estimate=exp;
contrast 'HSD vs. OSD' branch2 0 1 0 -1 0/estimate=exp;
contrast 'OD vs OSD' branch2 0 0 1 -1 0/estimate=exp;
contrast 'Chap vs. OSD' branch2 0 0 0 -1 1/estimate=exp;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.0986	1.1773	0.8709	0.3507
branch2	2	1	-0.0755	1.2128	0.0039	0.9504
branch2	3	1	0.0488	1.2239	0.0016	0.9682
branch2	4	1	-0.2397	1.2085	0.0393	0.8428
branch2	5	1	-0.6506	1.2957	0.2521	0.6156
branch2	6	1	-12.5643	1.5517	65.5635	<.0001

Contrast Estimation and Testing Results by Row									
Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
SOF vs. OSD	EXP	1	1.9167	2.4835	0.05	0.1512	24.2935	0.2521	0.6156
FSD vs. OSD	EXP	1	1.7773	1.0780	0.05	0.5414	5.8348	0.8990	0.3430
HSD vs. OSD	EXP	1	2.0125	1.2447	0.05	0.5988	6.7640	1.2786	0.2582
OD vs OSD	EXP	1	1.5082	0.9504	0.05	0.4386	5.1861	0.4252	0.5143
Chap vs. OSD	EXP	1	6.698E-6	7.687E-6	0.05	7.063E-7	0.000064	107.7453	<.0001

SAS Code and Output for Multivariable Analysis, Model 3: Scallan et al. (2006) case definition for AGI; factors associated with service members seeking medical care for AGI, Chapter 4, Table 8.

The variables with p-values<0.25 in the univariable analysis include region2, overseas, gender1, agecat, race2, education2, max_diarrhea2, blood2, sore_throat2, vomit2, max_vomit3, days_vomit3, daysD_V2, missed_work2, and days_missed. Some variables are subvariables of other and should be left out of the model. Decision is to leave out region2, max_vomit3, days_vomit3, daysD-V2, days_missed2, but keep overseas, vomit2, and miss_work2.

Full Model:

```
proc surveylogistic data=surveydata6;class overseas gender1 agecat race2 education2
max_diarrhea2 blood2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model sagedoc=overseas gender1 agecat race2 education2 max_diarrhea2 blood2
sore_throat2 vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.4060	0.8993	7.1571	0.0075
Overseas	1	1	0.2606	0.5179	0.2531	0.6149
gender1	1	1	0.1377	0.5098	0.0730	0.7871
Agecat	1	1	0.1138	0.7704	0.0218	0.8826
Agecat	2	1	0.3414	0.7471	0.2088	0.6477
Agecat	3	1	0.9431	0.7035	1.7970	0.1801
Agecat	4	1	-0.4726	0.6496	0.5293	0.4669
race2	1	1	-0.2303	0.5769	0.1594	0.6897
race2	2	1	1.0222	0.7028	2.1153	0.1458
education2	1	1	-1.1685	0.5352	4.7666	0.0290
education2	2	1	-1.6115	0.6059	7.0733	0.0078
max_diarrhea2	1	1	0.1039	0.4495	0.0535	0.8172
blood2	1	1	-0.00083	0.8127	0.0000	0.9992
sore_throat2	1	1	1.6757	0.4221	15.7620	<.0001
vomit2	1	1	1.4109	0.4872	8.3864	0.0038
miss_work2	1	1	1.3417	0.4535	8.7551	0.0031

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.298	0.470	3.581
gender1 1 vs 2	1.148	0.423	3.117
Agecat 1 vs 5	1.120	0.248	5.071
Agecat 2 vs 5	1.407	0.325	6.085
Agecat 3 vs 5	2.568	0.647	10.195
Agecat 4 vs 5	0.623	0.175	2.227

race2 1 vs 3	0.794	0.256	2.460
race2 2 vs 3	2.779	0.701	11.020
education2 1 vs 3	0.311	0.109	0.887
education2 2 vs 3	0.200	0.061	0.654
max_diarrhea2 1 vs 2	1.110	0.460	2.677
blood2 1 vs 2	0.999	0.203	4.913
sore_throat2 1 vs 2	5.342	2.336	12.218
vomit2 1 vs 2	4.100	1.578	10.653
miss_work2 1 vs 2	3.826	1.573	9.304

First, remove blood2.

```
proc surveyfreq data=surveydata6; tables Blood2*SAGE;run;
proc surveylogistic data=surveydata6;class overseas gender1 agecat race2 education2
max_diarrhea2
sore  throat2 vomit2 miss  work2/param=ref ref=last;
model sagedoc=overseas gender1 agecat race2 education2 max_diarrhea2
sore_throat2 vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1794	0.7743	7.9233	0.0049
Overseas	1	1	0.0711	0.5224	0.0185	0.8918
gender1	1	1	-0.0866	0.4546	0.0363	0.8489
Agecat	1	1	-0.0377	0.6829	0.0031	0.9559
Agecat	2	1	0.0669	0.6268	0.0114	0.9151
Agecat	3	1	0.7670	0.6175	1.5427	0.2142
Agecat	4	1	-0.6413	0.5951	1.1615	0.2812
race2	1	1	-0.2975	0.5297	0.3153	0.5744
race2	2	1	0.9041	0.5981	2.2848	0.1306
education2	1	1	-0.9435	0.5123	3.3926	0.0655
education2	2	1	-1.2570	0.5542	5.1452	0.0233
max_diarrhea2	1	1	0.0369	0.4217	0.0077	0.9302
sore_throat2	1	1	1.6037	0.4045	15.7180	<.0001
vomit2	1	1	1.3363	0.4540	8.6620	0.0032
miss_work2	1	1	1.4638	0.4274	11.7311	0.0006

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.074	0.386	2.989
gender1 1 vs 2	0.917	0.376	2.235
Agecat 1 vs 5	0.963	0.253	3.672
Agecat 2 vs 5	1.069	0.313	3.652
Agecat 3 vs 5	2.153	0.642	7.223
Agecat 4 vs 5	0.527	0.164	1.690

race2 1 vs 3	0.743	0.263	2.098
race2 2 vs 3	2.470	0.765	7.975
education2 1 vs 3	0.389	0.143	1.062
education2 2 vs 3	0.285	0.096	0.843
max_diarrhea2 1 vs 2	1.038	0.454	2.371
sore_throat2 1 vs 2	4.972	2.250	10.985
vomit2 1 vs 2	3.805	1.563	9.264
miss_work2 1 vs 2	4.322	1.870	9.989

Many variable ORs change by more than 10%. However, the number of cases with blood in stool by each of the variables yields very sparse cells. Could be an effect of the model being unstable due to sparse cells, not because blood is an actual confounder. Doesn't really make sense as a confounder either, leave out of model.

Next, remove max_diarrhea2.

```
proc surveylogistic data=surveydata6;class overseas gender1 agecat race2 education2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model sagedoc=overseas gender1 agecat race2 education2
sore_throat2 vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1464	0.7166	8.9711	0.0027
Overseas	1	1	0.0636	0.5184	0.0151	0.9024
gender1	1	1	-0.0857	0.4533	0.0358	0.8500
Agecat	1	1	-0.0360	0.6820	0.0028	0.9579
Agecat	2	1	0.0627	0.6235	0.0101	0.9199
Agecat	3	1	0.7672	0.6158	1.5525	0.2128
Agecat	4	1	-0.6442	0.5942	1.1752	0.2783
race2	1	1	-0.2984	0.5289	0.3182	0.5727
race2	2	1	0.8997	0.5936	2.2969	0.1296
education2	1	1	-0.9433	0.5101	3.4194	0.0644
education2	2	1	-1.2550	0.5478	5.2477	0.0220
sore_throat2	1	1	1.6055	0.4040	15.7922	<.0001
vomit2	1	1	1.3271	0.4413	9.0442	0.0026
miss_work2	1	1	1.4602	0.4246	11.8286	0.0006

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.066	0.386	2.943
gender1 1 vs 2	0.918	0.378	2.231
Agecat 1 vs 5	0.965	0.253	3.672
Agecat 2 vs 5	1.065	0.314	3.613

Agecat 3 vs 5	2.154	0.644	7.200
Agecat 4 vs 5	0.525	0.164	1.683
race2 1 vs 3	0.742	0.263	2.092
race2 2 vs 3	2.459	0.768	7.871
education2 1 vs 3	0.389	0.143	1.058
education2 2 vs 3	0.285	0.097	0.834
sore_throat2 1 vs 2	4.981	2.256	10.994
vomit2 1 vs 2	3.770	1.588	8.954
miss_work2 1 vs 2	4.307	1.874	9.898

No ORs change by more than 10%, keep out of model, next remove Overseas.

```
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2
sore_throat2 vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1444	0.7141	9.0169	0.0027
gender1	1	1	-0.0882	0.4537	0.0378	0.8458
Agecat	1	1	-0.0283	0.6768	0.0017	0.9667
Agecat	2	1	0.0747	0.6104	0.0150	0.9026
Agecat	3	1	0.7777	0.6084	1.6344	0.2011
Agecat	4	1	-0.6371	0.5876	1.1757	0.2782
race2	1	1	-0.2978	0.5275	0.3188	0.5723
race2	2	1	0.9055	0.5956	2.3110	0.1285
education2	1	1	-0.9486	0.5067	3.5044	0.0612
education2	2	1	-1.2619	0.5421	5.4187	0.0199
sore_throat2	1	1	1.6123	0.3966	16.5253	<.0001
vomit2	1	1	1.3332	0.4383	9.2506	0.0024
miss_work2	1	1	1.4582	0.4235	11.8550	0.0006

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 1 vs 2	0.916	0.376	2.228
Agecat 1 vs 5	0.972	0.258	3.663
Agecat 2 vs 5	1.078	0.326	3.564
Agecat 3 vs 5	2.177	0.661	7.172
Agecat 4 vs 5	0.529	0.167	1.673
race2 1 vs 3	0.742	0.264	2.088
race2 2 vs 3	2.473	0.770	7.947
education2 1 vs 3	0.387	0.143	1.046
education2 2 vs 3	0.283	0.098	0.819

sore_throat2 1 vs 2	5.014	2.305	10.910
vomit2 1 vs 2	3.793	1.607	8.956
miss_work2 1 vs 2	4.298	1.874	9.857

No ORs change by more than 10%, keep out of model, next remove gender.

```
proc surveylogistic data=surveydata6;class agecat race2 education2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model sagedoc=agecat race2 education2
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.2010	0.6130	12.8899	0.0003
Agecat	1	1	-0.1806	0.6732	0.0719	0.7885
Agecat	2	1	0.0734	0.6021	0.0149	0.9029
Agecat	3	1	0.7792	0.5921	1.7322	0.1881
Agecat	4	1	-0.6242	0.5756	1.1761	0.2782
race2	1	1	-0.2926	0.5175	0.3198	0.5717
race2	2	1	0.8091	0.5865	1.9033	0.1677
education2	1	1	-0.9405	0.4977	3.5714	0.0588
education2	2	1	-1.2257	0.5277	5.3952	0.0202
sore_throat2	1	1	1.6481	0.3937	17.5230	<.0001
vomit2	1	1	1.2868	0.4372	8.6622	0.0032
miss_work2	1	1	1.4491	0.4200	11.9010	0.0006

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Agecat 1 vs 5	0.835	0.223	3.123
Agecat 2 vs 5	1.076	0.331	3.502
Agecat 3 vs 5	2.180	0.683	6.956
Agecat 4 vs 5	0.536	0.173	1.655
race2 1 vs 3	0.746	0.271	2.058
race2 2 vs 3	2.246	0.711	7.090
education2 1 vs 3	0.390	0.147	1.036
education2 2 vs 3	0.294	0.104	0.826
sore_throat2 1 vs 2	5.197	2.402	11.243
vomit2 1 vs 2	3.621	1.537	8.531
miss_work2 1 vs 2	4.259	1.870	9.702

No ORs change by more than 10%, keep out of model, next remove race2.

```
proc surveylogistic data=surveydata6;class gender1 agecat education2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat education2 sore_throat2 vomit2 miss_work2;strata region2
installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.0034	0.6063	10.9201	0.0010
gender1	1	1	-0.2761	0.4521	0.3731	0.5413
Agecat	1	1	-0.3647	0.6397	0.3250	0.5686
Agecat	2	1	-0.1198	0.6156	0.0379	0.8457
Agecat	3	1	0.6135	0.5907	1.0786	0.2990
Agecat	4	1	-0.6665	0.5805	1.3185	0.2509
education2	1	1	-0.6553	0.4655	1.9818	0.1592
education2	2	1	-1.0368	0.5126	4.0907	0.0431
sore_throat2	1	1	1.5403	0.3784	16.5718	<.0001
vomit2	1	1	1.2548	0.4351	8.3187	0.0039
miss_work2	1	1	1.4440	0.4023	12.8819	0.0003

Odds Ratio Estimates			
Effect	Point Estimate	95% WaldCL	
gender1 1 vs 2	0.759	0.313	1.840
Agecat 1 vs 5	0.694	0.198	2.433
Agecat 2 vs 5	0.887	0.265	2.964
Agecat 3 vs 5	1.847	0.580	5.879
Agecat 4 vs 5	0.513	0.165	1.602
education2 1 vs 3	0.519	0.209	1.293
education2 2 vs 3	0.355	0.130	0.968
sore_throat2 1 vs 2	4.666	2.223	9.795
vomit2 1 vs 2	3.507	1.495	8.227
miss_work2 1 vs 2	4.238	1.926	9.323

Education and agecat changes by more than 10%. Race is a possible confounder of these variables, keep in the model. Remove age next.

```
proc surveylogistic data=surveydata6;class gender1 race2 education2
sore_throat2 vomit2 miss_work2/param=ref ref=last;
model sagedoc=gender1 race2 education2
sore_throat2 vomit2 miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.0751	0.6133	11.4468	0.0007
gender1	1	1	-0.0782	0.4474	0.0306	0.8612
race2	1	1	-0.1996	0.4948	0.1626	0.6867
race2	2	1	0.7515	0.6025	1.5556	0.2123
education2	1	1	-0.9060	0.4586	3.9034	0.0482
education2	2	1	-1.1407	0.5112	4.9785	0.0257
sore_throat2	1	1	1.4818	0.4058	13.3330	0.0003
vomit2	1	1	1.2786	0.4093	9.7560	0.0018

miss_work2	1	1	1.3663	0.3982	11.7723	0.0006

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
gender1 1 vs 2	0.925	0.385	2.223
race2 1 vs 3	0.819	0.311	2.160
race2 2 vs 3	2.120	0.651	6.906
education2 1 vs 3	0.404	0.164	0.993
education2 2 vs 3	0.320	0.117	0.870
sore_throat2 1 vs 2	4.401	1.987	9.750
vomit2 1 vs 2	3.591	1.610	8.011
miss_work2 1 vs 2	3.921	1.796	8.557

Race, education, and sore_throat change by >10%, age is possible confounder. Keep age in model.

Table B.4.9. Summary of the SAS output for odds ratios (ORs) and change in odds ratios before and after adding potential confounders back into the model. No evidence of confounding by rank. Branch has sparse cells, so a lot of values changed by >10% and it resulted in quasi-complete separation of data points. Keep out of model.

Variables	Pre-Final Model OR Outputs	OR After Add Rank	% Change	OR After Add Branch	% Change
gender1 1 vs 2	0.916	0.918	-0.2%	1.116	-21.83%
Agecat 1 vs 5	0.972	1.003	-3.2%	0.916	5.76%
Agecat 2 vs 5	1.078	1.081	-0.3%	1.264	-17.25%
Agecat 3 vs 5	2.177	2.188	-0.5%	2.036	6.48%
Agecat 4 vs 5	0.529	0.534	-0.9%	0.612	-15.69%
race2 1 vs 3	0.742	0.748	-0.8%	0.654	11.86%
race2 2 vs 3	2.473	2.461	0.5%	2.034	17.75%
education2 1 vs 3	0.387	0.378	2.3%	0.465	-20.16%
education2 2 vs 3	0.283	0.281	0.7%	0.316	-11.66%
sore_throat2 1 vs 2	5.014	4.963	1.0%	6.172	-23.10%
vomit2 1 vs 2	3.793	3.836	-1.1%	4.353	-14.76%
miss_work2 1 vs 2	4.298	4.236	1.4%	3.842	10.61%

SAS Code and Output to Check For Evidence of Multiplicative Interaction:

```
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
gender1*agecat;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
```

```
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
gender1*education2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
gender1*sore_throat2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
gender1*vomit2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
gender1*miss_work2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
agecat*education2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
agecat*sore_throat2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
agecat*vomit2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
agecat*miss_work2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
education2*sore_throat2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
```

```
education2*vomit2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
education2*miss_work2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
sore_throat2*vomit2;
strata region2 installation;run;
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
sore_throat2*miss_work2;
strata region2 installation;run;

proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2
vomit2*miss_work2;
strata region2 installation;run;
```

Table B.4.10. Summary of SAS output after adding interaction terms back into the model to look for evidence of multiplicative interaction. Table displays the interaction terms and associated p-values.

Interaction Term	P-value	Interaction Term	P-value
gender1*Agecat	0.6736	Agecat*sore_throat2	0.9912
gender1*Agecat	0.3707	Agecat*sore_throat2	0.9187
gender1*Agecat	0.5429	Agecat*vomit2	0.9111
gender1*Agecat	0.1193	Agecat*vomit2	0.8848
gender1*education2	0.9141	Agecat*vomit2	0.5357
gender1*education2	0.6132	Agecat*vomit2	0.7884
gender1*sore_throat2	0.8685	Agecat*miss_work2	0.6429
gender1*vomit2	0.2940	Agecat*miss_work2	0.9450
gender1*miss_work2	0.2033	Agecat*miss_work2	0.6062
Agecat*education2	0.0619	Agecat*miss_work2	0.7799
Agecat*education2	.	education*sore_throa	0.2585
Agecat*education2	0.6018	education*sore_throa	0.3680
Agecat*education2	0.1739	education2*vomit2	0.9226
Agecat*education2	0.3780	education2*vomit2	0.1815
Agecat*education2	0.1912	education*miss_work2	0.1855

Agecat*education2	0.4770	education*miss_work2	0.9690
Agecat*education2	0.2495	sore_throat2*vomit2	0.5204
Agecat*sore_throat2	0.8620	sore_thro*miss_work2	0.4404
Agecat*sore_throat2	0.7314	vomit2*miss_work2	0.4881

No evidence of multiplicative interaction.

SAS Code and Outputs For Model Fit Tests

```
/*model fit tests*/
proc logistic data=surveydata6;model sage=gender1 agecat race2 education2 sore_throat2
vomit2 miss_work2/scale=n aggregate lackfit;run;
```

There were 258 unique profiles/covariate patterns (J) and 631 observations (p). J is not≪n, Hosmer and Lemeshow Goodness of Fit Test is used. If p≤0.05 there is evidence of lack of model fit. If p>0.05, there is evidence of model fit. The SAS output for this is below, evidence of good fit.

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
4.0594	8	0.8517

SAS Code For Final Multivariable Model 3

```
proc surveylogistic data=surveydata6;class gender1 agecat race2 education2 sore_throat2 vomit2
miss_work2/param=ref ref=last;
model sagedoc=gender1 agecat race2 education2 sore_throat2 vomit2 miss_work2;
strata region2 installation;
contrast 'female vs. male'gender1 -1/estimate=exp;
contrast '25 or younger vs. 36-40' agecat 1 0 0 -1/estimate=exp;
contrast '26-30 vs. 36-40' agecat 0 1 0 -1/estimate=exp;
contrast '31-35 vs. 36-40' agecat 0 0 1 -1 /estimate=exp;
contrast '41+ vs. 36-40' agecat 0 0 0 -1/estimate=exp;
contrast 'black/aa vs. white' race2 -1 1/estimate=exp;
contrast 'other vs. white' race2 -1 0/estimate=exp;
contrast 'associates vs. bachelors' education2 1 -1/estimate=exp;
contrast 'advanced vs. bachelors'       education2 0 -1/estimate=exp;
contrast 'advanced vs. associates' education2 -1 0/estimate=exp;
contrast 'sore throat yes vs. no' sore_throat2 1/estimate=exp;
contrast 'vomit yes vs. no' vomit2 1/estimate=exp;
contrast 'miss work yes vs. no' miss_work2 1/estimate=exp;
run;
```

SAS Code and Output for Univariable Analysis for Model 4: Scallan et al. (2006) case definition for AGI; factors associated with service members seeking medical care for AGI and submitting a stool sample, Chapter 4, Table 9.

```
/*Region*/
```

```
proc surveyfreq data=surveydata6;tables region2 sagedoc region2*sagedoc;weight wgtreg; run;
proc surveyfreq data=surveydata6;tables region2 sagestool region2*sagestool;weight wgtreg;
run;
/*Overseas*/
proc surveyfreq data=surveydata6;tables overseas sagedoc overseas*sagedoc;weight wgtloc; run;
proc surveyfreq data=surveydata6;tables overseas sagestool overseas*sagestool; weight
wgtloc;run;
/*Gender*/
proc surveyfreq data=surveydata6;tables gender1 sagedoc gender1*sagedoc;weight wgtgen;run;
proc surveyfreq data=surveydata6;tables gender1 sagestool gender1*sagestool;weight
wgtgen;run;
proc surveylogistic data=surveydata6; class gender1/param=ref ref=first;
model sagestool=gender1; weight wgtgen; strata region2 installation;run;
/*rank*/
proc surveyfreq data=surveydata6;tables rankcat2 sagedoc rankcat2*sagedoc;weight
wgtrank;run;
proc surveyfreq data=surveydata6;tables rankcat2 sagestool rankcat2*sagestool;weight
wgtrank;run;
/*Age*/
proc surveyfreq data=surveydata6;tables agecat sagedoc agecat*sagedoc;weight wgtage;run;
proc surveyfreq data=surveydata6;tables agecat sagestool agecat*sagestool;weight wgtage;run;
/*race collapsed*/
proc surveyfreq data=surveydata6;tables race2 sagedoc race2*sagedoc; weight wgtrace; run;
proc surveyfreq data=surveydata6;tables race2 sagestool race2*sagestool; weight wgtrace; run;
/*education*/
proc surveyfreq data=surveydata6;tables education2 sagedoc education2*sagedoc;weight
wgtedu; run;
proc surveyfreq data=surveydata6;tables education2 sagestool education2*sagestool;weight
wgtedu;run;
/*max diarrhea*/
proc surveyfreq data=surveydata6; tables max_diarrhea2 sagedoc max_diarrhea2*sagedoc;run;
proc surveyfreq data=surveydata6; tables max_diarrhea2 sagestool
max_diarrhea2*sagestool;run;
/*Days Diarrhea Collapsed*/
proc surveyfreq data=surveydata6; tables days_diarrhea3 sagedoc days_diarrhea3*sagedoc;run;
proc surveyfreq data=surveydata6; tables days_diarrhea3 sagestool
days_diarrhea3*sagestool;run;
/*blood*/
proc surveyfreq data=surveydata6;tables blood2 sagedoc blood2*sagedoc;run;
proc surveyfreq data=surveydata6;tables blood2 sagestool blood2*sagestool;run;
/*Sore Throat*/
proc surveyfreq data=surveydata6;tables sore_throat2 sagedoc sore_throat2*sagedoc;run;
proc surveyfreq data=surveydata6;tables sore_throat2 sagestool sore_throat2*sagestool;run;
/*Vomit*/
proc surveyfreq data=surveydata6;tables vomit2 sagedoc vomit2*sagedoc;run;
proc surveyfreq data=surveydata6;tables vomit2 sagestool vomit2*sagestool;run;
```

```
/*Max Vomit Collapsed*/
proc surveyfreq data=surveydata6;tables max_vomit3 sagedoc max_vomit3*sagedoc;run;
proc surveyfreq data=surveydata6;tables max_vomit3 sagestool max_vomit3*sagestool;run;
/*Days Vomit Collapsed */
proc surveyfreq data=surveydata6;tables days_vomit3 sagedoc days_vomit3*sagedoc;run;
proc surveyfreq data=surveydata6;tables days_vomit3 sagestool days_vomit3*sagestool;run;
/*Diarrhea and Vomiting*/
proc surveyfreq data=surveydata6;tables D_V2 sagedoc D_V2*sagedoc;run;
proc surveyfreq data=surveydata6;tables D_V2 sagestool D_V2*sagestool;run;
/*Days diarrhea and vomiting*/
proc surveyfreq data=surveydata6; tables Days_D_V2 sagedoc Days_D_V2*sagedoc;run;
proc surveyfreq data=surveydata6; tables Days_D_V2 sagestool Days_D_V2 *sagestool;run;

/*Miss Work*/
proc surveyfreq data=surveydata6;tables miss_work2 sagedoc miss_work2*sagedoc;run;
proc surveyfreq data=surveydata6;tables miss_work2 sagestool miss_work2*sagestool;run;
/*Days Missed*/
proc surveyfreq data=surveydata6;tables days_missed2 sagedoc days_missed2*sagedoc;run;
proc surveyfreq data=surveydata6;tables days_missed2 sagestool days_missed2*sagestool;run;
/*Branch*/
proc surveyfreq data=surveydata6;tables branch2 sagedoc branch2*sagedoc;run;
proc surveyfreq data=surveydata6;tables branch2 sagestool branch2*sagestool;run;
```

Table B.4.11. Summary of SAS outputs of crude and weighted data for weighted variables used to crate Chapter 4 table 9 for model 4.

Variable	Crude # AGI Cases Seeking Care	Crude # Care Seekers Submitting Stool	Crude % Care Seekers Submitting Stool	Weighted # AGI Cases Seeking Care	Weighted # Care Seekers Submitting Stool	Weighted % Care Seekers Submitting Stool
Region						
ERMC	5	1	20.0	3.75	0.749	20.0
NRMC	12	3	25.0	12.29	3.072	25.0
PRMC	5	1	20.0	5.642	1.13	20.0
SRMC	15	3	20.0	16.18	3.24	20.0
WRMC	16	2	12.5	14.95	1.87	12.5
Overseas						
Yes	10	2	20.0	3.896	0.779	20.0
No	43	8	18.6	44.97	8.366	18.6
Gender						
Male	37	7	18.9	40.23	7.611	18.9
Female	15	3	20.0	9.94	1.99	20.0

B.4.11. Continued.

Variable	Crude #	Crude #	Crude %	Weighte	Weighted	Weighted

	AGI Cases Seeking Care	Care Seekers Submitting Stool	Care Seekers Submitting Stool	d # AGI Cases Seeking Care	# Care Seekers Submitting Stool	% Care Seekers Submittin g Stool
Rank						
Officer	17	2	11.8	8.77	1.03	11.7
Enlisted	36	8	22.2	45.94	8.77	19.1
Age						
25 or less	7	1	14.3	26.27	3.75	14.3
26-30	10	2	20.0	12.98	2.596	20.0
31-35	14	3	21.4	11.37	2.436	21.4
36-40	10	3	30.0	5.506	1.65	30.0
41 and Over	11	1	9.1	4.37	0.397	9.1
Race						
White non-Hispanic	27	4	14.8	33.14	4.9	14.8
Black or African American	13	3	23.1	14.04	3.24	23.1
All other races	13	3	23.1	5.51	1.27	23.0
Education						
Associate or Technical Degree or less	30	6	20.0	44.68	8.94	20.0
Bachelor's Degree	9	1	11.1	4.51	0.5	11.1
Advanced Degree	14	3	21.4	5.25	1.126	21.4

Table B.4.12. Summary of SAS outputs of data for non-weighted variables used to create Chapter 4 table 9 for model 4.

Variable	# AGI Cases Seeking Care	# Care Seekers Submitting Stool	% Care Seekers Submitting Stool
Concurrent symptoms			
Max number loose stools in 24 hrs			
≤5 loose stools	35	5	14.3
>5 loose stools	18	5	27.8
Diarrhea duration			
<3 Days	13	1	7.7
≥3 Days	38	7	18.4

Table B.4.12. Continued.

Variable	# AGI	# Care	% Care

	Cases Seeking Care	Seekers Submitting Stool	Seekers Submitting Stool
Blood in Stool			
Yes	6	0	0.0
No	39	7	17.9
Sore throat/cough			
Yes	29	3	10.3
No	24	7	29.2
Vomiting			
Yes	24	5	20.8
No	28	5	17.9
Max times vomit in 24 hrs			
≤5	18	4	22.2
>5	6	1	16.7
Vomit Duration			
<3 Days	13	3	23.1
≥3 Days	10	1	10.0
Both Diarrhea and Vomiting			
Yes	21	4	19.0
No	3	1	33.3
Days both diarrhea and vomiting			
<3 Days	11	2	18.2
≥3 Days	8	1	12.5
Missed Work			
Yes	35	7	20.0
No	17	2	11.8
Days Missed Work			
<2 Days Missed	6	3	50.0
≥2 Days missed	28	4	14.3
Branch			
Army SOF	1	0	0.0
FSD	17	3	17.6
HSD	14	3	21.4
OD	16	2	12.5
OSD	4	2	50.0
Chaplain	0	0	-

SAS Code and Output for Univariable Analysis Represented in Chapter 4 Table 9.

```
proc surveylogistic data=surveydata6; class region2/param=ref ref=last;
model sagestool=region2;weight wgtreg; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.9459	0.7284	7.1362	0.0076
region2	1	1	0.5596	1.4911	0.1409	0.7074
region2	2	1	0.8473	0.9473	0.7999	0.3711
region2	3	1	0.5596	1.4911	0.1409	0.7074
region2	4	1	0.5596	0.9846	0.3230	0.5698

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
region2 1 vs 5	1.750	0.094	32.527
region2 2 vs 5	2.333	0.364	14.940
region2 3 vs 5	1.750	0.094	32.527
region2 4 vs 5	1.750	0.254	12.054

```
proc surveylogistic data=surveydata6;class overseas/param=ref ref=last;
model sagestool=overseas;weight wgtloc; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4759	0.3652	16.3289	<.0001
Overseas	1	1	0.0896	0.9643	0.0086	0.9260

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
Overseas 1 vs 2	1.094	0.165	7.241

```
proc surveylogistic data=surveydata6; class gender1/param=ref ref=first;
model sagestool=gender1; weight wgtgen; strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4553	0.3825	14.4730	0.0001
gender1	2	1	0.0690	0.7557	0.0083	0.9273

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	
gender1 2 vs 1	1.071	0.244	4.712

proc surveylogistic data=surveydata6; class rankcat2/param=ref ref=first;
model sagestool=rankcat2;weight wgtrank;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.0149	0.7941	6.4381	0.0112
rankcat2	2	1	0.7621	0.9036	0.7113	0.3990

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
rankcat2 2 vs 1	2.143	0.365	12.594

proc surveylogistic data=surveydata6; class agecat/param=ref ref=last;
model sagestool=agecat;weight wgtage2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.3025	0.2676	74.0232	<.0001
Agecat	1	1	0.5107	1.2047	0.1797	0.6716
Agecat	2	1	0.9162	0.8922	1.0544	0.3045
Agecat	3	1	1.0032	0.7413	1.8313	0.1760
Agecat	4	1	1.4552	0.7869	3.4200	0.0644

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Agecat 1 vs 5	1.666	0.157	17.670
Agecat 2 vs 5	2.500	0.435	14.367
Agecat 3 vs 5	2.727	0.638	11.660
Agecat 4 vs 5	4.285	0.917	20.034

proc surveylogistic data=surveydata6; class race2/param=ref ref=first;
model sagestool=race2; weight wgtrace;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.7492	0.4993	12.2752	0.0005
race2	2	1	0.5452	0.7349	0.5504	0.4582
race2	3	1	0.5452	0.8438	0.4175	0.5182

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
race2 2 vs 1	1.725	0.409	7.284
race2 3 vs 1	1.725	0.330	9.017

```
proc surveylogistic data=surveydata6; class education2/param=ref ref=last;
model sagestool=education2;weight wgtedu;strata region2 installation;
contrast 'associates vs. bachelors' education2 1 -1/estimate=exp;
contrast 'advanced vs bachelors'        education2 0 -1/estimate=exp;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.2993	0.6579	3.8998	0.0483
education2	1	1	-0.0870	0.8267	0.0111	0.9162
education2	2	1	-0.7801	0.7004	1.2409	0.2653

Contrast Estimation and Testing Results by Row									
Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
associates vs. bachelors	EXP	1	2.0000	1.1496	0.05	0.6483	6.1702	1.4541	0.2279
advanced vs bachelors	EXP	1	2.1818	1.5280	0.05	0.5529	8.6090	1.2409	0.2653

```
proc surveylogistic data=surveydata6; class max_diarrhea2/param=ref ref=first; model
sagestool=max_diarrhea2;strata region2 installation; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.7918	0.4790	13.9941	0.0002
max_diarrhea2	2	1	0.8362	0.6859	1.4863	0.2228

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_diarrhea2 2 vs 1	2.308	0.602	8.852

```
proc surveylogistic data=surveydata6; class days_diarrhea3/param=ref ref=First; model
sagestool=days_diarrhea3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.4848	1.0619	5.4750	0.0193
days_diarrhea3	2	1	0.9967	1.1436	0.7597	0.3834

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_diarrhea3 2 vs 1	2.709	0.288	25.485

proc surveylogistic data=surveydata6; class blood2/param=ref ref=last;
model sagestool=blood2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.5198	0.3967	14.6756	0.0001
blood2	1	1	-11.4432	0.4529	638.4276	<.0001

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
blood2 1 vs 2			

proc surveylogistic data=surveydata6; class sore_throat2/param=ref ref=first;
model sagestool=sore_throat2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1595	0.6380	11.4575	0.0007
sore_throat2	2	1	1.2722	0.7718	2.7172	0.0993

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
sore_throat2 2 vs 1	3.569	0.786	16.196

proc surveylogistic data=surveydata6; class vomit2/param=ref ref=last;
model sagestool=vomit2;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.5261	0.4760	10.2787	0.0013
vomit2	1	1	0.1911	0.6297	0.0920	0.7616

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
vomit2 1 vs 2	1.211	0.352	4.159

proc surveylogistic data=surveydata6; class max_vomit3/param=ref ref=last;
model sagestool=max_vomit3;strata region2 installation;run;

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.6093	1.2605	1.6300	0.2017
max_vomit3	1	1	0.3565	1.3603	0.0687	0.7933

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
max_vomit3 1 vs 2	1.428	0.099	20.546

```
proc surveylogistic data=surveydata6; class days_vomit3/param=ref ref=last;
model sagestool=days_vomit3;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.1972	1.0505	4.3744	0.0365
days_vomit3	1	1	0.9932	1.0606	0.8770	0.3490

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_vomit3 1 vs 2	2.700	0.338	21.584

```
proc surveylogistic data=surveydata6; class D_V2/param=ref ref=first;
model sagestool=D_V2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.4469	0.5827	6.1650	0.0130
D_V2	2	1	0.7538	0.9926	0.5766	0.4476

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
D_V2 2 vs 1	2.125	0.304	14.869

```
proc surveylogistic data=surveydata6; class Days_D_V2/param=ref ref=last;
model sagestool=Days_D_V2;strata region2 installation; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.9457	1.0530	3.4141	0.0646
Days_D_V2	1	1	0.4416	1.1129	0.1575	0.6915

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
Days_D_V2 1 vs 2	1.555	0.176	13.776

```
proc surveylogistic data=surveydata6; class miss_work2/param=ref ref=last;
model sagestool=miss_work2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-2.0149	0.7780	6.7074	0.0096
miss_work2	1	1	0.6286	0.8901	0.4988	0.4800

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
miss_work2 1 vs 2	1.875	0.328	10.731

```
proc surveylogistic data=surveydata6; class days_missed2/param=ref ref=last;
model sagestool=days_missed2;strata region2 installation;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-1.7918	0.5024	12.7174	0.0004
days_missed2	1	1	1.7918	0.8543	4.3986	0.0360

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
days_missed2 1 vs 2	6.000	1.124	32.015

```
proc surveylogistic data=surveydata6; class branch2/param=ref ref=last;
model sagestool=branch2;strata region2 installation;
contrast 'FSD vs. Ops' branch2 0 1 0 -1 0/estimate=exp;
contrast 'HSD vs. Ops' branch2 0 0 1 -1 0/estimate=exp;
contrast 'Ops support vs. Ops' branch2 0 0 0 -1 1/estimate=exp;run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-625E-18	1.1049	0.0000	1.0000
branch2	1	1	-12.7793	1.5185	70.8246	<.0001
branch2	2	1	-1.5404	1.2933	1.4187	0.2336
branch2	3	1	-1.2993	1.2544	1.0729	0.3003
branch2	4	1	-1.9459	1.3663	2.0285	0.1544

Contrast Estimation and Testing Results by Row									
Contrast	Type	Row	Estimate	Standard Error	Alpha	Confidence Limits		Wald Chi-Square	Pr > ChiSq
FSD vs. Ops	EXP	1	1.5000	1.6156	0.05	0.1817	12.3842	0.1417	0.7066
HSD vs. Ops	EXP	1	1.9091	1.9708	0.05	0.2524	14.4396	0.3923	0.5311
Ops support vs. Ops	EXP	1	7.0000	9.5638	0.05	0.4810	101.9	2.0285	0.2544

SAS Code and Output for Multivariable Analysis for Model 4: Scallan et al. (2006) case definition for AGI; factors associated with seeking medical care and submitting a stool sample for AGI, Chapter 4, Table 10

The variables with p-values<0.25 in the univariable analysis include agecat, education2, max_diarrhea2, sore_throat2, and days_missed2. Similar to model 2, there are a lot of sparse cells resulting in an unstable model. Choose confounders based on what makes sense vs. 10% change in ORs.

Full Model:

```
/*full model*/
proc surveylogistic data=surveydata6; class agecat education2 max_diarrhea2 sore_throat2
days_missed2/param=ref ref=first;
model sagestool=agecat education2 max_diarrhea2 sore_throat2 days_missed2; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.5918	1.6021	0.1364	0.7118
Agecat	2	1	0.5318	1.7323	0.0943	0.7588
Agecat	3	1	-1.7762	2.3330	0.5796	0.4465
Agecat	4	1	0.5532	2.1377	0.0670	0.7958
Agecat	5	1	1.0645	2.2624	0.2214	0.6380
education2	2	1	-1.7790	2.5017	0.5057	0.4770
education2	3	1	-3.6023	1.8963	3.6086	0.0575
max_diarrhea2	2	1	-0.8870	1.4293	0.3851	0.5349
sore_throat2	2	1	3.6471	1.5015	5.9002	0.0151
days_missed2	2	1	-4.1434	2.1108	3.8531	0.0497

First remove max_diarrhea2.

```
/*remove max diarrhea*/
proc surveylogistic data=surveydata6; class agecat education2 sore_throat2
days  missed2/param=ref ref=first;
model sagestool=agecat education2 sore_throat2 days_missed2; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	0.2237	1.6757	0.0178	0.8938
Agecat	2	1	0.5217	1.7322	0.0907	0.7633
Agecat	3	1	-1.4623	2.5825	0.3206	0.5712
Agecat	4	1	0.6399	1.9078	0.1125	0.7373
Agecat	5	1	0.8282	2.3376	0.1255	0.7231
education2	2	1	-1.7724	2.4045	0.5433	0.4611
education2	3	1	-2.9039	1.4108	4.2363	0.0396
sore_throat2	2	1	3.0722	1.2510	6.0312	0.0141
days_missed2	2	1	-3.7707	2.0966	3.2346	0.0721

Remove age.

```
/*remove age*/
proc surveylogistic data=surveydata6; class education2 sore_throat2 days_missed2 param=ref
ref=first; model sagestool=education2 sore_throat2 days_missed2; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.00976	1.2475	0.0001	0.9938
education2	2	1	-1.6142	2.9573	0.2979	0.5852
education2	3	1	-1.8484	1.0294	3.2240	0.0726
sore_throat2	2	1	2.4576	1.1296	4.7334	0.0296
days_missed2	2	1	-3.0268	1.5307	3.9103	0.0480

Remove education.

```
/*remove education*/
proc surveylogistic data=surveydata6; class sore_throat2 days_missed2/param=ref ref=first;
model sagestool=sore_throat2 days_missed2; run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.6127	1.1006	0.3100	0.5777
sore_throat2	2	1	1.9812	1.1064	3.2069	0.0733
days_missed2	2	1	-2.5033	1.4129	3.1392	0.0764

Try adjusting for confounding by age and gender.

```
proc surveylogistic data=surveydata6; class sore_throat2 days_missed2 agecat
gender1/param=ref ref=first;
model sagestool=sore_throat2 days_missed2 agecat gender1;
contrast 'male vs. female' gender1 -1/estimate=exp;
contrast 'days missed 1 vs 2' days_missed2 -1/estimate=exp;
contrast 'age 1 v 3' agecat 0 -1 0 0/estimate=exp;
 contrast 'age 3 v 3' agecat 1 -1 0 0/estimate=exp;
contrast 'age 4 v 3' agecat 0 -1 1 0/estimate=exp;
contrast 'age 5 v 3' agecat 0 -1 0 1/estimate=exp;
run;
```

Analysis of Maximum Likelihood Estimates						
Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept		1	-0.00684	1.6311	0.0000	0.9967
sore_throat2	2	1	2.5592	0.9046	8.0034	0.0047
days_missed2	2	1	-2.9278	1.3592	4.6399	0.0312
Agecat	2	1	-0.1974	1.6150	0.0149	0.9027
Agecat	3	1	-1.3802	2.6136	0.2789	0.5974
Agecat	4	1	0.0964	1.6181	0.0035	0.9525
Agecat	5	1	-0.7694	1.9179	0.1609	0.6883
gender1	2	1	-0.8590	1.8550	0.2144	0.6433

SAS Code and Output to Check For Evidence of Multiplicative Interaction:
When adding interaction terms into the model, the model fell apart, (due to low power) so no interaction terms.

SAS Code and Outputs For Model Fit Tests

```
/*model fit tests*/
proc logistic data=surveydata6;
model sagestool=sore_throat2 days_missed2 agecat gender1/scale=n aggregate lackfit;run;
```

There were 21 unique profiles/covariate patterns (J) and 33 observations (p). J is not ≪ than n, so use Hosmer and Lemeshow Goodness of Fit Test. If $p \leq 0.05$ there is evidence of lack of model fit. If $p > 0.05$, there is evidence of model fit. The SAS output for both of this test is below and shows evidence of model fit.

Hosmer and Lemeshow Goodness-of-Fit Test		
Chi-Square	DF	Pr > ChiSq
2.0439	8	0.9796

SAS Code For Final Multivariable Model 4

```
/*FINAL MODEL*/
proc surveylogistic data=surveydata6; class sore_throat2 days_missed2 agecat
gender1/param=ref ref=first;
model sagestool=sore_throat2 days_missed2 agecat gender1;
contrast 'male vs. female' gender1 -1/estimate=exp;
contrast 'days missed 1 vs 2' days_missed2 -1/estimate=exp;
contrast 'age 1 v 3' agecat 0 -1 0 0/estimate=exp;
 contrast 'age 3 v 3' agecat 1 -1 0 0/estimate=exp;
contrast 'age 4 v 3' agecat 0 -1 1 0/estimate=exp;
contrast 'age 5 v 3' agecat 0 -1 0 1/estimate=exp;
run;
```

Appendix A-5

2014 Survey of Military Clinical Laboratories

Enteric Pathogen Capacity and Capabilities Laboratory Survey

Thank you for participating in the 2014 enteric pathogen testing capacity and capabilities laboratory survey. The survey contains questions about bacterial and viral enteric pathogen testing during the 2014 calendar year. Please answer questions to the best of your ability. Some answers may require you to review your 2014 laboratory records to answer accurately. Your responses will be used to understand enteric pathogen identification capacity and capabilities in Army laboratories, and aid in the development of future public health initiatives. You are authorized to print this survey and fill it out by hand initially, but please ensure the copy you submit is filled out electronically.

If you have any questions or concerns about this survey, please contact MAJ Sara B. Mullaney at sara.b.mullaney.mil@mail.mil.

Name of Laboratory:

Laboratory Address:

Primary Laboratory Point of Contact:

Name:

Telephone:

Email:

Does your laboratory receive any specimens to test for the presence of bacterial or viral enteric pathogens?

☐ **Yes Please continue this survey, starting with question 1 on the next page. The survey will take approximately 15 minutes to complete**

☐ **No If "No" then STOP and please return the survey. Thank you for your contribution.**

1

All of the following questions ask about enteric pathogen testing for samples received by your laboratory in **2014**. Please use laboratory records to give the most accurate answers. If you are unable to locate the answer in your laboratory records, please estimate to the best of your ability. Questions will be focused on six major pathogens: *Campylobacter, Salmonella, E. coli, Shigella, Listeria* and Norovirus.

Section A: General Questions

1. How many samples (i.e.: whole stools, rectal swabs, vomitus, autopsy specimens) were submitted to your lab in **2014** for **enteric pathogen** testing?

☐

2. How many of these samples were received as:

a) Whole stools (total number)? ☐

Whole stools on ice? ☐

Whole stools with transport media? ☐

Whole stools without transport media? ☐

b) Rectal swabs (total number)? ☐

Rectal swabs on ice? ☐

Rectal swabs with transport media? ☐

Rectal swabs without transport media? ☐

c) Other, i.e. vomitus, tissue (please specify): ☐

3. For specimens **without** transport media that are submitted to your laboratory for enteric pathogen testing, is there a length of time from collection to receipt in your laboratory after which you will NOT accept such specimens for testing?

☐ Yes

☐ No [proceed to q. 4]

If **Yes**, what is the length of time (in hours)? ☐

4. For specimens **without** transport media that are submitted to your lab for enteric pathogen testing, how does your laboratory usually store these specimens before testing or sending to reference laboratory?

- ☐ Hold at room temperature without transport media
- ☐ Put in refrigerator without transport media
- ☐ Place in transport media and hold at room temperature
- ☐ Place in transport media and refrigerate
- ☐ Put in freezer
- ☐ Not applicable (all specimens processed immediately)
- ☐ Other (please specify):

If other, please specify: _____

5. For specimens **with** transport media that are submitted to your lab for enteric pathogen testing, how does your laboratory usually store these specimens before testing or sending to reference laboratory?

- ☐ Hold at room temperature
- ☐ Put in refrigerator
- ☐ Put in freezer
- ☐ Not applicable (all specimens processed immediately)
- ☐ Other (please specify):

If other, please specify: _____

6. How many samples submitted to your laboratory in **2014** for **enteric pathogen** testing had positive culture results?

_____

Of these **positive** results, how many were from:

Whole fecal samples? _____

Rectal swabs? _____

Vomitus? _____

Tissue? _____

Other? _____

If other, please specify sample type(s): _____

7. Does your laboratory perform on-site antimicrobial resistance testing, serotyping, and/or PFGE/Genetic typing for any of the following bacterial enteric pathogens? (select all that apply)

	Antimicrobial Susceptibility Testing (AST)	Serotyping	PFGE/Genetic typing
Campylobacter	○	○	○
Shiga-Toxin Producing *E. coli* (*STEC aka. VTEC, EHEC*)	○	○	○
Shigella	○	○	○
Salmonella	○	○	○
Listeria	○	○	○

8. What do you do when an enteric pathogen test result is positive for a reportable medical event (select all that apply):

- ☐ Contact/Communicate to Preventive Medicine
- ☐ Contact/Communicate to State Public Health Laboratory or other applicable Government Regulatory Agency
- ☐ Submit isolate/specimen to reference laboratory for sero-typing, PFGE, or other post-identification characterization
- ☐ Other (please specify)

If you contact/communicate to Preventive Medicine, please describe how:

If you contact/communicate to state lab or other government agency, please describe how

If other, please describe:

9. Does your laboratory have any rejection criteria for testing inpatient enteric pathogen specimens based on length of hospitalization?

- ☐ Yes
- ☐ No [skip to q. 11]
- ☐ Not applicable (don't receive stool specimens from inpatients) [skip to q. 11]

10. What are the rejection criteria?

No bacterial stool cultures on inpatients after _____ days of hospitalization.

Other criteria, please describe:

11. Please estimate the average time (in hours) it takes for an enteric pathogen specimen to travel from the medical practitioner to your laboratory (i.e.: average time between time of collection and time of specimen processing).

12. Does your laboratory send any specimens off-site for bacterial enteric pathogen testing?

- ☐ Yes (specify below)
- ☐ No [skip to q. 16]

Where do you send your specimens for bacterial enteric pathogen testing?

13. How do the results of the specimens sent off-site for bacterial enteric pathogen testing get entered into CHCS?

- ☐ The off-site laboratory directly inputs the results into CHCS
- ☐ The results are sent back to our lab and we input into CHCS
- ☐ The results do not get entered into CHCS
- ☐ I don't know

14. When utilizing an off-site reference facility for **bacterial** enteric screening, how are specimens **sent from** your laboratory to that off-site facility:

	Routinely >80%	Sometimes 20-80%	Rarely <20%	Never 0%
As feces in a container and not in transport media	○	○	○	○
As feces in transport media	○	○	○	○
As feces on ice/refrigerated	○	○	○	○
As a rectal swab not in transport media	○	○	○	○
As a rectal swab in transport media	○	○	○	○
As a rectal swab on ice/refrigerated	○	○	○	○
As a bacterial isolate	○	○	○	○
Other (please specify)	○	○	○	○

If other, please describe:

15. Do you hold or 'batch' samples before shipping to the off-site laboratory?

☐ Yes
☐ No

If yes, how long (in hours) do you typically hold samples before shipping to the reference laboratory?

6

Section B: *Salmonella* Testing

16. Does your laboratory receive specimens for ***Salmonella*** testing?

- ☐ Yes
- ☐ No [Skip to q. 21]

If yes, does your laboratory perform *Salmonella* testing on-site? ☐ Yes ☐ No [skip to q. 20]

17. When does your laboratory test for *Salmonella* (check all that apply)?

- ☐ all specimens routinely (part of routine enteric screening)
- ☐ when a physician specifically requests testing for Salmonella
- ☐ when the specimen appears bloody
- ☐ when the patient has history of bloody stools
- ☐ when the patient has hemolytic uremic syndrome (HUS)
- ☐ when the patient is in a certain age group (specify below):
- ☐ during certain seasons (e.g., summer) (specify below):
- ☐ other, specify below:

If test based on patient age group, which age group? _____

If test during certain seasons, which season(s)? _____

If other, please specify: _____

18. What method(s) does your laboratory use to test samples for *Salmonella*?

- ☐ Culture-based methods only
- ☐ Non-culture methods only
- ☐ Both culture and non-culture methods

19. How many patient samples tested in your lab were positive for ***Salmonella*** in 2014?

_____

How many of these positive isolates were identified by culture and ID? _____

How many were identified by direct (non-culture) methods? _____

20. How many specimens did you send off-site for ***Salmonella*** testing in 2014?

_____

How many of these were positive? _____

7

Section C: *Shigella* Testing

21. Does your laboratory receive specimens for ***Shigella*** testing?

- ☐ Yes
- ☐ No [Skip to q. 26]

If yes, does your laboratory perform *Shigella* testing on-site? ☐ Yes ☐ No [skip to q. 25]

22. When does your laboratory test for ***Shigella*** (check all that apply)?

- ☐ all specimens routinely (part of routine enteric screening)
- ☐ when a physician specifically requests testing for Shigella
- ☐ when the specimen appears bloody
- ☐ when the patient has history of bloody stools
- ☐ when the patient has hemolytic uremic syndrome (HUS)
- ☐ when the patient is in a certain age group (specify below):
- ☐ during certain seasons (e.g., summer) (specify below):
- ☐ other, specify below:

If test based on patient age group, which age group? _____

If test during certain seasons, which season(s)? _____

If other, please specify: _____

23. What method(s) does your laboratory use to test samples for ***Shigella***?

- ☐ Culture-based methods only
- ☐ Non-culture methods only
- ☐ Both culture and non-culture methods

24. How many patient samples tested in your lab were positive for ***Shigella*** in 2014?

_____

How many of these positive isolates were identified by culture and ID? _____

How many were identified by direct (non-culture) methods? _____

25. How many specimens did you send off-site for ***Shigella*** testing in 2014?

_____

How many of these were positive? _____

Section D: *Campylobacter* Testing

26. Does your laboratory receive specimens for ***Campylobacter*** testing?

- ☐ Yes
- ☐ No [Skip to q. 31]

If yes, does your laboratory perform *Campylobacter* testing on-site? ☐ Yes ☐ No [skip to q. 30]

27. When does your laboratory test for ***Campylobacter*** (check all that apply)?

- ☐ all specimens routinely (part of routine enteric screening)
- ☐ when a physician specifically requests testing for Campylobacter
- ☐ when the specimen appears bloody
- ☐ when the patient has history of bloody stools
- ☐ when the patient has hemolytic uremic syndrome (HUS)
- ☐ when the patient is in a certain age group (specify below):
- ☐ during certain seasons (e.g., summer) (specify below):
- ☐ other, specify below:

If test based on patient age group, which age group? _____

If test during certain seasons, which season(s)? _____

If other, please specify: _____

28. What method(s) does your laboratory use to test samples for ***Campylobacter*** ?

- ☐ Culture-based methods only
- ☐ Non-culture methods only
- ☐ Both culture and non-culture methods

29. How many patient samples tested in your lab were positive for ***Campylobacter*** in 2014?

_____

How many of these positive isolates were identified by culture and ID? _____

How many were identified by direct (non-culture) methods? _____

30. How many specimens did you send off-site for ***Campylobacter*** testing in 2014?

_____

How many of these were positive? _____

9

Section E: *E. coli* O157, Shiga toxin-producing *E. coli* (STEC aka. VTEC, EHEC)

31. Does your laboratory receive specimens for ***E. coli* O157, STEC (aka VTEC, EHEC)** testing?

- ☐ Yes
- ☐ No [Skip to q. 37]

If yes, does your laboratory perform the testing on-site?

- ☐ Yes
- ☐ No [skip to q. 36]

32. When does your laboratory test for ***E. coli* O157, STEC (VTEC, EHEC)** (check all that apply)?

- ☐ all specimens routinely (part of routine enteric screening)
- ☐ when a physician specifically requests testing for E. coli O157, STEC (VTEC or EHEC)
- ☐ when the specimen appears bloody
- ☐ when the patient has history of bloody stools
- ☐ when the patient has hemolytic uremic syndrome (HUS)
- ☐ when the patient is in a certain age group (specify below):
- ☐ during certain seasons (e.g., summer) (specify below):
- ☐ other, specify below:

If test based on patient age group, which age group? _____

If test during certain seasons, which season(s)? _____

If other, please specify: _____

33. What method(s) does your laboratory use to test samples for ***E. coli O157, STEC (VTEC, EHEC)***?

- ☐ Culture-based methods only [skip to q. 35]
- ☐ Non-culture methods only
- ☐ Both culture and non-culture methods

34. When a specimen is Shiga toxin positive by a non-culture method, does your laboratory routinely.

Perform culture-based testing to isolate any STEC?

- ☐ Yes
- ☐ No

Send the specimen or isolate to the state lab?

- ☐ Yes
- ☐ No

35. How many patient samples tested in your lab were positive for ***E. coli O157, STEC (VTEC, EHEC)*** in 2014?

How many of these positive isolates were identified by culture and ID?

How many were identified by direct (non-culture) methods?

36. How many specimens did you send off-site for ***E. coli O157, STEC (VTEC, EHEC)*** testing in 2014?

How many of these were positive?

Section F: *Listeria* Testing

37. Does your laboratory receive specimens for *Listeria* testing?

- ☐ Yes
- ☐ No [Skip to q. 43]

If yes, does your laboratory perform the testing on-site?

- ☐ Yes
- ☐ No [skip to q. 42]

38. When does your laboratory test for *Listeria* (check all that apply)?

- ☐ all specimens routinely (part of routine enteric screening)
- ☐ when a physician specifically requests testing for Listeria
- ☐ when the specimen appears bloody
- ☐ when the patient has history of bloody stools
- ☐ when the patient has hemolytic uremic syndrome (HUS)
- ☐ when the patient is in a certain age group (specify below):
- ☐ during certain seasons (e.g., summer) (specify below):
- ☐ other, specify below:

If test based on patient age group, which age group? ☐

If test during certain seasons, which season(s)? ☐

If other, please specify: ☐

39. What method(s) does your laboratory use to test samples for *Listeria* ?

- ☐ Culture-based methods only
- ☐ Non-culture methods only
- ☐ Both culture and non-culture methods

40. How many patient samples tested in your lab were positive for *Listeria* in 2014?

☐

How many of these positive isolates were identified by culture and ID? ☐

How many were identified by direct (non-culture) methods? ☐

41. How many specimens did you send off-site for *Listeria* testing in 2014?

☐

How many of these were positive? ☐

Section G: Viral Testing

42. Does your laboratory receive specimens for **Norovirus** or other enteric virus testing?

- ☐ Yes
- ☐ No [Skip to q. 48]

If yes, does your laboratory perform the testing on-site?
- ☐ Yes
- ☐ No [skip to q.45]

43. When does your laboratory test for **Norovirus or other enteric viruses** (check all that apply)?

- ☐ all specimens routinely (part of routine enteric screening)
- ☐ when a physician specifically requests testing for viral pathogens
- ☐ when the patient has been vomiting
- ☐ when the patient is in a certain age group (specify below):
- ☐ during certain seasons (e.g., summer) (specify below):
- ☐ other, specify below:

If test based on patient age group, which age group? _____

If test during certain seasons, which season(s)? _____

If other, please specify: _____

44. What method(s) does your laboratory use to test samples for **Norovirus** or other enteric viruses?

- ☐ Electron microscopy (EM)
- ☐ Enzyme immunoassays (EIAs)
- ☐ Reverse transcription-polymerase chain reaction (RT-qPCR) assays
- ☐ Other (specify below):

If other, please specify: _____

45. How many samples were tested in your lab for **Norovirus** in 2014?

_____

How many of these samples tested positive for **Norovirus?** _____

46. Do you think methods to test for **Norovirus** on-site would be valuable for your laboratory to incorporate?

- ☐ Yes
- ☐ No

Why or why not? _____

13

47. How many specimens did you send off-site for **Norovirus** testing in 2014?

How man of these were positive?

48. Are your answers to all of the above questions that require a number (of specimens, positive cultures, etc.) estimates, or taken directly from laboratory records?

- ☐ Laboratory record
- ☐ Estimate

Please use this space for any additional comments or questions you may have.

Thank you for taking the time to complete this survey, your answers are very important to us.

Appendix A-6:

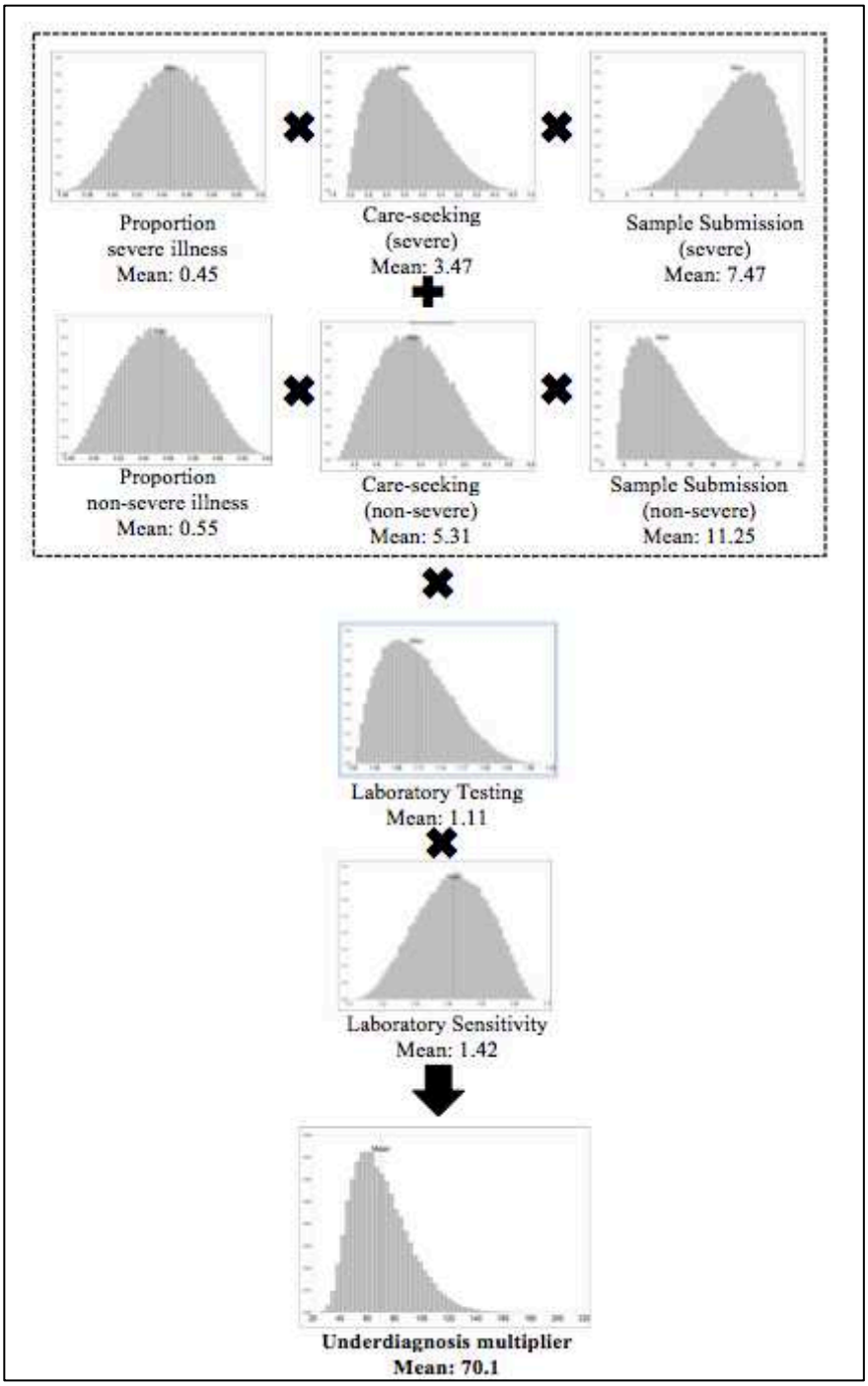


Figure A.6.1. Distributions and model inputs and out output for the *Campylobacter* underdiagnosis multiplier.

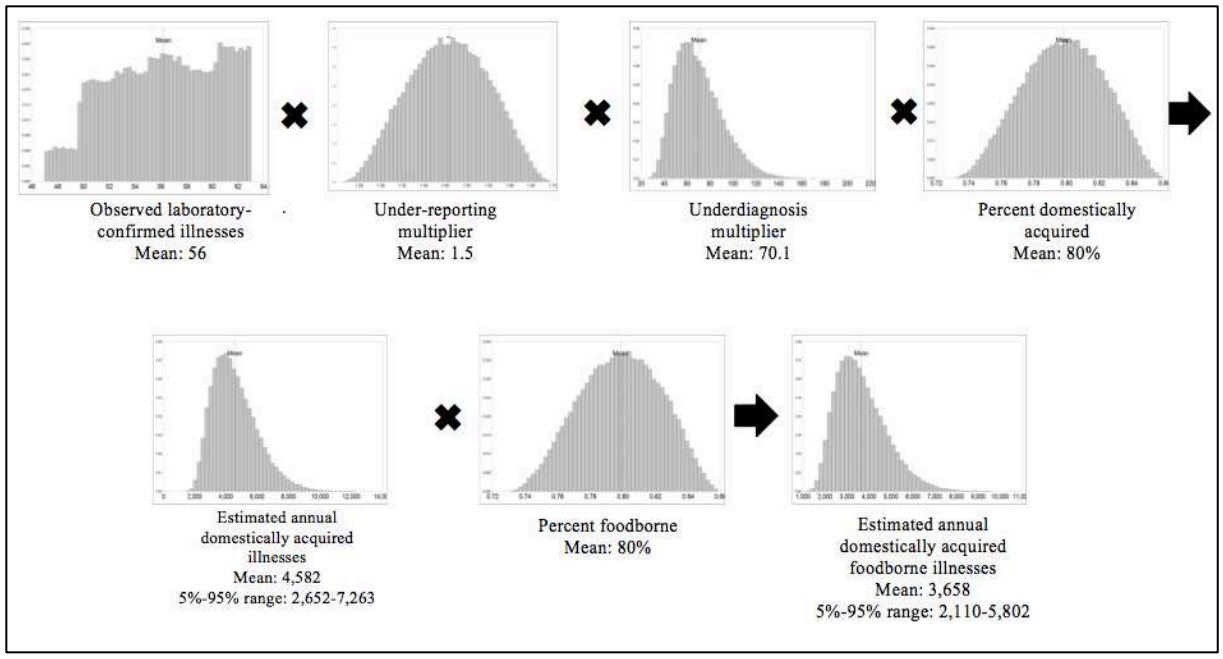


Figure A.6.2. Distributions and model inputs and out output for the *Campylobacter*.

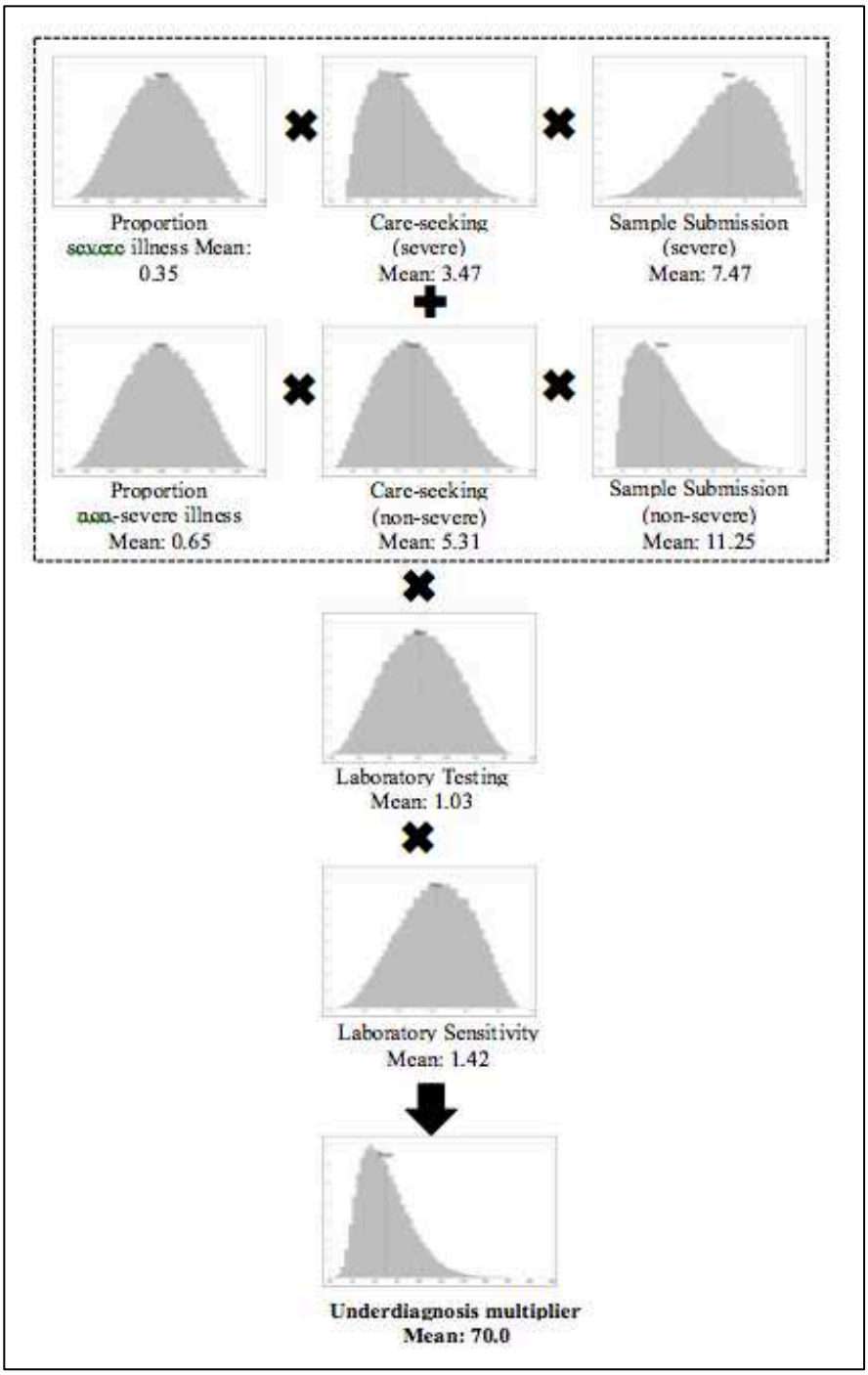


Figure A.6.3. Distributions and model inputs and out output for the *Shigella* underdiagnosis multiplier.

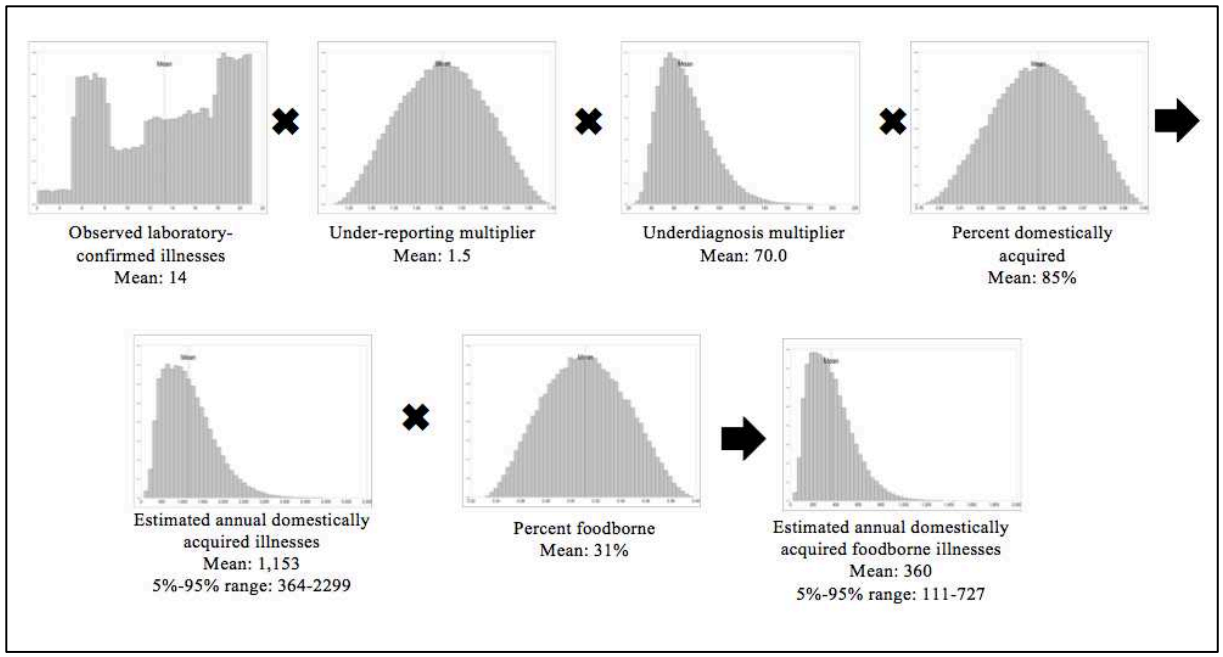


Figure A.6.4. Distributions and model output for *Shigella*.

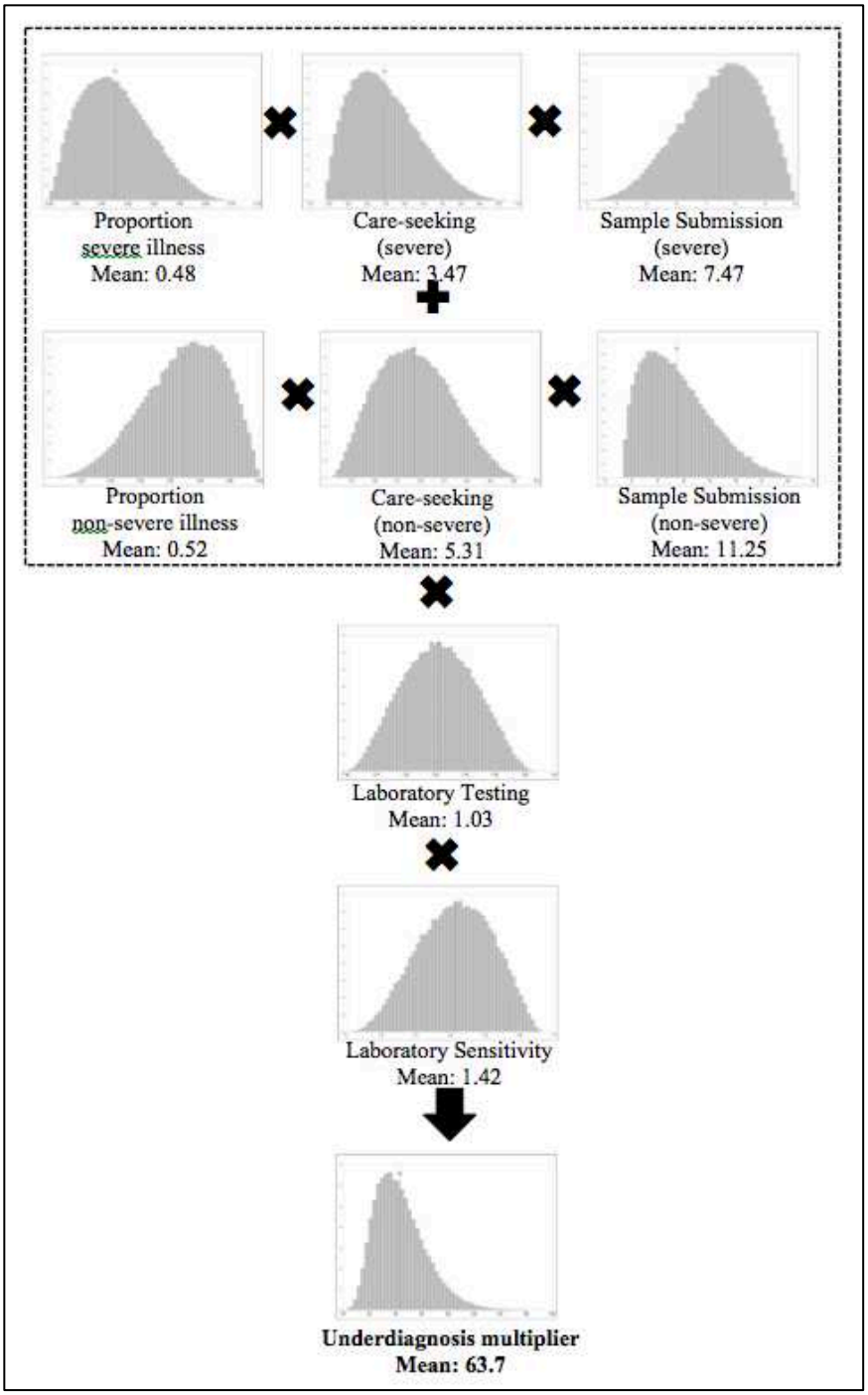


Figure A.6.5. Distributions and model inputs and out output for the *Salmonella enterica* non-typhoidal underdiagnosis multiplier.

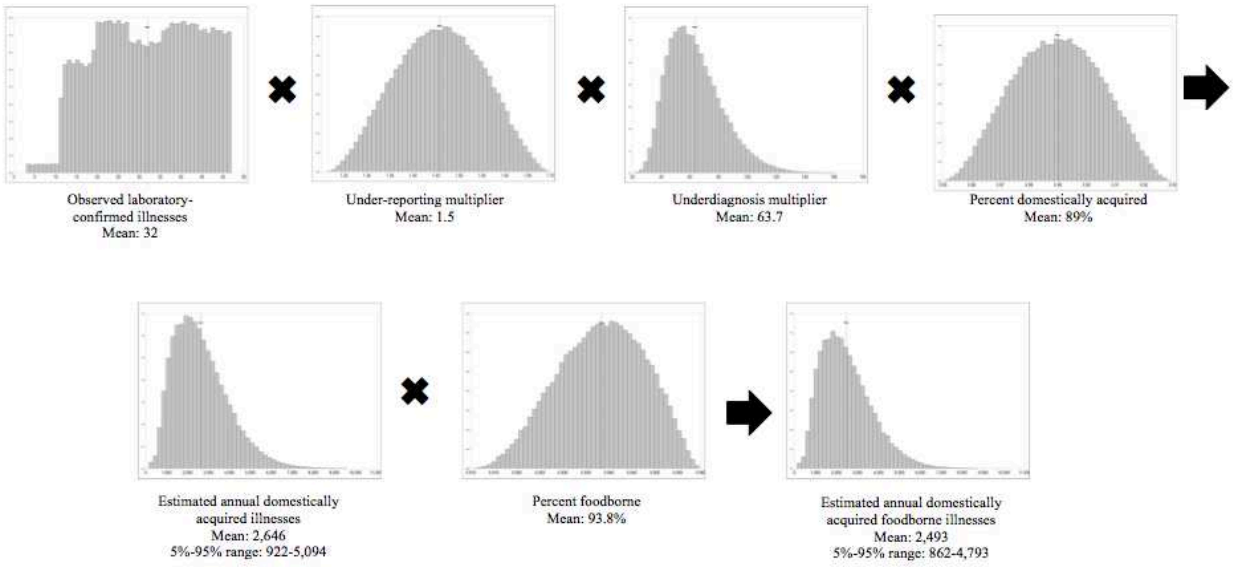


Figure A.6.6. Distributions and model output for *Salmonella enterica* non-typhoidal.

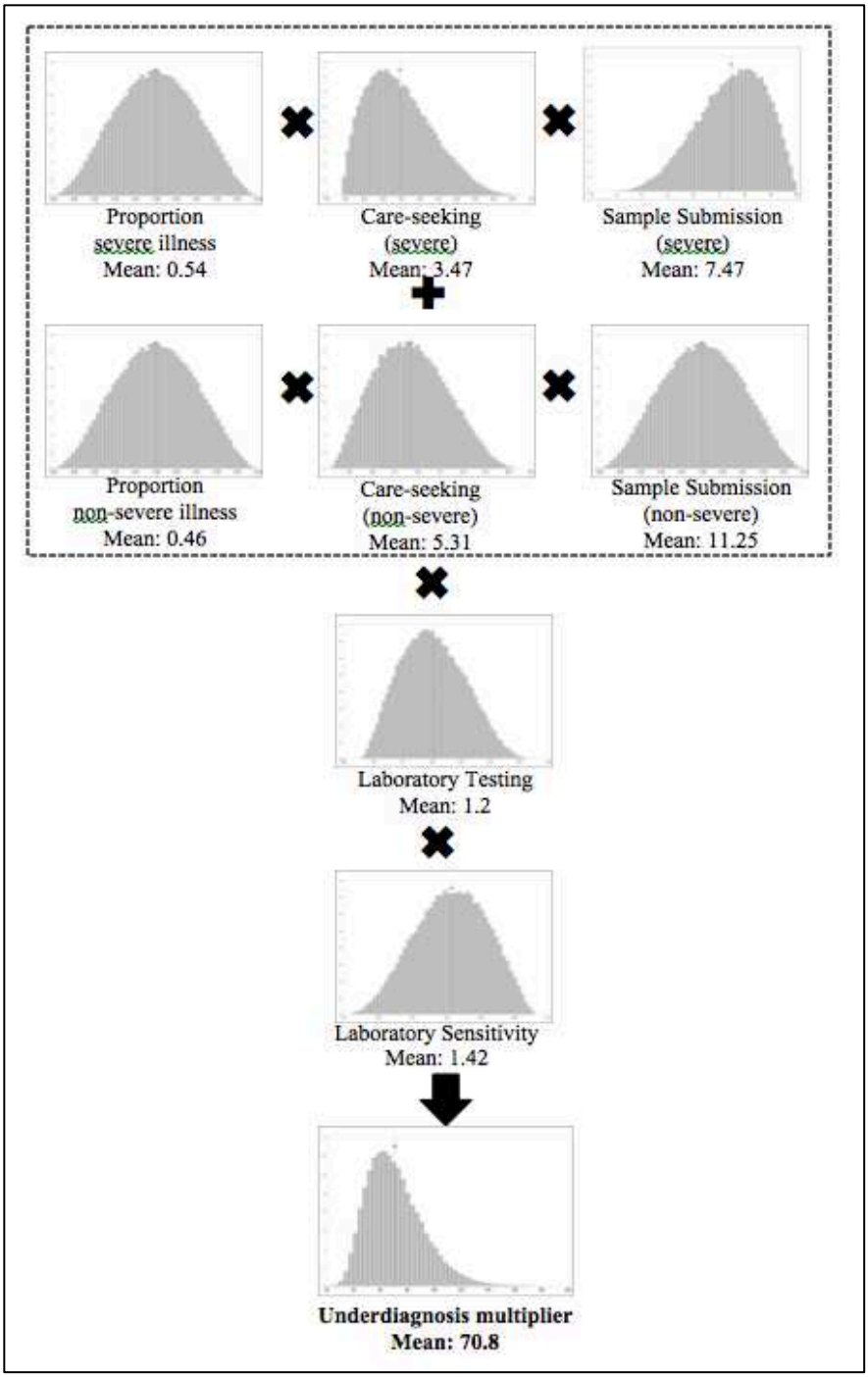


Figure A.6.7. Distributions and model inputs and out output for the STEC non-O157 underdiagnosis multiplier

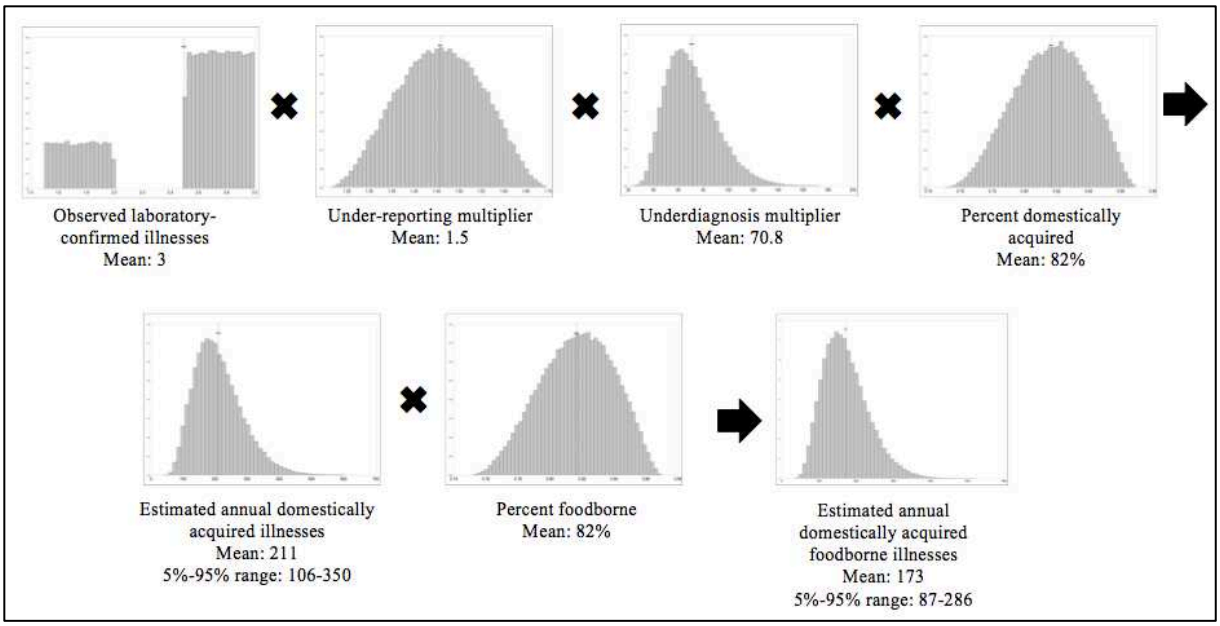


Figure A.6.8. Distributions and model output for STEC non-O157.

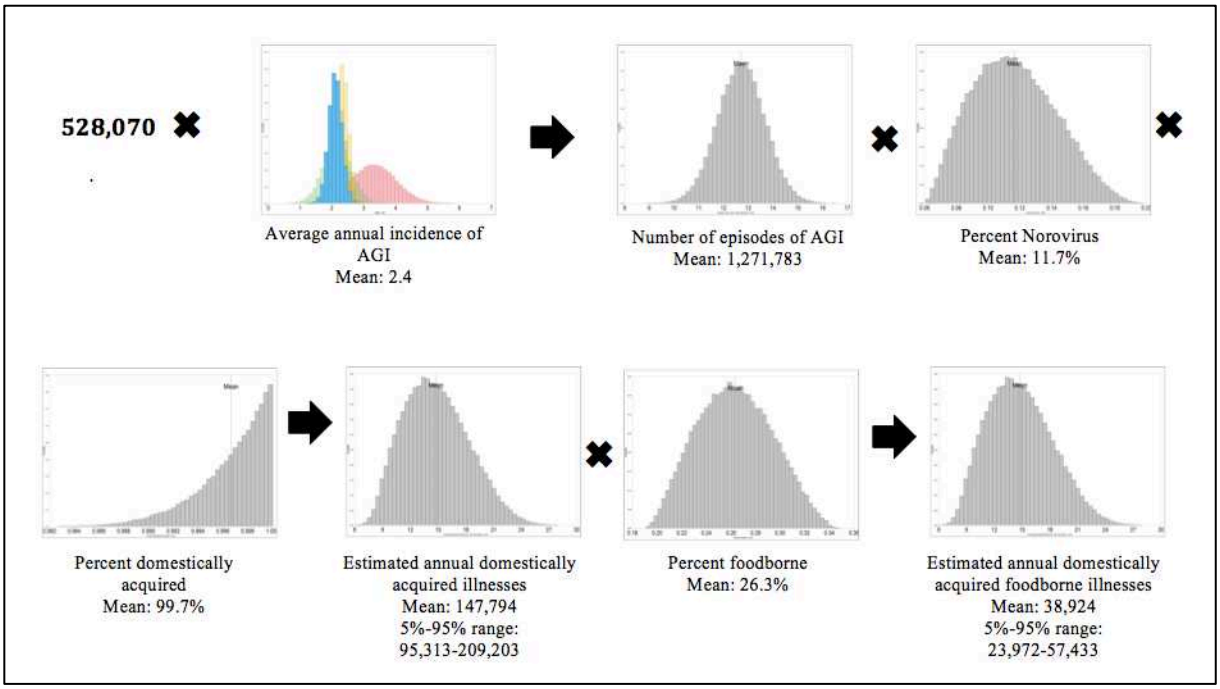


Figure A.6.9. Distributions and model output for *Norovirus*.

Appendix A-7

Example Communicable Disease Reporting Form [1]

Colorado Department of Public Health and Environment

Colorado Department of Health
Communicable Disease Reporting Form
(Please Print)

Disease being reported:				
Laboratory Information (check all that apply)				
Collection Date:	Test Result Date:		Name of Lab that did testing:	
Specimen: □ blood □ stool □ urine □ CSF □ joint □ bone □ Other:	**Test**		**Result**	
	Culture:	□ Positive	□ Negative	
	O & P:	□ Positive	□ Negative	
	IgM:	□ Positive	□ Negative	
	EIA:	□ Positive	□ Negative	
	PCR:	□ Positive	□ Negative	
	Rapid Antigen:	□ Positive	□ Negative	
WNV Index Value:	Other:			
Patient Demographic Information				
Patient Name:				
Patient DOB:			Sex: □ Male	□ Female
Patient ID/Medical Record #:			Is Patient Pregnant? □ Yes	□ No
Patient Street Address:				
City:	State:		Zip Code:	
County:			Phone Number:	
Race: □ American Indian/Alaskan Native □ White □ Pacific/Hawaiian □ African American □ Asian □ Other □ Unknown			Ethnicity: □ Hispanic □ Non Hispanic □ Unknown	
Physician Information				
Physician Name:			Practice Name:	
Address of Practice:				
City:			State:	Zip Code:
County:			Phone Number:	

For Hepatitis Cases Only (check all that apply)			
Test	**Result**	**Liver Function**	**Symptoms**
IgM anti-HAV	□ Yes □ No		□ Fatigue
HBsAg:	□ Yes □ No	SGOT/AST:	□ Abdominal Pain
HBeAg:	□ Yes □ No	SGPT/ALT:	□ Loss of Appetite
IgM anti-HBc:	□ Yes □ No	Alk Phosphate:	□ Nausea
anti-HBs (HBsAb):	□ Yes □ No	Total Bilirubin:	□ Vomiting
anti-HBc (Total Core antibody):	□ Yes □ No		□ Diarrhea
HCV CIA:	□ Yes □ No	S/Co Ratio:	□ Jaundice
HCV EIA:	□ Yes □ No	S/Co Ratio:	
HCV RNA by PCR:	□ Yes □ No	Quant. Value (if noted) :	

Reporter Information	
Agency:	
Address:	
Person Reporting:	Phone Number:
Return Report to: Colorado Department of Public Health and Environment Communicable Disease DCEED/DSI/A3 4300 Cherry Creek Drive South Denver, CO 80246-1530	**Fax:** 303-782-0338 **Alternate Fax:** 303-691-7753

For questions in completing this form please call: LaVelle Fernandez : 303-692-2627, Pat Acquaro: 303-692-2659, Breanna Kawasaki: 303-692-2635 or LeAnna Kent: 303-692-6445 .
For Hepatitis B or C please contact Hepatitis Help Line: 303-692-2780.

Example Foodborne Illness Complaint Form [2]

Foodborne Illness Complaint Form

The Environmental Health Specialists Network (EHS-Net) designed this form for state and local environmental health specialists working in food safety programs to use to capture information from consumers about their foodborne illness complaints. The information collected with this form can be used to help determine whether a consumer foodborne illness complaint should be investigated as potentially linked to a foodborne illness outbreak.

Incident No. _____ Contact No. _____

Origin of Complaint

Date Received: _____ **Receiving Agency**: _____ **Call Received By**: _____

Complainant Data

Name: _____ **DOB**: _____ **Gender**: M F

Phone: (Work) _____ (Home) _____ (Cell) _____ (Email)_____

Occupation(s): _____ **Previous Illness or Chronic Condition**: Y N **Existing Medications**: Y N

Comments: _____

Illness Data

Illness Onset: Date: _____ Time: _____ AM / PM **Illness Stopped**: Date: _____Time: _____ AM / PM
❑ **Illness Ongoing**

Signs and Symptoms:

❑ Diarrhea ___ Watery ___ Bloody	❑ Headache	❑ Itching (location) _____
❑ Vomiting	❑ Myalgia (muscle ache)	❑ Numbness (location) _____
❑ Nausea	❑ Dizziness	❑ Tingling (location) _____
❑ Abdominal Pain	❑ Double Vision	❑ Edema (location) _____
❑ Fever _____ °F	❑ Jaundice	❑ Rash
❑ Chills	❑ Weakness	❑ Other: _____

Diarrhea Onset: Date: _____ Time: _____ AM / PM **Diarrhea Stopped**: Date: _____Time: _____ AM / PM
❑ **Illness Ongoing**
Vomiting Onset: Date: _____ Time: _____ AM / PM **Vomiting Stopped**: Date: _____Time: _____ AM / PM
❑ **Illness Ongoing**

Clinical Data

Was a doctor or other healthcare provider visited? Y N

Date Visited: _____ **Time**: _____ AM / PM **Admitted**: Y N **Length of Stay**: _____ (hrs)

Healthcare Facility: _____ **Physician Name**: _____ **Phone**: _____

Were clinical specimens taken? Y N ❑ Blood ❑ Stool **Diagnosis**: _____

Would you be willing to provide a stool sample? Y N N/A – Samples no longer available

CDC EHS-Net 1

Foodborne Illness Complaint Form

Suspect Meal Data

Date: _____ **Location:** _____ **Suspect Meal:** _____

Time: _____ AM / PM _____ _____

_____ _____

_____ _____

Number of people in party: _____ **Number of people reportedly ill:** _____ **Group Contact:** _____

(Use following page for additional contacts) **(Phone):** _____

List anything unusual about the meal (temperature, taste, color, etc.)? _____

Other Contacts

Name		Phone	Associated Meal and/or Location
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____
_____	❑ Ill ❑ Well	_____	_____

Other Exposures

Other Possible Non-food Exposures within Past 2 Weeks: (swimming pool, river, lake, etc.)

Travel outside the US: Y N **Location(s):** _____

Water consumed outside residence: Y N **Location(s):** _____

Well water consumed: Y N **Location(s):** _____

Exposure to recreational water: Y N **Location(s):** _____

Exposure to the following:

❑ Petting zoo ❑ Ill person at home or outside of home ❑ Ill animal ❑ Diapered kids or adults
❑ Mass gatherings ❑ Domestic animals or livestock ❑ Birds or reptiles ❑ Visit nursing home
❑ Daycare facility ❑ Other _____

Foodborne Illness Complaint Form

Notes:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

72-hr Food History

Date:

This section is to be used to collect information about what the consumer ate and drank in the 72-hour period prior to the complaint.

Day of Illness Onset:

Breakfast: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Lunch: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Dinner: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Other Foods/Water*: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No

Foodborne Illness Complaint Form

72-hr Food History (Continued)

Date:

One Day Prior to Illness Onset:

Breakfast: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Lunch: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Dinner: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Other Foods/Water*: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No

Date:

Two Days Prior to Illness Onset:

Breakfast: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Lunch: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

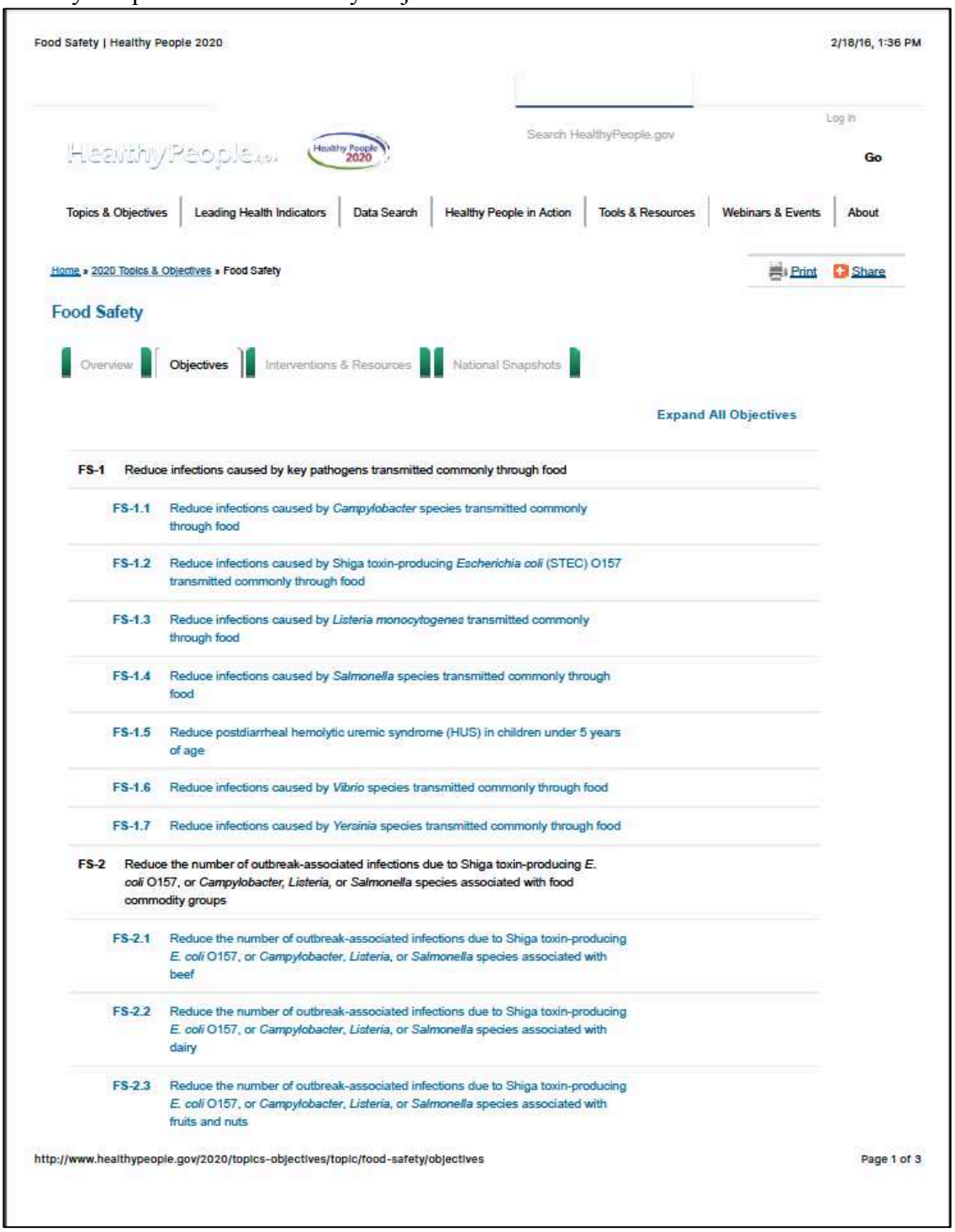
Dinner: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No
_____ **Contacts:** _____

Other Foods/Water*: _____ **Location:** _____ **Time:** _____ AM / PM
_____ _____ **Suspect Meal?** ❑ Yes ❑ No

* This section is to be used to collect information on any food the complainant ate or drank at times other than breakfast, lunch, and dinner, and to ensure that the complainant is asked about the water he or she drank.

Appendix B-7

Healthy People 2020 Food Safety Objectives [3]



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Expand All Objectives

FS-1 Reduce infections caused by key pathogens transmitted commonly through food

- **FS-1.1** Reduce infections caused by *Campylobacter* species transmitted commonly through food
- **FS-1.2** Reduce infections caused by Shiga toxin-producing *Escherichia coli* (STEC) O157 transmitted commonly through food
- **FS-1.3** Reduce infections caused by *Listeria monocytogenes* transmitted commonly through food
- **FS-1.4** Reduce infections caused by *Salmonella* species transmitted commonly through food
- **FS-1.5** Reduce postdiarrheal hemolytic uremic syndrome (HUS) in children under 5 years of age
- **FS-1.6** Reduce infections caused by *Vibrio* species transmitted commonly through food
- **FS-1.7** Reduce infections caused by *Yersinia* species transmitted commonly through food

FS-2 Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter*, *Listeria*, or *Salmonella* species associated with food commodity groups

- **FS-2.1** Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter*, *Listeria*, or *Salmonella* species associated with beef
- **FS-2.2** Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter*, *Listeria*, or *Salmonella* species associated with dairy
- **FS-2.3** Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter*, *Listeria*, or *Salmonella* species associated with fruits and nuts

http://www.healthypeople.gov/2020/topics-objectives/topic/food-safety/objectives Page 1 of 3

FS-2.4	Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter*, *Listeria*, or *Salmonella* species associated with leafy vegetables	
FS-2.5	Reduce the number of outbreak-associated infections due to Shiga toxin-producing *E. coli* O157, or *Campylobacter*, *Listeria*, or *Salmonella* species associated with poultry	
FS-3	**Prevent an increase in the proportion of nontyphoidal *Salmonella* and *Campylobacter jejuni* isolates from humans that are resistant to antimicrobial drugs.**	
FS-3.1	Prevent an increase in the proportion of nontyphoidal *Salmonella* isolates from humans that show reduced susceptibility to ciprofloxacin (fluoroquinolone)	Revised
FS-3.2	Prevent an increase in the proportion of nontyphoidal *Salmonella* isolates from humans that are resistant to ceftriaxone (third-generation cephalosporin)	
FS-3.3	Prevent an increase in the proportion of nontyphoidal *Salmonella* isolates from humans that are resistant to gentamicin	
FS-3.4	Prevent an increase in the proportion of nontyphoidal *Salmonella* isolates from humans that are resistant to ampicillin	
FS-3.5	Prevent an increase in the proportion of nontyphoidal *Salmonella* isolates from humans that are resistant to three or more classes of antimicrobial agents	
FS-3.6	Prevent an increase in the proportion of *Campylobacter jejuni* isolates from humans that are resistant to erythromycin	
FS-4	Reduce severe allergic reactions to food among adults with a food allergy diagnosis	
FS-5	**Increase the proportion of consumers who follow key food safety practices**	
FS-5.1	Increase the proportion of consumers who follow the key food safety practice of "Clean: wash hands and surfaces often."	
FS-5.2	Increase the proportion of consumers who follow the key food safety practice of "Separate: don't cross-contaminate."	
FS-5.3	Increase the proportion of consumers who follow the key food safety practice of "Cook: cook to proper temperatures."	
FS-5.4	Increase the proportion of consumers who follow the key food safety practice of "Chill: refrigerate promptly."	
FS-6	**Increase the proportion of fast-food and full service restaurants that follow food safety practices that prevent foodborne illness outbreaks**	
FS-6.1	Increase the proportion of fast-food restaurants where employees practice proper handwashing	Revised
FS-6.2	Increase the proportion of fast-food restaurants where food employees do not contact ready-to-eat (RTE) foods with bare hands	Revised
FS-6.3	Increase the proportion of fast-food restaurants where food contact surfaces are	Revised

	properly cleaned and sanitized	
FS-6.4	Increase the proportion of fast-food restaurants where foods requiring refrigeration are held at the proper temperature	Revised
FS-6.5	Increase the proportion of fast-food restaurants where foods displayed or stored hot are held at the proper temperature	Revised
FS-6.6	Increase the proportion of full-service restaurants where employees practice proper handwashing	Revised
FS-6.7	Increase the proportion of full-service restaurants where food employees do not contact RTE foods with bare hands	Revised
FS-6.8	Increase the proportion of full-service restaurants where food contact surfaces are properly cleaned and sanitized	Revised
FS-6.9	Increase the proportion of full-service restaurants where foods requiring refrigeration are held at the proper temperature	Revised
FS-6.10	Increase the proportion of full-service restaurants where foods displayed or stored hot are held at the proper temperature	Revised

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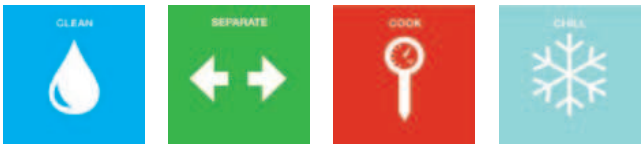
Appendix C-7

Example consumer food safety educational material [4]

KEEP YOUR FAMILY SAFER FROM FOOD POISONING



Check your steps at FoodSafety.gov

SAFE MINIMIUM INTERNAL TEMPERATURES *As measured with a food thermometer*	
Beef, pork, veal and lamb (roast, steaks and chops)	145 °F with a 3-minute "rest time" after removal from the heat source.
Ground Meats	160 °F
Poultry (whole, parts or ground)	165 °F
Eggs and egg dishes	160 °F Cook eggs until both the yolk and the white are firm. Scrambled eggs should not be runny.
Leftovers	165 °F
Fin Fish	145 °F
Safe Cooking Guidelines	
Shrimp, Lobster, Crabs	Flesh pearly and opaque
Clams, Oysters and Mussels	Shells open during cooking
Scallops	Milky white, opaque and firm

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GRILLING ESSENTIAL: FOOD THERMOMETERS

You cannot determine if food is fully cooked just by looking at it. The only way to make sure food has reached a safe minimum internal temperature is to use a food thermometer. Before using any food thermometer, read the manufacturer's instructions.

Tips for Using a Food Thermometer:

- These thermometers are not designed to remain in food while it is cooking.
- To ensure safety and prevent overcooking, check the internal temperature of the food toward the end of the cooking time, before the food is expected to finish cooking.
- The food thermometer should be placed in the thickest part of the food and should not be touching bone, fat, or gristle. Check the temperature in several places to make sure the food is evenly heated.
- Clean your food thermometer with hot water and soap before and after each use!

The best types of food thermometers for grilling:

Digital Instant-Read (Thermistor)
- Reads in 10 seconds
- Place at least 1/2" deep
- Can measure in thin and thick foods

Thermometer-Fork Combination
- Reads in 2-10 seconds
- Place at least ¼ " deep in thickest part of food
- Sensor in tine of fork must be fully inserted
- Can be used in most foods, convenient for grilling

Safe Minimum Internal Temps	
160 °F	Ground Beef
165 °F	Poultry, including ground poultry.
145 °F Plus 3 min stand time for safety.	Beef, veal, lamb, steaks & roasts.

Be sure to include safe food handling in your cookout plans!

CLEAN – Wash hands and surfaces often.
SEPARATE – Don't cross-contaminate!
COOK – Cook to proper temperature.
CHILL – Refrigerate promptly!

Partnership for Food Safety Education

CLEAN SEPARATE COOK CHILL

The Partnership for Food Safety Education | fightbac.org

References

1. Colorado Department of Public Health & Environment. *Report a Disease: General communicable disease reporting form.* 2016. https://www.colorado.gov/pacific/cdphe/report-a-disease. Accessed February 18, 2016.

2. Centers for Disease Control and Prevention. *Environmental Health Services Resources: Consumer Foodborne Illness Complaint Form.* http://www.cdc.gov/nceh/ehs/ehsnet/resources/index.htm. Accessed February 18, 2016.

3. Office of Disease Prevention and Health Promotion. Healthy Poeple 2020: Food Safety. 2016; http://www.healthypeople.gov/2020/topics-objectives/topic/food-safety/objectives. Accessed February 18, 2016.

4. Partnership for Food Safety Education. *Fight Bac! (R) Supporting consumers to prevent food poisoning.* 2016. http://www.fightbac.org. Accessed February 18, 2016.