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TITLE: Military Veterans with Eating Disorders: Prevalence, Incidence, Patterns of Comorbidity and Cost of Care

PRINCIPAL INVESTIGATOR: S. Bryn Austin

CONTRACTING ORGANIZATION: Children's Hospital Boston

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14. ABSTRACT

Scope: Eating disorders (ED), including anorexia nervosa, bulimia nervosa, and binge eating disorder, are serious illnesses that lead to disturbance in one's eating behaviors and can result in poorer health, lower quality of life, and long-term expensive treatment. Very little is known about the prevalence of ED and the patterns of co-occurring mental health and substance use problems among military Veterans. Our study is designed to estimate the prevalence, patterns of co-occurring illness, and costs of ED among Veterans so that we can evaluate the overall burden of disease to inform future design of effective ED screening and treatment programs for military Veterans.

Purpose: The purpose of our research activities is to use the largest and most comprehensive database of US military Veterans to: generate precise estimates of ED prevalence (% of Veterans with ED within a year) and incidence (new cases by year) among Veterans in the aggregate; estimate ED prevalence/incidence by sociodemographic groups, including by age, gender, race/ethnicity, obesity status, and age cohort; evaluate whether such co-occurring problems precede (and may lead to) ED or if they develop subsequently to an ED episode (and may be caused in part by ED); document the added utilization and cost of care to the Veterans Health Administration (VHA) associated with ED.

Major Findings:

For Aim 1, we have developed an algorithm (based on structured data elements from the electronic health record [EHR]) to identify lifetime ED among military Veterans and evaluated its performance relative to a chart review diagnosis gold standard. To identify lifetime ED diagnosis using the EHR algorithm compared to gold standard chart review labels, a threshold of 0.5 was chosen for obtaining optimal accuracy, sensitivity, specificity, PPV, and NPV. The performance characteristics were estimated through 1000 iterations of 10-fold cross validation and remained robustly high at the chosen threshold (all above 85%). Our algorithm showed higher accuracy and PPV compared to identifying ED cases based on the ICD diagnosis codes alone. We are finalizing an alternative algorithm that incorporates natural language processing (NLP) concepts/terms related to ED diagnosis that are identified in providers' notes (in addition to structured data elements), and preliminary results have shown improved performance over the model that includes structured data only.

For Aim 2, we estimated the prevalence and incidence of ED and ED subtypes in the aggregate and in high-risk subgroups defined by gender, race/ethnicity, obesity status, and age cohort. Since we were delayed with the development of the final algorithm for Aim 1, and because we are still refining the algorithm, we proceeded to base our interim analyses on diagnostic codes. We found that among VHA users between 2016-2019, the 4-year incidence of any ED was 0.20% (0.85% and 0.12% among women and men, respectively), and there was a modest increase in the rate of ED diagnosis over time. ED-unspecified/Other Specified Feeding and Eating Disorder (OSFED) were the most common diagnoses in Veterans Health Administration by far, followed by Binge Eating Disorder (BED), Bulimia Nervosa (BN), and Anorexia Nervosa (AN). We found no significant differences in incidence of ED by race/ethnicity. These findings were presented at the International Conference on Eating Disorders (ICED) 2022 annual meeting. Based on the final best-fitting model, we will be generating updated estimates of prevalence and incidence of EDs among Veterans.

For Aim 3, we have made significant progress in constructing an analytic dataset of utilization and costs from the Veterans Administration perspective, including extracting and cleaning variables. We have defined our study population, comparison groups (ED cases vs. controls), index dates, matching procedure, and categorized utilization/costs by healthcare setting (e.g., outpatient, inpatient, pharmacy) as well as overall type (behavioral vs. non-behavioral). In addition, we received approval for and access to several additional data sources to supplement our Aim 2 & 3 analyses, including Centers for Medicare and Medicaid Services (CMS) utilization and cost data, United States Veterans Eligibility Trends and Statistics (USVETS) data, and Office of Mental Health & Suicide Prevention (OMHSP) Suicide and Self-Directed Violence data.

15. SUBJECT TERMS

NONE LISTED

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1. **INTRODUCTION:**

We will develop a robust and validated methodology to more accurately identify ED cases in the VHA than has previously been possible using electronic health record (EHR) data. Using our newly developed algorithm, we will generate precise estimates of the prevalence and incidence of ED among Veterans in the aggregate and by ED subtype and by sociodemographic group, patterns of mental health, and substance use comorbidities, and utilization and cost of care to the VHA and other public payers. Further, longitudinal analyses of a 17-year period of CDW will (i) examine whether prevalence and incidence have changed over time and as individuals age, (ii) identify comorbidities associated with increased risk of developing ED, and (iii) assess the cost of care of new ED cohorts over the 17-year period. Our planned research will produce the most robust estimates to date of the scope and impact of ED on Veterans' health as a whole and in high-risk subgroups, changes in incidence over time and with age, and the health services and cost burden posed by ED for the VHA and other public payer systems.

2. **KEYWORDS:** Veterans, cost, comorbidity, healthcare utilization, eating disorder, anorexia, bulimia, binge eating, EHR, algorithm

3. **ACCOMPLISHMENTS:**

- **What were the major goals of the project?**

  - **Aim 1**: Develop a robust EHR-based algorithm to identify ED on the aggregate and for ED subtypes among military Veterans.
  - **Aim 2**: (a) Estimate the prevalence and incidence of ED and ED subtypes and (b) estimate the prevalence of comorbid mental health and substance use disorders among Veterans with ED in the aggregate and in high-risk subgroups defined by gender, race/ethnicity, obesity status, and age cohort.
  - **Aim 3**: Estimate the added healthcare costs and utilization associated with ED and ED subtypes.

- **What was accomplished under these goals?**

  - We used Lasso penalized regression with 10-fold cross-validation to perform robust variable selection, followed by unpenalized logistic regression to fit a prediction model for lifetime ED. The models were trained using 210 EHR chart reviews performed by subject-matter experts as the gold standard. We considered 88 candidate predictors for Lasso variable selection representing various domains such as ICD diagnosis codes, body mass index (BMI), vital signs, procedures, labs, medications, and demographic characteristics. We also considered interaction terms with various predictors. Sixty out of the 210 charts (28%) have been reviewed by at least 2 raters, and discrepancies were reviewed during meetings to reach final consensus ratings.
  - To reflect the prevalence of different ED subtypes in the VA population and yield accurate prediction estimates, we used sampling weights based on each patient's documented ED subtype diagnoses.
  - Inter-rater reliability for lifetime ED diagnosis was evaluated using Light's kappa statistic, representing an average kappa for all pairwise comparisons between raters. The weighted Light's kappa was 0.86, indicating strong agreement between raters.
  - We selected 10 predictors that were consistently retained through each model iteration for inclusion into the unpenalized regression. The selected predictors included gender, age, count of ICD diagnosis codes for ED, anticonvulsant medication use, and the procedures of psychotherapy, psychiatric diagnosis, and weight management. The variance inflation factors (VIF) are all below 2. To identify lifetime ED diagnosis using the EHR algorithm compared to gold standard chart review labels, a threshold of 0.5 was chosen for obtaining optimal accuracy, sensitivity, specificity, PPV, and NPV. The performance characteristics were estimated through 1000 iterations of 10-fold cross validation and remained robustly high at the chosen threshold (all above 85%). Our

  - algorithm showed higher accuracy and PPV compared to identifying ED cases based on the ICD diagnosis codes alone.
  - To detect ED cases in the general VA population, we are finalizing an alternative algorithm that incorporates natural language processing (NLP) concepts/terms related to ED diagnosis that are identified in providers' notes.
  - The final best-fitting model will be used to generate the final estimates of prevalence and incidence of EDs among Veterans (Aim 2).
  - We presented findings of the incidence of eating disorders overall and by type to the ICED 2022 annual meeting. Since we were delayed with the development of the final algorithm for Aim 1, we proceeded to base our interim analyses on diagnostic codes recorded in the EHR.
  - We found that among VHA users between 2016-2019 (pre-COVID-19 pandemic), the 4-year incidence of any ED was 0.20% (0.85% and 0.12% among women and men, respectively). We observed similar incidence of EDs across racial and ethnic subgroups (e.g., 0.20% for both Black and White Veterans; 0.25% for Hispanic/Latinx Veterans).
  - Over a 5-year period (2016-2020) there were 13,578 incident cases of ED. Among these newly diagnosed individuals, ED-unspecified/OSFED were the most common ED types (47.7%), followed by BED (25.9%), BN (12.8%), and AN (12.3%). The 5-year incidence rate was about 230 new ED cases per 100,000 population. There was a modest increase in the rate of ED incidence over time, e.g., from 42.01/100,000 in 2016 to 49.01/100,000 in 2020.

- **What opportunities for training and professional development has the project provided?**
  - Nothing to Report
- **How were the results disseminated to communities of interest?**
  - Nothing to Report
- **What do you plan to do during the next reporting period to accomplish the goals?**
  - We will conduct analyses of health care utilization and costs attributable to eating disorders. We will provide updated estimates in ED incidence and prevalence after the algorithm is finalized. Manuscript preparation is underway, corresponding to Aims 1 through 3, and each one will be completed shortly after results are finalized.

4. **IMPACT:**

- **What was the impact on the development of the principal discipline(s) of the project?**
  - Nothing to Report
- **What was the impact on other disciplines?**
  - Nothing to Report
- **What was the impact on technology transfer?**
  - Nothing to Report
- **What was the impact on society beyond science and technology?**
  - Nothing to Report

5. **CHANGES/PROBLEMS:**

- **Changes in approach and reasons for change**
  - Nothing to Report
- **Actual or anticipated problems or delays and actions or plans to resolve them**

    - Nothing to Report
- **Changes that had a significant impact on expenditures**
    - Nothing to Report
- **Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents**
    - Nothing to Report
- **Significant changes in use or care of human subjects**
    - Nothing to Report
- **Significant changes in use or care of vertebrate animals.**
    - Nothing to Report
- **Significant changes in use of biohazards and/or select agents**
    - Nothing to Report

6. **PRODUCTS:**

- **Publications, conference papers, and presentations**
    - **Journal publications.**
        - Nothing to Report
    - **Books or other non-periodical, one-time publications.**
        - Nothing to Report
    - **Other publications, conference papers, and presentations.**
        - Harrington KM, Lin J, Mitchell KS, Madari N, Young M, Gerlovin H, et al. Incidence of eating disorders in the Veterans Healthcare Administration electronic health record from 2016 to 2020. Paper presentation presented at: International Conference on Eating Disorders; 2022; Virtual.
- **Website(s) or other Internet site(s)**
        - Nothing to Report
- **Technologies or techniques**
        - Nothing to Report
- **Inventions, patent applications, and/or licenses**
        - Nothing to Report
- **Other Products**
        - Nothing to Report

7. **PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**

- **What individuals have worked on the project?**

Name:	Dr. Mihail Samnaliev, who then was replaced by Dr. Tracy Richmond effective September 2, 2022
Name:	Dr. Bryn Austin- no change

Name:	Dr. Kelly Harrington- no change
Name:	Dr. Kelly Cho- no change
Name:	Dr. Karen Mitchell- no change
Name:	Dr. David Gagnon- no change
Name:	Sherry Lin- no change

- **Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?**
  - Since the last reporting period, Dr. Tracy Richmond replaced Dr. Mihail Samnaliev as Collaborating/Partnering PI. This modification was approved by the U.S. Army Medical Research Acquisition Activity (See "Amendment of Solicitation/Modification of Contract, Amendment/Modification No. P00002, Effective Date 02-Sep-2022)
- **What other organizations were involved as partners?**
  - **Organization Name:** Boston VA Research Institute (BVARI)/Massachusetts Veterans Epidemiology Research and Information Center (MAVERIC)
  - **Location of Organization:** Boston, Massachusetts
  - **Partner's contribution to the project**
    - **Financial support:** Dept. of Defense
    - **In-kind support:** None
    - **Facilities:** Massachusetts Veterans Epidemiology Research and Information Center (MAVERIC) is an interdisciplinary research and development organization with the goal of creating a learning healthcare system within VA through application of research resources and methodologies to important clinical problems. Toward this end, MAVERIC combines resources from each of its core competencies.
    - **Collaboration:** Personnel with MAVERIC at the Boston VA site jointly with Dr. Austin and Dr. Samnaliev, subsequently replaced by Dr. Richmond, develop plans for analyses to address specific aims, providing direction for data programming with input from co-investigators and consultants. In addition, data analyses are carried out on site at the Boston VA. Collaboration will be ensured through regularly scheduled in-person meetings occurring every two weeks at minimum.
    - **Personnel exchanges:** Dr. Samnaliev can carry out work at Boston Children's Hospital and at the Boston VA.
    - **Other:** NA
  - **Organization Name:** Western Institute for Veteran's Research formerly known as Western Institute for Biomedical Research. (This site was included in BVARI's budget and BCH issued and is managing the award for more effect monitoring.) In 2021, the site changed its name to more accurately reflect its mission. No further changes to organization information.
  - **Location of Organization:** Salt Lake City, Utah
  - **Partner's contribution to the project**

- **Financial support:** Dept. of Defense
- **In-kind support:** None
- **Facilities**: Western Institute for Biomedical Research is a nonprofit corporation established in 1989 to promote research and related educational activities at the VA Salt Lake City Health Care System,
- **Collaboration**: Dr. Nelson provides guidance in dataset construction and analysis to estimate the healthcare costs associated with eating disorders. Collaboration will be ensured through regularly scheduled in-person meetings occurring every two weeks at minimum.
- **Personnel exchanges**: N/A
- **Other:** NA

8. **SPECIAL REPORTING REQUIREMENTS**
   - **COLLABORATIVE AWARDS:** NA
   - **QUAD CHARTS:** NA
9. **APPENDICES:**

Background: Eating disorders (ED), including anorexia nervosa, bulimia nervosa, and binge eating disorder, are serious illnesses that lead to disturbance in one's eating behaviors and can result in poorer health, lower quality of life, and long-term expensive treatment. About 30 million Americans at some point in their lifetimes will have an ED. Individuals with ED often suffer from substance use disorders and other mental health problems, including anxiety and depression. However, very little is known about the prevalence of ED and the patterns of co-occurring mental health and substance use problems among military Veterans. Researchers are beginning to recognize that additional evidence of the prevalence, patterns of co-occurring illness, and costs of ED among Veterans is needed to accurately evaluate the overall burden of disease and to design effective ED screening and treatment programs.

Research Plan: We will address several critical questions identified in the Department of Defense FY18 Peer Reviewed Medical Research Program (PRMRP) Area of Encouragement of eating disorders. 1) Using the largest and most comprehensive database of US military Veterans, we will generate precise estimates of ED prevalence (% of Veterans with ED within a year) and incidence (new cases by year) among Veterans in the aggregate. We will also estimate ED prevalence/incidence by sociodemographic groups, including by age, gender, race/ethnicity, obesity status, and age cohort. 2) Our study will document patterns of co-occurring mental health and substance use problems among Veterans with ED. These disorders affect military Veterans at disproportionately high rates compared to the general population but are often left untreated resulting in unnecessary health burden and excess costs of care. We will evaluate whether such co-occurring problems precede (and may lead to) ED or if they develop subsequently to an ED episode (and may be caused in part by ED). This information can be used by medical providers to develop effective screening and treatment programs for Veterans with ED based on the progression of the disease and co-occurring illnesses. 3) Our study will document the added utilization and cost of care to the Veterans Health Administration (VHA) associated with ED, which can be used by policymakers to evaluate the burden of disease to the VHA and in future evaluations of the cost-effectiveness of ED prevention and treatment.

Impact: Our study has the potential for an unprecedented impact on the health and quality of life among Veterans with the condition. We will produce the most accurate estimates to date of the scope and impact of ED on Veterans' health as a whole and in high-risk subgroups, changes in incidence over time and with age, and the health services and cost burden posed by ED for the VHA, in addition to Medicare. Through better detection of ED and through better understanding of the co-occurring illnesses among those with ED, our research can directly help medical providers assess risk of developing ED and mental health and substance use disorders, which will have a significant beneficial impact on the health, wellbeing, and quality of life of Veterans. Findings from this study will likely lead to several profound benefits for Veterans and the larger

general population by informing the development of: 1) More accurate screening tools for use in large EHR databases to identify undiagnosed eating disorders cases in healthcare samples; 2) Indicators for early identification of emerging eating disorders symptoms to enable early intervention when treatments are known to be most effective to prevent onset of full-blown disorder; and 3) Effective models of care for integrated treatment of ED and co-occurring mental health and substance use disorders.