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Excessive Vomiting in Pregnancy, Active Component Service Women, U.S. Armed Forces, 2005–2014

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Up to 80% of women experience some form of nausea and vomiting during pregnancy. However, in some women, nausea and vomiting can be excessive and require inpatient and/or outpatient treatment. Data were obtained on 149,071 live births from 116,510 service women from 1 January 2005 through 31 December 2014. A total of 19,175 of the service women with live births had pregnancies complicated by excessive vomiting in pregnancy (EVP) and accounted for 20,511 EVP cases (overall rate of 13.8%). Mild and severe hyperemesis gravidarum (HG) combined accounted for almost two-thirds of the total EVP cases. The slight increase observed in the annual rate of EVP between 2005 and 2014 was driven largely by the outpatient trend for mild HG. Together, mild and severe HG accounted for three-quarters of all hospital bed days for EVP. About one-third of the women with EVP-complicated pregnancies had two or more EVP-related medical encounters. A better awareness of this medical condition, severity of its symptoms, and their effect on a woman's functioning is needed to provide effective interventions that protect a woman's health-related functional status.

Nausea and vomiting affect 50%–80% of all pregnant women[1-4] and can have a substantial negative effect on quality of life during pregnancy.[5-7] In most women, nausea and vomiting are mild, self-limiting, and have little or no impact on the mother and the developing fetus. However, in some women, nausea and vomiting can be excessive and persistent—lasting beyond the first trimester and requiring dietary changes or medication to control symptoms.[8]

The most severe form of excessive vomiting in pregnancy (EVP) is called hyperemesis gravidarum (HG). HG has been estimated to occur in 0.3%–3% of all pregnancies[9-12] and is characterized by severe and intractable nausea and vomiting that can lead to dehydration, electrolyte and metabolic disturbances, and nutritional deficiencies.[13-14] Hospitalization may be required for correction of fluid and electrolyte imbalances as well as administration of antiemetic medication and provision of nutritional counseling. Adverse maternal and fetal outcomes may occur in cases with lack of symptom control, poor maternal weight gain, and persistent electrolyte abnormalities.[8-9,13,15-16] An estimated 50% of women presenting with HG will require inpatient treatment (general U.S. population).[5]

Despite its low incidence, HG is the second most common reason for prenatal hospitalizations in the U.S., accounting for 11.4% of all non-delivery prenatal admissions.[17-18] In the U.S. in 2012, more than 285,000 women were admitted to hospitals for HG with costs per HG patient estimated at $47,351.[19] The actual cost of HG is likely significantly higher when considering other factors such as emergency department visits, complications due to severe HG, and the fact that up to 35% of women with paid employment will lose time from work due to this condition.[20]

Women of reproductive age represent the majority of military females.[21] During 2001–2012, approximately 190,000 live births occurred among active component service women.[22] Accordingly, the past decade has seen a considerable increase in military-specific reproductive research.[21] However, no studies have focused on EVP among a population of U.S. service women since the 1990s.[23] The majority of studies of this condition among U.S. civilian women have focused on hospital admissions for HG.[9,14,24-28] The current study broadens the case definition to include all EVP diagnosis codes and draws on records of both inpatient and outpatient healthcare encounters.

This report summarizes the counts, rates, trends, and demographic and occupational characteristics of active component service women who had live births and were diagnosed with EVP in the course of their pregnancies during the surveillance period from 2005 through 2014. This report also provides estimates of the "morbidity burden" attributable to EVP based on the total number of EVP-related medical encounters, number of service women affected, and total bed days during hospitalizations for EVP.

METHODS

The surveillance period was 1 January 2005 through 31 December 2014. The surveillance population included all active component service women of the U.S. Army, Navy, Air Force, and Marine Corps who served at any time during the surveillance period. Records of both inpatient and outpatient healthcare encounters documented in the databases of the Defense Medical Surveillance System (DMSS) were searched to ascertain cases of EVP.

A case of EVP was defined by a record of a hospitalization or an outpatient encounter that included an ICD-9 code for EVP in either the first or the second diagnostic position **(Table 1)**. Each individual could be diagnosed as a case of EVP only

one time each per live birth and, for the purposes of examining rates over time, occurrence of EVP was linked to the year of live birth. If female service members had more than one case-defining encounter during pregnancy, an inpatient diagnosis was prioritized over an outpatient diagnosis, after which diagnoses were prioritized in terms of severity—for example, severe HG (ICD-9: 643.1x) > mild HG (ICD-9: 643.0x) > late vomiting (ICD-9: 643.2x) > other vomiting complicating pregnancy (ICD-9: 643.8x) > unspecified vomiting of pregnancy (ICD-9: 643.9x).

In estimating the rate of EVP, the appropriate denominator is difficult to define. It is problematic to determine the number of pregnancies in the study population for a given period. Studies of early pregnancy have estimated that up to 40% of all conceptions are lost before 24 weeks, and that 22% of those are not even clinically recognized.[29-30] Because live births are more easily identified, the rate of EVP to live births is presented here rather than the rate of EVP in pregnancy.

The denominator for rate calculations consisted of active component females who had medical encounters that documented live births. A live birth delivery was defined by a hospitalization record with an ICD-9 code of 650.xx–659.xx (if fifth digit is specified, must be 1 or 2 for delivered) [excluded: 656.41, intrauterine death], 660.xx–679.xx (if fifth digit is specified, must be 1 or 2 for delivered) or V27.0, V27.2, V27.3, V27.5, V27.6 in any diagnostic position. Individuals were allowed one live birth delivery every 280 days. The estimated date of conception was defined as the date 280 days before the start of the delivery hospitalization. The surveillance period was extended an additional 280 days to capture information on live births for service women with EVP diagnoses recorded near the end of calendar year 2014.

The numerator for rate calculations consisted of cases among the cohort of service women with a live birth during the surveillance period who met the case definition for EVP during the 280 days before the start of their delivery hospitalization. The rate of EVP was calculated as a percentage of live births. Service women in the numerator were further categorized as having had a multiple pregnancy (ICD-9: V27.2, V27.3, V27.5, V27.6, 651.x1, 652.61, 660.51) or a single pregnancy (all other codes not multiple). It is important to note that, because EVP can result in poor fetal health outcomes (including miscarriage/mortality), rates as a percentage of live births will be an underestimation of all EVP. To capture information on any excluded cases, the number of individuals with EVP who did not have a live birth on record also was summarized.

The burden of morbidity attributable to EVP was estimated based on the total number of prenatal EVP-related medical encounters (i.e., total hospitalizations and ambulatory visits for EVP with a limit of one encounter per individual per EVP diagnosis per day), number of service women affected, and total bed days during hospitalizations for EVP. For reporting by diagnosis code, the same prioritization rule was applied (e.g., severe HG > mild HG > late vomiting > other vomiting complicating pregnancy > unspecified vomiting of pregnancy).

TABLE 1. ICD-9 diagnostic codes used to identify excessive vomiting in pregnancy (EVP)

ICD-9 code	Diagnosis	Description
643.0x	Mild hyperemesis gravidarum (HG)	HG, mild or unspecified, starting before the end of the 22nd week of gestation
643.1x	HG with metabolic disturbance (severe)	HG, starting before the end of the 22nd week of gestation, with metabolic disturbance such as: carbohydrate depletion, dehydration, electrolyte imbalance
643.2x	Late vomiting of pregnancy, unspecified	Excessive vomiting starting after 22 completed weeks of gestation
643.8x	Other vomiting complicating pregnancy	Vomiting due to organic disease or other cause, specified as complicating pregnancy, or as a reason for obstetric care during pregnancy
643.9x	Unspecified vomiting of pregnancy	Vomiting as a reason for care during pregnancy, length of gestation unspecified

RESULTS

Data were obtained on a total of 149,071 live births from 116,510 service women during the 10-year surveillance period. A total of 19,175 of the service women with live births had pregnancies complicated by EVP. Of the service women affected by EVP, a total of 6,490 (33.8%) contributed two or more live births. Because a subset of these service women had multiple live births with pregnancies complicated by EVP, the total live births accounted for 20,511 EVP cases overall **(Table 2)**.

The overall rate of EVP during the surveillance period was 13.8%. Total EVP rates were highest for mild HG (7.4%) and "unspecified vomiting of pregnancy" (3.2%) and lowest for "other vomiting

TABLE 2. Numbers of live births, cases of excessive vomiting in pregnancy (EVP), and service women affected, active component, U.S. Armed Forces, 2005–2014

	Total no.
Live births during surveillance period	149,071
Service women with live births	116,510
Cases of EVP	20,511
Service women affected	19,175
With 1 live birth	12,865
With 2+ live births	6,490

complicating pregnancy" (0.5%) **(Table 3)**. Taken together, mild and severe HG accounted for close to two-thirds of the total EVP cases. The vast majority (95.5%) of total EVP cases were associated with outpatient encounters. Severe HG accounted for a higher proportion of inpatient EVP cases than outpatient cases (31.7% vs. 9.1%, respectively). A similar but less pronounced difference was observed for "late vomiting of pregnancy"; this diagnostic subcategory accounted for 15.1% of inpatient EVP cases and 9.2% of outpatient cases. "Unspecified vomiting of pregnancy" accounted for a higher proportion of outpatient EVP cases than inpatient cases (23.8% vs. 4.6%, respectively).

The annual EVP rate was 28.8% higher in 2014 than in 2005 (14.9% and 11.6%, respectively). Because the vast majority of EVP cases (95.5%) were diagnosed as outpatients, the upward trend in the overall rate was largely a reflection of the outpatient trend. Inpatient rates of EVP were relatively low and stable throughout the surveillance period **(Figure 1)**. Mild HG and "unspecified vomiting of pregnancy" were the two diagnoses that showed the most pronounced changes in annual rates over the course of the surveillance period. The annual rate for mild HG was 36.8% higher in 2014 than in 2005 (9.0% and 6.5%, respectively). The annual rate for "unspecified vomiting of pregnancy" peaked in 2010 at 4.0% followed by a slight decline in 2011 and then a leveling off through 2014 **(Figure 2)**.

During 2005–2014, service women aged 24 years or younger had the highest overall EVP rates and the highest rates of mild and severe HG, compared with those in the other age groups **(Table 4)**. Compared with other race/ethnicity groups, the overall EVP rate and the rate of mild HG were notably higher among black, non-Hispanic service women. Among the Services, rates of overall EVP and rates of mild HG were highest among female Army members, whereas the rate of severe HG was highest among female Air Force members. Married service women had the lowest rates of overall EVP and mild HG, compared with those in the "single" and "other" categories. Compared with other service women, those in armor/motor transport occupations had higher rates of overall EVP and mild HG **(Table 4)**.

Of the 20,511 EVP cases ascertained, the vast majority (98.1%) were associated with single pregnancies **(data not shown)**. These cases represent 18,778 of the 19,175 service women with EVP-complicated pregnancies **(data not shown)**. The overall distribution of proportions of EVP diagnoses associated with single versus multiple pregnancies were roughly similar, with the highest percentages of cases represented by mild HG and "unspecified vomiting of pregnancy" **(data not shown)**. However, a slightly higher percentage of total EVP cases associated with multiple pregnancies were diagnosed as inpatients, compared with cases associated with single pregnancies (9.6% vs. 4.4%, respectively) **(data not shown)**.

To capture information on any cases excluded from the main analysis, service women with EVP who did not have a live birth on record also were identified. A total of 21,132 incident EVP cases had no associated records of live births **(data not shown)**. The proportions by encounter type (inpatient vs. outpatient) for these EVP cases were comparable to that of the 20,511 cases with records of live births **(data not shown)**. The diagnosis of "unspecified vomiting of pregnancy" accounted for a slightly higher proportion of the EVP cases without a live birth on record than among cases associated with a live birth (28.5% vs. 22.9%, respectively) **(data not shown)**.

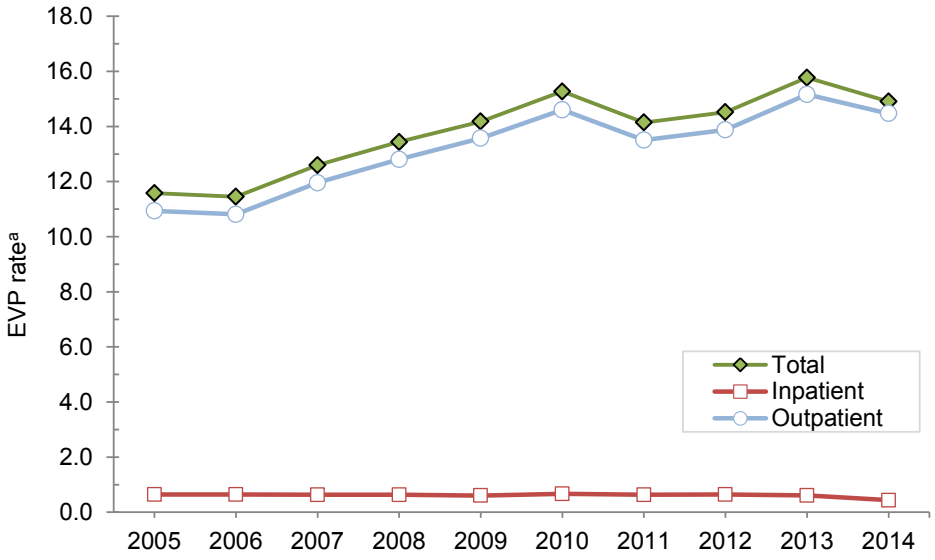
The 19,175 service women with pregnancies complicated by EVP contributed a total of 37,688 prenatal EVP-related medical encounters during the surveillance period, the majority of which were ambulatory visits (96.9%) **(Figure 3)**. Combined, mild HG and "unspecified vomiting of pregnancy" accounted for more than three-quarters (77.0%) of the total EVP-related medical encounters (48.3% and 28.7%, respectively). Severe HG and "late vomiting of pregnancy" accounted for 10.7% and 8.9% of total EVP-related encounters, respectively. Mild HG and "other vomiting complicating pregnancy"

TABLE 3. Counts and rates of EVP by diagnosis and encounter type, active component service women, U.S. Armed Forces, 2005–2014

			Total 2005–2014	
ICD-9 code	Diagnosis	Encounter type	No.	Rate[a]
	Total	Inpatient	921	0.62
		Outpatient	19,590	13.14
		Total	20,511	13.76
643.0x	Mild hyperemesis gravidarum	Inpatient	413	0.28
		Outpatient	10,677	7.16
		Total	11,090	7.44
643.1x	Severe hyperemesis gravidarum with metabolic disturbance	Inpatient	292	0.20
		Outpatient	1,776	1.19
		Total	2,068	1.39
643.2x	Late vomiting of pregnancy	Inpatient	139	0.09
		Outpatient	1,799	1.21
		Total	1,938	1.30
643.8x	Other vomiting complicating pregnancy	Inpatient	35	0.02
		Outpatient	678	0.45
		Total	713	0.48
643.9x	Unspecified vomiting of pregnancy	Inpatient	42	0.03
		Outpatient	4,660	3.13
		Total	4,702	3.15

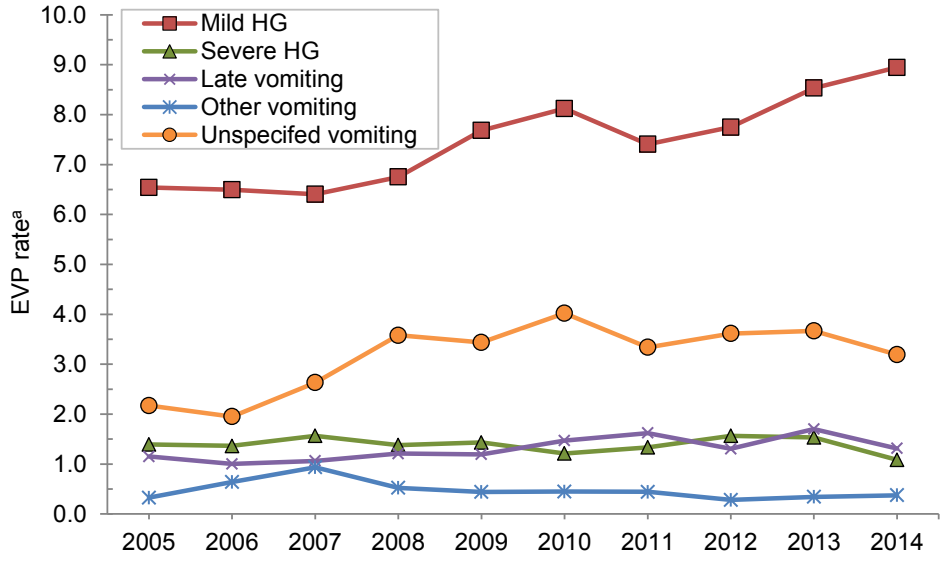
[a]Cases as a percentage of live births

FIGURE 1. Annual rates of excessive vomiting in pregnancy (EVP) by medical encounter type, active component service women, U.S. Armed Forces, 2005–2014



[a]Cases as a percentage of live births

FIGURE 2. Annual rates of excessive vomiting in pregnancy (EVP) by diagnosis, active component service women, U.S. Armed Forces, 2005–2014



[a]Cases as a percentage of live births

accounted for similar proportions of both inpatient and outpatient encounters. However, severe HG and "late vomiting of pregnancy" accounted for higher proportions (29.3% and 14.1%, respectively) of inpatient EVP-related medical encounters than outpatient encounters (10.1% and 8.7%, respectively). "Unspecified vomiting of pregnancy" accounted for the second highest proportion of outpatient encounters (29.5%) but less than 5% of inpatient encounters **(Figure 3)**.

Mild HG accounted for more hospital bed days (n=1,946) than any other diagnosis and 47.0% of all hospital bed days overall **(Figure 4).** Together, mild and severe HG accounted for three-quarters (75.5%) of all hospital bed days. The diagnosis "other vomiting complicating pregnancy" accounted for the fewest number of hospital days (n=105) and 2.5% of all hospital days.

During the 10-year surveillance period, about one-third (33.9%; n=6,506) of the service women with pregnancies complicated by EVP had two or more EVP-related medical encounters **(data not shown)**. Among these service women, the median number of inpatient encounters was 2 (range 2–10) and the median number of outpatient encounters was also 2 (range 2–157). The majority (97.3%) of the service women with two or more EVP-related medical encounters had outpatient encounters only; 2.4% (n=156) had both inpatient and outpatient EVP-related medical encounters. Only 18 of the service women with two or more EVP-related medical encounters had inpatient encounters only **(data not shown)**.

EDITORIAL COMMENT

This report documents that, during the 10-year surveillance period, close to one in six (16.5%) active component service women with live births had pregnancies complicated by EVP. The overall rate of EVP during this period was 13.8%. Considered together, mild and severe HG accounted for close to two-thirds of the total EVP cases and yielded a combined rate of 8.8%. As expected, severe HG and "late vomiting of pregnancy" accounted for a higher proportion of inpatient EVP cases than outpatient cases.

Estimates of EVP and HG incidence vary widely because of the different diagnostic criteria, study designs, and study populations (race/ethnicity composition) employed.[12, 31-32] More specifically, there is no single accepted definition of HG; it is a clinical diagnosis of exclusion based on a typical presentation in the absence of other diseases that could explain the findings.[31] The overall rate of EVP and the HG-specific rate computed in the current analysis are considerably higher than estimates reported in the past two decades by

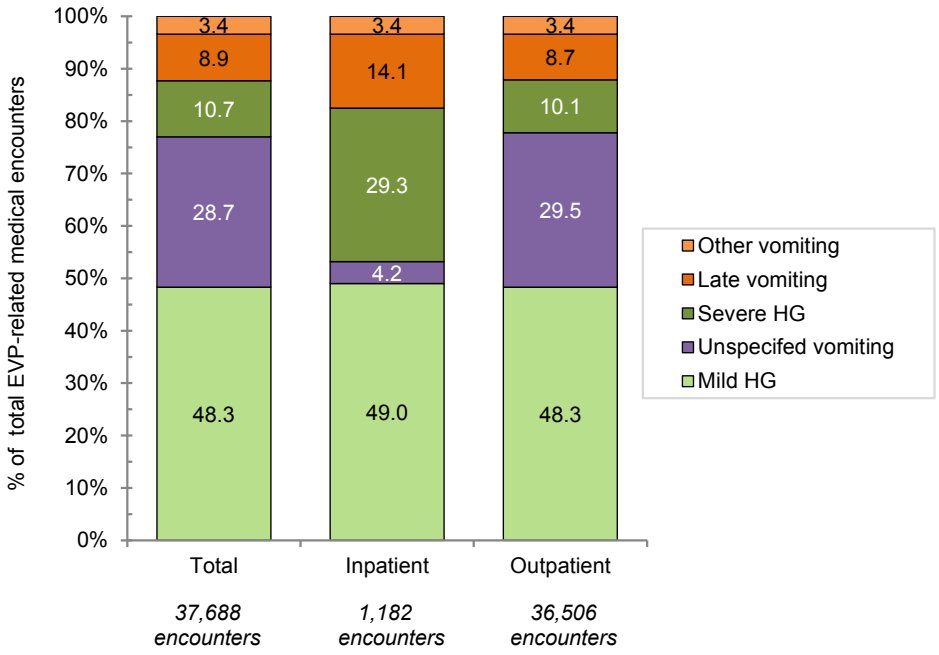
TABLE 4. Counts and rates of excessive vomiting in pregnancy (EVP) by diagnosis and demographic characteristics, active component service women, U.S. Armed Forces, 2005–2014

			4th digit level of ICD-9									
	Total (all EVP)		Mild hyperemesis gravidarum		Severe hyperemesis gravidarum with metabolic disturbance		Late vomiting of pregnancy		Other vomiting complicating pregnancy		Unspecified vomiting of pregnancy	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	20,511	13.8	11,090	7.4	2,068	1.4	1,938	1.3	713	0.5	4,702	3.2
Age												
<20	854	20.6	476	11.5	83	2.0	84	2.0	32	0.8	179	4.3
20-24	10,746	16.9	5,788	91.1	1,105	1.7	986	1.6	390	0.6	2,477	3.9
25-29	5,886	12.8	3,150	6.9	590	1.3	567	1.2	206	0.4	1,373	3.0
30-34	2,191	9.1	1,217	5.1	219	0.9	207	0.9	66	0.3	482	2.0
35-39	725	7.4	399	4.1	60	0.6	79	0.8	15	0.2	172	1.8
40+	109	6.2	60	3.4	11	0.6	15	0.9	4	0.2	19	1.1
Service												
Army	9,413	17.9	5,640	10.8	759	1.4	890	1.7	319	0.6	1,805	3.4
Navy	4,753	12.1	2,214	5.6	418	1.1	385	1.0	157	0.4	1,579	4.0
Air Force	5,015	11.1	2,629	5.8	722	1.6	534	1.2	176	0.4	954	2.1
Marine Corps	1,330	11.2	607	5.1	169	1.4	129	1.1	61	0.5	364	3.1
Race/ethnicity												
White, non-Hispanic	8,973	12.9	4,762	6.8	924	1.3	892	1.3	356	0.5	2,039	2.9
Black, non-Hispanic	6,421	16.5	3,634	9.3	645	1.7	586	1.5	190	0.5	1,366	3.5
Hispanic	2,888	13.2	1,530	7.0	279	1.3	258	1.2	96	0.4	725	3.3
Asian/Pacific Islander	685	11.3	397	6.5	70	1.2	51	0.8	22	0.4	145	2.4
American Indian/Alaska Native	274	12.0	144	6.3	17	0.7	25	1.1	13	0.6	75	3.3
Other/unknown	1,270	12.2	623	6.0	133	1.3	126	1.2	36	0.3	352	3.4
Marital status												
Single	5,087	15.6	2,776	8.5	465	1.4	462	1.4	180	0.6	1,204	3.7
Married	14,307	13.1	7,688	7.0	1,485	1.4	1,344	1.2	499	0.5	3,291	3.0
Other	1,117	15.5	626	8.7	118	1.6	132	1.8	34	0.5	207	2.9
Military occupation												
Combat-specific	300	13.8	153	7.0	37	1.7	42	1.9	3	0.1	65	3.0
Armor/motor transport	839	16.3	468	9.1	67	1.3	78	1.5	31	0.6	195	3.8
Pilot/air crew	151	7.9	90	4.7	14	0.7	11	0.6	8	0.4	28	1.5
Repair/engineering	3,781	13.5	1,924	6.9	387	1.4	334	1.2	137	0.5	999	3.6
Communications/intelligence	7,866	14.1	4,331	7.8	789	1.4	743	1.3	266	0.5	1,737	3.1
Health care	3,889	13.2	2,084	7.1	388	1.3	392	1.3	132	0.4	893	3.0
Other/unknown	3,685	14.0	2,040	7.7	386	1.5	338	1.3	136	0.5	785	3.0

[a]Cases as a percentage of live births

EVP-focused studies among samples of civilian women inside and outside of the U.S. (e.g., Norway, England, Canada). The most comparable rate reported for EVP was 5.5% obtained from a study of women enrolled in a health maintenance organization in the southeastern U.S. during 2000–2006.[26] This study searched electronic inpatient, outpatient, and emergency services data for ICD-9 codes 643. xx in any diagnostic position. One likely explanation for the disparity in rates relates to the current study's broader case definition using EVP diagnoses in the first and second diagnostic positions drawn from records of both inpatient and outpatient encounters. Also, the higher rates obtained in the current analysis are likely, at least partially, explained by U.S. service women's unrestricted access to prenatal care at no cost to them. Consistent with existing

FIGURE 3. Percentage of excessive vomiting in pregnancy (EVP)-related medical encounters by encounter type and diagnosis, active component service women, U.S. Armed Forces, 2005–2014



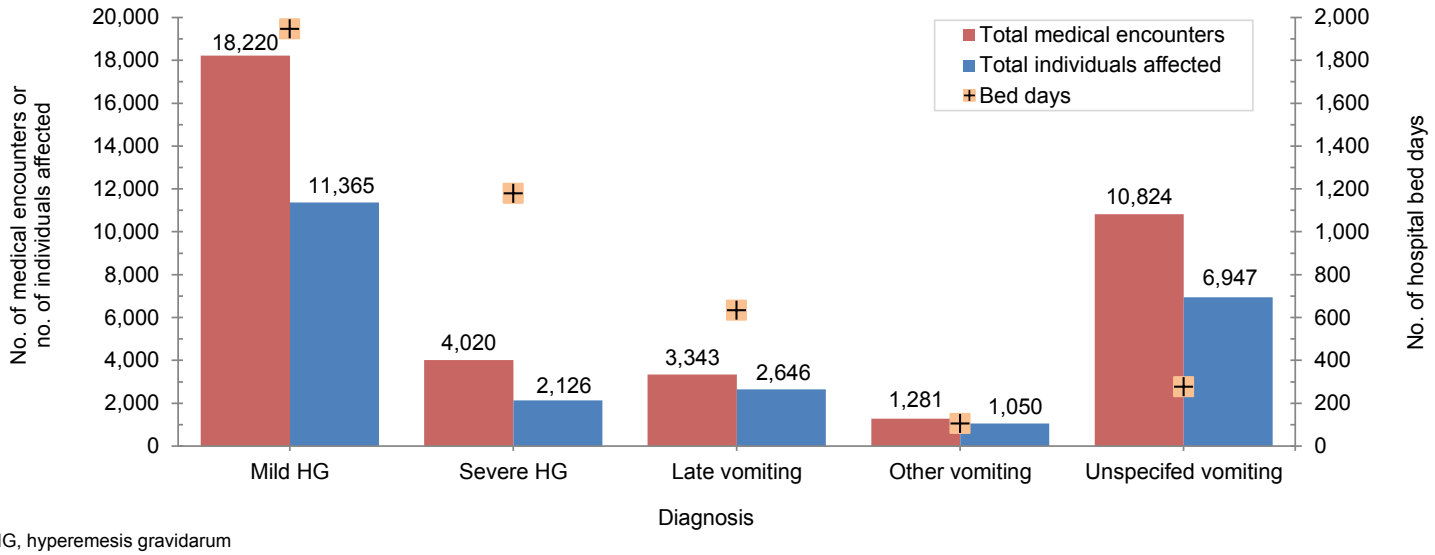
literature on EVP in the U.S. civilian population, results of this study showed that EVP- and HG-complicated pregnancies (and/or associated hospital admissions) were more common among women of black, non-Hispanic race/ethnicity[9,25,28,33] and younger age.[9,28]

The slight increase observed in the annual rate of EVP between 2005 and 2014 was driven largely by the outpatient trend; this trend was, in turn, largely a reflection of the trend observed for mild HG. Review of the published literature from the past two decades identified one study that examined annual rates of hospital admissions for severe vomiting during pregnancy (per 100 deliveries).[25] The authors posited that the dramatic declines observed in rates of this condition from 1991 through 2003 reflected a transition from in-hospital care to out-of-hospital care.[25]

During the past several years, there has been an increase in research on alternatives to inpatient treatment of EVP, including day care treatment and midwifery support. Results from one recent trial suggest that initial treatment of EVP in outpatient day care reduced subsequent hospital admissions, compared with standard inpatient treatment.[34] Findings from another recent trial indicate that day care treatment plus ongoing midwifery support may be an effective alternative for treating women with severe EVP.[35] Additional research is needed to examine characteristics that contribute to decisions regarding inpatient versus outpatient management of EVP.

During the surveillance period, mild HG accounted for more hospital bed days than any other EVP diagnosis and close to half of all hospital bed days for EVP overall.

FIGURE 4. Numbers of medical encounters for excessive vomiting in pregnancy (EVP),[a] individuals affected,[b] and hospital bed days, by diagnosis, active component service women, U.S. Armed Forces, 2005–2014



HG, hyperemesis gravidarum

[a]Total hospitalizations and ambulatory visits for EVP (with no more than one encounter per individual per day)

[b]Individuals with at least one hospitalization or ambulatory visit for EVP

Together, mild and severe HG accounted for three-quarters of all hospital bed days for EVP. The majority of the service women with two or more EVP-related medical encounters had outpatient encounters only; less than 3% had both inpatient and outpatient EVP-related medical encounters and only 18 had inpatient encounters only.

Research indicates that HG is likely to recur in subsequent pregnancies.[28,36-37] A recent population-based study of hospital readmission for HG found that history of HG was the strongest independent risk factor for readmission for HG.[28] Two population-based studies reported the risk of recurrent HG in a second pregnancy was 15%[36] and 20%[15] in women with previous HG, but only 0.7% in women with no such history.[36] Despite this research, understanding of the risks of EVP readmission in a current pregnancy and reoccurrence rates in later pregnancies is limited, both of which are necessary for developing measures to reduce the onset or worsening of the condition. The potentially high risk of recurrence has led to recommendations that women with a previous history of HG and their providers may want to discuss a treatment plan before pregnancy.[37] In addition, women with previous HG may need to be seen more frequently in early pregnancy to facilitate more rapid diagnosis and treatment of the condition.[37]

There are several important limitations that should be considered when interpreting the results of this analysis. First, the findings presented here are likely to underestimate the numbers and rates of EVP. As previously noted, because rates in this analysis were computed as a percentage of live births, EVP-complicated pregnancies that resulted in miscarriage/mortality were excluded. In addition, it is possible that patients presented with EVP (ICD-9: 643.xx) but received alternative or less specific diagnostic coding (i.e., gastritis, nausea, or vomiting) and thus were not included in the analysis. Finally, this report summarizes diagnoses of EVP that were reported on standardized records of hospitalizations and outpatient encounters in fixed U.S. and civilian (i.e., purchased care) medical facilities if reimbursed through the Military Health System (MHS). Records of non-reimbursed care received at medical facilities outside of the MHS were not available for this analysis.

Also, there are limitations to the generalizability of the findings because of the characteristics of the surveillance population. For example, active component service women have unrestricted access to prenatal care at no cost; as such this may limit the validity of comparisons to civilian women, for whom limited access to, and inability to pay for, care may restrict hospitalization and use of outpatient services. Thus, generalizations of the observed results should be limited to similar groups. Finally, findings related to temporal trends need to take into account factors such as changes in awareness of the condition and shifts in clinical practice patterns that may have occurred during the course of the surveillance period. Because of changes in management of pregnancy complications (e.g., transition from in-hospital care to out-of-hospital care), it is likely that some of the service women who were hospitalized at the beginning of the surveillance period would now be treated as outpatients.[25,34]

The results of this analysis showed a substantial burden of EVP-related morbidity, as measured by prenatal EVP-related medical encounters, number of service women affected, and total bed days during hospitalizations for EVP. Research on the psychosocial morbidity associated with EVP indicates that severe EVP has substantial effects on women's occupational, family, and social functioning.[37] Given its negative impact on women's quality of life, EVP is a condition that should be taken seriously by healthcare professionals responsible for providing care to women during pregnancy.[37-41]

As women become more established in U.S. military operations, pregnancy care ensuring healthy outcomes should remain a principal area of research. Specifically, a better awareness of this medical condition, severity of its symptoms, and their effect on a woman's functioning are needed to provide effective interventions that protect a woman's health-related functional status.

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Importance of External Cause Coding for Injury Surveillance: Lessons from Assessment of Overexertion Injuries Among U.S. Army Soldiers in 2014

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Injuries are a barrier to military medical readiness, and overexertion has historically been a leading mechanism of injury among active duty U.S. Army soldiers. Details are needed to inform prevention planning. The Defense Medical Surveillance System (DMSS) was queried for unique medical encounters among active duty Army soldiers consistent with the military injury definition and assigned an overexertion external cause code (ICD-9: E927.0–E927.9) in 2014 (n=21,891). Most (99.7%) were outpatient visits and 60% were attributed specifically to sudden strenuous movement. Among the 41% (n=9,061) of visits with an activity code (ICD-9: E001–E030), running was the most common activity (n=2,891, 32%); among the 19% (n=4,190) with a place of occurrence code (ICD-9: E849.0–E849.9), the leading location was recreation/sports facilities (n=1,332, 32%). External cause codes provide essential details, but the data represented less than 4% of all injury-related medical encounters among U.S. Army soldiers in 2014. Efforts to improve external cause coding are needed, and could be aligned with training on and enforcement of ICD-10 coding guidelines throughout the Military Health System.

Among active duty U.S Army personnel, injuries and injury-related musculoskeletal conditions result in more than 1.3 million medical encounters annually and affect nearly 300,000 soldiers.[1] For commanders and medical personnel determined to address this leading medical readiness issue, summaries of available medical surveillance data offer a starting point for understanding Army injuries. Information available from existing medical surveillance data has the potential to facilitate data-driven injury prevention planning such that scarce prevention resources are directed at leading causes, mechanisms, and activities.[2-5]

In the past, cause-coded injury hospitalization data were a focus of military injury surveillance analyses.[6-8] Nearly all traumatic injury hospitalizations received cause codes because the reporting of cause codes was required for all traumatic injury hospitalizations (i.e., formerly hospitalizations with International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM] diagnosis codes 800–999).[9] However, in recent years, hospitalization rates for injuries declined among U.S. service members[10]; in 2014, for example, less than 2% of injuries among active duty U.S. Army personnel resulted in hospitalization.[1] Many injuries treated in outpatient settings cause significant morbidity and functional impairment; for example, in 2014, nearly one out of 10 (9%) were due to fractures and nearly half (46%) were due to sprains or strains.[1] To date, there is no national requirement to assign external cause of injury codes for injuries treated in outpatient settings[11]; in turn, in military as in civilian treatment facilities, cause-of-injury coding has been incomplete.[6] As has been recommended in the past, now more than ever there is a need for outpatient injury cause coding to identify targets for prevention.[3,9,12]

Monthly installation injury reports produced by the Armed Forces Health Surveillance Branch (AFHSB) and Army annual injury surveillance reports have consistently identified overexertion as the leading mechanism of outpatient injuries among active duty U.S. Army soldiers.[1,13,14] Overexertion, as defined in the International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM), includes prolonged static or awkward postures, repetitive movements, specified strenuous movements or postures, and strenuous movement or load.[11] The purpose of this analysis is to provide additional details concerning overexertion injuries among active duty U.S. Army soldiers to inform prevention planning for this leading mechanism of injury.

METHODS

In December 2015, the databases of the Defense Medical Surveillance System (DMSS) were searched for records of medical encounters for overexertion injuries sustained by individuals who served in the active component of the U.S. Army during calendar year 2014, the latest full calendar year of data available at the time of analysis. Injuries were ascertained from records of medical encounters that included diagnoses within the ICD-9 Injury and Poisoning code group (800–999); codes related to late effects of injuries, toxic effects, poisonings, and surgical or medical complications were excluded. Selected diagnoses from the ICD-9 Diseases of the Musculoskeletal System and Connective Tissue code group (710–739) were also included, consistent with recommendations for military injury surveillance[15] and current military injury

surveillance definitions.[16] A complete code list is presented elsewhere.[16]

The database used for analyses consisted of inpatient and outpatient medical records (direct military treatment facility care and TRICARE purchased care) with injury-specific ICD-9 codes as primary diagnoses. If multiple relevant diagnosis codes were reported on single records, the analysis used the primary diagnosis as the case-defining diagnosis, since the primary diagnosis indicates the most serious injury, according to coding guidelines.[17]

Because a majority of injuries among active duty U.S. Army soldiers are treated in outpatient settings[1] and a maximum of four diagnosis codes can be entered for outpatient visits, for analysis purposes, any external cause codes present in the electronic medical record were assumed to apply to the primary diagnosis. To limit follow-up encounters, multiple encounters for the same three-digit ICD-9 diagnosis within 60 days were considered as single episodes of the indicated injury. Overexertion injuries were identified as those containing an "overexertion" external cause of injury code (ICD-9: E927.0–E927.9) in any diagnosis field following the primary injury diagnosis. For each overexertion injury-related medical encounter, the injured patient's age, gender, military rank, military occupational specialty (MOS), and injury diagnosis were obtained.

Rates were calculated using denominators from the DMSS reflecting 2014 distributions by age, gender, rank and MOS for active duty Army personnel. Rate ratios (RRs) and 95% confidence intervals (CIs) were calculated using OpenEpi.[18] Injuries were classified by injury type and body region using two different injury classification tools. Diagnoses with ICD-9 codes 800–999 were categorized using the Barell injury diagnosis matrix, a tool developed by members of the International Collaborative Effort on Injury Statistics to summarize traumatic injuries.[19] This matrix includes all injuries in ICD-9 codes 800–995, excluding Injury and Poisoning codes related to complications of surgical and medical care, not elsewhere classified (996–999). Diagnoses with ICD-9 codes 710–739 were summarized using the injury-related musculoskeletal condition matrix developed by Army epidemiologists and clinicians and described by Hauret et al.[20] This matrix was developed to categorize and standardize reporting of musculoskeletal conditions common in young, active populations (e.g., meniscal tears, recurrent shoulder dislocations, Achilles tendinitis, stress fractures) that often result from microtrauma due to overuse and related to participation in recreational activities, sports, and physical training. The matrix does not include conditions in the ICD-9 Diseases of the Musculoskeletal System and Connective Tissue code group (710–739) such as osteoarthritis and acquired deformities. Place of occurrence (ICD-9: E849.0–E849.9) and activity (ICD-9: E001–E030) codes associated with overexertion injuries were also described. Place of occurrence codes supplement external cause codes and specify the location of the patient at the time of injury (e.g., home, recreational facility, workplace). Activity codes (E001–E030) describe the activity that caused or contributed to the injury. ICD-9 coding guidelines recommended assignment of external cause codes for the initial encounter only. Place of occurrence was not assigned if the location of injury was not stated in the record.[17]

This analysis was part of an ad hoc request made by an installation injury prevention team and is part of a project plan approved by the Army Public Health Center Public Health Review Board. The request for DMSS data was fulfilled by the AFHSB, Defense Health Agency.

TABLE 1. Counts and rates of overexertion injury visits[a] (n=21,891) by demographic characteristics of service members, active component, U.S. Army, 2014

	Overexertion injuries n (%)	Injury rate (per 1,000)	Rate ratio (95% CI)
Sex			
Male	18,587 (85)	45.2	1
Female	3,304 (15)	49.0	1.09 (1.05, 1.13)
Age (years)			
<25	9,137 (42)	55.4	1.92 (1.78, 2.07)
25–34	8,525 (39)	44.1	1.53 (1.41, 1.65)
35–44	3,529 (16)	36.6	1.27 (1.17, 1.37)
45+	700 (3)	28.9	1
Rank			
Jr. enlisted (E1–E4)	12,124 (55)	58.9	2.83 (2.52, 3.17)
Sr. enlisted (E5–E9)	7,288 (33)	40.2	1.93 (1.72, 2.17)
Jr. officer (O1–O4)	1,757 (8)	27.7	1.33 (1.18, 1.51)
Sr. officer (O5–O10)	295 (1)	20.8	1
Warrant officer (W1–W5)	427 (2)	30.0	1.44 (1.25, 1.67)
Occupation			
Motor transport	750 (3)	52.5	1.31 (1.21, 1.41)
Repair/engineer	4,869 (22)	50.1	1.25 (1.20, 1.30)
Communications/intelligence	5,780 (26)	48.4	1.20 (1.16, 1.25)
Health care	2,332 (11)	45.7	1.14 (1.08, 1.19)
Infantry/artillery/combat engineer	4,807 (22)	40.2	1
Pilot/air crew	176 (1)	22.1	0.55 (0.47-0.64)
Other	3,177 (15)	45.9	1.14 (1.09, 1.19)

[a]Injuries were defined using the current military injury surveillance definition, which includes visits with a primary diagnosis in ICD-9 Injury and Poisoning (800–999) and selected injury-related Diseases of the Musculoskeletal System and Connective Tissue (710–739).[16] Overexertion injuries were identified by selected external cause codes (ICD-9: E927.0–E927.9) in any diagnosis field following the primary injury diagnosis.

RESULTS

Among individuals who served in the active component of the U.S. Army in 2014, a total of 21,891 unique medical encounters consistent with the injury definition and assigned an overexertion external cause code were identified. The majority (99.7%) were outpatient visits.

Overexertion visit rates were higher among female soldiers, compared with males (RR 1.09, 95% CI: 1.05, 1.13); soldiers younger than 25 years of age, compared with those older than 45 years of age (RR 1.92, 95% CI: 1.78, 2.07); those with a junior enlisted rank (E1–E4), compared with senior officers (O5–O10) (RR 2.83, 95% CI: 2.52, 3.17); and soldiers in a motor transport occupation, compared with infantry/artillery/combat engineers (RR 1.31, 95% CI: 1.21, 1.41) **(Table 1).**

More than half (60%) of overexertion injuries were attributed specifically to sudden strenuous movement. Overexertion injuries were seen in a variety of medical departments, from primary care (39%) to emergency medicine (28%) to family practice (20%). Most overexertion injuries (87%) received a diagnosis in the Injury and Poisoning code group (800–999) and the leading specific diagnosis related to overexertion was "Unspecified site of ankle sprain" (ICD-9: 845.00) (18%) **(Table 2).**

Among overexertion injuries with traumatic injury diagnoses in the ICD-9: 800–999 (Injury and Poisoning) code series (n=18,929), all could be classified in the Barell matrix.[19] The majority of acute injuries (72%) were sprains and strains. More than half (59%) were to the lower extremities **(Table 3).**

Of those overexertion injuries consistent with the military injury definition that received a diagnosis with ICD-9 codes 710–739 (Diseases of the Musculoskeletal System and Connective Tissue) (n=2,962), nearly 100% (n=2,961) were musculoskeletal conditions likely due to overuse in young, active populations and as a result could be classified in the injury-related musculoskeletal matrix.[20] More than 70% of cases of injury-related musculoskeletal conditions attributed to overexertion received diagnoses consistent with inflammation and/or pain resulting from physical damage to musculoskeletal tissue due to overuse. Nearly half of these injuries (47%) were to the lower extremities **(Table 4).**

Forty-one percent of outpatient visits for overexertion injuries also contained external cause of injury codes specifying the activities associated with the injuries (ICD-9: E001–E030). Running, along with walking/marching/hiking, and basketball, were the most common activities associated with overexertion injuries (32%, 11%, and 10%, respectively) **(Table 5).**

Nineteen percent of outpatient visits for overexertion injuries also contained external cause of injury codes indicating the places of occurrence (ICD-9: E849), providing further detail on the locations where the injuries occurred. Approximately half of overexertion injuries occurred in recreation/sports facilities (32%), at home (13%), or in industrial places/premises (6%) **(Table 6).**

TABLE 2. Overexertion injury visit details, active component, U.S. Army, 2014 (n=21,891)

Variable	Category	Overexertion injuries n (%)
Specific overexertion mechanism (four-digit codes)	Overexertion from sudden strenuous movement (E927.0)	13,194 (60)
	Other overexertion and strenuous and repetitive movements or loads (E927.8)	4,466 (20)
	Unspecified (E927.9)	1,481 (7)
	Cumulative trauma from repetitive motion (E927.3)	1,441 (7)
	Excessive physical exertion from prolonged activity (E927.2)	784 (4)
	Cumulative trauma from repetitive impact (E927.4)	397 (2)
	Overexertion from prolonged static position (E927.1)	128 (1)
Medical department where diagnosis assigned	Primary care or primary medical care not elsewhere classified	8,631 (39)
	Emergency medical	6,206 (28)
	Family practice care not elsewhere classified	4,341 (20)
	Other	1,768 (8)
	Missing	945 (4)
ICD-9 category	Diseases of the Musculoskeletal System and Connective Tissue (710–739)	2,962 (13)
	Injury and Poisoning (800–999)	18,929 (87)
Top five specific diagnoses	Unspecified site of ankle sprain (845.00)	4,098 (18)
	Other and unspecified injury to knee, leg, ankle, and foot (959.7)	1,807 (8)
	Sprain of unspecified site of knee and leg (844.9)	1,463 (7)
	Lumbar sprain (847.2)	1,257 (6)
	Other and unspecified injury of other sites of trunk (959.19)	1,016 (5)

EDITORIAL COMMENT

This report summarizes information available from military medical surveillance data regarding injuries due to "overexertion" during calendar year 2014, the first detailed look at a leading mechanism of injury among U.S. Army soldiers.

The findings of this report document that lower extremity sprains and strains occurring while running or during sports activities account for disproportionate numbers of overexertion injuries among

TABLE 3. Traumatic injury visits due to overexertion by body location and diagnosis (n=18,929), active component, U.S. Army, 2014[a]

		Diagnosis													
		Fracture	Dislocation	Sprains/ strains	Internal	Open wound	Amputa-tion	Blood vessel	Contusion/ superficial	Crush	Burns	Nerves	Unspeci-fied	System-wide and late effects	No. of visits (%)
Body region	Traumatic brain injury (TBI)	-	-	-	2	-	-	-	-	-	-	-	-	-	2 (<0.1)
	Other head, face, neck	3	7	-	-	15	-	-	11	-	0	0	71	-	107 (0.6)
	Spinal cord	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	Vertebral column	4	1	1,968	-	-	-	-	-	-	-	-	-	-	1,973 (10.4)
	Torso	12	2	1,004	1	4	-	-	74	-	-	-	1,076	-	2,173 (11.5)
	Upper extremity	117	169	1,963	-	19	-	-	67	2	3	7	699	-	3,046 (16.1)
	Lower extremity	500	130	8,221	-	15	-	-	287	2	-	-	1,933	-	11,088 (58.5)
	Other, unspecified	1	-	436	1	-	-	-	32	-	1	2	30	-	503 (2.7)
	System-wide and late effects	-	-	-	-	-	-	-	-	-	-	-	-	37	37 (0.2)
	Total (%)	637 (3.4)	309 (1.6)	13,592 (71.8)	4 (<0.1)	53 (0.3)	0	0	471 (2.5)	4 (<0.1)	4 (<0.1)	9 (<0.1)	3,809 (20.1)	37(0.2)	18,929 (100)

[a]Matrix includes all ICD-9 codes 800–995.[19] Eighty-seven percent (87%) of overexertion injuries had diagnoses within ICD-9-CM Injury and Poisoning (800–995).

TABLE 4. Injury-related musculoskeletal condition visits due to overexertion by body location and diagnosis (n=2,961), active component, U.S. Army, 2014[a]

		Diagnosis						
	Injury location	Inflammation and pain (overuse)	Joint derangement	Joint derangement with neurological involvement	Stress fracture	Sprains/strains/ rupture	Dislocation	No. of visits (%)
Body region	Vertebral column	179	32	716	-	-	-	927 (31.3)
	Upper extremity	585	12	-	-	6	7	610 (20.6)
	Lower extremity	1,305	40	-	29	11	-	1,385 (46.8)
	Others and unspecified	32	-	1	4	2	-	39 (1.3)
	Total (%)	2,101 (71.0)	84 (2.8)	717 (24.2)	33 (1.1)	19 (0.6)	7 (0.2)	2,961 (100)

[a]Matrix includes selected musculoskeletal condition codes (710–739) attributed to overuse and common in young, active populations.[20] Thirteen percent (13%) of overexertion injuries had diagnoses contained in this matrix. One code within the military surveillance definiton16 (733.99) was not part of the matrix.

U.S. Army soldiers. The finding is not surprising because physical training and sports have been identified as leading activities associated with military injuries overall.[21,22] The identification of military occupational activities and demographic subgroups that are most associated with increased injury risk should be a priority. To this end, multivariable analyses to identify independent risk factors associated specifically with overexertion injuries are warranted.

Of note, during the year of interest for this report, only a small portion (12%) of the electronic medical records documenting injury-related outpatient medical encounters included external cause codes.[1] As a result, the overexertion injuries described in the report account for less than 4% of all injury-related medical encounters among U.S. Army soldiers during the year of interest. ICD-9 coding guidelines recommend assignment of an external cause code for "the initial encounter of an injury, poisoning, or adverse effect of drugs, not for subsequent treatment."[17] Possible reasons for the low levels of external cause coding include inadequate enforcement of recommended

TABLE 5. Top 10 activities associated with overexertion injury visits,[a] active component, U.S. Army, 2014

Activity	Total (%)
Running (E001.1)	2,891 (32)
Walking, marching, and hiking (E001.0)	989 (11)
Basketball (E007.6)	880 (10)
Free weights (E010.2)	662 (7)
Push-ups, pull-ups, sit-ups (E010.1)	445 (5)
Martial arts (E008.4)	350 (4)
Tackle football (E007.0)	336 (4)
Other activity involving other muscular strengthening exercises (E010.9)	285 (3)
Soccer (E007.5)	214 (2)
Baseball (E007.3)	167 (2)

[a]ICD-9 activity code (E001–E030) was assigned to a total of 9,061 injury visits with an overexertion external cause code.

TABLE 6. Places of occurrence for overexertion injury visits,[a] active component, U.S. Army, 2014

ICD-9 place of occurrence code	Count (% of overexertion injury visits with place of occurrence code)
Recreation/sports facility (E849.4)	1,332 (32)
Home (E849.0)	563 (13)
Industrial place/premise (E849.3)	262 (6)
Street/highway (E849.5)	184 (4)
Public building (E849.6)	161 (4)
Residential institution (E849.7)	37 (1)
Farm (E849.1)	5 (<1)
Mine/quarry (E849.2)	5 (<1)
Other specified place (E849.8)	1,029 (25)
Unspecified place (E849.9)	612 (15)

[a]ICD-9 place of occurrence code (E849.0–E849.9) was assigned to 4,190 injury visits with an overexertion external cause code.

cause coding practices and lack of understanding of how and when to enter cause codes. Furthermore, a strict interpretation of ICD-9 coding guidelines could have resulted in external cause codes not being assigned to encounters outside the Injury and Poisoning code group (ICD-9: 800–999). Such an interpretation could result in a lack of cause codes for numerous military-relevant injuries with diagnosis codes in Diseases of the Musculoskeletal System and Connective Tissue (ICD-9: 710–739). Further investigation into barriers to external cause coding in the Military Health System is warranted.

Causes of and circumstances related to injury incidents are part of a recommended minimum basic data set for injury prevention[23], and mandatory cause coding of outpatient records has been recommended to support military injury prevention efforts.[6,12] In the U.S., more than one-half of states have mandated cause coding in either hospital discharge or emergency department data systems.[24] Factors that have contributed to improved external cause coding in civilian medical treatment facilities have included policies mandating assignment of external cause codes, monitoring of the completeness and accuracy of cause coding, training on external cause coding, and increased awareness among providers and medical record coders of the role and value of external cause codes in the prioritization and evaluation of injury prevention efforts. [24]

The most recent version of the medical record coding guidelines used throughout the Military Health System is the ICD-10. The ICD-10 contains approximately 6,200 more external cause of injury codes than were available in its predecessor (ICD-9).[25] As such, the new coding manual provides enhanced ability to capture information essential for planning and monitoring the effects of injury prevention initiatives.[11] Notably, ICD-10 codes enable the capture of details such as the intent of injured persons or intentional injury perpetrators, causal mechanisms, objects involved, places of occurrence, and activities associated with injuries (e.g., work-related, during sports).[5]

Important changes with ICD-10 include that coding guidelines recommend assigning external cause code(s) for each encounter, and that external cause codes may be used for *any condition (injury or illness) attributable to an external source*.[11] Previously, ICD-9 guidelines recommended assigning external cause codes only for initial encounters and those conditions that indicated an injury, poisoning, or adverse effect of an external cause. This change represents an opportunity to capture causes of musculoskeletal conditions, often the result of overuse, that may have an identifiable cause and are often tracked along with injuries by sports medicine and occupational health communities as well as the military.[16,26-28] Medical providers can help to improve prevention efforts by ensuring that health care encounters for injuries and musculoskeletal conditions, and the medical records that document such encounters, include details regarding mechanisms, intents, locations, and activities associated with injuries.[24]

To support the Army and other Services' needs for data to guide injury prevention planning, the quality and completeness of reporting of causes of injuries must be improved. AFHSB Installation Injury Reports, which began reporting outpatient cause of injury information in 2015, reported that only 12%–13% of all active duty Army incident outpatient injury visits had causes documented in the associated medical records.[14] The effects of ICD-10 implementation in October 2015 on external cause coding are not yet clear. The experience of one country was an initial reduction in external cause coding in the first few years after implementation of ICD-10.[29] This finding emphasizes the need for training on and enforcement of ICD-10 coding guidelines throughout the Military Health System.

The findings of this report should be interpreted in light of its limitations. Most

notably, and as discussed in detail above, most of the injuries of interest for the report were not documented with cause of injury codes. Although the data are not complete, they represent findings on almost 22,000 cases of overexertion injuries and results are consistent with what would be expected based on prior military surveillance and survey analyses.[20,21,22] A key strength of the analysis is the use of records of all inpatient and outpatient medical encounters of all active component members of the U.S. Army during the year of interest.

In summary, this report highlights the potential value of routinely reporting the causes of and circumstances related to injuries, a major source of morbidity, disability, lost duty, and early termination of service of U.S. military members. Small investments in coding and recording time could enable military medical and front line leaders, health promotion practitioners, and medical staffs to tailor injury prevention programs, policies, and practices for specific installations, units, activities, and military and demographic subgroups.

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Acetaminophen Overdoses, Active Component, U.S. Armed Forces, 2006–2015

Leslie L. Clark, PhD, MS; Stephen B. Taubman, PhD

Acetaminophen, a drug commonly used to relieve pain and fever, is generally safe and effective when used as directed. However, acetaminophen overdose can cause serious adverse events, including liver damage and death. From 2006 through 2015, a total of 2,588 cases of acetaminophen overdose were identified in active component military members. Rates of acetaminophen overdose declined during this 10-year surveillance period, from 2.2 cases per 10,000 person-years (p-yrs) in 2006 to 1.2 cases per 10,000 p-yrs in 2015. Rates of overdose were higher among females, members of the Army, and service members younger than 25 years of age. Despite the apparent decline in acetaminophen overdose in the active component, continued surveillance is warranted to monitor this trend.

Acetaminophen (also known as paracetamol), a commonly used antipyretic and analgesic drug, has been available over the counter (OTC) in the U.S. since 1960. It is used alone and in combination in hundreds of OTC and prescription medications. Although generally safe and well tolerated when taken at therapeutic doses, acetaminophen overdose can cause serious adverse events, including liver damage and death.[1]

In the U.S., acetaminophen is one of the most frequently identified drugs in both intentional and unintentional poisonings. On average, more than 100,000 calls annually to poison control centers involve acetaminophen and up to one-third of these calls are for intentional overdose. It is estimated that more than 30,000 Americans are hospitalized for acetaminophen overdose per year and approximately 10% experience liver toxicity as a result. Acetaminophen toxicity is the leading cause of acute liver failure in the U.S.[2-5]

In 2012, Taylor et al. reported that the annual prevalence of acetaminophen overdose in the Military Health System had increased by 38.5% between 2004 and 2008. In addition, this analysis documented that the period prevalence of overdose in active duty military males (3.9 per 10,000 people) and females (14.4 per 10,000 people) was more than twice that in non-active duty males and females.[6]

This analysis reports on the prevalence of acetaminophen overdoses in active component service members identified in hospital discharge records or theater medical records, and the relative proportions that were intentional. Additionally, the proportion of cases subsequently receiving a diagnosis indicating hepatic toxicity is reported.

METHODS

The surveillance period for this analysis was 1 January 2006 through 31 December 2015. The surveillance population included all individuals who served at any time in the active component of the U.S. Air Force, Army, Navy, or Marine Corps during the surveillance period. For this analysis, cases of acetaminophen overdose were ascertained from the Defense Medical Surveillance System (DMSS), a large, longitudinal data warehouse that contains records of all U.S. military members' hospitalizations and ambulatory healthcare visits in U.S. military and civilian medical facilities worldwide. DMSS also contains medical records from the Theater Medical Data Store (TMDS), which include medical encounters of service members deployed in support of operations in Southwest Asia and the Middle East.

For surveillance purposes, a case of acetaminophen overdose was defined as the presence of the ICD-9 code 965.4 or the ICD-10 code T39.1 in any diagnostic position of a record of a hospitalization or TMDS medical encounter. These codes have been reported as having high sensitivity, specificity, and positive predictive value for acetaminophen overdose.[6,7] Intentionally self-inflicted acetaminophen overdoses were defined as those cases with either of the following external cause of injury codes in any diagnostic position in the same medical record as the overdose itself: ICD-9 code E950.0 or ICD-10 code X60. All diagnostic codes used to identify cases of acetaminophen overdose and the intentionality of overdose are shown in **Table 1**. An individual could be counted as a case each time he or she was hospitalized with a defining diagnosis indicating acetaminophen overdose; for cases identified in TMDS, an individual could be counted as a case once every 30 days. Service members who died as a result of an acetaminophen overdose without being hospitalized were not included in this study.

Cases of hepatotoxicity (e.g., hepatic necrosis, toxic hepatitis) were identified using the codes listed in **Table 2**. All incident (first-time) cases of acetaminophen overdose were reviewed for an occurrence of any of these codes in any inpatient or outpatient medical encounter occurring at any time after being identified as an acetaminophen overdose case. Acetaminophen overdose cases were followed from the time of their first overdose until they

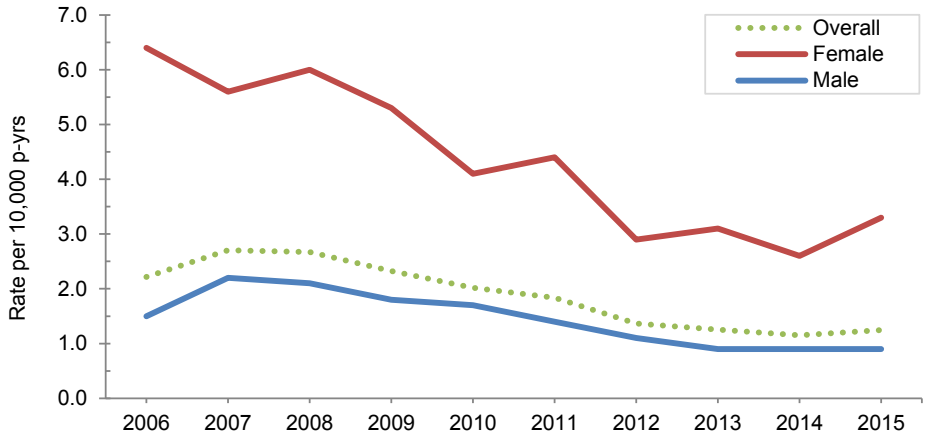
TABLE 1. ICD-9/ICD-10 diagnostic codes used to identify acetaminophen overdose and intentionality of overdose

Diagnostic codes	Description
ICD-9	
965.4	Poisoning by aromatic analgesics including acetaminophen
E850.4	Accidental poisoning by aromatic analgesics including acetaminophen
E950.0	Suicide and self-inflicted poisoning by analgesics, antipyretics, and antirheumatics
ICD-10	
T39.1	Poisoning by 4-aminophenol derivatives
X40*	Accidental poisoning by and exposure to nonopioid analgesics, antipyretics, and antirheumatics including acetaminophen
X60*	Intentional self-poisoning by and exposure to nonopioid analgesics, antipyretics, and antirheumatics including acetaminophen
Y10*	Poisoning by and exposure to nonopioid analgesics, antipyretics, and antirheumatics, including acetaminophen, of undetermined intent

TABLE 2. ICD-9/ICD-10 diagnostic codes used for identification of potential hepatotoxic outcomes

Diagnosis	ICD-9	ICD-10
Hepatic necrosis	570	K71.1
Toxic hepatitis	573.3	K71.2, K71.6, K71.9
Hepatic encephalopathy	572.2	K72.0, K72.9
Jaundice	782.4	R17
Hepatorenal syndrome	572.4	K76.7

FIGURE. Annual rates of acetaminophen overdose overall and by sex, active component, U.S. Armed Forces, 2006–2015



left service or until the end of the surveillance period. A published and validated algorithm was initially used to identify ICD-9 and ICD-10 codes suggestive of, and sensitive to, diagnoses indicative of hepatotoxicity related to acetaminophen overdose.[7] For reporting purposes, identified cases of hepatotoxicity were reported in the year of the acetaminophen overdose to which they were linked. For example, if a service member was diagnosed with an acetaminophen overdose in 2010 and subsequently received a diagnosis of hepatic necrosis in 2012, the diagnosis of hepatic necrosis would have been reported in 2010. The percentage of acetaminophen overdose cases with a subsequent diagnosis indicating hepatotoxicity was calculated by year; the denominator was calculated as the number of incident (first-time) acetaminophen overdoses identified that year and the numerator included the number of those cases which subsequently had a diagnosis indicating hepatotoxicity at any time later in the surveillance period.

RESULTS

During 2006–2015, there were 2,588 cases of acetaminophen overdose identified in active component military members. The overall crude rate during the period was 1.9 cases per 10,000 person-years (p-yrs) **(Table 3)**. The rate declined during the period from 2.2 cases per 10,000 p-yrs in 2006 to 1.2 cases per 10,000 p-yrs in 2015. The rates peaked in 2007 and 2008 at 2.7 per 10,000 p-yrs and then declined steadily **(Figure)**. About 1% of the total cases (n=30) were ascertained from TMDS medical encounters and occurred while the service member was deployed. All but one of these cases resulted in medical evacuation from theater, hospitalization in theater, or both **(data not shown)**.

Female active component service members were almost three times as likely to receive a diagnosis of acetaminophen overdose as their male counterparts **(Table 3)**. Although the male-specific annual rates of acetaminophen overdose declined every year since 2007, the rate in females was lowest in 2014 but increased slightly in 2015 **(Figure)**.

During 2006–2015, crude rates of acetaminophen overdose were slightly higher among black, non-Hispanic service members than other race/ethnicity groups. Among the Services, rates of acetaminophen overdose were highest in the Army **(Table 3)**.

TABLE 3. Counts and rates of acetaminophen overdoses by demographic characteristics, active component, U.S. Armed Forces, 2006–2015

	Total 2006–2015	
	No.	Rate (per 10,000 p-yrs)
Total	2,588	1.9
Sex		
Female	876	4.4
Male	1,712	1.5
Service		
Army	1,371	2.6
Navy	514	1.6
Air Force	343	1.0
Marine Corps	360	1.9
Race/ethnicity		
American Indian/ Alaska Native	31	2.0
Asian/Pacific Islander	97	1.8
Black, non-Hispanic	532	2.4
Hispanic	291	1.8
White, non-Hispanic	1,502	1.8
Other	135	1.8
Age group		
17–19	439	5.0
20–24	1,306	2.9
25–29	485	1.5
30–34	190	0.9
35–39	101	0.6
40–44	47	0.5
45–54	19	0.4
55+	1	0.4
Age group (females)		
17–19	172	11.9
20–24	446	6.6
25–29	164	3.3
30–34	51	1.7
35–39	24	1.2
40–44	14	1.2
45–54	5	0.8
55+	0	0.0
Age group (males)		
17–19	267	3.6
20–24	860	2.3
25–29	321	1.2
30–34	139	0.8
35–39	77	0.6
40–44	33	0.4
45-54	14	0.3
55+	1	0.4

The highest overall age- and sex- specific rates of acetaminophen overdose occurred in females under 20 years of age. Females in every age stratum, except for those 55 years of age or older, had higher rates of acetaminophen overdose than their male counterparts. In both males and females, incidence rates decreased with increasing age **(Table 3)**.

Over the entire surveillance period, almost half (48.7%) of all acetaminophen overdose cases were classified as intentional. The overall proportion of intentional overdoses declined about 30% during the period from 2006 to 2016 (52.8% and 37.0%, respectively) **(Table 4)**. Over the 10-year surveillance period, a relatively low proportion of acetaminophen overdoses (7.5%) had concurrent diagnostic codes indicating that the overdose was accidental or of undetermined intent. A substantial proportion (43.8%) of acetaminophen overdoses had no causal diagnostic codes that would allow for categorization of the overdose as intentional or accidental. During the surveillance period, the proportion of these "unclassifiable" overdoses ranged from 40.9% in 2006 to 58.0% in 2015 **(Table 4)**.

During 2006–2015, the most frequent hepatotoxic diagnosis received any time after an initial (first time) acetaminophen overdose was toxic hepatitis (n=81, 3.3%), followed by hepatic necrosis (n=60, 2.5%) **(Table 5)**.

EDITORIAL COMMENT

During 2006–2015, active component military members were hospitalized or treated in theater for acetaminophen overdose more than 2,500 times. Rates of overdose were higher among females, members of the Army, and service members younger than 25 years of age.

This report demonstrates that rates of acetaminophen overdoses have been declining in active component military members since 2008. This finding mirrors that of a recently published summary of civilian trends in rates of acetaminophen-related adverse events in the U.S. that reported declining rates of hospitalization for acetaminophen-related poisoning since 2009.[4] These declines come after significant media attention was generated about the risks of acetaminophen overdoses and the risk of concomitant liver damage. Subsequently, the U.S. Food and Drug Administration has adopted changes in the dosing and labeling of acetaminophen products in the U.S., including labeling requirements warning of the risk of severe liver injury.[8] In addition, several education programs were established to increase consumer awareness regarding the safe use of acetaminophen, such as the "Know Your Dose" campaign launched in 2010 by the Acetaminophen Awareness Coalition.[9]

The rates of acetaminophen overdose in this report differ substantially from the prevalence rates reported in the analysis by Taylor et al. In the Taylor et al. report, the overall period prevalence of acetaminophen overdose for active duty females and males was reported as 14.4 and 3.9 per 10,000 people, respectively. This is higher than the overall rates reported here. There were several differences in the methodology of the two analyses that could partially account for these differences. The denominator for this report was person time, rather than number of service members. The underlying surveillance period for the Taylor et al. report was 5 years while the current report covers a 10-year surveillance period. The current analysis focused specifically on active component service members rather than active duty as reported by Taylor et al. (which presumably includes activated reservists and guard members). The underlying data sources were different and the current study also included acetaminophen overdoses that occurred in theater, but such overdoses were not included in the Taylor et al. study. There were undoubtedly other methodologic differences between the two studies that also contribute to the disparity in estimates. However, it is noteworthy that many findings of the two reports are similar. Among these are that females had higher rates of overdose than males; that overdose rates were higher in service members who were less than 25 years of age, compared to their older counterparts; and that the Army had higher overall rates of acetaminophen overdose, compared to other Services.

TABLE 4. Intentionality of acetaminophen overdose, active component, U.S. Armed Forces, 2006–2015

	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		Total 2006–2015	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total acetaminophen overdoses	303	100.0	368	100.0	367	100.0	326	100.0	286	100.0	260	100.0	190	100.0	172	100.0	154	100.0	162	100.0	2,588	100.0
Intentional or self-inflicted	160	52.8	170	46.2	190	51.8	164	50.3	141	49.3	126	48.5	102	53.7	78	45.3	70	45.5	60	37.0	1,261	48.7
Accidental	19	6.3	26	7.1	25	6.8	30	9.2	23	8.0	20	7.7	16	8.4	12	7.0	14	9.1	8	4.9	193	7.5
Unclassified	124	40.9	172	46.7	152	41.4	132	40.5	122	42.7	114	43.8	72	37.9	82	47.7	70	45.5	94	58.0	1,134	43.8

TABLE 5. Number and proportion of acetaminophen overdose cases with a subsequent diagnosis indicating liver problems, active component, U.S. Armed Forces, 2006–2015

	Total	
	No.	%
Total acetaminophen overdoses	2,437	100.0
Hepatic necrosis	60	2.5
Toxic hepatitis	81	3.3
Hepatic encephalopathy	16	0.7
Jaundice	30	1.2
Hepatorenal syndrome	4	0.2

There are several limitations to consider when interpreting the results of this report. As with any analysis relying on administrative data, the numbers, rates, and trends of acetaminophen overdoses relied on identification of the event through ICD-9 and ICD-10 diagnostic codes that are subject to miscoding. In addition, more than 40% of overdoses could not be classified as intentional or accidental due to the absence of causal coding in the hospital or theater medical records.

In summary, this report provides encouraging evidence that the rate of acetaminophen overdose in the active component force has been declining, and that a relatively small percentage of overdose cases receive diagnoses indicating subsequent hepatotoxicity. However, continued surveillance is warranted to confirm these trends.

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