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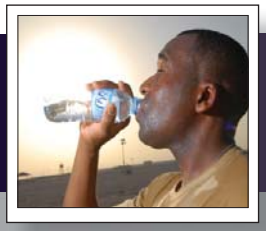

MEDICAL SURVEILLANCE MONTHLY REPORT

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Motorcycle and Other Motor Vehicle Accident-related Deaths, U.S. Armed Forces, 1999-2010

Motor vehicle accidents (MVA) are the leading cause of deaths of U.S. military members during peacetime. During the four years prior to operations in Iraq and Afghanistan, one-third of all deaths of service members were caused by MVAs. Since the beginning of those operations, there have been nearly as many deaths of service members due to "transportation accidents" as war-related injuries.[1]

Many military members are young, single, male, and high-school educated; these characteristics are associated with increased risk of dying in motor vehicle crashes.[2,3] Compared to their older counterparts, young military members have less driving experience and are more likely to take risks while driving (e.g., no seatbelts, under the influence of alcohol).[3] In addition, because military service is inherently dangerous, and because all U.S. military members are volunteers, they may be more willing than their civilian counterparts to take risks or overlook dangers while driving or riding in motor vehicles.

Motorcycles are used for transportation and recreation by many U.S. military members. The National Highway Traffic Safety Administration (NHTSA) recently estimated that motorcyclists are 37 times more likely than passenger car occupants to die in road accidents.[4] Previous MSMR reports have documented recent sharp increases in motorcycle accidents and associated deaths among U.S. service members.[5-7]

This report updates previous summaries of numbers, rates, trends and correlates of risk of motor vehicle accident-related fatalities among service members since 1999. The report also describes military and demographic characteristics of service members who died in motorcycle and other motor vehicle accidents.

Table 1. Motor vehicle deaths by "underlying cause of death" category, U.S. military members, active and reserve components, 1999-2010

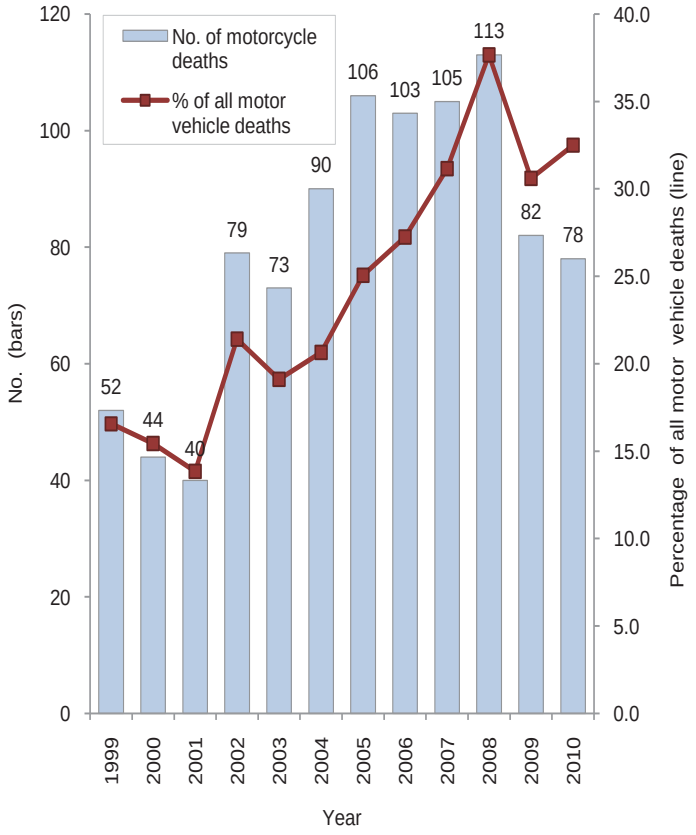
Underlying cause of death	Total service members	
	No.	%
Motorcycle-related accidents		
Motorcyclist involved in any accident except collision with railway train	965	24.0
Subtotal	965	24.0
"Other" motor vehicle-related accidents		
Other and unspecified motor vehicle accidents	760	18.9
Occupant of car pickup truck or van in collision with other motor vehicle	613	15.2
Occupant of motor vehicle in collision with non-motorized vehicle, pedestrian, fixed object	536	13.3
Occupant of motor vehicle in noncollision accident	476	11.8
Occupant of special-use motor vehicle in any accident (include military vehicle)	415	10.3
Pedestrian in collision with motor vehicle	225	5.6
Pedal cyclist in collision with motor vehicle	17	0.4
Other motor vehicle accident involving collision with railway train	9	0.2
Occupant of heavy transport vehicle or bus in collision with other motor vehicle	5	0.1
Subtotal	3,056	76.0
Total	**4,021**	**100.0**

Methods:

The surveillance period was 1 January 1999 to 31 December 2010. The surveillance population included all individuals who served on active duty as a member of the active or Reserve component of the Army, Navy, Air Force, or Marine Corps any time during the surveillance period.

Motor vehicle accident (MVA)-related deaths of service members on active duty were ascertained from records maintained in the DoD Medical Mortality Registry of the Armed Forces Medical Examiner System and routinely

Figure 1. Number of motorcycle-related deaths and percentage of all motor vehicle deaths attributable to motorcycle accidents, active and reserve components, U.S. Armed Forces, by calendar year, 1999-2010



provided to the Armed Forces Health Surveillance Center for integration in the Defense Medical Surveillance System (DMSS). For this analysis, an MVA-related death was defined by a casualty record with an "underlying cause of death" code corresponding to one of ten different types of collision and non-collision motor vehicle accidents **(Table 1).** Motor vehicle-related deaths that were considered "intentional" (i.e., suicide, homicide, war-related) were excluded.

Summary measures were numbers and rates of MVA-related deaths in the surveillance population overall. Mortality rates were calculated as MVA-related deaths per 100,000 person-years of active military service during various periods of interest. Mortality rates were summarized using person-years at risk (rather than individuals at risk) because the U.S. military is a dynamic cohort — each day, many individuals enter and many others leave active service. Thus, in a given year, there are more individuals who serve on active duty than total person-years of active service; the latter was considered a more consistent measure of cumulative exposure to mortality risk among service members on active duty. Mortality rates were estimated only for the active component because the start and end dates of all active duty service periods of reserve component members were not available.

Results:

From 1999 through 2010, 4,021 service members died from motor vehicle accidents while on active duty; nearly one-fourth (n=965; 24%) of all MVA-related deaths were due to motorcycle accidents **(Table 1).** Over the period, the proportion of all MVA-related deaths that were due to motorcycle accidents increased from 14 percent (n=40) in 2001 to 38 percent (n=113) in 2008 and then declined to 33 percent (n=78) by 2010 **(Figure 1).**

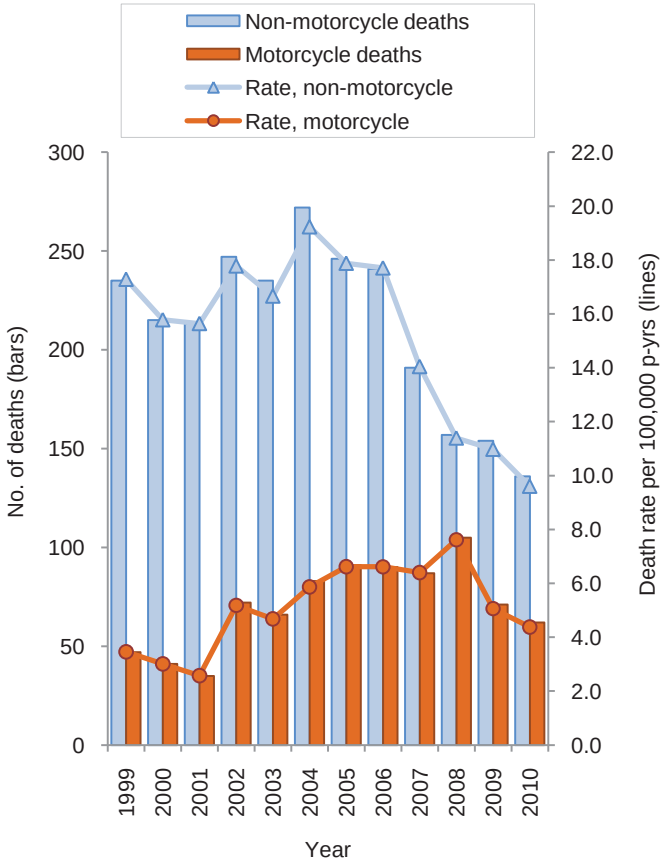
Non-motorcycle ("other") MVA-related deaths with specified causes affected occupants of vehicles involved in collisions (n=1,149; 29%) and noncollision accidents (e.g., rollovers, fires, loss of control) (n=476; 12%); occupants of

Table 2. Demographic and military characteristics of individuals who died in motorcycle accidents vs. other motor vehicle-related accidents, active component, U.S. Armed Forces, 1999-2010

	Non-motorcycle ("other") MVA-related deaths			Motorcycle-related deaths			Total MVA-related deaths			Ratio of non-motorcycle ("other") to motorcycle-related deaths
	No.	Rate[a]	Rate ratio	No.	Rate[a]	Rate ratio	No.	Rate[a]	Rate ratio	
Total	2,542	15.3	.	850	5.1	.	3,392	20.4	.	3.0
Service										
Army	1,081	18.0	1.8	301	5.0	1.2	1,382	23.0	1.6	3.6
Navy	504	11.9	1.2	225	5.3	1.3	729	17.2	1.2	2.2
Air Force	406	9.7	Ref[b]	177	4.2	Ref[b]	583	14.0	Ref[b]	2.3
Marine Corps	551	25.3	2.6	147	6.7	1.6	698	32.0	2.3	3.7
Sex										
Male	2,341	16.5	2.0	832	5.9	7.9	3,172	22.4	2.5	2.8
Female	201	8.3	Ref[b]	18	0.7	Ref[b]	219	9.1	Ref[b]	11.2
Race ethnicity										
White, non-Hispanic	1,662	15.9	1.3	564	5.4	1.9	2,226	21.3	1.4	2.9
Black, non-Hispanic	499	16.6	1.4	198	6.6	2.4	697	23.2	1.6	2.5
Other	381	12.0	Ref[b]	88	2.8	Ref[b]	469	14.8	Ref[b]	4.3
Age group										
<20	376	29.6	5.8	38	3.0	0.9	414	32.6	3.9	9.9
20-24	1,315	23.8	4.7	336	6.1	1.9	1,651	29.9	3.6	3.9
25-29	438	12.4	2.4	209	5.9	1.8	647	18.3	2.2	2.1
30-39	327	7.2	1.4	212	4.6	1.4	538	11.8	1.4	1.5
40+	86	5.1	Ref[b]	55	3.2	Ref[b]	141	8.3	Ref[b]	1.6
Military occupation										
Combat	731	21.6	2.3	205	6.1	2.4	936	27.6	2.3	3.6
Health care	131	9.4	Ref[b]	35	2.5	Ref[b]	166	11.9	Ref[b]	3.7
Admin/supply	554	14.2	1.5	145	3.7	1.5	699	17.9	1.5	3.8
Other	1,126	14.2	1.0	465	5.9	1.6	1,591	20.1	1.1	2.4

[a]Rates are expressed as deaths per 100,000 person-years of active military service
[b]Ref indicates the subgroup-specific rate that is the referent for rate ratio calculations

Figure 2. Motor vehicle deaths, by year and underlying cause (motorcycle vs. non-motorcycle accidents), active component, U.S. Armed Forces, 1999-2010



special-use (including military) vehicles (n=415, 10%); and pedestrians (n=225, 6%) and bicyclists (n=17, <1%) who were hit by motor vehicles **(Table 1).**

Of all military members who died in MVAs during the period, 84 percent (n=3,373) were in the active component. Among them, on average, there were 71 motorcycle and 212 non-motorcycle ("other") MVA-related deaths each year. However, during the period, annual numbers of motorcycle-related deaths varied by threefold (from 35 in 2001 to 105 in 2008), and numbers of other MVA-related deaths varied by twofold (from 136 in 2010 to 272 in 2004) **(Figure 2).**

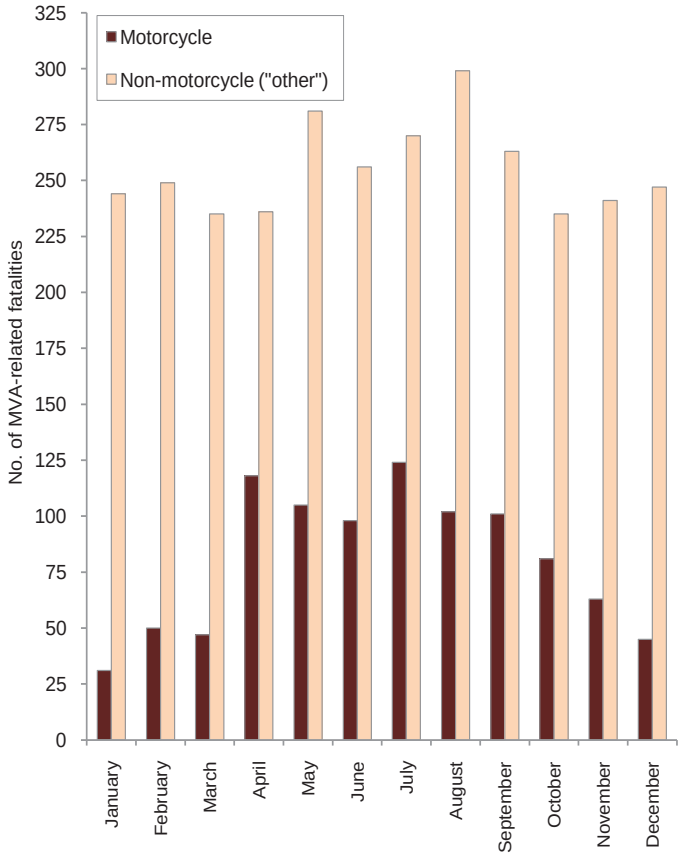
Annual rates of non-motorcycle-related fatal MVAs declined steadily from 2004 (19.2 per 100,000 p-yrs) through 2010 (9.6 per 100,000 p-yrs); the rate in 2010 was the lowest of any year of the surveillance period. In contrast, annual rates of fatal motorcycle accidents approximately tripled between 2001 (2.6 per 100,000 p-yrs) and 2008 (7.6 per 100,000 p-yrs) and then declined sharply in 2009 and 2010; the rate in 2010 (4.4 per 100,000 p-yrs) was lower than in any year since 2001 **(Figure 2).**

Among active component members overall, the crude rate of MVA-related fatalities (all causes) was 20.4 per 100,000 person-years (p-yrs); the overall rate of motorcycle-related fatalities (5.1 per 100,000 p-yrs) was one-third the rate of other MVA-related fatalities (15.3 per 100,000 p-yrs) **(Table 2).**

Among military and demographic subgroups of active component members, the highest motorcycle-related fatality rates (unadjusted) affected service members who were in the Marine Corps (6.7 per 100,000 p-yrs), black, non-Hispanic (6.6 per 100,000 p-yrs), in combat-specific occupations (6.1 per 100,000 p-yrs), and 20-24 years old (6.1 per 100,000 p-yrs) **(Table 2).** Rates of other MVA-related deaths were highest among those younger than 20 years (29.6 per 100,000 p-yrs), in the Marine Corps (25.3 per 100,000 p-yrs), and in combat-specific occupations (21.6 per 100,000 p-yrs). Rates of other MVA-related deaths (and MVA-related deaths overall) sharply declined with increasing age; in contrast, rates of motorcycle-related deaths were higher among service members in their twenties than those younger or older. Of note, compared to females, males were eight times more likely to die from motorcycle-related injuries, but only twice as likely to die from non-motorcycle-related MVAs **(Table 2).**

Females and teenaged service members were approximately ten times more likely to die from non-motorcycle than motorcycle-related injuries (ratio, non-motorcycle-to-motorcycle-related deaths: females, 11.2; <20 year olds: 9.9). In contrast, service members older than 30 years were only approximately 55 percent more likely to die from non-motorcycle than motorcycle-related injuries (ratio,

Figure 3. Number of fatal motorcycle and non-motorcycle-related accidents, by calendar month, active and reserve component service members on active duty, U.S. Armed Forces, 1999-2010



non-motorcycle-to-motorcycle-related deaths: 30-39 years old, 1.5; >40 years olds: 1.6) **(Table 2)**.

During the 12-year period, there was distinct seasonality in the incidence of fatal motorcycle but not other motor vehicle accidents. For example, there was a four-fold difference between the months with the most and least motorcycle-related deaths (July, n=124; January, n=31); however, there was only a 27 percent difference between the months with the most and least non-motorcycle-related deaths (August, n=299; March, October, n=235). Also, more than two-thirds (67%) of all motorcycle-related fatalities, but only approximately one-half (53%) of all other MVA-related fatalities, occurred during the six months between April and September **(Figure 3)**.

Of all service members who died from MVAs during the period, approximately one-half (49%) of motorcyclists and one-third (33%) of all others had documented medical encounters (e.g., hospitalizations, emergency department visits) within 7 days prior to their deaths. Injuries of the head and of "multiple sites" were the most frequent diagnoses among both motorcyclists and non-motorcyclists who ultimately died from their injuries **(data not shown)**.

Editorial comment:

This report reiterates the importance of motor vehicle accidents as a significant cause of deaths of U.S. service members. On average, during each year of the 12-year surveillance period, 80 service members died from motorcycle accidents and 255 died from other motor vehicle accidents (active and reserve component members combined). Of note, however, in 2010, there were fewer motorcycle-related deaths (n=78) than in any year since 2001 and fewer other MVA-related deaths (n=162) than in any other year of the period.

This report documents important differences in temporal and epidemiologic characteristics of fatal motorcycle accidents and other MVAs. For example, from 2002 through 2008, rates of fatal motorcycle accidents increased while rates of other MVA-related deaths declined. Fatal motorcycle accidents are much more frequent in warm weather months; in contrast, there is not distinct seasonality in the incidence of non-motorcycle-related fatal accidents. Compared to their female counterparts, males are eight times more likely to die from motorcycle-related injuries but only twice as likely to die from other MVAs. Rates of fatal non-motorcycle-related accidents sharply decline with increasing age; in contrast, rates of motorcycle-related fatalities are highest among service members in their twenties.

The sharp differences in temporal relationships and correlates of risk between fatal motorcycle and other MVAs suggest that preventive interventions should be tailored to each specifically. For example, the sharp increases in motorcycle-related deaths prior to 2008 were noted and aggressively countered by the Services. Service and local safety centers highlighted vehicle safety in publications, messages, and educational and training materials; installations required training and proficiency testing before issuing permits for on-post motorcycle use; some installations provided controlled, supervised venues for high performance uses of motorcycle; and so on. The sharp declines in motorcycle-related fatalities in 2009 and 2010 are likely due at least in part to such efforts. The effects of preventive interventions should be tracked, and the most effective should be identified and documented to enable broader implementation.

Finally, there are limitations to this analysis that should be considered when interpreting the results. For example, at the time of the analysis, final determinations of underlying causes were pending for approximately 4 percent of all deaths in 2010. Hence, numbers and rates of MVA-related deaths in 2010 may be slightly underestimated in this report. Also, this analysis did not account for the deaths of service members who were on active duty at the times of ultimately fatal MVAs but not when they died of the resulting injuries (e.g., post-medical disability retirement). Also, the analysis did not account for fatal MVAs among reserve component members who were not on active duty at the times of their accidents. Because such deaths were not included, the mortality impact of motor vehicle accidents on the total U.S. Armed Forces is underestimated in this report.

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Update: Heat Injuries, Active Component, U.S. Armed Forces, 2010

Heat-related injuries are significant threats to the health and operational effectiveness of military members and their units.[1,2] Operational lessons learned and findings of numerous research studies have resulted in doctrine, equipment, and methods that can significantly reduce the adverse effects of military activities in heat.[1-3] Although numerous and effective countermeasures are available, physical exertion in hot environments still causes many hundreds of injuries — some life threatening — among U.S. military members each year.[4,5]

In the U.S. Military Health System, the most serious of heat-related injuries are considered notifiable medical events. Since 31 July 2009, a notifiable case of "heat stroke" (ICD-9-CM: 992.0) has been defined as a "severe heat stress injury, specifically including injury to the central nervous system, characterized by central nervous system dysfunction and often accompanied by heat injury to other organs and tissue." Notifiable cases of heat injuries other than heat stroke ("unspecified effects of heat" [ICD-9-CM: 992.9]) include "moderate to severe heat injuries associated with strenuous exercise and environmental heat stress" … "that require medical intervention or result in lost duty time." All heat injuries that require medical intervention or result in lost duty are reportable. Cases of "heat exhaustion" (ICD-9-CM: 992.3-992.5) that do not require medical intervention or result in lost duty time are not reportable.

This report summarizes heat injury-related hospitalizations, ambulatory visits and reportable medical events among members of active components during 2010 and compares them to recent prior years. Episodes of "heat stroke" and "other heat injuries" are summarized separately; for this analysis, "other heat injuries" includes "heat exhaustion" (which was reportable prior to 31 July 2009) and "unspecified effects of heat" (reportable since 31 July 2009).

Table 1. Incident cases and incidence rates[a] of heat injury, active component, U.S. Armed Forces, 2010

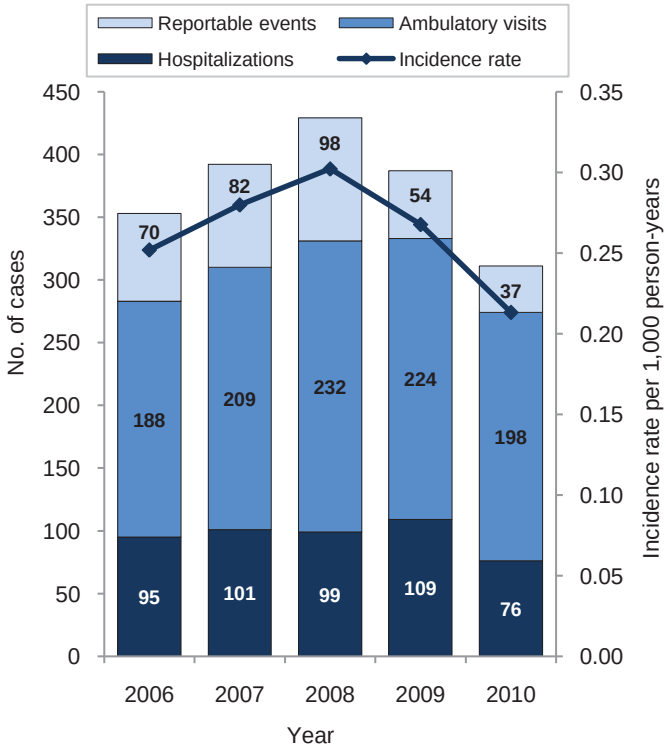
	Heat stroke ICD-9-CM: 992.0		Other heat injury 992.3-5,992.9	
	No.	Rate[a]	No.	Rate[a]
Total	311	0.21	2,576	1.77
Sex				
Male	285	0.23	2,091	1.67
Female	26	0.12	485	2.32
Age group				
< 20	27	0.31	515	5.86
20-24	129	0.27	1,112	2.30
25-29	84	0.24	508	1.44
30-34	37	0.17	232	1.08
35-39	13	0.08	117	0.69
40+	21	0.14	92	0.61
Race/ethnicity				
White, non-Hispanic	199	0.22	1,658	1.80
Black, non-Hispanic	55	0.24	470	2.01
Other	57	0.19	448	1.49
Service				
Army	207	0.37	1,527	2.73
Navy	15	0.05	173	0.53
Air Force	19	0.06	280	0.85
Marine Corps	67	0.33	564	2.79
Coast Guard	3	0.07	32	0.76
Military status				
Enlisted	261	0.21	2,386	1.96
Officer	50	0.21	190	0.79
Military occupation				
Combat	112	0.39	705	2.43
Health care	24	0.20	146	1.20
Other	175	0.17	1,725	1.65

[a]Rate per 1,000 person-years

Methods:

The surveillance period was 1 January 2006 through 31 December 2010. The surveillance population included all individuals who served in the active component of the Army, Navy, Air Force, Marine Corps or Coast Guard at any time during the surveillance period. The Defense Medical Surveillance System (DMSS) was searched to identify all records of medical encounters and notifiable medical event reports that included primary (first-listed) or secondary (second listed) diagnoses of "heat stroke" (ICD-9-CM:992.0) or "other

Figure 1. Incident cases and incidence rates of "heat stroke", by source of report and year of diagnosis, active component, U.S. Armed Forces, 2006-2010



heat injury" ("heat exhaustion" [ICD-9-CM:992.3-992.5] and "unspecified effects of heat" [ICD-9-CM:992.9]).

This report estimates numbers of individuals affected by heat injuries ("incident cases") and "heat injury events" during each calendar year. To estimate numbers of incident cases per year, each individual who was affected by a heat injury event (one or more) during a year accounted for one incident case during the respective year. To classify the severity of incident cases per year, those that were associated with any "heat stroke" diagnosis were classified as "heat stroke" cases; all others were classified as "other heat injury" cases.

To estimate numbers of heat injury events per year, affected individuals could account for multiple events during years. To discriminate follow-up encounters from new heat injury events, affected service members were not considered at risk of a "new" heat injury event within 60 days of a prior event. Annual numbers of "heat stroke" and "other heat injury"-related events were estimated separately. To categorize the clinical management of heat injury events, those that were documented with hospitalization records were classified as hospitalization cases; among the others, those documented with reportable event records were prioritized over those documented by ambulatory records only.

Results:

In 2010, there were 311 incident cases of "heat stroke" and 2,576 incident cases of "other heat injury" among active component members. Overall crude incidence rates of "heat stroke" and other heat injury were 0.21 and 1.77 per 1,000 person-years (p-yrs), respectively **(Table 1).**

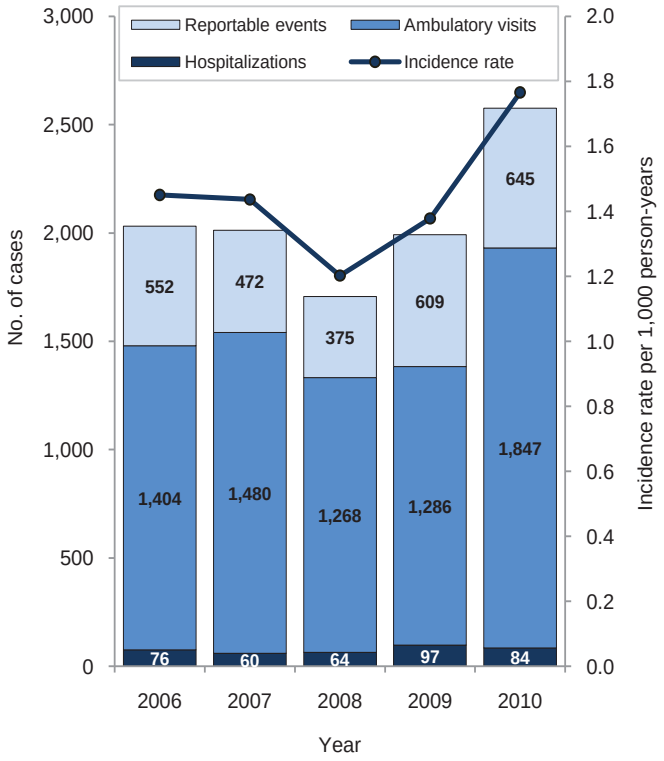
In 2010, the incidence rate (unadjusted) of heat stroke was lower than in any prior year of the period; in addition, there were fewer heat stroke-related hospitalizations, ambulatory visits, and notifiable medical event reports in 2010 than in any prior year **(Figure 1).** The recent sharp decline in heat stroke-related notifiable event reports may reflect at least in part the 2009 revision of the clinical definition of a notifiable case of heat stroke **(Figure 1).**

Table 2. Heat injury events[a] by location of diagnosis/report, active component, U.S. Armed Forces, 2006-2010

Medical facility location	No.	% of total
Fort Bragg, NC	2,167	15.5
Fort Benning, GA	1,434	10.2
Parris Island/Beaufort, SC	893	6.4
Camp Lejeune/Cherry Point, NC	628	4.5
Fort Polk, LA	592	4.2
Fort Jackson, SC	542	3.9
Fort Campbell, KY	406	2.9
Fort Hood, TX	315	2.2
Fort Stewart, GA	301	2.1
Fort Sill, OK	301	2.1
Camp Pendleton, CA	295	2.1
NMC San Diego, CA	246	1.8
Okinawa, Japan	239	1.7
MCB Quantico, VA	236	1.7
All other locations	5,423	38.7
Total	14,018	100.0

[a]One heat injury per person per 60 days

Figure 2. Incidence cases and incidence rates of "other heat injury", by source of report and year of diagnosis, active component, U.S. Armed Forces, 2006-2010



The overall incidence rate (unadjusted) of "other heat injury" was higher in 2010 than in any prior year of the period; of particular note, the rate was approximately 48 percent higher in 2010 than 2008. There were more "other heat injury"-related ambulatory visits and notifiable medical event reports in 2010 than in any prior year; however, there were fewer hospitalizations for "other heat injuries" in 2010 than 2009 **(Figure 2).**

In 2010, crude subgroup-specific incidence rates of heat stroke were highest among service members in combat-specific occupations (0.39 per 1,000 p-yrs), in the Army (0.37 per 1,000 p-yrs) and Marine Corps (0.33 per 1,000 p-yrs), and among those younger than 20 years old (0.31 per 1,000 p-yrs). Heat stroke rates were approximately four-fold higher among members of the Army and Marine Corps, and almost twice as high among males and those in combat-specific occupations, compared to their respective counterparts. Of note, crude rates of heat stroke were similar among officers and enlisted members and across race/ethnicity-defined subgroups **(Table 1).**

In 2010, crude subgroup-specific incidence rates of "other heat injuries" were highest among service members younger than 20 years old (5.86 per 1,000 p-yrs), in the Marine Corps and Army (2.79 and 2.73 per 1,000 p-yrs respectively), and

in combat-specific occupations (2.43 per 1,000 p-yrs). In contrast to heat stroke trends, the crude incidence rate of "other heat injuries" was higher among females than males and more than twice as high among enlisted members than officers **(Table 1)**.

In 2010, 381 heat stroke events affected 304 individuals (average number of heat stroke events per affected individual: 1.25); 59 individuals experienced more than one heat stroke event during the year. The number of service members affected by more than one heat stroke event in 2010 was lower than the average per year (n=92) during the prior years of the period. Also, in 2010, 2,783 "other heat injury" events affected 2,725 individuals (average number of other heat injury events per affected individual: 1.02); 56 individuals experienced more than one "other heat injury" event during the year. The number of service members affected by more than one "other heat injury" event in 2010 was lower than the average per year (n=70) during the prior years of the period **(data not shown)**.

During the five-year surveillance period, heat-related injuries were diagnosed at more than 200 military installations/geographic locations worldwide. However, two Army installations accounted for more than one-fourth of all heat injury events during the period (Fort Bragg, NC [n=2,167], Fort Benning, GA [n=1,434]); and four other installations accounted for more than 500 heat injury events each (Parris Island/Beaufort, SC [n=893], MCB Camp Lejeune/Cherry Point, NC [n=628], Fort Polk, LA [n=592], Fort Jackson, SC [n=542]). Of the nine installations with the most heat injury events, eight are in the southeastern United States **(Table 2)**.

Editorial comment:

From 2008 through 2010, rates of heat stroke declined, but rates of other clinically significant heat-related injuries increased. Of note, in 2010, there were fewer hospitalizations for heat stroke than in the past four years and fewer hospitalizations for other heat injuries than in 2009.

The results of this update should be interpreted with consideration of its limitations. For example, clinical criteria for mandatory reporting of heat-related injuries as "heat stroke" or "other heat injury" cases changed in 2009. Since that time, central nervous system dysfunction must be present for a heat casualty to qualify as a case of heat stroke. Prior to the 2009 change, cases of heat stroke did not necessarily exhibit nervous system dysfunction; the diagnosis was also applicable to patients with laboratory evidence of injury to the liver, muscles, or kidneys. The change likely affected the numbers and natures of heat injury-related notifiable medical event reports in 2009 and 2010. In addition, similar heat-related clinical illnesses are likely managed differently and reported with different diagnostic codes at different locations and in different clinical settings. Such differences undermine the validity of direct comparisons of rates of nominal heat stroke and "other heat injury" events across locations and settings. Also, this update is based on records of medical encounters at fixed (e.g., not deployed or at sea) medical facilities. As a result, heat injuries during training exercises and deployments that are treated in field/deployed medical facilities are not ascertained as cases for this report.

In spite of its limitations, this report reiterates that heat injuries are a significant threat to the health of U.S. military members and the effectiveness of military operations. Of all military members, the youngest and most inexperienced Marines and soldiers (particularly those training at installations in the southeastern United States) are at highest risk of heat injuries — including heat stroke, exertional hyponatremia, and exertional rhabdomyolysis.

Commanders, small unit leaders, training cadre, and supporting medical personnel, particularly at recruit training centers and installations with large combat troop populations, must ensure that military members whom they supervise and support are informed regarding risks, preventive countermeasures (e.g., water consumption), early signs and symptoms, and first responder actions related to heat injuries.[1-3] Leaders should be aware of the dangers of insufficient hydration on the one hand and excessive water intake on the other; they must have detailed knowledge of, and rigidly enforce countermeasures against, all types of heat injuries.

Policies, guidance, and other information related to heat injury prevention and treatment among U.S. military members are available on-line at: http://chppm-www.apgea.army.mil/heat/#PM and http://www.marines.mil/news/publications/Documents/MCO%206200.1E%20W%20CH%201.pdf.

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Update: Exertional Rhabdomyolysis, Active Component, U.S. Armed Forces, 2010

Rhabdomyolysis is the breakdown of striated muscle cells with release into the bloodstream of their potentially toxic contents. In U.S. military members, rhabdomyolysis is a significant threat during physical exertion, particularly under heat stress. Each year, the MSMR summarizes numbers, rates, trends, risk factors and locations of occurrences of exertional heat injuries, including exertional rhabdomyolysis. Information regarding the definition, causes and prevention of exertional rhabdomyolysis can be found in previous issues of the MSMR.[1]

Methods:

The surveillance period was 1 January 2006 to 31 December 2010. The surveillance population included all individuals who served in an active component of the U.S. Armed Forces any time during the surveillance period. For surveillance purposes, a case of "exertional rhabdomyolysis" was defined as a hospitalization or ambulatory visit with a discharge diagnosis in any position of ICD-9-CM: 728.88 "rhabdomyolysis" and/or ICD-9-CM: 791.3 "myoglobinuria"; plus a diagnosis in any position of ICD-9-CM: 276.5 "volume depletion (dehydration)" and/or ICD-9-CM: 992.0-992.9 "effects of heat" and/or ICD-9-CM: 994.3-994.5 "effects of thirst (deprivation of water)," "exhaustion due to exposure," and "exhaustion due to excessive exertion (overexertion)." Each individual could be included as a case only once per calendar year.

To exclude cases of rhabdomyolysis that were secondary to traumatic injuries, intoxications, or adverse drug reactions, medical encounters with diagnoses in any position of ICD-9-CM: 800-999 "injury, poisoning, toxic effects" (except ICD-9-CM: 992.0-992.9, 994.3-994.5, and 840-848 "sprains and strains of joints and adjacent muscles") were excluded from consideration as "exertional rhabdomyolysis" case defining encounters.

Table 1. Incident diagnoses and incidence rates[a] of exertional rhabdomyolsis, active component, U.S. Armed Forces, 2010

	Hospitalized		Ambulatory		Total	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	142	9.7	216	14.8	358	24.5
Service						
Army	65	11.6	117	20.9	182	32.5
Navy	16	4.9	25	7.7	41	12.7
Air Force	28	8.5	18	5.4	46	13.9
Marine Corps	33	16.3	53	26.2	86	42.5
Coast Guard	0	0.0	3	7.2	3	7.2
Sex						
Male	134	10.7	196	15.7	330	26.4
Female	8	3.8	20	9.6	28	13.4
Race/ethnicity						
White, non-Hispanic	74	8.0	108	11.7	182	19.7
Black, non-Hispanic	43	18.4	67	28.7	110	47.1
Other	25	8.3	41	13.6	66	21.9
Age						
<20	11	13.0	39	46.1	50	59.1
20-24	54	11.4	79	16.6	133	28.0
25-29	34	9.6	51	14.4	85	23.9
30-34	26	12.0	22	10.1	48	22.1
35-39	11	6.5	16	9.4	27	15.9
40+	6	3.8	9	5.8	15	9.6
Rank						
Enlisted	125	10.3	190	15.6	315	25.9
Officer	17	7.0	26	10.7	43	17.8
Military occupation						
Combat	34	11.7	51	17.6	85	29.3
Health care	9	7.4	20	16.5	29	23.9
Other	99	9.5	145	13.9	244	23.3

[a]Rate per 100,000 person-years

Results:

In 2010, there were 358 incident episodes of rhabdomyolysis likely due to physical exertion and/or heat stress ("exertional rhabdomyolysis") **(Table 1)**. The crude incidence rate was 24.5 per 100,000 person-years (p-yrs).

Figure 1. Incident diagnoses of exertional rhabdomyolysis, by type of medical encounter and calendar year, active component, U.S. Armed Forces, 2006-2010

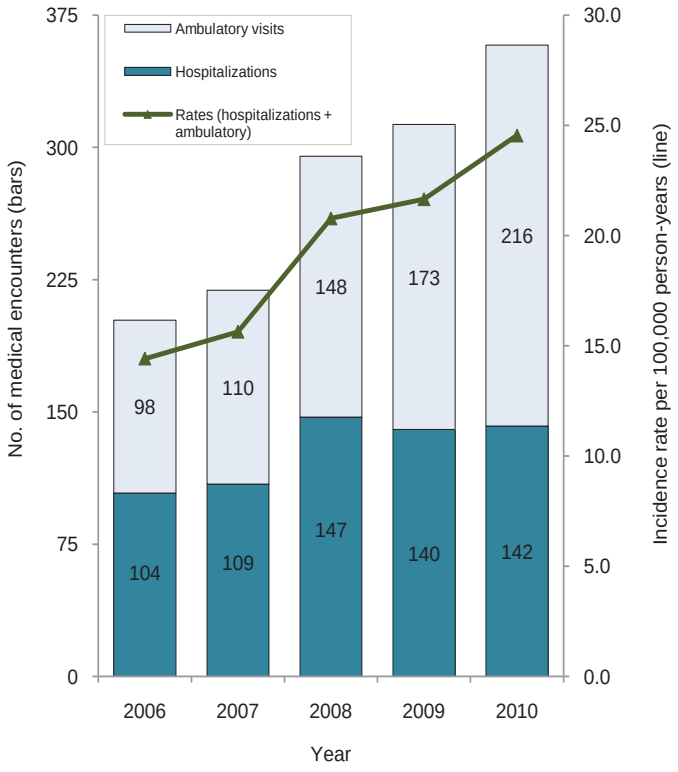
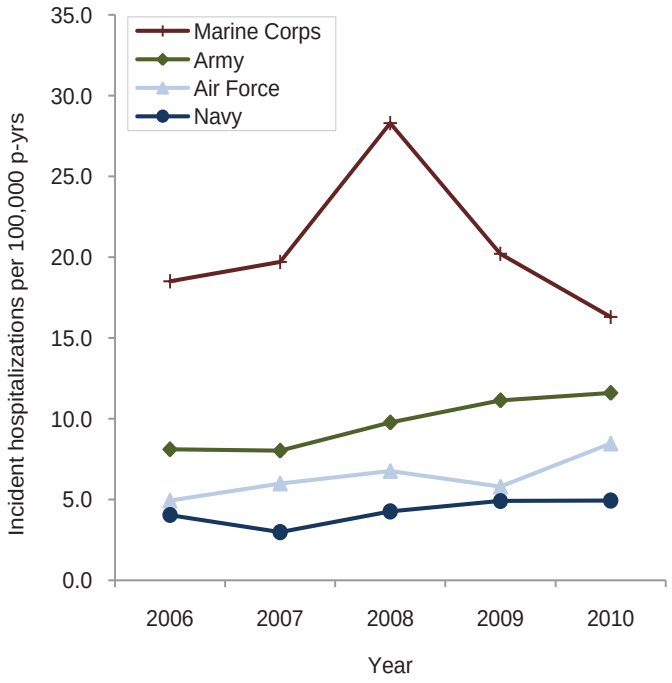


Table 2. Incident cases of exertional rhabdomyolysis, by installation (among installations with at least 20 cases during the period), active component, U.S. Armed Forces, 2006-2010

	Total 2006-2010	
Location of diagnosis	No.	%
Fort Bragg, NC	190	13.7
MCRD Parris Island/Beaufort, SC	158	11.4
Fort Jackson, SC	60	4.3
Camp Pendleton, CA	55	4.0
Lackland AFB, TX	50	3.6
Camp Lejeune/Cherry Pt, NC	43	3.1
Fort Benning, GA	40	2.9
NMC San Diego, CA	34	2.5
Fort Belvoir, VA	28	2.0
Fort Shafter, HI	27	1.9
NMC Portsmouth, VA	27	1.9
Fort Hood, TX	25	1.8
Fort Campbell, KY	24	1.7
Fort Sill, OK	22	1.6
Fort Knox, KY	22	1.6
Fort Polk, LA	20	1.4
NH Jacksonville, FL	20	1.4
Other locations	542	39.1
Total	1,387	100.0

Figure 2. Incidence rates of hospitalization for exertional rhabdomyolysis, by service and calendar year, active component, U.S. Armed Forces, 2006-2010



In 2010, relative to their respective counterparts, the highest incidence rates of exertional rhabdomyolysis were among service members who were in the Marine Corps (42.5 per 100,000 p-yrs) or Army (32.5 per 100,000 p-yrs), younger than 20 years old (59.1 per 100,000 p-yrs), black, non-Hispanic (47.1 per 100,000 p-yrs), enlisted (25.9 per 100,000 p-yrs), and in a combat-specific occupation (29.3 per 100,000 p-yrs) **(Table 1).**

There were more incident diagnoses of exertional rhabdomyolysis in 2010 than in any previous year of the period **(Figure 1).** During the five-year period, the rate of incident diagnoses of exertional rhabdomyolysis increased by 70 percent. From 2008 to 2010, the number of hospitalized cases declined slightly while the number of cases diagnosed in outpatient settings increased; in turn, the ratios of outpatient to hospitalized cases were higher in 2009 and 2010 than in prior years **(Figure 1).**

Approximately 70 percent of all service members hospitalized with exertional rhabdomyolysis in 2010 were in the Army (n=65) or Marine Corps (n=33) **(Table 1).** In 2010, the rate of hospitalized cases continued to generally increase among soldiers but decreased to 2005-2007-like rates among Marines **(Figure 2).**

During the period, the medical treatment facilities at five installations accounted for at least 50 cases each and more than one-third of all cases; of these installations, three support recruit/basic combat training centers (Fort Jackson, SC; Lackland AFB, TX; MCDR Parris Island/Beaufort, SC) and two support large combat troop populations (Fort Bragg, NC; Camp Pendleton, CA) **(Table 2).** The most cases overall (accounting for nearly one-fourth of the total) were reported from Fort Bragg, NC (n=190) and Beaufort, SC (which supports the Marine Corps Recruit Depot Parris Island) (n=158) **(Table 2).**

Editorial comment:

This report documents a continuing increase in incident diagnoses of presumably exertional rhabdomyolysis among active component members of the U.S. military. Most cases are diagnosed at installations that support basic combat/recruit training centers or major Army or Marine Corps combat units. Individuals who suddenly increase overall levels of physical activity and/or increase stress on weight bearing muscles – particularly in high heat and humidity – are at increased risk of exertional rhabdomyolysis. Recruits who are not physically fit when they begin training have relatively high risks of training-related (including exertional heat) injuries, in general.[2] Also, recruits from relatively cool and dry climates may not be acclimated to the high heat and humidity at training camps in mid-late summer.[3] Soldiers and Marines in combat units often conduct rigorous unit physical training, personal fitness training, and field training exercises regardless of weather conditions. It is not surprising, therefore, that recruit camps and installations with large combat units account for most exertional rhabdomyolysis cases.

The findings of this report should be interpreted with consideration of several limitations. For example, because the diagnostic code specific for "rhabdomyolysis" was not added to the International Classification of Diseases, 9th revision, clinical modifications [ICD-9-CM] until 2004, a complete and consistent record of recent experience is not available. The recency of implementation of a specific diagnostic code makes it difficult to determine if the steady increase in diagnoses of "rhabdomyolysis" from 2006 through 2010 reflects increasing awareness and use of the indicator code in standardized reporting, an actual increase in case incidence, or both. Also, the diagnosis of "rhabdomyolysis" does not indicate the cause; hence, it is difficult to discern cases that are "exertional" and/or heat-related from those with other precipitating causes.

The higher rate in black, non-Hispanic service members compared to other racial/ethnic subgroup members may reflect, at least in part, increased risk of exertional rhabdomyolysis among individuals with sickle cell trait.[4,5] Supervisors at all levels should assure that guidelines to prevent heat injuries are enforced for all service members. They should be vigilant for early signs of exertional heat injuries including rhabdomyolysis among all (particularly, black, non-Hispanic) service members.

The measures that are effective at preventing exertional heat injuries in general are also indicated for preventing exertional rhabdomyolysis. Work-rest cycles should be adapted not only to ambient weather conditions but also to the fitness levels of participants in strenuous activities. Of particular note, the strenuous physical activities of overweight and/or previously sedentary new recruits – particularly in hot, humid weather – should increase gradually and be closely monitored. Water intake should comply with current guidelines and be closely supervised. Strenuous activities during relatively cool mornings following days of high heat stress should be particularly closely monitored; in the past, such situations have been associated with increased risk of exertional heat injuries (including rhabdomyolysis).[6] Commanders and supervisors at all levels should be aware of and alert for early signs of exertional heat injuries – including rhabdomyolysis – and should aggressively intervene when dangerous conditions, activities, or suspicious illnesses are detected.

Finally, medical care providers should consider exertional rhabdomyolysis in the differential diagnosis when service members – particularly recruits – present with muscular pain, swelling, and limited range of motion after strenuous physical activity, particularly in hot, humid weather. Brown-colored urine from increased concentrations of myoglobin in urine is a distinctive clinical sign of rhabdomyolysis.

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Correction:

A corrected version of "Sexually transmitted infections, U.S. Armed Forces, 2004-2009" published in the August 2010 MSMR (v17, no. 08) is now available in the MSMR archives at: http://www.afhsc.mil/msmrToc. The previous version inadvertently excluded data that should have been used in the summary. We apologize for any inconvenience this may have caused.

- The Editors

Update: Exertional Hyponatremia, Active Component, U.S. Armed Forces, 1999-2010

Hyponatremia is defined as a low concentration of sodium in the blood (i.e., serum sodium concentration <135 mEq/L); it can have serious and sometimes fatal clinical effects.[1,2] In otherwise healthy, physically active young adults (e.g., long distance runners, military recruits), hyponatremia is often associated with excessive water consumption during prolonged physical exertion ("exertional hyponatremia"), particularly during heat stress.[1-3]

Acute hyponatremia creates an osmotic imbalance between fluids outside and inside of cells. The osmotic gradient causes water to flow from outside to inside the cells of various organs, including the lungs ("pulmonary edema") and brain ("cerebral edema"). Swelling of the brain increases intracranial pressure which can decrease cerebral blood flow and disrupt brain function (e.g., hypotonic encephalopathy, seizures, coma). Without rapid and definitive treatment to relieve increasing intracranial pressure, the brain stem can herniate through the base of the skull which can compromise life sustaining functions controlled by the cardio-respiratory centers of the brain stem.[1-3]

In the summer of 1997, Army training centers reported five hospitalizations of soldiers for hyponatremia secondary to excessive water consumption during military training in hot weather— one case was fatal, and several others required intensive medical care.[4] In April 1998, the U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, Massachusetts, published new guidelines for fluid replacement during military training in heat. The new guidelines were designed to protect service members not only from heat injury but also from hyponatremia due to excessive water consumption. The guidelines limited fluid intake regardless of heat category or work level to no more than 1½ quarts hourly and 12 quarts daily.[5] There were fewer hospitalizations of soldiers for hyponatremia due to excessive water consumption during the year after compared to before implementation of the new guidelines.[5]

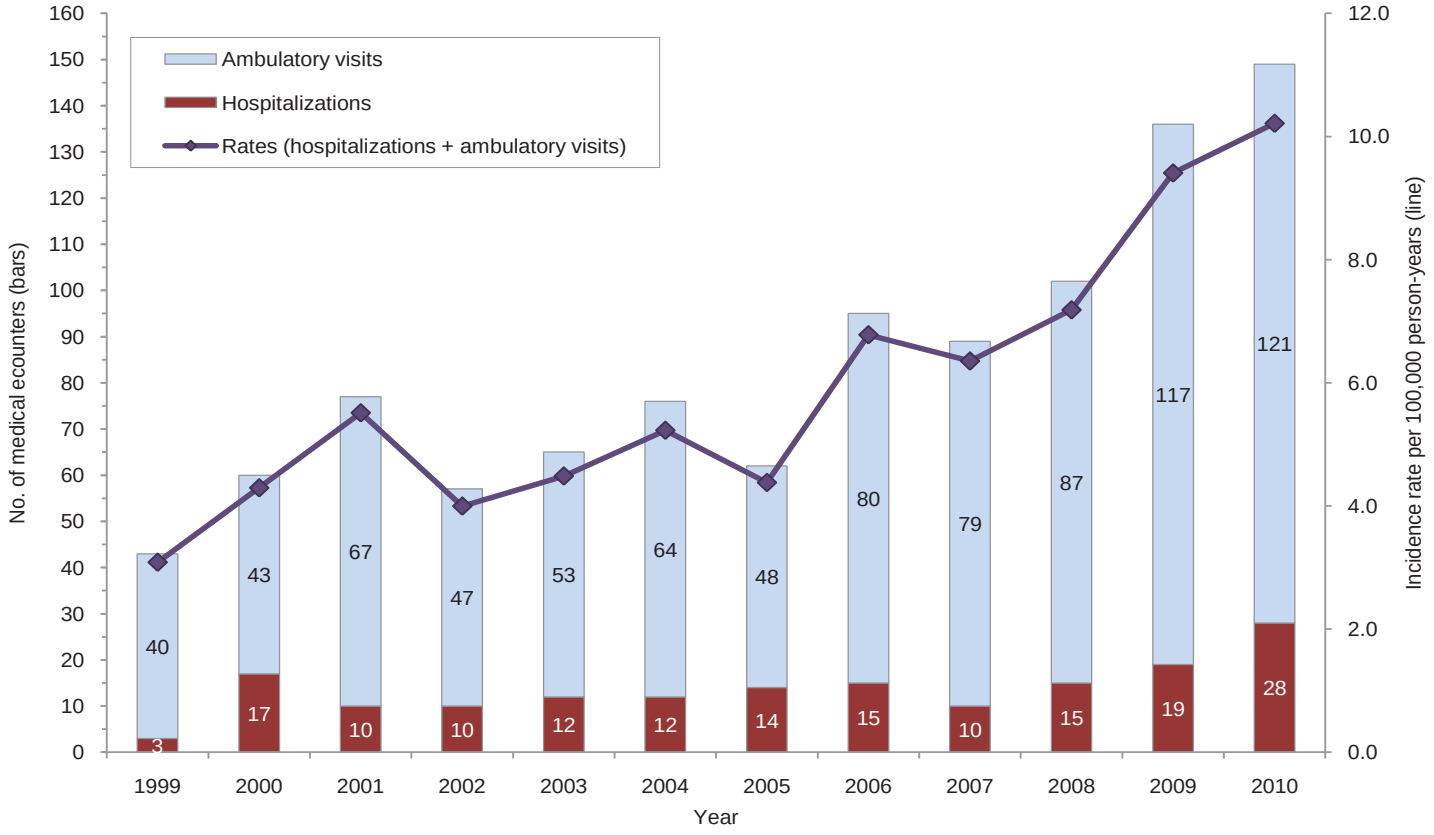
This report uses a surveillance case definition for "exertional hyponatremia" to estimate frequencies, rates, trends, geographic locations, and demographic and military characteristics of exertional hyponatremia cases among U.S. military members from 1999 through 2010.

Table 1. Incident cases and incidence rates[a] of hyponatremia/overhydration, active component, U.S. Armed Forces, January 1999-December 2010

	Total 1999-2010		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		2010	
	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]	No.	Rate[a]
Total	1,011	5.9	43	3.1	60	4.3	77	5.5	57	4.0	65	4.5	76	5.2	62	4.4	95	6.8	89	6.4	102	7.2	136	9.4	149	10.2
Service																										
Army	368	6.1	17	3.6	25	5.3	37	7.8	19	4.0	22	4.5	29	5.9	25	5.1	37	7.5	29	5.7	26	4.9	47	8.6	55	9.8
Navy	137	3.2	4	1.1	7	1.9	5	1.4	12	3.2	13	3.5	13	3.5	7	2.0	17	4.9	12	3.6	15	4.6	17	5.2	15	4.6
Air Force	197	4.7	17	4.8	14	4.0	9	2.6	14	3.9	17	4.6	16	4.3	13	3.7	16	4.6	14	4.2	22	6.8	20	6.1	25	7.6
Marine Corps	295	13.5	5	2.9	11	6.4	26	15.2	12	7.0	13	7.4	17	9.6	17	9.5	23	12.9	32	17.5	37	19.0	50	24.7	52	25.7
Coast Guard	14	3.0	0	0.0	3	8.6	0	0.0	0	0.0	0	0.0	1	2.6	0	0.0	2	5.0	2	4.9	2	4.8	2	4.7	2	4.8
Sex																										
Male	836	5.7	31	2.6	48	4.0	58	4.9	45	3.7	51	4.1	62	5.0	51	4.2	84	7.0	68	5.7	89	7.3	116	9.4	133	10.6
Female	175	7.1	12	6.1	12	6.0	19	9.3	12	5.7	14	6.5	14	6.5	11	5.3	11	5.4	21	10.5	13	6.5	20	9.7	16	7.7
Race/ethnicity																										
White, non-Hispanic	698	6.5	26	3.0	39	4.4	51	5.8	37	4.1	44	4.8	57	6.2	40	4.5	69	7.8	65	7.3	75	8.3	95	10.3	100	10.8
Black, non-Hispanic	130	4.3	3	1.1	8	2.9	11	4.0	10	3.7	12	4.5	5	1.9	12	4.9	12	5.1	12	5.2	10	4.3	14	6.0	21	9.0
Other	183	5.6	14	5.4	13	5.4	15	6.2	10	3.9	9	3.4	14	5.1	10	3.6	14	5.0	12	4.3	17	6.0	27	9.2	28	9.3
Age																										
<20	159	12.3	6	5.1	11	8.8	20	15.8	9	7.3	15	13.0	14	12.5	8	8.1	8	8.4	11	11.3	14	14.0	21	22.2	22	25.0
20-24	329	5.8	11	2.6	17	3.9	18	4.0	18	3.8	16	3.2	26	5.2	20	4.2	31	6.5	42	9.0	34	7.2	45	9.4	51	10.6
25-29	179	4.9	10	3.5	14	5.0	16	5.9	10	3.6	6	2.1	9	3.0	8	2.6	20	6.5	9	2.9	20	6.1	29	8.5	28	7.9
30-34	98	3.9	4	1.8	5	2.3	9	4.3	6	2.9	7	3.4	10	4.8	6	2.9	12	6.0	8	4.0	7	3.5	11	5.3	13	6.0
35-39	107	4.8	8	3.8	4	1.9	6	3.0	7	3.6	9	4.8	8	4.4	9	5.2	10	5.8	7	4.1	9	5.2	14	8.1	16	9.5
40+	139	7.8	4	2.9	9	6.6	8	5.6	7	4.7	12	7.9	9	5.8	11	7.2	14	9.3	12	8.1	18	12.3	16	10.6	19	12.6
Military occupation																										
Combat	222	6.4	10	3.5	21	7.5	20	7.1	14	5.0	10	3.5	18	6.1	15	5.0	21	7.2	19	6.5	18	6.0	32	10.9	24	8.3
Health care	87	6.2	7	6.0	3	2.6	7	6.0	11	9.4	9	7.6	4	3.4	7	6.0	5	4.3	3	2.6	11	9.6	9	7.7	11	9.1
Other	702	5.8	26	2.6	36	3.6	50	5.0	32	3.1	46	4.4	54	5.2	40	4.0	69	6.9	67	6.8	73	7.3	95	9.2	114	10.9

[a]Rate per 100,000 person-years

Figure 1. Incident diagnoses of hyponatremia/overhydration, active component, U.S. Armed Forces, 1999-2010



Methods:

The surveillance period was 1 January 1999 to 31 December 2010. The surveillance population included all individuals who served in an active component of the U.S. Armed Forces any time during the surveillance period.

For surveillance purposes, a case of exertional hyponatremia was defined as a hospitalization or ambulatory visit with a primary (first-listed) diagnosis of "hyposmolality and/or hyponatremia" (ICD-9-CM: 276.1) and no other illness or injury-specific diagnoses (ICD-9-CM: 001-999) in any diagnostic position; or both a diagnosis of "hyposmolality and/or hyponatremia" (ICD-9-CM: 276.1) and at least one of the following within the first three diagnostic positions (dx1-dx3): "fluid overload" (ICD-9-CM: 276.6), "alteration of consciousness" (ICD-9-CM: 780.0), "convulsions" (ICD-9-CM: 780.39), "altered mental status" (ICD-9-CM: 780.97) ,"effects of heat/light" (ICD-9-CM: 992.0-992.9) or "rhabdomyolysis" (ICD-9-CM: 728.88).

Medical encounters were not considered case-defining events if they included complicating diagnoses such as alcohol/illicit drug abuse; psychosis, depression, or other major mental disorders; endocrine (e.g., pituitary, adrenal) disorders; kidney diseases; intestinal infectious diseases; cancers; major traumatic injuries; or complications of medical care. Each individual could be included as a case only once per calendar year.

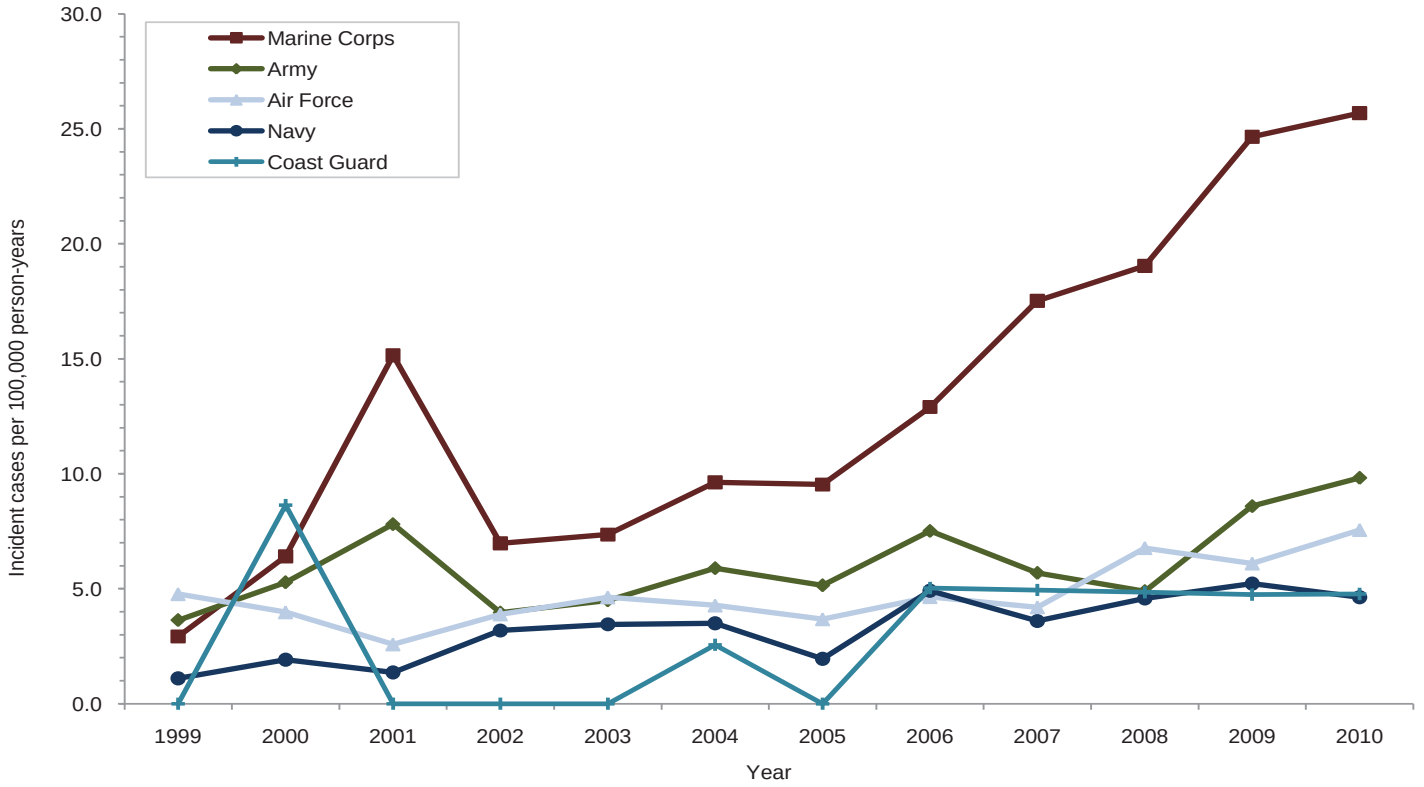
Results:

From 1999 through 2010, there were 1,011 incident diagnoses of exertional hyponatremia among active component members. In 2010, there were 149 diagnoses (incidence rate: 10.2 per 100,000 person-years [p-yrs]) of exertional hyponatremia among active component members. During the 12-year period, the average number of incident cases per year was 84 and the range was 43 (1999) to 149 (2010). The number and rate of cases in 2010 were higher than in any other year of the period **(Table 1, Figure 1).**

Among the Services in 2010, the crude overall incidence rate was highest in the Marine Corps (25.7 per 100,000 p-yrs), lowest in the Navy and Coast Guard (4.6 and 4.8 per 100,000 p-yrs, respectively), and intermediate in the Army and Air Force (9.8 and 7.6 per 100,000 p-yrs, respectively) **(Table 1, Figure 2).** In the Marine Corps, Army, and Air Force, the numbers and rates of hyponatremia diagnoses in 2010 were higher than in any other year of the period. Annual rates of exertional hyponatremia increased each of the last five years in the Marine Corps and the last two years in the Army. In the Marine Corps, the rate was more than 3.6 times higher in 2010 than 2002; in the Army, the rate was more than twice as high in 2010 than 2008 **(Figure 2).**

In 2010, 89 percent of exertional hyponatremia cases affected males. The rate among males in 2010 was the highest male-specific rate of any year of the surveillance period; however,

Figure 2. Incidence rates of hypornatremia/overhydration by service, active component, U.S. Armed Forces, 1999-2010



the rate among females was lower in 2010 than in 2009 and two other years of the period. During most (n=9) years of the surveillance period, the annual rate was higher among females than males; however, in 2010, the rate was approximately 40 percent higher among males than females **(Table 1).**

In each of the last five years, annual incidence rates were higher among white non-Hispanic than black, non-Hispanic or other racial/ethnic subgroup members; for the past two years, annual rates sharply increased among service members of all racial-ethnic groups **(Table 1).**

In 2010, the highest age group-specific incidence rate by far affected the youngest aged (<20 years) service members; among teenaged service members, the rate more than doubled from 2007 to 2010. However, during most years of the surveillance period (including 2010), the most cases were among 20-24 year olds **(Table 1).**

During the surveillance period, there were not consistent relationships between exertional hyponatremia rates and military occupational groups. In 2010, service members in combat-specific occupations had slightly lower rates of exertional hyponatremia than those in health care or other military occupational groups **(Table 1).**

During the 12-year surveillance period, exertional hyponatremia cases were diagnosed at U.S. military medical facilities at more than 150 locations; however, six locations were affected by 25 or more cases each and accounted for more than one-third (34%) of all cases. The locations with the most cases overall were Marine Corps Recruit Depot (MCRD) Parris Island/Beaufort, SC (n=141), Fort Benning, GA (n=76), Marine Corps Base Camp Lejeune/Cherry Point, NC (n=40), Navy Medical Center San Diego, CA (n=32) and Fort Bragg, NC (n=30) **(Table 2).** In 2010, 29 cases (19.5% of the total) were reported from MCRD Parris

Table 2. Incident cases of hypornatremia/overhydration by location of diagnosis, active component, U.S. Armed Forces, 1999-2010

Medical facility location	1999-2010	
	No.	% of total
MCRD Parris Island/Beaufort, SC	141	13.9
Fort Benning, GA	76	7.5
MCB Camp Lejeune/Cherry Point, NC	40	4.0
NMC San Diego, CA	32	3.2
Fort Bragg, NC	30	3.0
NMC Portsmouth, VA	25	2.5
MCB Quantico, VA	24	2.4
MCB Camp Pendleton, CA	22	2.2
NNMC Bethesda, MD	19	1.9
Fort Leonard Wood, MO	19	1.9
Lackland AFB, TX	19	1.9
Fort Sam Houston, TX	18	1.8
Walter Reed AMC, Washington, DC	18	1.8
Fort Jackson, SC	18	1.8
Fort Shafter, HI	15	1.5
All other locations	495	49.0
Total	1,011	1.4

Island/Beaufort, SC; there were 12 percent fewer cases at MCRD Parris Island/Beaufort, SC, in 2010 than in 2009.

Editorial comment:

This report documents sharp increases in the numbers and rates of exertional hyponatremia diagnoses among active component U.S. military members in the last two years. The increased incidence in the U.S. military overall reflects sharply increasing rates in the Marine Corps since 2005 and in the Army since 2009.

The results of this report should be interpreted with consideration of several limitations. For example, there is not a diagnostic code specific for "exertional hyponatremia." Thus, for surveillance purposes, cases of presumed exertional hyponatremia were ascertained from records of medical encounters that included diagnoses of "hyposmolality and/or hyponatremia" but not other conditions that increase risk of hyponatremia in the absence of physical exertion or heat stress (e.g., metabolic, renal, psychiatric, iatrogenic). As such, the results of this analysis should be considered estimates of the actual incidence of symptomatic exertional hyponatremia from excessive water consumption among U.S. military members. The accuracy of estimated numbers, rates, trends, and correlates of risk depends on the completeness and accuracy of diagnoses that are reported on standardized records of relevant medical encounters. As a result, an increase in reporting of diagnoses indicative of exertional hyponatremia may reflect at least in part increasing awareness of, concern regarding, and aggressive management of incipient cases among military supervisors and primary health care providers.

In the past, concerns regarding hyponatremia from excessive water consumption were focused at training – particularly recruit training – installations. Not surprisingly, in this analysis, the highest rates were among the youngest – hence, the most junior – service members, and the most cases were diagnosed at medical facilities that support large recruit training centers and large Army and Marine Corps combat units: Parris Island, SC; Fort Benning, GA; Fort Bragg, NC; San Diego, CA; Camp Lejeune/Cherry Point, NC. In many circumstances (e.g., recruit training, Ranger School), military trainees rigorously adhere to their training schedules – regardless of weather conditions. In hot, humid weather, commanders, supervisors, instructors, and medical support staff must be aware of, and enforce guidelines for work-rest cycles and water consumption.

In regard to hyponatremia, service members and their supervisors must be knowledgeable of the dangers of excessive water consumption and the prescribed limits for water intake **(Figure 3)** during prolonged physical activity– e.g., field training exercises, personal fitness training, recreational activities – in hot, humid weather. Service members (particularly trainees) and their supervisors must be vigilant for early signs of heat-related illnesses – and immediately and appropriately (but not excessively) intervene in such cases.

Figure 3. Fluid replacement guidelines for warm weather training (applies to average acclimated soldier wearing BDU, hot weather)

Heat Category	WBGT Index, °F	Easy Work		Moderate Work		Hard Work	
		Work / Rest	Water Intake, Qt/hr	Work /Rest	Water Intake, Qt/hr	Work /Rest	Water Intake, Qt/hr
1	78-81.9	NL	½	NL	¾	40/20 min	¾
2 (Green)	82-84.9	NL	½	50/10 min	¾	30/30 min	1
3 (Yellow)	85-87.9	NL	¾	40/20 min	¾	30/30 min	1
4 (Red)	88-89.9	NL	¾	30/30 min	¾	20/40 min	1
5 (Black)	> 90	50/10 min	1	20/40 min	1	10/50 min	1

- The work:rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hours of work in the specified heat category. Individual water needs will vary ± ¼ qt/hour.
- NL= no limit to work time per hour.
- Rest means minimal physical activity (sitting or standing), accomplished in shade if possible.
- **CAUTION: Hourly fluid intake should not exceed 1½ quarts.**
- **Daily fluid intake should not exceed 12 quarts.**
- Wearing body armor add 5°F to WBGT Index
- Wearing MOPP overgarment add 10°F to WBGT Index.

Easy Work	Moderate Work	Hard Work
• Walking Hard Surface at 2.5 mph, ≤ 30 lb Load • Weapon Maintenance • Manual of Arms • Marksmanship Training • Drill and Ceremony	• Walking Hard Surface at 3.5 mph < 40 lb Load • Walking Loose Sand at 2.5 mph no Load • Calisthenics • Patrolling • Individual Movement Techniques. i.e. low crawl, high crawl • Defensive Position Construction • Field Assaults	• Walking Hard Surface at 3.5 mph, ≥ 40 lb Load • Walking Loose Sand at 2.5 mph with Load

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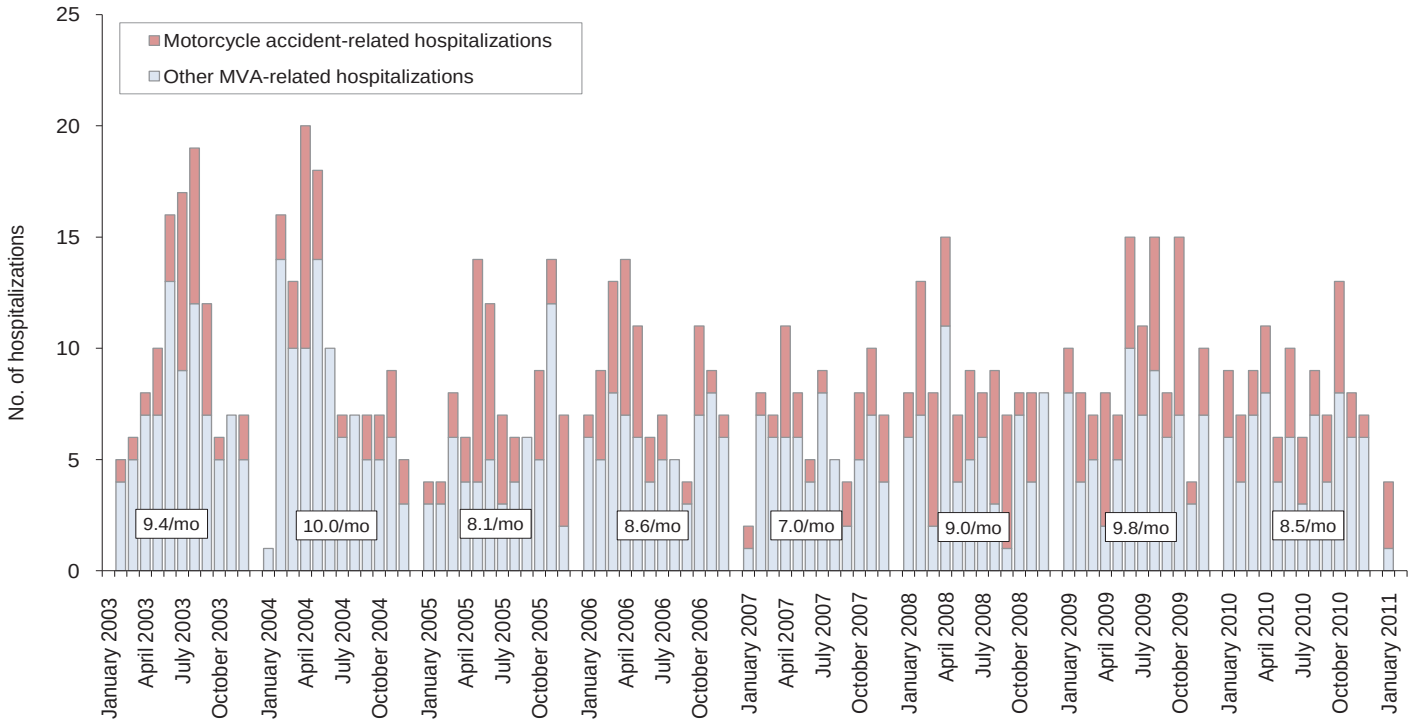
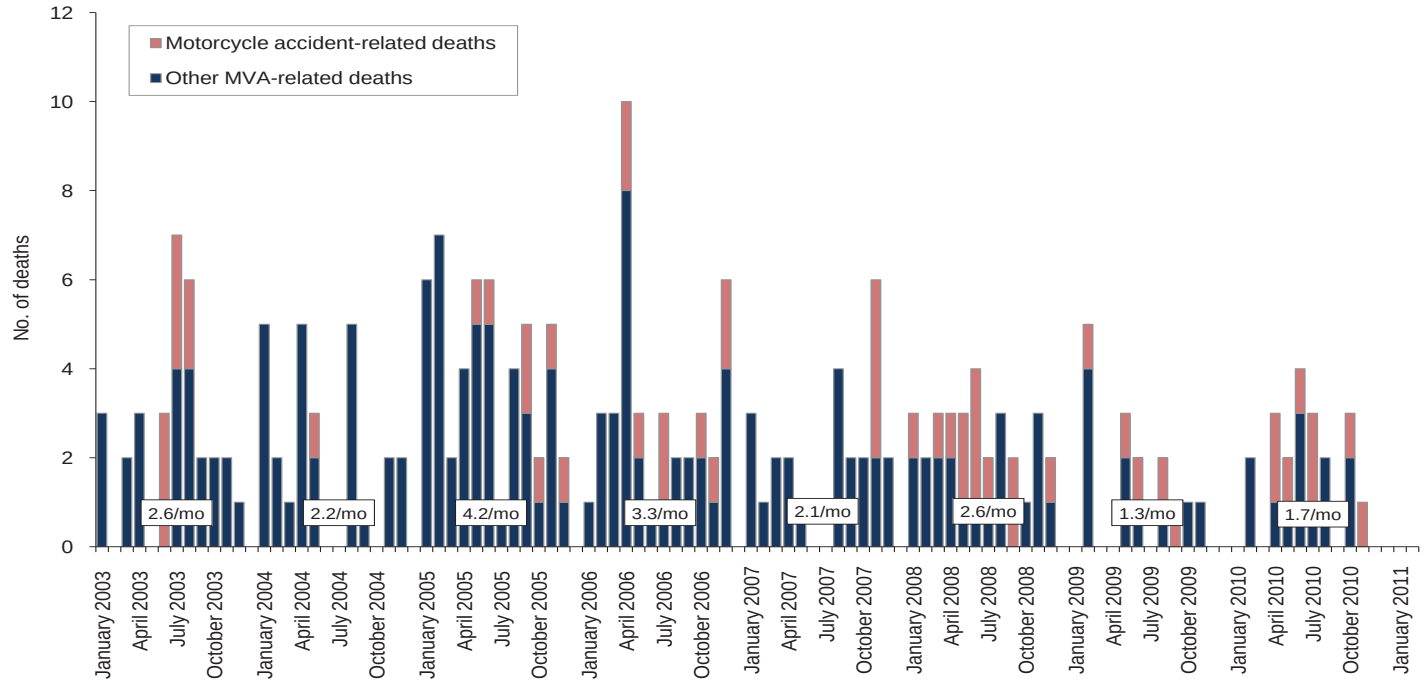
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - February 2011 (data as of 28 March 2011)

Motor vehicle accident-related hospitalizations (outside of the operational theater) (ICD-9-CM: E810-E825; NATO Standard Agreement 2050 (STANAG): 100-106, 107-109, 120-126, 127-129)



Note: Hospitalization (one per individual) while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days of a motor vehicle accident-related hospitalization.

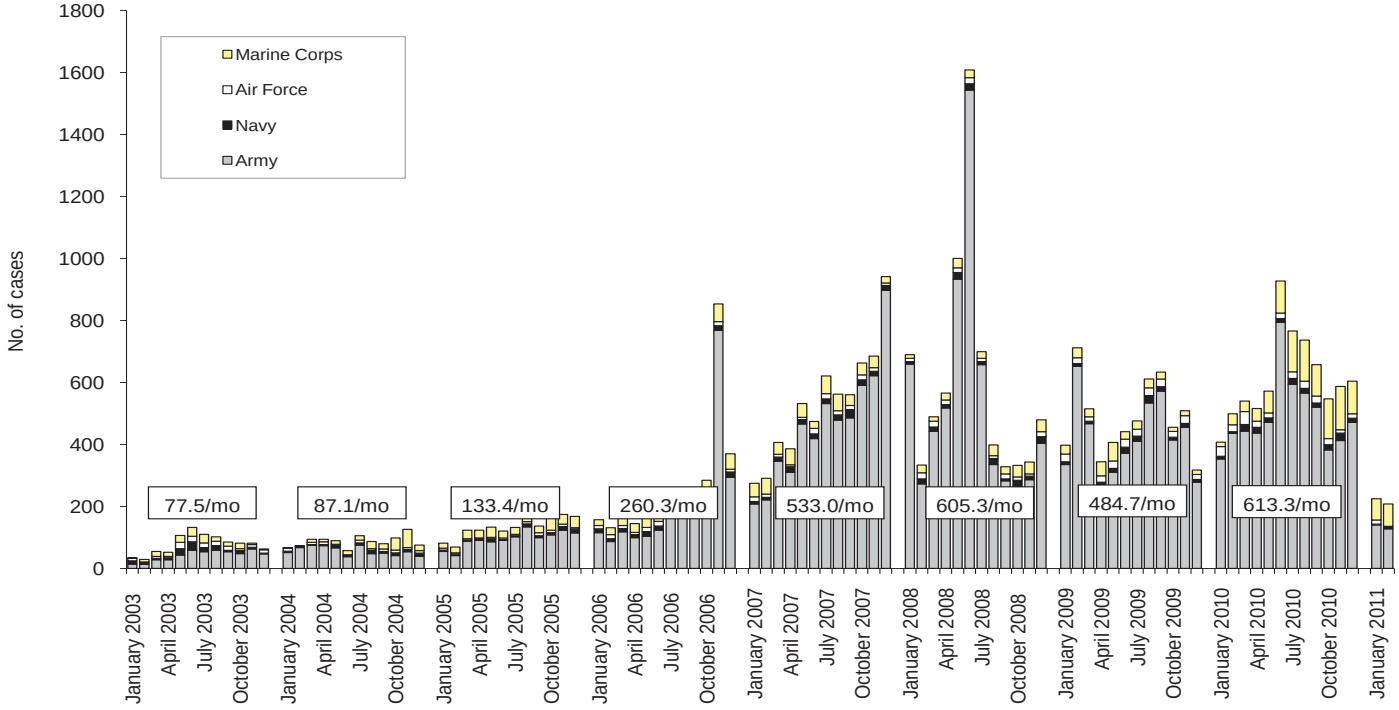
Motor vehicle accident-related deaths (outside of the operational theater) (per the DoD Medical Mortality Registry)



Reference: Armed Forces Health Surveillance Center. Motor vehicle-related deaths, U.S. Armed Forces, 2010. *Medical Surveillance Monthly Report (MSMR)*. Mar 2011;17(3):2-6.
Note: Death while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days prior to death.

Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - February 2011 (data as of 28 March 2011)

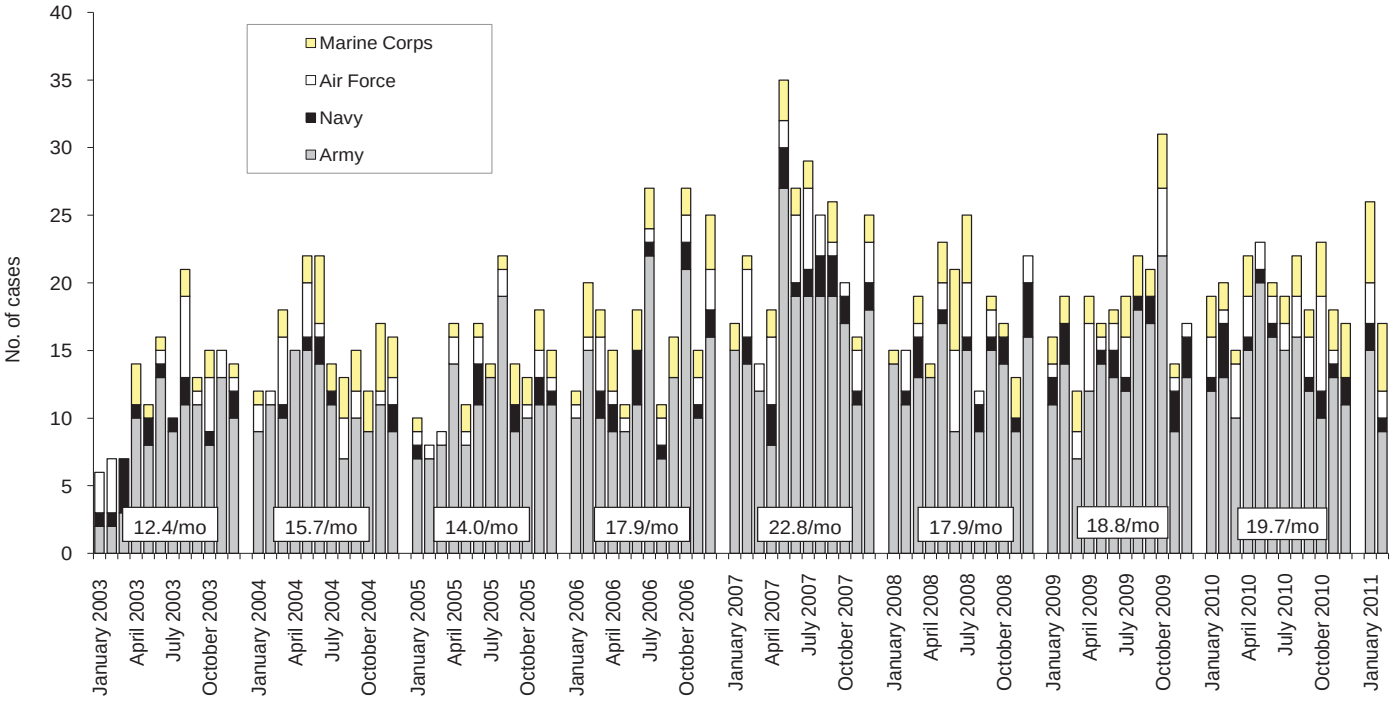
Traumatic brain injury (ICD-9: 310.2, 800-801, 803-804, 850-854, 907.0, 950.1-950.3, 959.01, V15.5_1-9, V15.5_A-F, V15.59_1-9, V15.59_A-F)[a]



Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. Dec 2009; 16(12):2-8.

[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 2,762 deployers who had at least one TBI-related medical encounter any time prior to OEF/OIF).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40 - 453.42 and 453.8)[b]

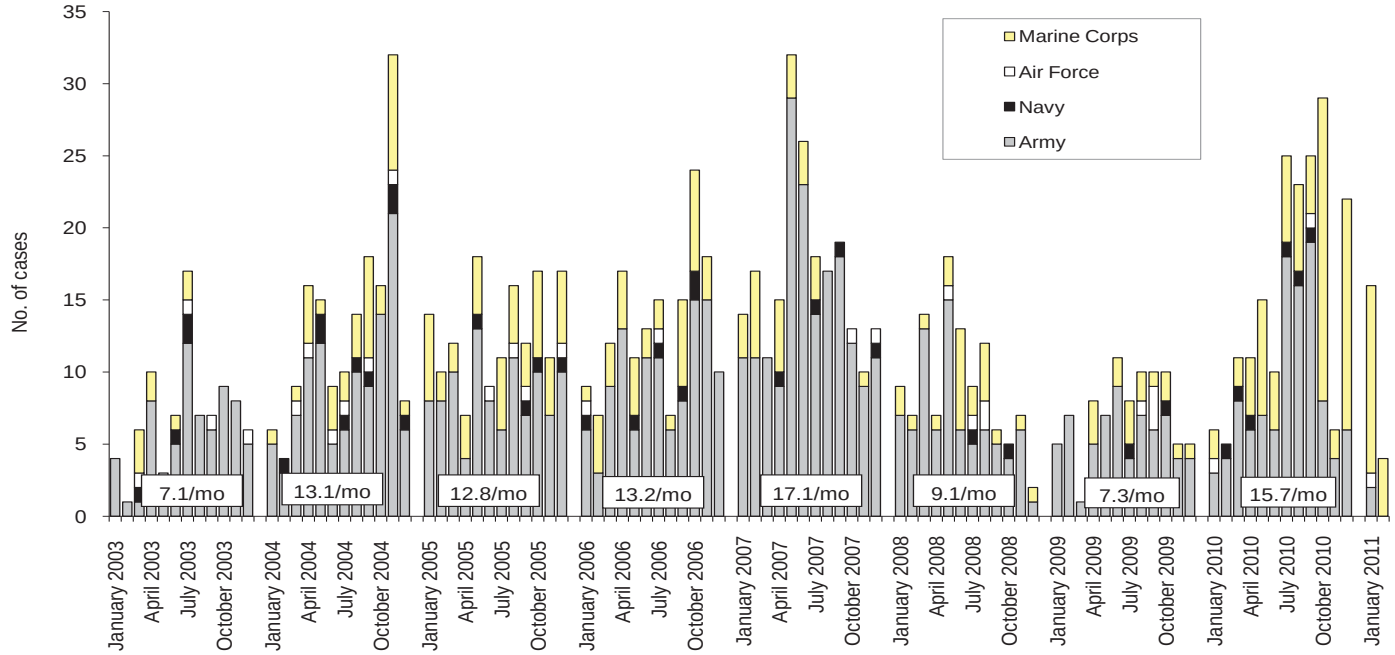


Reference: Isenbarger DW, Atwood JE, Scott PT, et al. Venous thromboembolism among United States soldiers deployed to Southwest Asia. *Thromb Res*. 2006;117(4):379-83.

[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from OEF/OIF.

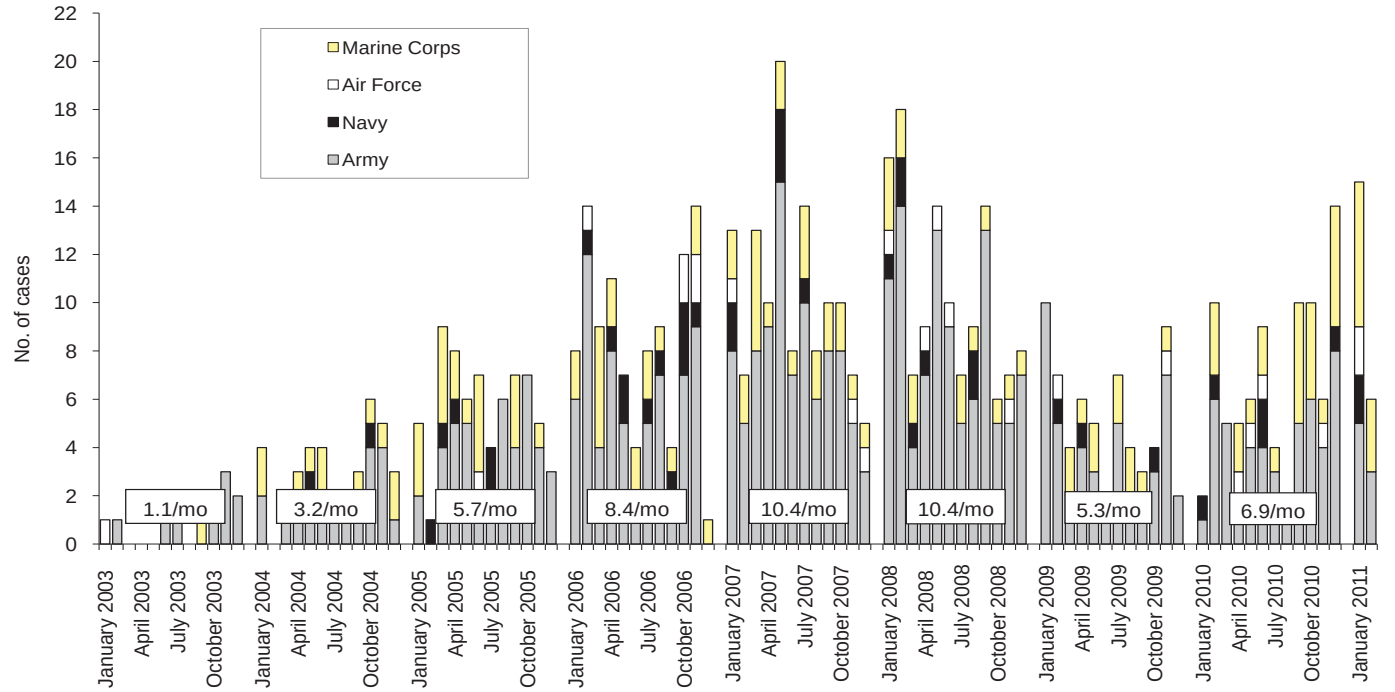
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - February 2011 (data as of 28 March 2011)

Amputations (ICD-9: 887, 896, 897, V49.6 except V49.61-V49.62, V49.7 except V49.71-V49.72, PR 84.0-PR 84.1, except PR 84.01-PR 84.02 and PR 84.11)[a]



Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: amputations. Amputations of lower and upper extremities, U.S. Armed Forces, 1990-2004. *MSMR*. Jan 2005;11(1):2-6.
[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from OEF/OIF.

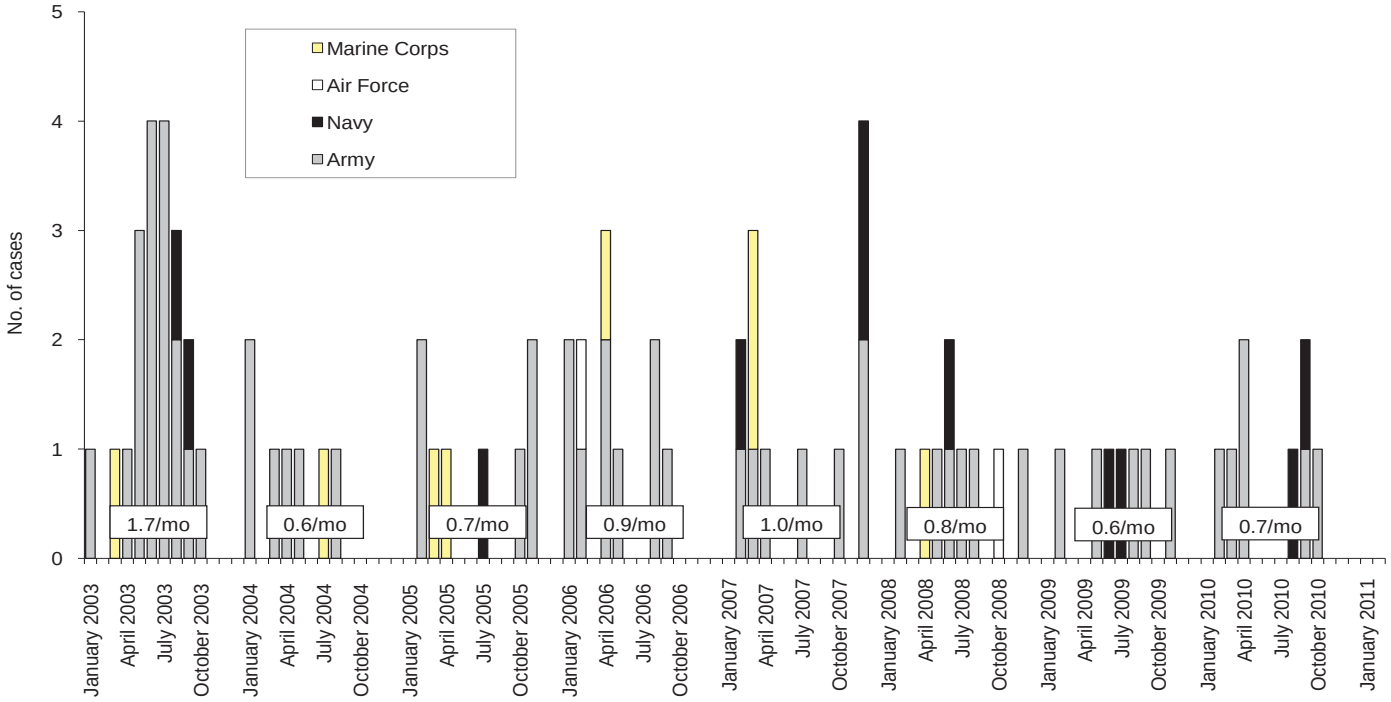
Heterotopic ossification (ICD-9: 728.12, 728.13, 728.19)[b]



Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002-2007. *MSMR*. Aug 2007; 14(5):7-9.
[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 365 days of returning from OEF/OIF.

Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - February 2011 (data as of 28 March 2011)

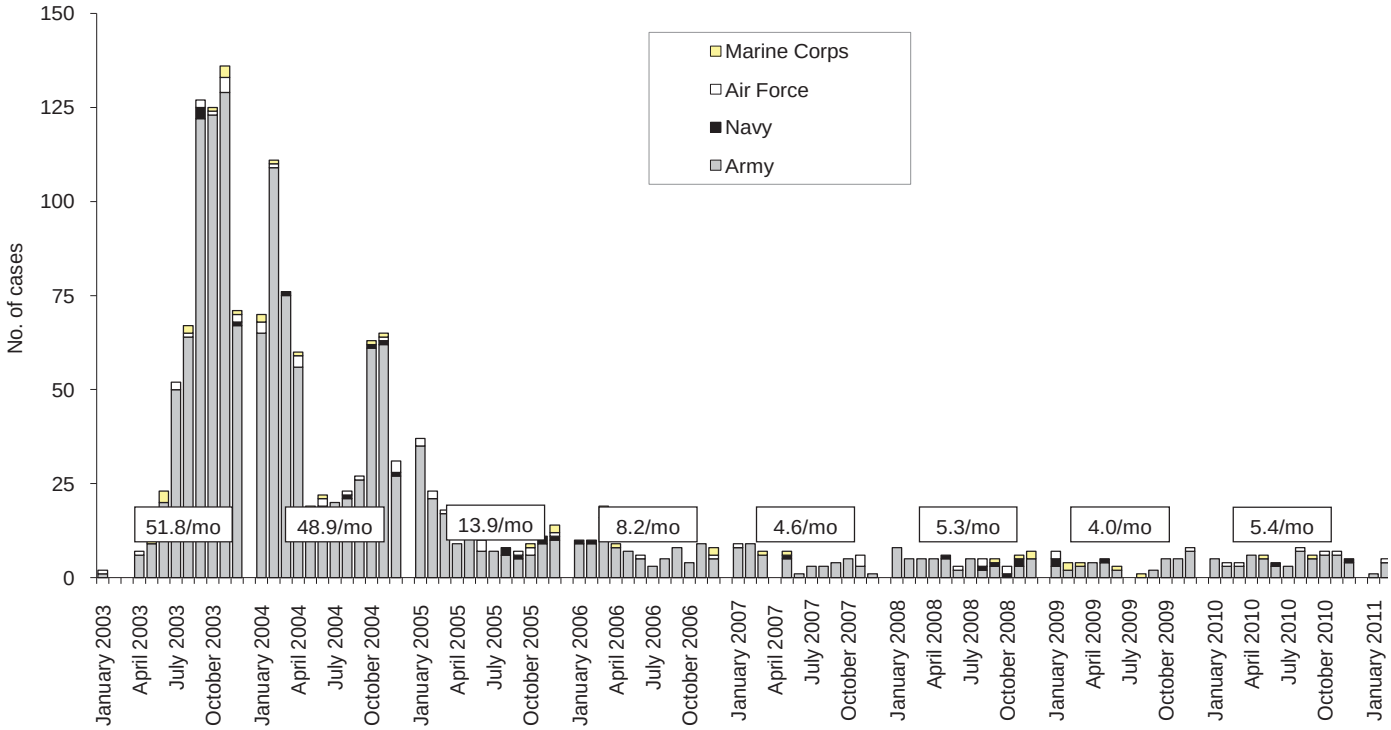
Severe acute pneumonia (ICD-9: 518.81, 518.82, 480-487, 786.09)[a]



Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: severe acute pneumonia. Hospitalizations for acute respiratory failure (ARF)/acute respiratory distress syndrome (ARDS) among participants in Operation Enduring Freedom/Operation Iraqi Freedom, active components, U.S. Armed Forces, January 2003-November 2004. *MSMR*. Nov/Dec 2004;10(6):6-7.

[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 30 days of returning from OEF/OIF.

Leishmaniasis (ICD-9: 085.0 to 085.9)[b]



Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: leishmaniasis. Leishmaniasis among U.S. Armed Forces, January 2003-November 2004. *MSMR*. Nov/Dec 2004;10(6):2-4.

[b]Indicator diagnosis (one per individual) during a hospitalization, ambulatory visit, and/or from a notifiable medical event during/after service in OEF/OIF.

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