



Veterans Affairs  
Canada

Anciens Combattants  
Canada

---

## **2019 Gulf War Mortality Report; Follow-up period 1991 to 2014.**

### **Veterans Affairs Canada, Research Directorate**

Linda VanTil, DVM MSc, Senior Epidemiologist  
Julian Reyes Velez, PhD, Senior Researcher  
Alain Poirier, Senior Statistics Officer

### **Department of National Defence**

François Thériault, MSc, Epidemiologist Canadian Forces Health Services

Research Directorate  
Veterans Affairs Canada  
Charlottetown PE Canada  
Email: [VAC.Research-Recherche.ACC@canada.ca](mailto:VAC.Research-Recherche.ACC@canada.ca)

December 31, 2019

© Her Majesty the Queen in Right of Canada, 2019.

ISBN: 978-0-660-33881-1  
Catalogue #: V3-1/6-2020E-PDF

Published by:

Veterans Affairs Canada  
161 Grafton Street  
Charlottetown, Prince Edward Island  
C1A 8M9  
Email: [VAC.Research-Recherche.ACC@vac-acc.gc.ca](mailto:VAC.Research-Recherche.ACC@vac-acc.gc.ca)

Citation:

VanTil L, Reyes Velez J, Poirier A, Thériault F. *2019 Gulf War Mortality Report; Follow-up period 1991 to 2014*. Charlottetown (PE): Veterans Affairs Canada, Research Directorate Technical Report; 31 December, 2019.

Available at: <http://publications.gc.ca/pub?id=9.884083&sl=0>

## **Executive Summary**

### **Introduction**

The Gulf War of 1990/91 officially began with the invasion of Kuwait by Iraq on August 2, 1990 and ended with Iraq's retreat from Kuwait on February 28, 1991. Canada's contribution began on August 24, 1990 with a naval task force, as well as an air task group, a field hospital, and clean-up missions that ended by October 1, 1991. Over 5,000 Canadians were deployed to the Gulf War during this period.

Since the end of the war, concerns have been expressed about the health of personnel who were deployed to the Persian Gulf. Several countries have examined the mortality of those who deployed. This included a Canadian study of mortality with a nine-year follow-up period (1991-1999). That study found Canadians deployed to the Gulf War had similar mortality rates as Canadian military not deployed to the Gulf. This report describes the results of subsequent analyses, based on a 24-year follow-up (1991-2014). The main objective of this study was to determine if Canadian military personnel deployed to the Gulf between August 24, 1990 and October 1, 1991 were at a higher risk of death after their return to Canada than other members of the military who were not deployed to the Persian Gulf or the general Canadian public.

### **Methods**

Two cohorts of members of the Canadian military were defined. The Gulf War cohort consisted of all Canadian Forces members deployed to the Gulf War of 1990/91. The Control cohort was a random selection of members serving in 1990/91 who were eligible for this deployment but who were not deployed. The mortality experience of these cohorts was determined using record linkage to the Canadian Vital Statistics Death Database. At the time of the linkage procedure, national mortality data were available until December 31, 2014 permitting a 24-year follow-up period. Mortality rates for both cohorts were computed and compared using direct standardization. A second comparison of mortality using indirect standardization was performed between each cohort and the general Canadian population.

### **Key Findings**

- There was no significant difference in the overall risk of death between the Gulf War and Control cohorts.
- For both the Gulf War and the Control cohort, there was a statistically significant lower risk of death from all causes of about 50% compared to the general Canadian population.
- For the Gulf War cohort, there was a statistically significant lower risk of suicide of about 50% compared to the general Canadian population; the suicide risk in the Control cohort was similar to the general Canadian population.

### **Conclusion**

Among Canadian military personnel who were eligible to deploy to the Gulf War of 1990/91, those who did deploy were not at higher risk of mortality over the following 24 years compared to those who did not deploy.

## **Sommaire**

### **Introduction**

La guerre du Golfe de 1990-1991 a commencé officiellement le 2 août 1990 avec l'invasion du Koweït par l'Iraq et s'est terminée le 28 février 1991 avec le retrait de l'Iraq du Koweït. La contribution du Canada a commencé le 24 août 1990 par le déploiement d'une force opérationnelle navale, ainsi que d'un groupe opérationnel aérien, d'un hôpital de campagne et de missions de nettoyage, et elle a pris fin pour le 1er octobre 1991. Pendant cette période, plus de 5 000 Canadiens et Canadiennes ont été déployés dans le cadre de la guerre du Golfe.

Depuis la fin de la guerre, des inquiétudes ont été soulevées concernant la santé du personnel déployé dans le golfe Persique. Plusieurs pays ont examiné la mortalité de ceux qui ont été déployés. On compte notamment une étude canadienne sur la mortalité au cours d'une période de suivi de 9 ans (1991-1999). Selon cette étude, les Canadiens et les Canadiennes déployés dans le cadre de la guerre du Golfe ont des taux de mortalité similaires à ceux des militaires canadiens qui n'ont pas été déployés dans le Golfe. Le présent rapport décrit les résultats des analyses subséquentes, fondées sur un suivi de 24 ans (1991-2014). L'étude visait principalement à déterminer si les militaires canadiens déployés dans le Golfe entre le 24 août 1990 et le 1er octobre 1991 présentaient un risque supérieur de décès après leur retour au Canada par rapport aux autres membres de l'Armée qui n'ont pas été déployés dans le golfe Persique ou à l'ensemble de la population canadienne.

### **Méthodes**

Deux cohortes de militaires canadiens ont été formées. La cohorte de la guerre du Golfe se composait de tous les membres des Forces canadiennes déployés dans le cadre de la guerre du Golfe de 1990-1991. La cohorte témoin comprenait les membres sélectionnés au hasard en service en 1990-1991 qui auraient pu être déployés à cet endroit, mais qui ne l'ont pas été. La mortalité subie au sein de ces cohortes a été déterminée au moyen de couplage de dossiers avec Statistique de l'état civil – base canadienne de données sur les décès. Lors de la procédure de couplage, les données nationales sur la mortalité étaient disponibles jusqu'au 31 décembre 2014, ce qui permettait un suivi sur 24 ans. Les taux de mortalité pour les deux cohortes ont été calculés et comparés au moyen de la standardisation directe. Une seconde comparaison de la mortalité au moyen de la standardisation indirecte a été réalisée entre chaque cohorte et l'ensemble de la population canadienne.

### **Principales conclusions**

- Relativement au risque global de décès, il n'y avait aucune différence significative entre la cohorte de la guerre du Golfe et la cohorte témoin.
- Pour la cohorte de la guerre du Golfe et la cohorte témoin, le risque de décès toutes causes confondues était statistiquement plus faible d'environ 50 % par rapport à celui de l'ensemble de la population canadienne.
- Pour la cohorte de la guerre du Golfe, le risque de suicide était statistiquement plus faible d'environ 50 % par rapport à celui de l'ensemble de la population canadienne. Le risque de suicide dans la cohorte témoin était similaire à celui de l'ensemble de la population canadienne.

### **Conclusion**

Parmi les militaires canadiens pouvant être déployés dans le cadre de la guerre du Golfe de 1990-1991, ceux qui l'ont été ne présentaient pas un risque de mortalité plus élevé pendant la période de suivi sur 24 ans que ceux qui n'ont pas été déployés.

# 2019 Gulf War Mortality Report; Follow-up period 1991 to 2014.

## Table of Contents

<b>Executive Summary</b> .....	3
<b>Sommaire</b> .....	4
<b>1. Introduction</b> .....	7
Gulf War Background .....	7
Canadian Operations in the Gulf War .....	8
Studies related to the Gulf War .....	9
Objective of this study .....	9
<b>2. Description of Canadian Gulf War Cohort</b> .....	10
<b>3. Methods</b> .....	11
Follow-up period .....	11
Military Personnel Cohorts (GW and control) .....	11
Canadian Vital Statistics Death Database .....	12
Record linkage .....	12
Comparisons to other Military Personnel .....	13
Comparisons to the Canadian population .....	13
Explanatory Variables .....	14
Ethics and Confidentiality .....	14
<b>4. Results of Comparisons to other Military Personnel</b> .....	15
All-cause Mortality .....	15
Suicide Mortality .....	16
<b>5. Results of Comparisons to the Canadian population</b> .....	17
All-cause Mortality .....	17
Suicide Mortality .....	18
<b>6. Discussion</b> .....	19
Key findings .....	19
Comparison of 2019 findings with 2005 findings .....	19
International comparison of Gulf War Veterans Studies .....	20
Strengths and limitations .....	21
<b>7. Conclusion</b> .....	21

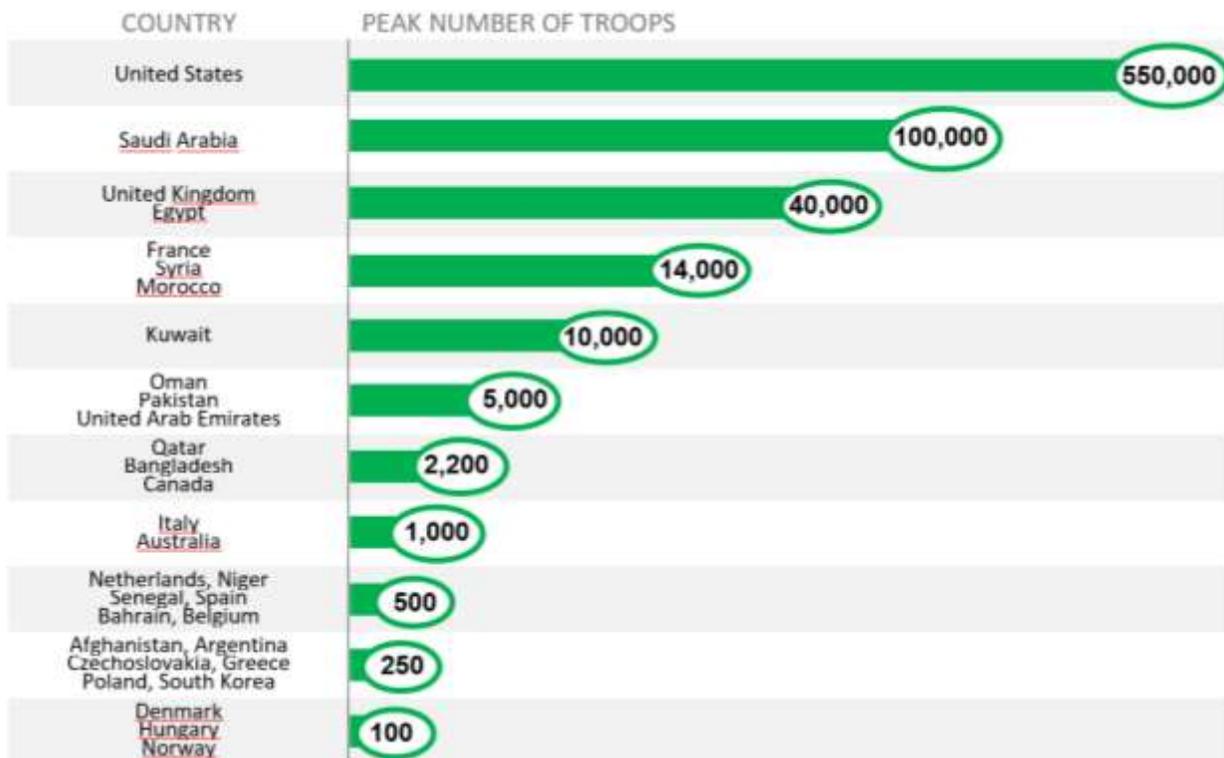
Appendix A.	Canadian Operations in Gulf War .....	22
Appendix B.	Creation of Gulf War cohort .....	24
Appendix C.	Creation of Control cohort .....	25
Appendix D.	Record linkage methodology .....	27
<b>References</b>	.....	<b>29</b>

## 1. Introduction

### ***Gulf War Background***

Iraqi forces invaded the Emirate of Kuwait on August 2, 1990, taking possession of one quarter of the oil reserves of the world. This situation produced an unilateral reaction of the United States to protect Saudi Arabia territory and a consecutive set of actions by the United Nations (UN). The Security Council of the United Nations approved a series of Security Resolutions (660, 661, 665 and 678) between August 2 to November 29, 1990 with the aim of the withdrawal of Iraqi forces from Kuwait by January 15, 1991. The Iraqi forces did not withdraw by this date and the United Nations supported the mobilization of a coalition force from over 30 nations (including Canada). Figure 1 shows the distribution of the international coalition forces at the peak of the war.(1)

**Figure 1. International Coalition Forces Jan-Feb 1991.**



Source: IOM 1999 (1)

A large scale logistic build up was required as part of this international interception force supported by the United Nations, including approximately 110 ships, 2,000 tanks, 2,200 armed personnel carriers, 1,800 fixed wing aircraft and 1,700 helicopters.(2) The naval blockade of Iraq began in August 1990, air intervention began in January 1991 and ground operations began February 23, 1991.(3)

Iraq capitulated after retreating from Kuwait, ending the war on February 28, 1991.(3) Iraqi military forces set fire to more than 700 oil wells during their retreat, and the subsequent international clean-up effort lasted 8 months. By October 11, 1991, the UN Security Resolution 715 assumed control of the Iraqi military industry.(4)

### **Canadian Operations in the Gulf War**

Canada was supportive of the United Nations recommendations and provided a military response. Canadian deployment was announced August 10, 1990, to establish a military presence in the Persian Gulf in support of Canadian policy and the United Nations resolutions.(4)

Canada had an active but limited participation in the United Nations led coalition: the Royal Canadian Navy organized the protection of a loosely bound multinational logistical force; the Royal Canadian Air Force flew protective cover for allied naval forces; the Canadian Army set up a state-of-the-art field hospital. Canada continued to contribute after the war, with follow up missions such as ammunition disposal.(4) Canada's major operations related to the Gulf War are listed in Table 1.

**Table 1. Canadian military operations related to the Gulf War.**

<b>Name of operation</b>	<b>Country</b>	<b>Main Task</b>	<b>Start date</b>	<b>End date</b>
<b>SCIMITAR</b>	Iraq, Kuwait	Combat air patrols, air cover for naval blockade, fighter escort of bombers and bombing missions.	1990-08-01	1991-04-06
<b>ACCORD</b>	Iraq, Kuwait	Creation and transportation of the headquarters and field hospital.	1990-08-02	1991-04-06
<b>FRICTION</b>	Iraq, Kuwait	Warships and a supply vessel for the naval blockade.	1990-08-02	1991-04-06
<b>SPONGE</b>	Saudi Arabia	Support clean-up of oil spills from offshore terminals.	1991-02-11	1991-02-17
<b>AXE</b>	Iraq, Kuwait	Ammunition disposal and investigation of Iraqi weapons.	1991-03-01	1991-04-30
<b>NECESSITY</b>	Kuwait	Restoration of the Canadian Embassy in Kuwait.	1991-03-03	1991-03-07

Source: DND website (5)

Additional details of the Canadian operations related to the 1990/91 Gulf War are found in Appendix A.

### ***Studies related to the Gulf War***

Upon the return of the deployed military personnel to their host countries, concerns about potential after-effects of the war on their health gradually developed. Multiple harmful exposures have been recognized internationally to have potential long term effects on the deployed personnel.(1) Several mortality and health studies have been published internationally, evaluating the long term consequences of this conflict.(2) To date, these studies have not found higher mortality rates among those deployed to the Gulf.

Studies in the United States (US), United Kingdom (UK) and Australia (as well as Canada) have used record-linkage methodology, in order to compare the mortality rates of military personnel deployed to the Gulf to the mortality rates of military personnel not posted to that area. In the US, two-year mortality of deployed personnel was slightly higher than those not posted, attributed to accidental deaths such as motor vehicle accidents.(6) The US seven-year mortality comparison found no excess in the mortality rates, accidental death rates, and suicide rates.(7) In the UK, eight-year mortality comparison also found no differences in mortality rates between the deployed and the not posted groups.(8) In Australia, eight-year mortality comparison also found no differences in mortality rates between the deployed and the not posted groups.(9)

In Canada, a health survey commissioned in 1997 found a higher prevalence of self-reported health problems in Canadians deployed to the Gulf War compared to a control group of military personnel not posted to the Gulf.(10) A subsequent report described mortality of these groups with a nine-year follow-up period (1991-1999). That 2005 report found Canadians deployed to the Gulf War had similar mortality rates as Canadian military not deployed to the Gulf.(11) The lack of observed differences between the two groups may have been related to the small number of events: there were 42 deaths in the deployed cohort and 54 in the control cohort, and nine suicides in each group. The report suggested a longer follow-up may provide sufficient time for the accumulation of events, and improve the examination of long-term outcomes such as mortality.

### ***Objective of this study***

This report describes the results of analyses, based on a 24-year follow-up (1991-2014), on mortality among Canadians deployed to the Gulf War. The analysis builds upon the earlier nine-year mortality study, using record linkage methodology and comparison of the group of Canadian military personnel deployed to the Gulf to a control group of Canadian military personnel not posted to that area.

The main objective of this study was to determine if military personnel deployed to the Gulf between August 24, 1990 and October 1, 1991 were at a higher risk of death after their return to Canada than other members of the military who were not deployed to the Persian Gulf or the general Canadian public.

## 2. Description of Canadian Gulf War Cohort

Over 5,000 Canadian military members deployed to Gulf War between August 24, 1990 and October 1, 1991, with about 2,200 in-theatre during the peak of the war.(11) The large majority were male (95%), and over half (52%) were at Junior Non-Commissioned Member (Jr. NCM) ranks (see Table 2). Almost all were deployed from the Regular Force and only 37 were in the Reserve Force at the time of the Gulf War.(11)

**Table 2. Characteristics of Canadians at time of Deployment to Gulf War**

Characteristic		%
Sex	Male	95%
	Female	5%
Age in Years	Mean age	30.7 yr
Military Rank	Officer	20%
	Sr. NCM	28%
	Jr. NCM	52%
Length of Military Service	Mean years	18 yr
Environment of service	Land	26%
	Air	40%
	Sea	33%
Component	Regular Force	100%
	Reserve Force	<1%

Source: Statistics Canada 2005 (11)

The Canadian Gulf War cohort was based on a list previously compiled by the Department of National Defense for the first Canadian study.(12) The list was extended and modified to include people who had died prior to the 1997 survey, and other sources of identification such as medals lists were incorporated. The start of the deployment was defined as August 24, 1990 to correspond to the departure from Halifax of Canada's initial naval operation; the end of the deployment was defined as October 1, 1991 (11) to correspond to Canadian participation in international operations (see Appendix A) prior to UN Security Resolution 715. Additional details on the creation of the Gulf War cohort are described in Appendix B.

At the time of the Gulf War, cohort members had served in the Canadian Armed Forces for various periods of time, with an average of 18 years of military service. 24% (n=1217) had enrolled prior to 1976 and already had at least 15 years of military experience; the other 76% (n=3910) enrolled in the Canadian Armed Forces between 1976 and 1991, and had between 1 to 15 years of military experience.

The final size of the Canadian Gulf War cohort used in this study was 5,127. At the end of the follow-up period, this cohort would be about 24 years older than at the time of deployment to the Gulf War. Of the 5,127 cohort, on average 170 personnel released from the military each year, so that by the end of this study the majority (80%) were veterans (n=4,077) and the other 20% were still serving in the Canadian Armed Forces (n=1,050).

### 3. Methods

Record linkage methodology was used for this 24-year follow-up study, with analysis that compared the mortality experience of the group of Canadian military personnel deployed to the Gulf War of 1990/91 to a control group of Canadian military personnel not posted to that area. The methodology is consistent with the earlier nine-year mortality study,(11) and with recent international studies described in the discussion section of this report.

#### ***Follow-up period***

The 24-year follow-up for this report covers the period 1991 to 2014. The starting point was April 1, 1991.(11) This was the same reference date used by the UK mortality follow-up study,(8) and similar to the May 1, 1991 date used by the US mortality study.(6) This date was chosen as the starting date for the mortality follow-up for all three countries since it excluded deaths occurring during active service in the Gulf War. Australia used an earlier start date of January 1, 1991.(9) The April 1 start date of this study created potential overlap with cohort definition dates that were extended to October 1, 1991; however there were no deaths during this time.

At the time of the record linkage procedure, national mortality data were available until December 31, 2014 (see Record Linkage section below). Between the two dates are 23.75 years of follow-up, with the midpoint at February 14, 2003.

#### ***Military Personnel Cohorts (GW and control)***

Two cohorts of Canadian Force (CF) members were defined. The Gulf War cohort consisted of all CF members deployed to the Gulf War of 1990/91. The control cohort was a random selection of CF members who were eligible for this deployment but who were not deployed. The datafile for the cohorts only listed their Service Number, no other characteristics were provided.

*Gulf War cohort* consisted of 5,127 Canadian Armed Forces personnel who were deployed to the Persian Gulf between August 24, 1990 and October 1, 1991. All 5,127 personnel were included in this study. By the end of the follow-up period this cohort was 80% Veterans, and 20% still-serving in the Canadian Armed Forces. Characteristics of the Gulf War cohort and its creation are described in Section 2, and in Appendix B.

*Control cohort* consisted of 6,019 Canadian Armed Forces personnel who were not deployed to the Persian Gulf between August 24, 1990 and October 1, 1991, but were considered eligible for this deployment. Because of the stratified random process, personnel in the control group were considered an adequate match to the Gulf War cohort on gender, age, and component.(12) By the end of the follow-up period the control cohort was also 80% Veterans, and 20% still-serving in the Canadian Armed Forces. Characteristics of the control cohort and its creation are described in Appendix C.

### **Canadian Vital Statistics Death Database**

The Canadian Vital Statistics Death Database is a census of all deaths occurring in Canada each year. Deaths are reported by the provincial and territorial Vital Statistics Registries to Statistics Canada; the information provided includes demographic and underlying cause of death information. Cause of death information is coded using the version of the International Classification of Diseases (ICD) in effect at the time of death. At the time of record linkage, deaths that occurred up to December 31, 2014 were available.

The legislative requirement to report deaths ensures completeness of the Canadian Vital Statistics Death Database. Quality control processing is conducted by Statistics Canada, with feedback to the Provincial/Territorial Registrars for review and approval. The entire process has resulted in a time lag of four or more years in the reporting cycle.(13) Mortality studies inside Statistics Canada also use the tax filing system's notification of death or moves out of the country to ensure completeness since 1984.

All-cause mortality deaths were assigned for all ICD codes. Deaths coded as E950-E959 and occurring between 1991 to 1999, or as X60-X84 and occurring between 2000 to 2014, were considered suicides. This reflected the 2000 nation-wide change from ICD-9 to ICD-10 in mortality coding. Airspace crashes were not analyzed separately in this study, since the earlier follow-up concluded that differences in this risk were attributed to the higher number of personnel in flying-related occupations.(11)

### **Record linkage**

Both the Gulf War and control cohorts were linked with mortality data. The analysis period for this study required the linkage to include both veterans released from the military and personnel still serving in the Canadian Armed Forces.

In 2016 and 2017, prior to the initiation of this study, Statistics Canada had already completed a linkage of the Canadian Vital Statistics Death Database with a military cohort that included both veterans released from the military and personnel still serving in the Canadian Armed Forces. Their military history dated back to 1976, predating the Gulf War and control cohorts. This linkage has been utilized by 2 related studies, one that examined mortality for those who enrolled after 1976,(14) and one that examined suicide mortality for those who were released after 1976.(15) Unfortunately, the use of one study would exclude 24% of the Gulf War cohort that enrolled prior to 1976, and the use of the other study would exclude 20% of the Gulf War cohort that were still serving. To ensure complete coverage of the Gulf War (and Control) cohorts, this study used the version of the linked dataset prior to the enrollment and release criteria applied by the aforementioned studies.

Statistics Canada merged the Gulf War and control cohorts to the Canadian Forces Mortality linkage, using the unique Service Number, making available deaths that occurred up to December 31, 2014. Cancer linkage was not available. Service Numbers were removed from the file, and the anonymized linked data file was available for analysis inside the federal Research Data Centre by authorized personnel from VAC and DND.

Details on the record linkage are provided in Appendix D.

### **Comparisons to other Military Personnel**

Comparison of the Gulf War cohort with the control cohort was done for all-cause mortality and suicide mortality for the 24-year period (1991-2014). The comparison reported crude mortality rate ratios (MRR), as well as age standardized MRR, using the *direct standardization* method. Age was categorized into five-year age groups, and treated as time-varying. Each subject was followed from April 1, 1991 to either their date of death or December 31, 2019, whichever date came first. The resulting accumulation of person-years observed in the study is reported in the results.

In compliance with requirements of the *Statistics Act*, age groups were collapsed to ensure minimum cell counts of 10. The reported tables do not include females due to small numbers. Calculation of MRRs used Stata commands (*IR, istandard*) to weight the estimate and 95% confidence interval (CI) according to the reference period of the Gulf War cohort. CIs that overlap 1.0 indicated the mortality rates were not statistically significantly different at the 95% confidence level.

### **Comparisons to the Canadian population**

Comparison of the Gulf War cohort with the Canadian general population was performed for all-cause mortality and suicide mortality for the 24-year period (1991-2014). The comparison reported observed death counts, expected death counts, and the ratio of these, using the *indirect standardization* method. Canadian data on mortality counts, suicide counts, and population counts (by five-year age groups) was extracted to another Stata file for the period 1991 to 2014. Canadian mortality and suicide age-specific rates were calculated and applied to the appropriate age-specific person-years accumulated in each cohort to generate the expected number of deaths. The ratio of the observed number of deaths to the expected number produced the Standardized Mortality Ratio (SMR).

In compliance with the requirements of the *Statistics Act*, age groups were collapsed to ensure minimum cell counts of 10. Where collapsing was not possible, data points were suppressed (indicated by F). The reported tables did not include females due to small numbers. An SMR value of 1.0 indicated that the observed mortality in the cohort was the same as that observed in the Canadian population. Values less than 1.0 indicated a lower mortality in the cohort while values greater than 1.0 indicated a higher than expected mortality in the cohort. In addition to the point estimate, 95% CIs were calculated using normal approximation; CIs that overlap 1.0 indicated the mortality rates were not statistically significantly different at the 95% confidence level.

### **Explanatory Variables**

Exposures that may contribute to pre-mature mortality would improve the analysis for this study. The 1997 Gulf War survey collected some of this self-reported information as summarized in Table 3. Individual level information was only available for six months following the survey, according to the privacy restrictions at the time the survey was conducted. Consequently, this data could not be linked with mortality records. No additional information to describe exposures after military service was available for this study.

**Table 3. Exposure variables measured at time of 1997 survey**

<b>Exposure</b>	<b>Gulf War Cohort</b>	<b>Control cohort</b>
Responses	3,113 (73% response rate)	3,439 (60% response rate)
Deployment area:		
minimal conflict areas	57%	73%
conflict areas with arms fire	43%	27%
multiple Gulf War deployments	14%	0
Deployed Jan-Feb 1991	49%	0
Language spoken at home:		
English	84%	76%
French	13%	21%
Years in military:		
<5 yr	2%	2%
6-10 yr	14%	16%
11-15 yr	27%	21%
16-20 yr	28%	26%
21-25 yr	14%	16%
25+ yr	15%	19%
Reported an adverse health outcome	53%	26%

Source: Goss Gilroy 1998 (12)

### **Ethics and Confidentiality**

The protocol for this project was reviewed and was approved by an external Institutional Review Board (QUORUM Review IRB), as part of the Canadian Forces Cancer and Mortality Study. This review was based on adherence to ethical guidelines for record linkage projects in Canada. (16) The record linkage requires some degree of loss of privacy that was considered minimal risk.

In addition, all record linkages conducted by Statistics Canada must be reviewed and approved through a formal application process with the Chief Statistical Officer of Statistics Canada, in accordance with the rules and regulations of the Canadian federal *Statistics Act*. Statistics Canada did not provide an external release of the microdata generated by the record linkage.

Epidemiological staff from DND and VAC were required to have an enhanced security check, take the oath of secrecy, and be declared a "deemed employee" of Statistics Canada. They could then access the anonymized dataset for this study within the secured domain of the federal Research Data Centre to complete the analysis. Statistics Canada staff vetted the output results prior to their release to ensure confidentiality rules were applied to appropriately aggregate the output, in order to avoid any type of disclosure of personal information.

#### 4. Results of Comparisons to other Military Personnel

This section describes the comparison of the Gulf War cohort with the control cohort for all-cause mortality and suicide mortality for the 24-year period (1991-2014). The sex distribution of the cohorts used in this study is described in Table 4. The sex distribution matches the nine-year follow-up (see Section 2), with 5% females in each cohort.

**Table 4. Final counts of 24 year follow-up, by sex**

Sex	Gulf War cohort		Control Cohort		Total	
	N	%	N	%	N	%
Male	4,859	94.8	5,671	94.2	10,530	94.5
Female	268	5.2	348	5.8	616	5.5
Total	5,127	100	6,019	100	11,146	100

The 616 females included in this only represented 5.5% of the entire sample and, over the 24-year period, had 10 deaths and 0 suicides. Because of the small numbers, females were excluded from all further analyses presented in this report. However, unreleased analysis confirmed that this exclusion did not change the results from the male-only analyses presented below.

#### **All-cause Mortality**

Table 5 contains information for each cohort on the number of deaths, and the crude and adjusted mortality rate ratios (MRR).

**Table 5. Male All-cause Mortality Comparison, 1991-2014**

	GW Cohort		Control Group	
	Observed Person-years	Observed deaths	Observed Person-years	Observed deaths
<b>Age groups</b>				
20-24	27,957	16	31,336	15
35-44	41,887	40	47,439	54
45-54	32,391	67	38,092	65
55-64	10,056	49	13,688	74
65-79	1,828	23	2,442	28
<b>Total</b>	114,119	195	132,997	236
<b>Crude MRR</b> (95% CI)	0.96 (0.79 – 1.17)			
<b>Standardized MRR</b> (95% CI)	1.02 (0.84 – 1.23)			

Overall mortality between the two cohorts was similar (adjusted MRR = 1.02, 95% CI = 0.84, 1.23). There was no statistically significant difference in the overall risk of death between those who deployed to the Gulf War and those who were eligible but did not deploy to the Gulf War.

### ***Suicide Mortality***

Table 6 contains information for each cohort on the number of suicide deaths, and the crude and adjusted mortality rate ratios (MRR).

**Table 6. Male Suicide Mortality Comparison, 1991-2014**

	<b>GW Cohort</b>		<b>Control Group</b>	
	Observed Person-years	Observed suicide deaths	Observed Person-years	Observed Suicide deaths
<b>Age groups</b> 20-79	114,119	14	132,997	27
<b>Crude MRR</b> (95% CI)	0.60 (0.29 – 1.19)			
<b>Standardized MRR</b> (95% CI)	0.60 (0.32 – 1.15)			

Overall suicide mortality between the two cohorts was not statistically significantly different (adjusted MRR = 0.60, 95% CI = 0.32, 1.15). Although the risk of suicide for those who deployed to the Gulf War was 40% lower than for the control group of those who were eligible but did not deploy to the Gulf War, this was not a statistically significant difference. The small number of suicides reduced the statistical power and generated wide confidence intervals that overlapped 1.0. This report is not able to make a conclusive statement on the comparison of suicide among the Gulf War cohort compared to the control group.

## 5. Results of Comparisons to the Canadian population

This section describes the comparison of the Gulf War cohort with the Canadian population for all-cause mortality and suicide mortality for the 24-year period (1991-2014). The comparison is repeated for the control group. Because of the very small proportion of women in the cohort (5%), only results for males are presented in this section of the report.

### **All-cause Mortality**

The mortality experience of the two cohorts was compared to that of the general Canadian population. Tables 7 and 8 describe the observed and expected deaths used to produce age Standardized Mortality Ratios (SMRs).

For the Gulf War cohort, all-cause mortality was statistically significantly lower than for the male Canadian population (SMR = 0.56, 95% CI = 0.48 - 0.64).

**Table 7. Male All-cause Mortality Canadian Comparison with Gulf War cohort, 1991-2014**

	Observed Person-years	Observed deaths	Can mortality per 100,000	Expected deaths
<b>Age groups</b>				
20-34	27,957	16	93.6	26
35-44	41,887	40	156.5	66
45-54	32,391	67	347.6	113
55-64	10,056	49	897.0	90
65-79	1,828	23	2,959.1	54
<b>Total</b>		195		349
<b>SMR (95% CI)</b>	0.56 (0.48 - 0.64)			

For the Control cohort, all-cause mortality was also statistically significantly lower than for the male Canadian population (SMR = 0.55, 95% CI = 0.48 - 0.62).

**Table 8. Male All-cause Mortality Canadian Comparison with Control cohort, 1991-2014**

	Observed Person-years	Observed deaths	Can mortality per 100,000	Expected deaths
<b>Age groups</b>				
20-34	31,336	15	93.6	29
35-44	47,439	54	156.5	74
45-54	38,092	65	347.6	132
55-64	13,688	74	897.0	123
65-79	2,442	28	2,959.1	72
<b>Total</b>		236		431
<b>SMR (95% CI)</b>	0.55 (0.48 - 0.62)			

### Suicide Mortality

Comparisons of suicide mortality for the two cohorts was compared to that of the general Canadian population. Tables 9 and 10 described the observed and expected suicide deaths used to produce age Standardized Mortality Ratios (SMRs).

For the Gulf War cohort, suicide mortality was statistically significantly lower than for the male Canadian population (SMR = 0.50, 95% CI = 0.24 - 0.75).

**Table 9. Male Suicide Mortality Canadian Comparison with Gulf War cohort, 1991-2014**

	Observed Person-years	Observed suicide deaths	Can suicides per 100,000	Expected Suicide deaths
<b>Age groups</b>				
20-34	27,957	F	22.3	6
35-44	41,887	F	25.8	11
45-54	32,391	F	26.6	9
55-64	10,056	F	22.5	2
65-79	1,828	F	19.4	0
<b>Total</b>		14		28
<b>SMR (95% CI)</b>	0.50 (0.24 - 0.75)			

F= counts less than 10 suppressed

For the Control cohort, suicide mortality was similar to the male Canadian population (SMR = 0.82, 95% CI = 0.51 - 1.13). There was no statistically significant difference between these groups.

**Table 10. Male Suicide Mortality Canadian Comparison with Control cohort, 1991-2014**

	Observed Person-years	Observed suicide deaths	Can suicides per 100,000	Expected Suicide deaths
<b>Age groups</b>				
20-34	31,336	F	22.3	7
35-44	47,439	F	25.8	12
45-54	38,092	F	26.6	10
55-64	13,688	F	22.5	3
65-79	2,442	F	19.4	1
<b>Total</b>		27		33
<b>SMR (95% CI)</b>	0.82 (0.51 - 1.13)			

F= counts less than 10 suppressed

## 6. Discussion

### Key findings

- There was no significant difference in the overall risk of death between the Gulf War and Control cohorts.
- For both the Gulf War and the Control cohort, there was a statistically significant lower risk of death from all causes of about 50% compared to the general Canadian population.
- For the Gulf War cohort, there was a statistically significant lower risk of suicide of about 50% compared to the general Canadian population; the suicide risk in the Control cohort was similar to the general Canadian population.

### Comparison of 2019 findings with 2005 findings

The key findings of this 24-year follow-up mortality study are consistent with the results of the earlier nine-year Canadian study (see details in Table 11). The additional years of follow-up generated narrower confidence intervals around the MRR and SMR estimates.

Both studies estimated a lower risk of suicide in the Gulf War cohort compared to the general Canadian population, but it required the longer 24-year follow-up period to be conclusive about this difference.

**Table 11. Canadian Gulf War Mortality Study Results**

	<b>1991-1999</b>	<b>1991-2014</b>
All-cause mortality MRR GW:Control	0.97 (0.65 - 1.45)	1.02 (0.84 – 1.23)
Suicide mortality MRR GW:Control	1.17 (0.46 - 2.95)	0.60 (0.32 – 1.15)
All-cause mortality SMR GW:Canadian	0.56* (0.40 - 0.75)	0.56* (0.48 - 0.64)
All-cause mortality SMR Control:Canadian	0.57* (0.43 - 0.75)	0.55* (0.48 - 0.62)
Suicide mortality SMR GW:Canadian	0.76 (0.35 - 1.43)	0.50* (0.24 - 0.75)
Suicide mortality SMR Control:Canadian	0.64 (0.29 - 1.21)	0.82 (0.51 - 1.13)

\*p<=0.05

Sources: Statistics Canada 2005 (11), VanTil 2019

### **International comparison of Gulf War Veterans Studies**

The key findings of this 24-year follow-up mortality study are consistent with the results of the international mortality studies (see details in Table 12). International studies have also updated their follow-up periods.

The international studies consistently report their Gulf War cohorts have similar mortality rates compared to their control groups (MRR). The Gulf War cohorts have lower mortality rates compared to their general populations (SMR), although this was not significant in the smallest study.(17)

**Table 12. Comparisons of International Gulf War Mortality Studies**

Characteristic	Country			
	US (18)	UK (19)	Australia (17)	Canada
<b>Characteristics at time of GW</b>				
Number deployed to GW	621,901	53,409	1,833	5,127
<b>Sex</b>				
Male	93%	98%	98%	95%
Female	7%	2%	2%	5%
Mean age	28.4 yr	27.2 yr	28.1 yr	30.7 yr
Officer Rank	9.5%	11.2%	22.1%	18.7%
<b>Environment</b>				
Land	52%	70%	6%	26%
Air	12%	19%	9%	40%
Sea	22%	10%	85%	33%
Combination/ Marine Corp	15%	1%		
<b>Component</b>				
Regular	90%	96%	NA	100%
Reserve	10%	4%		<1%
<b>Follow-up after GW</b>				
Final year	2004	2015	2010	2014
Length of FU period	13 yr	25 yr	20 yr	24 yr
Number of deaths	10,869	1,746	49	195
All-cause MRR (95%CI)	0.98 (0.97 - 0.99)	0.97 (0.91 - 1.03)	1.37 (0.94 - 2.02)	1.02 (0.84 - 1.23)
All-cause SMR (95%CI)	0.48 (0.47 - 0.49)	0.59 (0.56 - 0.62)	.077 (0.58 - 1.02)	0.56 (0.48 - 0.64)

Sources: Barth 2016 (18), MOD 2016 (19), Sim 2015 (17), VanTil 2019

### ***Strengths and limitations***

The cohort was relatively small in size, but the power of the study was improved by utilizing a 24-year period of follow up. This was evidenced by the narrow confidence intervals for the MRR and SMR estimates.

Because of the very small proportion of women in the cohort (5%), only results for males were compared with Canadian rates. There were too few deaths among females in the study group to make any meaningful interpretation. This limitation was also noted in Australia.(17)

The strength of this study lies in its use of comprehensive administrative datasets to follow these cohorts over a 24-year follow-up period. The death registration system in Canada ensured complete coverage. In addition, suicide deaths were captured using the same mechanism for both Veterans and the general population, and this reduced the potential for misclassification of suicides that could affect the risk.

## **7. Conclusion**

The Gulf War of 1990/91 did not result in higher risk of mortality for those who were deployed compared to military personnel who were not deployed to the Gulf. Canadian military personnel in both these groups were at lower risk of death than comparable Canadians. The 24-year follow-up period provided adequate power for this study to detect excess mortality in the cohort. Similar results were reported by international studies of varying follow-up periods.

Canadians who deployed to the Gulf War have benefitted from the research performed in other jurisdictions. International studies from the US and UK have much larger cohorts that may continue to contribute to the body of available knowledge.

### Canadian Operations in Gulf War

Canada was supportive of the UN recommendations and provided a military response. Canadian deployment was announced August 10, 1990 to establish a military presence in the Persian Gulf in support of Canadian policy.(4)

Canadian operations contributed to the United Nations led Coalition. These operations included a naval task group, air task group, headquarters, and field hospital.

#### **Naval Task Group:**

The naval operation was designated FRICTION, with the initial departure from Halifax August 24, 1990 following ship modifications, refitting helicopters, and training.(4) Canada had a three-ship force: HMCS Athabaskan (DDH 282) as the flagship, HMCS Terra Nova (DDE 259) and HMCS Protecteur (AOR 509).(4) The ships were home base for five Sea King helicopters for surface surveillance. These ships were part of the multinational interception force with the designated task Group number 302.3.(4) The three Canadian ships represented less than 10% of the military force and accounted for 25% of the interceptions responsible for sector Charlie of the Persian Gulf. HMCS Huron arrived in Bahrain on April 24, 1991 and returned to Canada on June 27, 1991.(12)

**Air Task Group:** The air operation was designated SCMITAR. On October 8, 1990, 18 CF-18s from the 409 Squadron stationed in Baden Germany began arriving in Doha Qatar. This force was augmented by personnel and aircrafts from the 421, 437 and 439 squadrons and supported by the 1 Air Maintenance Squadron flying CC-130 Hercules and Boeing 707 to transport personnel and cargo.(4) Compounds called Canada Dry 1 and 2 were set up for accommodations and security, as well as headquarters and infirmary.(12)

**Headquarters:** The joint Headquarters-Canadian Forces Middle East (HQ CANFORME) was located in Manamah, Bahrain.(12) This operation was identified with the designation ACCORD (5) and FRICTION.(4) Headquarters closed April 16, 1991.(4)

**Field Hospital:** The field hospital operation was designated SCALPEL. The 1<sup>st</sup> Canadian Field Hospital was located in Al-Qaysumah and was supported by the British 32 Field Hospital.(12) The field hospital ceased operations on March 3, 1991.(4)

After the war, Canada had follow up operations of ammunition disposal designated as operation AXE(4,12) and MAGNOLIA.(4)

Canada also contributed to international operations:

- UNIKOM to patrol the demilitarized zone, restore Kuwaiti property, assist with water purification (RECORD in Canada)
- PROVIDE COMFORT, ASSIST, REGARD for humanitarian aid in Northern Iraq for the assistance of Kurdish refugees (12)
- UNSCOM to inspect and eliminate weapons of mass destruction (FORUM in Canada)
- Maritime Interdiction Force (MIF) to continue the naval presence in the Persian Gulf to enforce economic sanctions (AUGMENTATION, MERCATOR, FLAG, PREVENTION in Canada).

Operations continued for years after the end of the Gulf War, some continued to the 2003 American-led invasion of Iraq (IRAQI FREEDOM), referred to as the second Gulf War.(5)

In the first Gulf War there were no Canadian deaths from military actions.(4)

### Creation of Gulf War cohort

The Gulf War cohort consisted of all Canadian Armed Forces members deployed to the Gulf War over the period from August 24, 1990 to October 1, 1991.

In 1997, a list of 4,262 personnel who served in the Gulf was generated for a mailed survey. Name, service number, rank, date of birth, SIN, and mailing address were included for deployments from August 1990 to July 1991. Using survey response to a question on GW deployment, 127 of control group members were re-assigned to the GW cohort; 22 were re-assigned to the control group.(10)

In preparation for the 2005 mortality linkage project, people who had died or not had an address at the time of the survey were included in the cohort, increasing the number to 4,476. Using an extended time frame of August 24, 1990 to October 1, 1991, the list was extended and modified by Statistics Canada and DND to include 299 Gulf and Kuwait War veterans identified through UN medals lists. Additional persons were found in other sources: death file search; DND medal list; Camp Doha participation; Unikom participation; Deployment history records; Gulf Deployment; Gulf Medal list. Records missing sex (n=13) and/or DOB (n=20) were excluded. A review using HRMS found 38 duplicate names that were erroneous, not deployed and removed from the list. There were some very young officers in the cohort (e.g. a captain at age 22), and eight subjects who were under age 15 on entry into the cohort. The final Gulf War cohort comprised a total of 5,117 members.(11)

In preparation for the 2019 mortality linkage project, additional names were identified from medals lists, increasing the cohort to 5,185. Of these, 39 did not link with the CFCAMS/VSMS mortality cohort and were dropped as there was no record of military pay going back to 1976. Three were dropped since they had a release date prior to 1990, and 16 were dropped since their first entry into the military pay system was post 1991. The final Gulf War cohort comprised a total of 5,127 members.

### Creation of Control cohort

The Control cohort consisted of a random selection of Canadian Armed Forces members who were eligible to be deployed to the Gulf War but who were not deployed.

In 1997, a list of 5,922 personnel who were a control group for the Gulf War cohort was generated for a mailed survey. The random selection was designed to include more persons than the GW cohort, since a lower response rate to the questionnaire was expected and a target of 3,000 completed questionnaires from each group was determined. Members of the control cohort were randomly selected from members of the Canadian Forces who were eligible for deployment to the Persian Gulf but who were never deployed between August 24, 1990 and October 1, 1991. Eligibility for deployment was dependent on a medical code that varied across occupations and a medical pre-screening process. Some persons considered deployable according to their medical category may not have been deployed following the pre-deployment screening process. This means that although the intent was to match groups according to fitness for deployment, there may have been some selection of healthy personnel in the Gulf War veteran cohort. Self-reported classification of GW/control was used to re-assign 127 Control Group to GW, and 22 from GW reclassified to Control Group. 281 (4.5%) of the original sample of 6,181 were labelled unfit.(10)

In preparation for the 2005 mortality linkage project, people who had died or not had an address at the time of the survey were included in the cohort, increasing the number to 6,223. For the 2005 mortality linkage project, the Control cohort comprised a total of 6,093 military personnel. A difference in the age distribution for the control and Gulf War cohorts was noted.(11)

In preparation for the 2019 mortality linkage project, 6,094 records were sent for linkage. Of these, 32 did not link with the CFCAMS/VSMS mortality cohort and were dropped as there was no record of military pay going back to 1976. 35 were dropped since they had a release date prior to 1990, and eight were dropped since their first entry into the military pay system was post 1991. The final Control cohort comprised a total of 6,019 members.

<b>Military Characteristic</b> (available as of 2014)	<b>GW</b>	<b>Control</b>
<b>Release year</b>	127	297
1991	192	289
1992	158	263
1993	222	285
1994	309	353
1995	307	364
1996	194	251
1997	159	182
1998	146	144
1999	150	159
2000	155	137
2001	130	140
2002	141	150
2003	142	176
2004	145	134
2005	165	166
2006	185	180
2007	161	182
2008	155	177
2009	149	155
2010	133	155
2011	155	163
2012	155	161
2013	142	175
2014		
Serving	1,050	1,181
<b>TOTAL</b>	<b>5,127</b>	<b>6,019</b>
<b>Enrollment Date</b>		
prior to 1976	1,217	1,618
1976-1983	2,128	2,310
1984-1991	1,782	2,091
<b>Sex</b>		
Male	4,859	5,671
Female	268	348

## Record linkage methodology

The record linkage methodology mitigates multiple challenges for mortality surveillance:

- Defining the cohort
- Creating a cohort file
- Data completeness in linked file
- Establishing denominators and comparator populations
- Achieving the complete ascertainment of mortality and/or cancer morbidity
- Changes in ICD-coding over time
- Selecting key explanatory variables
- Adhering to ethics and privacy responsibilities

### Social Data Linkage Environment

Statistics Canada's Social Data Linkage Environment (SDLE) is a highly secure linkage environment that facilitates the creation of linked population data files for social analysis. At the core of the SDLE is a Derived Record Depository (DRD), a national dynamic relational database containing only basic personal identifiers. The DRD is created by linking selected Statistics Canada source index files for the purpose of producing a list of unique individuals. These files, which contain personal identifiers without analysis variables, are brought into the environment, processed and linked only once to the DRD. Updates to these data files are linked to the DRD on an ongoing basis.

This project used a direct, deterministic linkage pass based on SIN and a second linkage pass based on sex, date of birth and name. The second linkage pass allows for missing values and disagreements on the linkage variables. This linkage project is equivalent to a hierarchical deterministic record linkage.

A direct match based on SIN was completed, with a linkage rate of 99.1%. Subsequent linkage used Sex, Date of Birth, and Name. G-Link was used with a set of potential pairs defined to evaluate many different possible situations, such as missing values, typos, initials. This step increased the linkage rate to 99.77%. A final manual review rejected some problematic SIN matches for a final linkage rate of 99.71%.<sup>(14)</sup>

### Identification of the Military Cohort for Linkage

Creation of the cohort file for linkage at Statistics Canada started with extraction of data from the CCPS. Validation and cleaning of this data required screening to identify data abnormalities, evaluate the possibility of misclassification, accuracy and completeness, and editing. The data dictionary provided by the CCPS analysts was used to establish the "in-range" values for the different variables of interest. A random selection of records was compared to data from other sources such as HRMS. In the case of the CFCAMS II data, more important/complicated changes/recoding to the data were discussed and agreed upon by the CFCAMS II epidemiology working group prior to changes being made. This included deciding on the suitability of HRMS data to fill in missing data within the developing cohort file. Whenever changes were made to data, the original data were left uncorrected, and a new version of the variable was created. Furthermore, all changes were also documented both within the dataset and the data dictionary, so as to ensure clarity, transparency and consistency of the data cleaning process.

Military variables for the subset that enrolled since 1976 include years in the military, reason for release, military occupational history, deployment history, rank history. Unfortunately, element (land, sea, air) was missing for about a third of this database.

Evidence on the data quality of the CCPS, comes from the payment of salaries and wages in an accurate and timely manner. This automated system has reduced manual intervention and the risk of errors.(14)

## References

1. Institute of Medicine Committee on Measuring the Health of Persian Gulf Veterans. Gulf War Veterans: Measuring Health [Internet]. Hernandez LM, Durch JS, Blazer DG, Hoverman IV, editors. Washington, DC: National Academies Press (US); 1999 [cited 2019 Dec 2]. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK224706/>
2. Kang HK, Bullman TA, Macfarlane GJ, Gray GC. Mortality among US and UK veterans of the Persian Gulf War: a review. *Occup Environ Med*. 2002 Dec 1;59(12):794–9.
3. Helmkamp JC. United States military casualty comparison during the Persian Gulf War. *J Occup Med Off Publ Ind Med Assoc*. 1994 Jun;36(6):609–15.
4. Morin J, Gimblett R. Operation Friction, 1990-1991 : the Canadian forces in the Persian Gulf [Internet]. Toronto: Dundurn Press; 1997. 162 p. Available: <http://publications.gc.ca/pub?id=9.645912&sl=0>
5. Department National Defence. Past operations [Internet]. aem. 2019 [cited 2019 Nov 14]. Available from: <https://www.canada.ca/en/department-national-defence/services/military-history/history-heritage/past-operations.html>
6. Kang HK, Bullman TA. Mortality among U.S. veterans of the Persian Gulf War. *N Engl J Med*. 1996 Nov 14; 335(20):1498–504.
7. Kang HK, Bullman TA. Mortality among US veterans of the Persian Gulf War: 7-year follow-up. *Am J Epidemiol*. 2001 Sep 1; 154(5):399–405.
8. Macfarlane GJ, Thomas E, Cherry N. Mortality among UK Gulf War veterans. *Lancet* 2000 Jul 1; 356:17–21.
9. Sim M, Abramson M, Forbes A, Glass D, Ikin J, Ittak P, et al. Australian Gulf War veteran's health study [Internet]. Monash University; 2002. Available from: <https://findanexpert.unimelb.edu.au/scholarlywork/256445-australian-gulf-war-veteran%27s-health-study>
10. Goss Gilroy Inc. Health study of Canadian Forces Personnel Involved in the 1991 Conflict in the Persian Gulf; Volume I. Ottawa: Department of National Defence; 1998 Apr.
11. Statistics Canada. Canadian Persian Gulf Cohort Study: Detailed Report. Ottawa: Statistics Canada; 2005 [cited 2019 Nov 14]. Summary report Available from: [http://epe.lac-bac.gc.ca/100/200/301/statcan/cdn\\_persion\\_gulf\\_summary-e/82-580-XIE2005001.pdf](http://epe.lac-bac.gc.ca/100/200/301/statcan/cdn_persion_gulf_summary-e/82-580-XIE2005001.pdf)
12. Goss Gilroy Inc. Health study of Canadian Forces Personnel Involved in the 1991 Conflict in the Persian Gulf; Volume II. Ottawa: Department of National Defence; 1998 Apr.
13. Statistics Canada. Canadian Vital Death Statistics Database (CVSD). 2019 [cited 2019 Dec 9]. Available from: <https://www.statcan.gc.ca/eng/rdc/cvds-nacrs>

14. Rolland-Harris E, VanTil L, Zamorski MA, Boulos D, Reicker A, Masoud H, et al. The Canadian Forces Cancer and Mortality Study II: a longitudinal record-linkage study protocol. *CMAJ Open*. 2018 Dec 4; 6(4):E619–27.
15. Simkus K, VanTil L, Pedlar D. 2017 Veteran Suicide Mortality Study: 1976 to 2012. Charlottetown (PE): Veterans Affairs Canada, Research Directorate Technical Report; 30 November, 2017. Available: <http://www.publications.gc.ca/pub?id=9.847961&sl=0>
16. Canadian Institutes of Health Research. Tri-Council policy statement: ethical conduct for research involving humans. [Internet]. 2018 [cited 2019 Dec 5]. Available from: [http://publications.gc.ca/collections/collection\\_2019/irsc-cihrr/RR4-2-2019-eng.pdf](http://publications.gc.ca/collections/collection_2019/irsc-cihrr/RR4-2-2019-eng.pdf)
17. Sim M, Clarke D, Forbes A, Glass D, Gwini S, Ikin J, et al. Australian Gulf War Veterans' Follow Up Health Study Technical Report 2015. Monash University; 2015 p. 356.
18. Barth SK, Kang HK, Bullman T. All-Cause Mortality Among US Veterans of the Persian Gulf War: 13-Year Follow-up. *Public Health Rep*. 2016 Nov;131(6):822–30.
19. Ministry of Defence. 1990/1991 Gulf Conflict UK Gulf Veterans mortality data: Causes of death. Ministry of Defence; 2016 p. 24.