Cancer Epidemiology 62 (2019) 101563

Contents lists available at ScienceDirect

Cancer Epidemiology

journal homepage: www.elsevier.com/locate/canep

Mortality experience of US veterans following service as international peacekeepers in Bosnia/Kosovo theater, 1996–2002

Tim Bullman*, Aaron Schneiderman

Post Deployment Health Services, US Department of Veterans Affairs, 810 Vermont Ave, Washington DC, 20420, United States

ARTICLE INFO

Keywords:
Veterans
Leukemia
Respiratory disease
Epidemiology

ABSTRACT

Background: Beginning in 1996 US military personnel served as peacekeeping forces in Bosnia/Kosovo. No studies have assessed the long-term post-deployment health of this US cohort. Based on the health concerns raised in studies of military personnel from other countries, this study focused on mortality due to Leukemia, respiratory disease, respiratory cancer, and heart disease.
Methods: This study compared the post-war cause-specific mortality of 53,320 veterans who deployed to Bosnia/Kosovo between 1996–2002 to that of 117,267 veterans who also served in the military between 1996–2002, but were not deployed to Bosnia/Kosovo. Expressed as standardized mortality ratios (SMR)s the cause-specific mortality for both deployed and non-deployed were compared separately to that of the US general population. Cause-specific mortality risks among Bosnia/Kosovo veterans relative to that of non-deployed veterans were assessed using Hazard Ratios (HR)s generated by Cox proportional-hazards models.
Results: The overall mortality of both deployed and non-deployed veterans was almost half that of the US population, SMR = 0.59, 95%, C.I., 0.55–0.62 and SMR = 0.66, 95%, C.I., 0.64–0.68, respectively. Neither group of veterans had any excess of disease related mortality compared to that of the US population. Compared to non-deployed, deployed veterans did not experience any increased risks for any of the diseases of a priori interest.
Conclusion: It does not appear that US military deployed to Bosnia/Kosovo have any increased risks of disease related mortality. However, this study would not have been able to detect increased risk of cancers with latency periods that exceeded the 18 years of follow-up available in this study.

1. Introduction

Beginning in December 1996 US military personnel were deployed to war-torn Bosnia-Herzegovina, located in the former Republic of Yugoslavia. These initial forces served alongside multinational forces as part of Operation Joint Endeavor, which was a North Atlantic Treaty Organization (NATO) led effort to oversee implementation of the Dayton Peace Accords [1]. The provisions of this agreement included enforcing the peace by separating the warring factions that had been embroiled in a civil war since 1992. Operation Joint Endeavor was followed by Operations Joint Guard in December 1996 and Joint Forge in June 1998. Due to ongoing tensions in Kosovo, NATO forces have continued to maintain a presence in Kosovo. As recently as July 2017, 500 US military personnel were deployed to Kosovo due to rising tensions between Kosovo and Serbia [2].

1.1. Potential exposures

Among the potentially hazardous environmental exposures that were present in the Bosnia/Kosovo theater were; 1) high levels of particulates in ambient air due to power plants and factories using coal; 2) heavy metal contamination of soil, crops, and fish; and 3) contamination of water and air, by mercury, sulfur dioxide, and ammonia [3,4]. Much of the contamination of air, soil and water occurred after factories and other industrial facilities were destroyed during the NATO air campaign against Yugoslav forces. The effects of both short term and long-term exposure to particulate air pollution including increased risks of respiratory morbidity and mortality are well documented [5–9]. A study of US forces deployed to Bosnia between 1997 and 1998 reported that time periods of highest measured levels of airborne particulate equal to or less than 10 µm in aerodynamic diameter (PM_{10}) at specific US military camps were associated with increased rates of upper respiratory diseases among the troops stationed at these camps [10]. Another exposure of interest is that of depleted uranium (DU). Due to

* Corresponding author.
E-mail addresses: tim.bullman@va.gov (T. Bullman), aaron.schneiderman@va.gov (A. Schneiderman).

https://doi.org/10.1016/j.canep.2019.07.002
Received 11 December 2018; Received in revised form 12 June 2019; Accepted 1 July 2019
Available online 23 July 2019
1877-7821/

its ability to pierce the armor of tanks, DU was used in some of the NATO artillery ordinance. Although most of the highly radioactive isotopes are removed from DU munitions reducing radioactivity by 40%, upon impact with targets DU munitions release uranium particles into the air where they can be inhaled by nearby personnel [11]. DU exposure may also result from embedded DU shrapnel fragments from ordnance. Concern over the potential exposure to DU in Bosnia/Kosovo conflict was heightened by report of 17 cases of leukemia among 150,000 NATO troops who served in Kosovo [12]. While not assessing specific health outcomes, a study of 46 US military personnel deployed to Bosnia for six months found no DU in their urine [13]. Another study assessing urine uranium (U) levels in a group of veterans, who served in the 1991 Gulf War and subsequent conflicts including Bosnia/Kosovo, detected no elevated U levels among those who did not report DU embedded fragments from service related injuries [14]. Even among a small group of veterans from the 1991 Gulf War with known DU exposure as evidenced by elevated U levels, there were no health effects in organs known to be targeted by U toxicity 25 years after DU exposure [15]. Relying on self-reported DU exposure, a study of UK military personnel who served in the 1991 Gulf War found no increased cancer risk associated with DU exposure [16]. Studies of Swedish, Dutch, Norwegian, and Italian personnel who served in Bosnia/Kosovo, while not directly addressing DU exposure or air contaminants, reported no increased risk of cancer morbidity or mortality associated with Bosnia/Kosovo deployment [17–20]. While there is little evidence for subsequent morbidity or mortality related to DU exposure among military personnel, a study assessing long term mortality outcomes among a cohort of uranium mine workers reported increased risks of deaths due to lung cancer, pneumoconiosis, and emphysema [21,22]. Animal studies have suggested that DU may impact the brain, kidney, and bones and that the risk of cancers may be greater than thought [23]. However, these findings may not be generalizable to the level of DU exposure among the military specifically, or non-military otherwise occupationally exposed.

To date no study has assessed the post-deployment mortality outcomes among US military personnel who served as peacekeepers in Bosnia/Kosovo. This current study was undertaken to determine whether US Bosnia/Kosovo veterans, i.e. those who deployed to Bosnia/Kosovo, are at increased risk for cause-specific mortality of a priori interest. Based on a review of potential exposures that may have been present in the Bosnia/Kosovo theater and reported adverse health outcomes related to these exposures in occupational studies this study focused on respiratory cancers, leukemia, heart diseases, and respiratory diseases.

2. Material and methods

2.1. Identification of study subjects

The cohorts of both deployed veterans, i.e. deployed as part of Bosnia/Kosovo operations, and non-deployed veterans, i.e. served in the military during the same time frame as Bosnia/Kosovo operations but were not deployed to Bosnia/Kosovo, were identified by the Department of Defense (DOD) Army Medical Surveillance Activity (AMSA) using the Defense Medical Surveillance System (DMSS). DMSS is a computerized data base that includes health surveillance data as well as longitudinal deployment data on all military personnel. Military service data for both deployed and non-deployed veterans included beginning and ending dates for all data captures recorded between December 1996 and February 2002. Because both cohorts were selected from those separated between 1996 and 2002, it is assumed that end date of last data capture is equivalent to date of separation from the military. All veterans also had deployment specific data for any deployments, including additional non-Bosnia/Kosovo deployments, between 1996 and 2002. These additional deployments included Haiti, countries in Southwest Asia, and Somalia. Using the DMSS data, 71,200 veterans who deployed to Bosnia/Kosovo and separated from the military between December 1996 and February 2002 were identified. Non-deployed veterans were selected from all those who separated from the military between December 1996 and February 2002, but were not deployed as part of Bosnia/Kosovo operations. It was decided to frequency match non-deployed to deployed veterans using gender, branch of service, and component, i.e. active, reserve or National Guard. Non-deployed were randomly selected from each of the matched stratum until a 2-1 ratio of non-deployed to deployed veterans was achieved, resulting in 142,400 non-deployed comparison group veterans. To better focus on health effects related to Bosnia/Kosovo deployment, veterans who had other deployments including the 1990–1991 Gulf War and Operations Enduring Freedom or Iraqi Freedom (OEF/OIF) through 2014 were removed from this study's deployed and non-deployed groups, resulting in final groups of 53,320 deployed and 117,267 non-deployed. Deployment as part of the 1990–1991 Gulf War or OEF/OIF was determined by using DOD rosters of those veterans.

2.2. Vital status/cause of death ascertainment

Vital status follow-up for deployed veterans began using the latest date found: end date of last data capture or last out of theater date. Follow-up for comparison group veterans began on the end date of last data capture. Follow-up period for both groups ended on earlier of date of death or December 31, 2014. Mortality related data was obtained from the VA Suicide Data Repository (SDR). At the time of matching against the SDR, which relies primarily on data from the National Death Index, cause of death and fact of death was available through 2014, for all veterans who separated from the military since 1974. Underlying cause of death was coded using the International Classification Disease (ICD) code in use at time of death, i.e. ICD-9 or ICD-10.

2.3. Statistical analysis

The data were analyzed in several stages. First, the observed numbers of cause-specific mortality of deployed and non-deployed were compared separately to the expected based on that of the US general population, adjusted for age, race, sex, and calendar year. The ratio of observed to expected is expressed as a standardized mortality ratio (SMR) and 95% confidence intervals (C.I.)s were calculated around each SMR [24]. Crude cause-specific mortality rates per 100,000 Person Years at Risk (PYR) were calculated separately for deployed and non-deployed veterans. Cause-specific mortality risks by Bosnia/Kosovo deployment were further assessed using Cox Proportional Hazards Models generated by SAS® PHREG procedure [25]. The Cox Model, which incorporates time at risk, was used to calculate Hazard Ratios (HR)s that assessed the effect of covariates on risk of cause-specific mortality of a priori interest among Bosnia/Kosovo deployed veterans. Covariates included in the model were: deployment to Bosnia/Kosovo, age at entry to follow-up, race, and gender. Based on the potential environmental exposures that may have been present in Bosnia/Kosovo at the time of deployment, cause-specific mortality of a priori interest that were examined in this study included; 1) respiratory cancers, which included neoplasms of the larynx, trachea, lung, and bronchus; 2) leukemia; 3) respiratory diseases, which included influenza, pneumonia, COPD, silicosis, and asthma; 4) heart disease, which included hypertension with heart disease, ischemic heart disease, chronic disease of endocardium; and 5) other heart disease, which included cerebrovascular disease and hypertension without heart disease. The grouping of individual ICD-9 and ICD-10 codes included in each of the diagnostic groups are defined in the software used to calculate SMRs and can be downloaded from the National Institute of Occupational Safety and Health website that houses the Life Table Analysis System (LTAS) [26].

Table 1
Demographic and Military Service Characteristics By Bosnia/Kosovo Deployment Status of US Military 1996–2002.

	Deployed		Non-Deployed		
	Number (n = 53,320)	Percent	Number (n = 117,267)	%	P-value**
Age at Entry to Follow-Up					< .0001
< =22	7,293	13.7	35,390	30.2	
23-25	15,462	29.0	24,764	21.1	
26-32	18,052	33.9	27,276	23.2	
33+	12,513	23.5	29,837	25.4	
Mean age at Entry	28.9		28.3		
Race					0.0002
White	40,079	75.2	87,269	74.4	
Non-White	13,241	24.8	29,998	25.6	
Sex					0.3344
Male	47,981	90.0	105,702	90.1	
Female	5,339	10.0	11,565	9.9	
Branch of Service					< .0001
Army	29928	56.1	61,413	52.4	
Marines	1,027	1.9	2,121	1.8	
Navy	14,027	26.3	33,158	28.3	
Air Force	8,337	15.6	20,563	17.5	
Coast Guard	*	0	12	0	
Component					< .0001
Active	45068	84.5	104471	89.1	
Reserve	5016	9.4	7453	6.4	
National Guard	3236	6.1	5343	4.6	
Year at Entry to Follow-Up					< .0001
1996	3382	6.3	18608	15.9	
1997	5465	10.2	16367	14.0	
1998	6141	11.5	17278	14.7	
1999	7546	14.1	15777	13.5	
2000	10409	19.5	16358	13.9	
2001	11234	21.1	17144	14.6	
2002	9143	17.2	15735	13.4	
Mean Number of Days of Follow-up	5363.6		5602.2		

* Fewer than 10 observations.
** Chi-squared test.

3. Results

3.1. Demographic/military service characteristics

Table 1 has selected demographic and military service characteristics for deployed and non-deployed veterans. Both groups were similar relative to gender. While the P-value for race indicates the two groups are significantly different regarding race, the difference of only 1% is likely due to the large number of veterans in each group, rather than any meaningful difference in racial composition. Deployed veterans were older than non-deployed veterans at entry to follow-up, 57.4% aged 26 or older compared to 48.6% respectively. Even though deployed and non-deployed were originally matched based on component, a higher percentage of non-deployed veterans had served in active duty units compared to deployed, 89.18% and 84.5% respectively. This disparity is the result of the removal of ineligible veterans, i.e. served as part of other deployments, from originally assembled cohorts of deployed and non-deployed. Non-deployed veterans had a longer follow-up period than deployed, the mean number of days of follow-up for non-deployed was 5602.2 days compared to 5363.6 days for deployed. This disparity in length of follow-up seems to be due in part to non-deployed entering follow-up earlier than deployed.

3.2. Cause-specific mortality risks compared to US population

Table 2 compares the cause-specific mortality rates of both deployed and non-deployed veterans separately to the expected based on the US population, adjusted for race, sex, and calendar year. The overall mortality risk of both deployed and non-deployed veterans was almost half that of the US population, SMR = 0.59; (95%, C.I., 0.55–0.62) and SMR = 0.66; (95%, C.I., 0.64–0.68), respectively. Among deployed there was a small excess in leukemia deaths, SMR = 1.02, however the 95% C.I. included 1, (95%, C.I., 0.58–1.65). With the exception of leukemia among deployed veterans the mortality risks of both deployed and non-deployed veterans for the diseases examined were less than that of the US population. While not presented in Table 2, 119 other cause-specific mortality comparisons of veterans to US population were made with no excess in any disease mortality observed for either deployed or non-deployed veterans.

3.3. Mortality risks associated with deployment

Table 3 provides various assessments of cause-specific mortality risks associated with deployment to Bosnia/Kosovo. With the exceptions of leukemia and respiratory disease, crude rates for cause-specific mortality were higher among non-deployed than deployed. The resultant HRs from Cox Proportional Hazards models assessing cause-specific mortality risk associated with deployment, adjusted for age, sex, and race are also presented. Compared to non-deployed veterans, deployed veterans had decreased risk of overall mortality, HR = 0.82; (95%, C.I., 0.76-0.87), however the cause-specific mortality risks for the diseases of interest based on confidence intervals may be similar for both groups.

Table 2
Observed to Expected Cause Specific Mortality Comparisons By Bosnia/Kosovo Deployment Status Among US Military.

Cause of Death[a]	Deployed (n = 53,320)			Non-Deployed (n = 117,267)		
	Obs	SMR[b]	95% CI***	Obs	SMR[b]	95% CI***
All Deaths	1114	0.59	0.55–0.62	3215	0.66	0.64–0.68
Respiratory Cancers	40	0.53	0.38–0.72	131	0.54	0.45–0.64
Leukemia	16	1.02	0.58–1.65	30	0.72	0.49–1.03
Heart Diseases	145	0.47	0.40–0.56	384	0.45	0.41–0.50
Other Circulatory	37	0.44	0.31–0.60	102	0.45	0.37–0.55
Respiratory Diseases	24	0.40	0.25–0.59	54	0.30	0.23–0.40

Abbreviation: CI, confidence interval; SMRstandardized mortality ratio.
***95% Confidence Interval (C.I.).
[a] The grouping of individual ICD-9 and ICD-10 codes included in each of the diagnostic groups are defined in the software used to calculate SMRs and can be downloaded from the National Institute of Occupational Safety and Health website that houses the Life Table Analysis System (LTAS). www.cdc.gov/niosh/ltas/rates.
[b] Standardized Mortality Ratio (SMR) is the ratio of observed to the expected based on the US population, adjusted for age, sex, race, and calendar year.

Table 3
Cause Specific Mortality Risk by Bosnia/Kosovo Deployment Status Among US Military.

Cause-Specific Mortality*	Deployed # (Crude Rate)**	Non-Deployed # (Crude Rate)**	Hazard Ratio***	P-value****	95% CI*****
All Causes	1114 (142.2)	3215 (178.1)	0.82	< .0001	0.76–0.87
Respiratory Cancers	40 (5.1)	131 (7.3)	0.96	0.83	0.67–1.38
Leukemia	16 (2.0)	30 (1.7)	1.24	0.48	0.68–2.29
Respiratory Disease	24 (3.1)	54 (3.0)	1.16	0.55	0.71–1.89
Heart Disease	145 (18.5)	384 (21.3)	1.02	0.87	0.84–1.23
Other Heart Disease	37 (4.7)	102 (5.7)	0.91	0.64	0.63–1.33

Abbreviation: CI, confidence interval.

* The grouping of individual ICD-9 and ICD-10 codes included in each of the diagnostic groups are defined in the software used to calculate SMRs and can be downloaded from the National Institute of Occupational Safety and Health website that houses the Life Table Analysis System (LTAS). www.cdc.gov/niosh/ltas/rates.

** Crude Rate per 100,000 Person Years at Risk.

*** Hazard Ratio for deployed derived from Cox Proportional Hazards Model adjusted for age, sex, and race.

**** Chi-squared test.

***** 95% Confidence Interval (C.I.).

4. Discussion

This study assessed the cause-specific mortality risks of veterans who were deployed to Bosnia/Kosovo between 1996 and 2002. Comparison groups included both the US population and veterans who were in the military between 1996 and 2002, but were not deployed to Bosnia/Kosovo. Of particular interest to this study were deaths due to respiratory disease, respiratory cancers, heart disease, and leukemia. Compared to the US population, Bosnia/Kosovo veterans were at decreased risk of overall mortality, as well as disease related mortality, including those of interest to this study. Non-deployed veterans were likewise at lower risk for mortality due to examined causes than the US population. This observation, known as the “healthy soldier effect”, has been reported in other studies where veteran groups are compared to the US population. Because of health screening required to enter and remain in the military and the ease of access to medical care while in the military, active duty military, as well as veterans, are healthier than the US population [27,28]. Comparing deployed directly to non-deployed veterans, there were no statistically significant increased risks of cause-specific morality of a priori interest after 15 years of follow-up. However, there was a small but not statistically significant increased risk of leukemia among deployed compared to US population, SMR = 1.02; (95%, C.I., 0.58,1.65), whereas no such excess was found among non-deployed. Deployed also had an increased risk of leukemia compared to nod-deployed, but this was not statistically significant HR = 1.24; (95%, C.I., 0.68,2.29). The observed increased risks of leukemia among deployed would suggest that risk of leukemia may be associated with deployment to Bosnia/Kosovo. However, with C.I.s for both the SMR and HR for leukemia that included 1.00, the risk for leukemia among deployed may have been the same or even less than the estimates calculated for both the US population and non-deployed veterans.

The lack of an association between deployment to Bosnia/Kosovo and risk of disease related mortality reported in this study is replicated by studies of other cohorts of military personnel who served in Bosnia/Kosovo [17–20]. Like this current study, these earlier studies also had relatively short periods of follow-up, i.e. had a maximum of 15 years, and therefore they may not have been able to demonstrate increased risks of cancers that had longer latency periods. Estimates of lung cancer latency have ranged from 13.7 years based on modeling [29] to 20 to 30 years based on a study of cohorts of manufacturing and construction workers [30]. With a maximum follow-up period of 18 years, this current study may not have been able to discern an increased risk of lung cancer mortality due to service in Bosnia/Kosovo. Because leukemia has a 61.4% survival rate five years after diagnosis, all leukemia diagnoses related to Bosnia/Kosovo deployment might not be captured by only 18 years of mortality follow-up [31]. However, the Centers for Disease Control and Prevention and the National Academies of Science reviewed studies conducted over a 50 year period, some of which had lengthy follow-up periods, none of which suggested an association between occupational Uranium exposure and risk of cancer [32].

The primary strength of this study was the ability to identify all veterans who had deployed to Bosnia/Kosovo and non-deployed veterans with contemporaneous service. This study was also enhanced by removing those veterans who had deployments other than Bosnia/Kosovo. The primary limitation to this study is lack of specific exposure data, such as PM_{10} or measures of other air contaminants that could be linked to data on location and duration of service. Data relative to DU exposure, such as; having assigned duties while in the military that may have increased risk of exposure to DU; self-reported DU exposure data; or biomarkers for DU exposure were also not available. It has been suggested that studies of lead and other metal exposures, which may be similar to DU exposure relative to route of exposure, target organs, and chemistry, may provide some insight into the effect of DU exposure among Bosnia/Kosovo veterans [33]. If in fact DU exposure is related to cause-specific mortality risk among Bosnia/Kosovo veterans, then the analysis of both exposed and unexposed veterans as a single ‘exposed’ group would tend to diminish risk of leukemia.

5. Conclusion

This is the first study to examine the cause-specific mortality risks of US veterans who were deployed to Bosnia/Kosovo; and the findings do not support an association between deployment to Bosnia/Kosovo and risk of respiratory diseases, circulatory diseases, respiratory cancers, or leukemia. However, continued follow-up for this cohort is warranted, given the duration of follow-up observed in this analysis may preclude detecting increases in cancer mortality for those cancers with longer latency period or cancers with high survival rates 20 or more years after diagnosis. While not available for this study, future studies of risk of leukemia associated with DU exposure would be greatly enhanced by having DU exposure. The lack of DU exposure data in this study, which would have identified exposed and unexposed veterans, may have precluded finding a statistically significant association between deployment to Bosnia/Kosovo and risk of leukemia.

Funding

US Department Of Veterans Affairs.

Authors’ contributions

Both authors made substantial contributions to study design, data collection, data analysis, and manuscript preparation, and have approved this final version being submitted to your journal.

Declaration of Competing Interest

Neither I nor my co-author have affiliations with any organizations with a direct or indirect financial interest in the subject matter presented in the manuscript.

References

[1] Phillips R. Bosnia-Herzegovina, The US Army's Role in Peace Enforcement Operations 1995–2004. U.S. Army Center of Military History (CMHD), US Department of the Army, CMHD Publication, 2005 70-97-1.

[2] M. Egnash, US Soldiers Deploy to Kosovo Amid Enduring Tensions, Stars and Stripes News, 2017 Available at: www.stripes.com/news.europe/us-soldiers-deploy-to-kosovo-amid-enduring-tensions ; (Accessed July 12, 2018).

[3] J. Kirkpatrick, The impact of US military operations in Kuwait, Bosnia, and Kosovo (1991–2000) on environmental health Surveillance, Mil. Med. 176 (7) (2011) 41–45.

[4] Committee on the Environmental Planning and Local Authorities, Environmental Impact of the War in Yugoslavia on South-East Europe, Parliamentary Assembly of Council of Europe. Document 8925, 2001 Available at:http://www.assembly.coe.int/nw/xml/XRef/X2H-Xref- (Accessed June 7, 2018).

[5] M. Li, L. Fan, B. Mao, et al., Short-term exposure to ambient fine particulate matter increases hospitalizations and mortality in COPD, Chest 149 (2) (2016) 447–458.

[6] C. Pope, R. Burnett, M. Thun, et al., Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution, JAMA 287 (9) (2002) 1132–1141.

[7] D. Dockerty, C. Pope, X. Xu, et al., An association between air pollution and mortality in six US cities, N. Engl. Med. 329 (24) (1993) 1753–1759.

[8] J. Sunyer, J. Castellsague, M. Saez, A. Tobias, J. Anto, Air pollution and mortality in Barcelona, J. Epidemiol. Commun. Health 50 (Suppl1) (1996) s76–s80.

[9] M. Vigotti, G. Rossi, L. Bisanti, A. Zanobetti, J. Schwartz, Short term effects of urban air pollution on respiratory health in Milan, Italy, 1980–89, J. Epidemiol. Commun. Health 50 (suppl 1) (1996) s71–s75.

[10] D. Hasting, S. Jardine, The relationship between air particulate levels and upper respiratory disease in soldiers deployed to Bosnia (1997–1998), Mil. Med. 167 (2002) 296–303.

[11] A. Bleise, P. Danesi, W. Burkart, Properties, use and health effects of depleted uranium (DU): a general overview, J. Enviorn. Radio 64 (2003) 93–112.

[12] Anon, Mixed messages about depleted uranium [editorial], Lancet Oncol. 2 (2) (2001) 65.

[13] L. May, J. Heller, Y. Kalinsky, et al., Military deployment human exposure assessment: urine total and isotopic uranium sampling results, J. Tox. Environ. Health Part A 67 (2004) 697–714.

[14] C. Dorsey, S. Engelhardt, K. Squibb, M. McDiarmid, Biological monitoring for depleted uranium exposure in US veterans, Environ. Health Perspect. 117 (6) (2009) 953–956.

[15] M. McDiarmid, J. Gaitens, S. Hines, et al., The US Department of Veterans Affairs depleted uranium exposed cohort at 25 years: longitudinal surveillance results, Environ. Res. 152 (2017) 175–184.

[16] G. Macfarlane, M. Biggs, N. Maconochie, et al., Incidence of cancer among UK Gulf War veterans: cohort study, BMJ 327 (2003) 1–5.

[17] P. Gustavsson, M. Talback, A. Lundin, B. Lagercrantz, P. Gyllestad, L. Fornell, Incidence of cancer among Swedish military and civil personnel involved in UN missions in the Balkans 1989–99, Occup. Environ. Med. 61 (2004) 171–173.

[18] R. Bogers, F. Leeuwen, L. Grievink, L. Schouten, L. Kiemeney, D. Schram-Bijkerk, Cancer incidence in Dutch Balkan veterans, Cancer Epidemiol. 37 (2013) 550–555.

[19] L. Strand, J. Martinsen, E. Borud, Cancer risk and all-cause mortality among Norwegian military United Nations peacekeepers deployed to Kosovo between 1999–2011, Cancer Epidemiol. 38 (2014) 364–368.

[20] M. Peragallo, F. Lista, G. Sarnicola, F. Marmo, A. Vecchione, Cancer surveillance in Italian army peacekeeping troops deployed in Bosnia and Kosovo, 1996–2007: Preliminary results, Cancer Epidemiol. 34 (2010) 47–54.

[21] R. Roscoe, J. Deddens, A. Salvan, T. Schnorr, Mortality among Navajo uranium miners, Am. J. Public Health 85 (1995) 535–540.

[22] R. Roscoe, An update of mortality from all causes among white uranium miners from the Colorado Plateau study group, J. Occup. Med. 31 (1997) 211–222.

[23] W. Briner, The toxicity of depleted uranium, Int. J. Environ. Res. Public Health 7 (2010) 303–313.

[24] M. Schubauer-Berigan, W. Raudabaugh, A. Ruder, et al., LTAS.NET: a NIOSH life table analysis system for the windows environment, Ann. Epidemiol. 15 (8) (2005) 656.

[25] SAS Institute, SAS/STAT® 9.3 Users Guide, SAS Institute Inc., Cary, NC, 2011.

[26] National Institute of Occupational Safety and Health (NIOSH), US Department of Health and Human Services, Washington DC. Available at: www.cdc.gov/niosh/ltas/rates ; (Accessed August 8, 2018) (2019).

[27] H. Kang, T. Bullman, Mortality among US veterans of the Persian Gulf War, N. Eng. J. Med. 335 (1996) 1498–1505.

[28] R. McLaughlin, L. Nielson, M. Waller, An evaluation of the effect of military service on mortality: quantifying the healthy soldier effect, Ann. Epidemiol. 18 (2008) 928–936.

[29] D. Nadler, I. Zurbenko, Developing a weibull model extension to estimate cancer latency, ISRN Epidemiol. 2013 (2013) 1–6.

[30] S. Ahn, K. Jeong, Epidemiologic characteristics of compensated occupational lung cancers among Korean workers, J. Korean Med. Sci. 29 (2014) 1473–1481.

[31] National Institutes of Health, National Cancer Institute, Surveillance, Epidemiology, and End Results (SEER), (2019) (Accessed 3/7/2019), https://seer.cancer.gov/statfacts/html/leuks.html.

[32] M. McDiarmid, Depleted uranium and public health fifty years' study of occupational exposure provides little evidence of cancer, BMJ 322 (2001) 123–124.

[33] W. Briner, The evolution of depleted uranium as an environmental risk factor: lessons from Other metals, Int. J. Environ. Res. Public Health 3 (2) (2006) 129–135.