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Cancer risk and all-cause mortality among Norwegian military United Nations peacekeepers deployed to Kosovo between 1999 and 2011

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ABSTRACT

Objective: Media reports of leukaemia and other cancers among European United Nations (UN) peacekeepers who served in the Balkans, and a scientific finding of excess Hodgkin lymphoma among Italian UN peacekeepers who served in Bosnia, suggested a link between cancer incidence and depleted uranium (DU) exposure. This spurred several studies on cancer risk among UN peacekeepers who served in the Balkans. Although these studies turned out to be negative, the debate about possible cancers and other health risks caused by DU exposure continues. The aim of the present study was to investigate cancer incidence and all-cause mortality in a cohort of 6076 (4.4% women) Norwegian military UN peacekeepers deployed to Kosovo between 1999 and 2011.
Methods: The cohort was followed for cancer incidence and mortality from 1999 to 2011. Standardised incidence ratios for cancer (SIR) and mortality ratios (SMR) were calculated from national rates.
Results: Sixty-nine cancer cases and 38 deaths were observed during follow-up. Cancer incidence in the cohort was similar to that in the general Norwegian population. No cancers in the overall cohort significantly exceeded incidence rates in the general Norwegian population, but there was an elevated SIR for melanoma of skin in men of 1.90 (95% confidence interval [CI] 0.95–3.40). A fivefold increased incidence of bladder cancer was observed among men who served in Kosovo for ≥1 year, based on 2 excess cases (SIR = 5.27; 95% CI 1.09–15.4). All-cause mortality was half the expected rate (SMR = 0.49; 95% CI 0.35–0.67).
Conclusion: Our study did not support the suggestion that UN peacekeeping service in Kosovo is associated with increased cancer risk.

1. Introduction

The use of munitions containing depleted uranium (DU) during the First Gulf War and the Balkans conflict has raised concerns about the possible health risks of DU exposure for troops who served in these areas. Natural uranium is only weakly radioactive, and is as abundant in nature as molybdenum and arsenic. In the production of DU, most of the highly radioactive isotopes are removed, reducing the radioactivity by 40% [1]. Upon impact with armoured targets, DU releases uranium particles into the air, after which nearby personnel can be exposed through inhalation [1].

In 1999, before the arrival of Norwegian military United Nations (UN) peacekeepers, a total of 10 tonnes of DU were fired during 98 air strikes at 86 different targets in Kosovo [2]. Post-conflict field investigation of the environmental impact of DU in strike areas revealed no alarming levels of DU contamination [3,4]. However, media reports in 2000 and 2001 on the incidence of leukaemia and other cancers among European soldiers who served in the Balkans [5–8], as well as a scientific report of an elevated rate of Hodgkin lymphoma among Italian UN peacekeepers who served in Bosnia [9] raised the question of a causal relationship between DU exposure and cancer incidence. However, it was found after extended follow-up that the elevated cancer risk previously reported among Italian UN peacekeepers was restricted to the year 2000, was lacking in peacekeepers who served in Kosovo, and was also evident among troops who were not deployed to Kosovo, leading Peragallo et al. to conclude that the previous finding was a sporadic event [9].

Similar studies with shorter follow-up times were also performed among Swedish [10] and Danish [11] UN peacekeepers

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who served in the Balkans. The average follow-up time in the Swedish and Danish studies was only 4.8 and 6.7 years, respectively, but revealed no elevated cancer risk. Nevertheless, the media continued to report on the cancer risk associated with DU exposure [12,13]. Short-term follow-up after radioactive exposure may only reveal excess lympho-haematopoietic cancers; therefore longer follow-up is needed for solid tumours. Recently, a study on cancer incidence in Dutch Balkan peacekeepers followed for a median of 11 years revealed lower cancer incidence among the veterans, as compared to both non-deployed military personnel and the Dutch population [14]. Given the recent attention in the Norwegian media to a possible link between brain cancer and UN peacekeeping service in Kosovo, we aimed to determine the cancer risk in a cohort of Norwegian UN peacekeepers who served in Kosovo and were followed for an average of 10.6 years.

2. Materials and methods

A cohort of 6076 Norwegian UN peacekeepers who were deployed to Kosovo between 1999 and 2011 (5808 men and 268 women) was established by the National Conscript Service of the Norwegian Armed Forces. Year of birth in the cohort ranged from 1941 to 1984, and median age at start of service in Kosovo was 23.5 years (interquartile range (IQR) 8.7) for men and 26.0 (IQR 7.6) for women. Average duration of service in Kosovo was 10.3 months for both sexes. Cohort characteristics are presented in Table 1.

We had no information on DU exposure or other potentially harmful exposures in Kosovo. Thus, service in Kosovo was used as a surrogate for exposure, and duration of service as a surrogate for dose.

Data on vital status and emigration for the cohort was available from the National Population Register. Information on cancer diagnoses and date of diagnosis in the cohort were obtained by linkage to the Cancer Registry of Norway, which is regarded as virtually complete for Norwegian citizens as from 1953 [15]. The linkage was based on the 11-digit unique personal identification number assigned to all Norwegian citizens at birth. The Cancer Registry of Norway uses the International Classification of Diseases (ICD), 7th Revision to classify and register cancers; therefore the same classification was used in this study. Cohort members were followed up from their first day of service in Kosovo, until date of emigration, death, or the end of follow-up (December 31, 2011), whichever occurred first.

Table 1
Demographic and service characteristics of the cohort of Norwegian United Nations peacekeepers who served in Kosovo during 1999–2011. IQR, interquartile range.

Characteristics	*N*	%
Total cohort	6076	100
Men	5808	95.6
Women	268	4.4
Died during follow-up	38	0.6
Emigrated during follow-up	75	1.2
Year of birth		
1940–1949	66	1.1
1950–1959	257	4.2
1960–1969	973	16.0
>1970	4780	78.7
Year deployed to Kosovo		
1999	1404	23.1
2000	1691	27.8
2001	1090	17.9
≥2002	1891	31.1
Age at deployment to Kosovo (years)	Range	Median (IQR)
Men	19–59	23.5 (8.7)
Women	19–51	26.0 (7.6)
Duration of service in Kosovo (months)		
Total duration – men	0.3–41	8.8 (6.0)
Total duration – women	1.5–27	9.5 (6.0)
<1 year (both sexes, *N* = 3402)	0.3–11.9	7.5 (2.5)
≥1 year (both sexes, *N* = 2674)	12.0–41	13.0 (2.4)
Age et end of follow-up (years)		
Men	27–70	34.9 (8.9)
Women	28–61	36.3 (7.2)

The expected number of cancers and all causes of death combined were computed from the national 1-year age-specific and 5-year period-specific rates among all Norwegian men and women. The observed number from the cohort was then compared to the expected number, and standardised incidence ratios (SIRs) for cancer and standardised mortality ratios (SMRs) for all causes of death combined with corresponding 95% confidence intervals (CI) were calculated based on the assumption of a Poisson distribution of the observed events [16].

SIRs and SMRs were computed for male and female cohort members separately, regardless of their duration of service in Kosovo. SIRs were also computed for men according to duration of service in Kosovo, assuming that cancer risk might increase with increasing length of service if carcinogenic agents were present in Kosovo. Due to the fact that our cohort members had relatively short durations of service in Kosovo, a cut-off of 1 year was chosen for comparison within the cohort (duration of service <1 year, short-term service; and ≥1 year, longer-term service). Initially, all personnel were followed-up from their first day in Kosovo. Those who continued their service for 1 year or more were followed as long-term workers from this point onwards. Poisson regression was used then to compare the rates of cohort members with short-term and longer-term service in Kosovo. Observation period and age at risk were included in the models. Rate ratios (RR) were calculated for cohort members with longer-term service, using those with short-term service as the reference group. Stata software package version 12 was used for analysis (Stata Corporation, College Station, TX, USA).

3. Results

During follow-up, 61,739 person-years were accumulated for male UN peacekeepers and 2729 for female UN peacekeepers, during which 69 incident cancers – 67 in men and two in women – were observed. The two cancers observed in women (one breast cancer and cancer of cervix uteri) rendered a SIR of 0.55 (95% CI: 0.07–1.98) for all cancer sites combined (*N* = 268, 2729 person-years, mean follow-up time 10.3 years) (data not shown). The SIRs for all cancer sites combined, as well as for specified cancer sites in male UN peacekeepers are shown in Table 2. The 67 observed cancers versus the 64.21 expected cancers yielded a SIR of 1.04 (95% CI 0.81–1.33). No SIRs deviated significantly from the national rates, but the almost doubled risk of malignant melanoma was bordering on statistical significance, based on 11 cases in the cohort (SIR 1.90, 95% CI: 0.95–3.40). Testicular cancer was the most frequent cancer observed in the cohort, but remained close to the expected number (16 observed versus 17.2 expected). There were nine lympho-haematopoietic cancers observed in the cohort (the number of lymphomas, leukaemias and myelomas combined), which was also on par with the expected numbers (8.86) (Table 2). A total of 38 deaths were observed during follow-up, whereof one in women. The 38 observed deaths versus the 77.5 expected gave an all-cause SMR of 0.49 (95% CI 0.35–0.67).

The results by duration of service in Kosovo showed that all three observed bladder cancers occurred among cohort members with longer-term service, increasing the risk fivefold for this