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Cancer incidence and all-cause mortality in a cohort of 21 582 Norwegian military peacekeepers deployed to Lebanon during 1978–1998

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ABSTRACT

Objective: We investigated cancer incidence and all-cause mortality among 21 582 Norwegian male military peacekeepers deployed to Lebanon during 1978–1998. We also looked at cancer risk according to duration of service in Lebanon, in the occupational groups of cooks and mechanics, and the risk of alcohol- and smoking-related cancers among those who served during high- or low-conflict periods.
Methods: The cohort was followed for cancer incidence and all-cause mortality from 1978 through 2012. Standardised incidence ratios (SIR) for cancer and mortality ratios (SMR) were calculated from national rates for the total cohort. SIRs were calculated according to duration of service; among cooks and mechanics; and according to high- and low-conflict exposure. Poisson regression, expressed as rate ratio (RR), was used to see the effect of duration of service, and of conflict exposure.
Results: A decreased risk was found for cancer incidence overall (1050 cases, SIR = 0.90, 95% confidence interval [CI] 0.84–0.95) and for cancers of the prostate (SIR = 0.78) and skin (other than melanoma) (SIR = 0.58). The incidence of rectal cancer was 73% higher in those who served for 1 year or more than in those with shorter-term service (RR = 1.73, 95% CI 1.00–3.02). The cancer risk in cooks and mechanics was within expected values. The risk of lung cancer was higher in the high-conflict exposure group than in the low-conflict exposure group (RR = 1.79; 95% CI 1.00–3.18). In the total cohort, all-cause mortality was lower than expected (SMR = 0.83; 95% CI 0.78–0.88).
Conclusion: We found a "healthy soldier effect" for overall cancer incidence and all-cause mortality. Service during high-conflict periods was associated with a higher risk of lung cancer than service during low-conflict periods, but this risk was in line with that of the reference population.

1. Introduction

The United Nations Security Council established the United Nations Interim Force in Lebanon (UNIFIL) in March 1978 to confirm Israeli withdrawal from Lebanon, restore international peace and security, and to assist the Lebanese Government in restoring its effective authority in the area [1]. Norwegian peacekeepers were deployed to Lebanon from 1978 through 1998. The level of conflict during this period varied; during the first 9 years it was relatively high, with incidents such as combat with the Palestine Liberation Organisation, attacks on UNIFIL headquarters in Naqoura, the crash of a Norwegian helicopter, an Israeli invasion in South Lebanon, the massacres of Palestinian refugees in the Sabra and Shatila refugee camps, and the kidnapping and killing of UNIFIL soldiers. After 1987, the level of conflict was lower, with the exception of two incidents: the Israeli operations "Accountability" (July 1993) and "Grapes of Wrath" (April 1996) [2–4].

Peacekeepers serving as cooks or mechanics may be exposed to hazardous chemicals. Indeed, the cooking process can produce emissions of carcinogenic compounds and is linked to an increased risk of lung cancer in chefs and kitchen workers [5,6]. Elevated

Abbreviations: UNIFIL, United Nations Interim Force in Lebanon; SIR, standardised incidence ratio; SMR, standardised mortality ratio; RR, rate ratio; CI, confidence interval; ICD-7, International Classification of Diseases, Revision 7.

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rates of lung cancer were reported among British Royal Army cooks [7], and among Chinese non-smoking women exposed to cooking oil vapours [8]. Mechanics in Lebanon conducted maintenance and repair, mostly on vehicles and generators. The main source of hazardous exposure in this occupational group was through inhalation of diesel exhaust, vapours and exhaust from benzene-containing gasoline, and dermal absorption of benzene from gasoline.

Diesel exhaust is classified as carcinogenic to the lung and urinary bladder [9], and there is a positive association between benzene exposure and lympho-haematopoietic cancers [10]. Higher risk of pancreatic cancer among men having worked as "machinery mechanics and fitters" [11], and elevated haemato-poietic cancer mortality among vehicle mechanics [12] have been observed.

Heavy alcohol consumption and binge-drinking have been a concern within the military [13], and links between traumatic stress during military service, post-traumatic stress symptoms, and alcohol abuse have been demonstrated [14]. Smoking may also be mediated by traumatic stress, and a positive relationship between exposure to trauma and smoking has been shown in several studies [15–17], including one on Vietnam veterans [18]. Norwegian peacekeepers who served in Lebanon during high-conflict periods would have experienced a more traumatic and stressful service resulting from the higher risk of being injured or killed, and/or from the perception of civilian suffering, which may have led to higher alcohol consumption and smoking rates among these peacekeepers than those who served during more peaceful periods. We hypothesise that if this is the case, the incidence of alcohol-related cancers and lung cancer will be higher in the high-conflict exposure group.

The aim of our study was to investigate cancer incidence and all-cause mortality in a cohort of Norwegian male UNIFIL peacekeepers, as well as cancer risk according to duration of service in Lebanon, in the occupational groups of cooks and mechanics, and risk of alcohol- and smoking-related cancers among those who served during high- and low-conflict periods. Our study is the first study on cancer risk and all-cause mortality among military peacekeepers deployed to Lebanon.

2. Materials and methods

2.1. Study population

The National Conscript Service of the Norwegian Armed Forces has established a cohort of 21 606 men deployed to Lebanon from March 1978 until the withdrawal of the Norwegian forces in November 1998. The cohort is regarded as virtually complete. Twenty-four men who emigrated before deployment were removed, leaving a cohort of 21 582 men eligible for this analysis. Year of birth spanned 1921–1978, and median age at start of service in Lebanon was 22.8 years. Each deployment lasted approximately 6 months, and 41.1% of the peacekeepers were deployed twice or more (Table 1). Average duration of service in Lebanon was 10 months (standard deviation 5.5), computed cumulatively, including all the deployments to Lebanon of each member of the cohort.

2.2. Follow-up for cancer incidence and all-cause mortality

Cancer diagnoses and dates of diagnosis were obtained by linkage to the Cancer Registry of Norway. The registry is regarded as complete, due to compulsory reporting by clinicians and pathology laboratories. Cancer was classified according to International Classification of Diseases, 7th revision (ICD-7), as registered by the Cancer Registry of Norway, and one individual may have more than one cancer diagnosis. Information on death and emigration was obtained by linkage to the National Population Register, which is continuously updated for the whole Norwegian population. Linkages were performed based on the 11-digit unique personal identification numbers given to all citizens of Norway alive in 1960 or born later. All cohort members were followed for incident cancers and death from their first date of service in Lebanon, until date of death, date of emigration, or end of follow-up (31 December 2012), whichever came first. Follow-up was complete for all cohort members.

Table 1
Demographic and service characteristics of the cohort of Norwegian United Nations male peacekeepers deployed to Lebanon during 1978–1998.

Characteristics	*N*	%
Original cohort	21 606	
Excluded: Emigrated before start of follow-up	24	
Total cohort included in analyses	21 582	100
Died during follow-up	1118	5.2
Emigrated during follow-up	496	2.3
Year of birth		
1921–1939	699	3.2
1940–1949	1415	6.6
1950–1959	5363	24.8
1960–1969	10 755	49.8
>1970	3350	15.5
Year of first deployment		
1978–1980	4304	19.9
1981–1983	3329	15.4
1984–1986	3323	15.4
1987–1989	3559	16.5
1990–1992	3242	15.0
1993–1995	2441	11.3
1996–1998	1384	6.4
No. of deployments*		
1 deployment	12 722	58.9
2 deployments	6338	29.4
≥3 deployments	2522	11.7
Age at first deployment (years)	Range	Median (IQR)
Total cohort	18–59	22.8 (5.4)
High-conflict exposure group (*N* = 12 355)	18–59	22.8 (6.1)
Low-conflict exposure group (*N* = 9227)	19–59	22.9 (4.5)
Cooks (*N* = 839)	19–50	22.4 (4.2)
Mechanics (*N* = 1328)	19–54	23.0 (3.9)
Age at end of follow-up (years)	20–90	49.3 (10.4)

* Nearly all deployments lasted approx. Six months (median 187 days).
IQR = interquartile range.

2.3. Alcohol-related cancers and lung cancer

Alcohol-related cancers were defined as liver cancer (ICD-7 code 155) and cancers of the upper aerodigestive tract, which includes cancer of the tongue (code 141), mouth (codes 143 and 144), pharynx (codes 145–148), oesophagus (code 150), and larynx (code 161), as per previous studies also using ICD-7 [19–22]. Smoking accounts for approximately 90% of lung cancer cases in men [23]. We therefore assumed that any variation in lung cancer incidence within our cohort, which was most likely not exposed to occupational lung carcinogens, was due to smoking.

2.4. Occupational groups and conflict groups

The occupational group "cooks" consisted of 839 men identified from job titles containing the words "cook" or "chef", while the 1328 men with job titles that included the terms "repair" or "maintenance" in combination with "car", "vehicle", or "generator" constituted the occupational group "mechanics". Five individuals who were listed as "cooks" and "mechanics" at different time periods were placed in the occupational category of their first job.