



NATIONAL STATISTICS NOTICE



28th March 2013

Issued by

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1990/1991 GULF CONFLICT – UK GULF VETERANS MORTALITY DATA: CAUSES OF DEATH

INTRODUCTION

1. This annual Statistical Notice provides summary statistics on the causes of deaths that occurred among the UK veterans of the 1990/91 Gulf Conflict between 1 April 1991 and 31 December 2012. These statistics are based on deaths in this time period that were reported to the Ministry of Defence (MOD) by 1 February 2013. This report updates the previous notice for deaths that occurred up to 31 December 2011 released on 29 March 2012. Information on deaths that may have occurred during the period 1 April 1991 to 31 December 2012 but are reported to the MOD after the release of this publication will be added to future publications.
2. The purpose of this Statistical Notice is to compare the mortality rates of 53,409 UK Armed Forces personnel that deployed to the 1990/91 Gulf Conflict to those of a comparison group, the Era cohort. The Era cohort consists of 53,143 UK Armed Forces personnel of similar age, gender, Service, regular/reservist status and rank who were in Service on 1 January 1991 but did not deploy to the Gulf. The findings include deaths that occurred to personnel whilst in service and deaths that occurred after personnel had left the UK Armed Forces.
3. This Statistical Notice also compares the mortality rates of Gulf veterans and the Era comparison group to rates observed in the UK general population over the same time period. This enables the mortality rates of the Gulf and Era cohorts to be placed in context. This analysis is presented as age and gender standardised mortality rates and Standardised Mortality Ratios (SMR). For the first time SMR have also been presented by cause of death.
4. The Statistical Notice published on 17 January 2005 discussed the issue of an age bias found within the cohorts used to produce this series of Statistical Notices. The **statistical methods** section of this report give further details of the findings. Age adjusted estimates are provided in this report for the Era cohort to account for differences in the age profile of those in the Gulf and Era cohorts who were aged 40 and above on 1 January 1991.

KEY POINTS

5. There were 1,392 deaths among the Gulf veterans up to 31 December 2012 and 1,501 deaths in the Era comparison group, representing increases of 109 and 137 respectively since the last release of this Statistical Notice in March 2012. These increases result in an estimate of 1,461 deaths in the age-adjusted Era comparison group. (**Table 1**)
6. There was no statistically significant difference in the total number of deaths between the Gulf veterans and the age-adjusted Era comparison group. (**Table 1**)
7. The number of disease-related deaths among Gulf veterans was statistically significantly lower than in the age-adjusted Era comparison group, with 799 deaths compared with an estimate of 899 respectively. This finding will be monitored in subsequent reports to ascertain if the finding is real or has occurred by chance. (**Table 1**)

8. There were no statistically significant differences in the total number of deaths due to neoplasms between the Gulf veterans and the age-adjusted Era comparison group. However, the numbers of deaths within two of the specific cancer sites were statistically significantly lower among Gulf 1 veterans than in the Era comparison group; for malignant neoplasm of the colon there were 15 and 29 deaths respectively and for malignant neoplasm of the bronchus and lung there were 43 and 68 deaths respectively. These findings will continue to be monitored in subsequent reports to ascertain if they are real or have occurred by chance. (**Table 2**)
9. UK general population mortality rates were applied to the age and gender profile of the Gulf cohort to estimate comparable mortality rates. There would have been an estimated 2,298 deaths among Gulf veterans if they had experienced the age and gender specific mortality rates of the UK general population, compared to the 1,392 deaths that have actually occurred between 1 April 1991 and 31 December 2012 (**Figures 2 and 3**).
10. Standardised Mortality Ratios (SMR) were calculated for both the Gulf and Era cohorts covering all deaths from 1991 to 2012. The SMR showed that there was a statistically significant decreased risk of dying in both the Gulf and Era cohorts compared to the UK general population (**Table 3**).
11. For the first time in this release, SMR have also been calculated by cause of death. For disease related deaths, the SMR showed that there was a statistically significant decreased risk of dying in the Gulf and Era cohorts compared to the UK population.
12. For deaths due to external causes, there was no significant difference in the risk of dying in the Gulf and Era cohorts compared to the UK population. However, for deaths due to transport accidents, a statistically significant increased risk of dying was found for both the Gulf and Era cohorts, compared to the UK population. This finding is discussed further in paragraphs 45-46.
13. The trends over time for disease related deaths show that there was a statistically significant decreased risk of dying in the Gulf cohort for all years from 1993 to 2012, and in the Era cohort for all years from 1992 to 2012 compared to the UK population. The trends over time for deaths due to external causes show that in the early 1990s the risk of dying was higher than in the UK population. Since 2009 the risk of dying due to external causes has been lower in both cohorts than the UK population. The peak in deaths due to external causes in the early 1990s is explained by a peak in deaths due to transport accidents and deaths due to external causes in the younger age groups at the same time.

RESULTS

Comparisons between Gulf veterans and Era cohort

All deaths

14. **Table 1** provides details of the number of deaths among personnel who deployed to the 1990/91 Gulf Conflict and the Era comparison group between 1 April 1991 and 31 December 2012, by cause of death. Also provided are the age-adjusted estimates of the number of deaths in the Era comparison group, crude mortality rate ratios and age-adjusted mortality rate ratios (RR) with their associated confidence intervals.
15. The 95% confidence interval for a rate provides the range of values within which we expect to find the real value of the indicator under study, with a probability of 95%. If the confidence interval for a rate does not include 1.00, the result is deemed to be statistically significant. Please see **statistical methods** for more information about confidence intervals.
16. There were 1,392 deaths among the Gulf veterans up to 31 December 2012 and 1,501 deaths in the Era comparison group, representing increases of 109 and 137 respectively since the last release of this Statistical Notice in March 2011. These increases resulted in an estimate of 1,461 deaths in the age-adjusted Era comparison group.
17. There was no statistically significant difference between the total number of deaths among Gulf veterans (n=1,392) and the age-adjusted Era comparison group (n=1,461) (RR: 0.95, 95% CI: 0.88-1.02).

Table 1: Deaths among UK Gulf 1 veterans¹ by cause of death², 1 April 1991 - 31 December 2012, numbers and rate ratios

ICD Chapter	Cause of death	Gulf	Era	Adjusted ⁶ Era	Crude	Adjusted ⁶	Adjusted ⁶
					Mortality Rate Ratio	Mortality Rate Ratio	95% Confidence Interval
	All deaths	1,392	1,501	1,461	0.92	0.95	(0.88 1.02)
	All cause coded deaths	1,321	1,419	1,382	0.92	0.95	(0.88 1.03)
I - XVIII	Disease-related causes	799	934	899	0.85	0.89	(0.81 0.98)
I	Certain infectious and parasitic diseases	11	9	7	1.21	1.39	(0.55 3.55)
II	Neoplasms	353 ^r	405 ^r	389	0.86	0.91	(0.79 1.05)
V	Mental and behavioural disorders	20	28	25	0.71	0.81	(0.45 1.46)
VI	Diseases of the nervous system	28	39	38	0.71	0.76	(0.46 1.23)
IX	Diseases of the circulatory system	257	302 ^r	297	0.84	0.87	(0.74 1.03)
X	Diseases of the respiratory system	30	30	26	0.99	1.08	(0.64 1.84)
XI	Diseases of the digestive system	75	82	82	0.90	0.93	(0.68 1.27)
III, IV, XII - XVIII	All other disease related causes ³	25	39	36	0.63	0.68	(0.40 1.14)
XX	External causes of mortality	522	485	483	1.06	1.08	(0.95 1.22)
	Transport accidents:	212	180	181	1.16	1.17	(0.95 1.43)
	Land transport accident:	177	152	152	1.15	1.15	(0.93 1.44)
	Pedestrian	17 ^r	7	8	2.40	2.29	(0.95 5.53)
	Motorcycle rider	56	51 ^r	49	1.09	1.11	(0.76 1.65)
	Car occupant	50	44	45	1.12	1.10	(0.73 1.66)
	Other ⁴	54	50	50	1.07	1.07	(0.73 1.58)
	Water transport	5	3	4	1.65	1.49	(0.37 5.98)
	Air and space transport	30	25	25	1.19	1.21	(0.71 2.06)
	Other external causes of accidental injury:	89	97	92	0.91	0.92	(0.68 1.23)
	Falls	11	18	17	0.60	0.66	(0.31 1.38)
	Exposure to inanimate mechanical forces	18	17	18	1.05	0.97	(0.50 1.91)
	Accidental drowning and submersion and other accidental threats to breathing	12	13	13	0.91	0.87	(0.39 1.97)
	Accidental poisoning by and exposure to noxious substances	17	25	23	0.67	0.69	(0.36 1.32)
	Accidental exposure to other and unspecified factors	20	13 ^r	13	1.52	1.60	(0.78 3.27)
	Other	11 ^r	11 ^r	11	0.99	1.01	(0.43 2.38)
	Intentional self-harm and events of undetermined intent ⁵	197 ^r	176	175	1.11	1.12	(0.91 1.38)
	Assault	7	10	10	0.69	0.65	(0.24 1.74)
	Legal intervention and operations of war	9	10	11	0.89	0.91	(0.37 2.28)
	Complications of medical care	0	1 ^r	1	-	-	-
	Sequelae of external causes of morbidity and mortality	0	2	1	-	-	-
	Deaths where the inquest has been adjourned	8	9 ^r				
	Other deaths for which cause data are not yet available	51^r	73^r				
	Overseas deaths for which cause data are not available	20	9				

1. Service and Ex-Service personnel only.
2. Causes have been coded to the World Health Organisation's International Statistical Classification of Diseases and Related Health Problems, 10th revision (ICD-10), 1992.
3. Includes cases with insufficient information on the death certificate to provide a known cause of death.
4. Under ICD-10 coding if the death certificate does not specifically mention the type of vehicle that was involved in the accident, the death is coded to "motor- or nonmotor vehicle accident, type of vehicle unspecified". There were 38 of these deaths among Gulf veterans compared to 35 in the Era group.
5. Includes both coroner-confirmed suicides and open verdict deaths in line with the definition used by the Office for National Statistics (ONS) in the publication of National Statistics.
6. Adjusted for the single years of age structure of the Gulf cohort at 1 January 1991.

18. **Figure 1** presents the main causes of death for both the Gulf and Era cohorts.

Disease-related causes

19. **Table 1** shows that the number of disease-related deaths among Gulf veterans was statistically significantly lower than in the age-adjusted Era comparison group, with 799 deaths compared with an

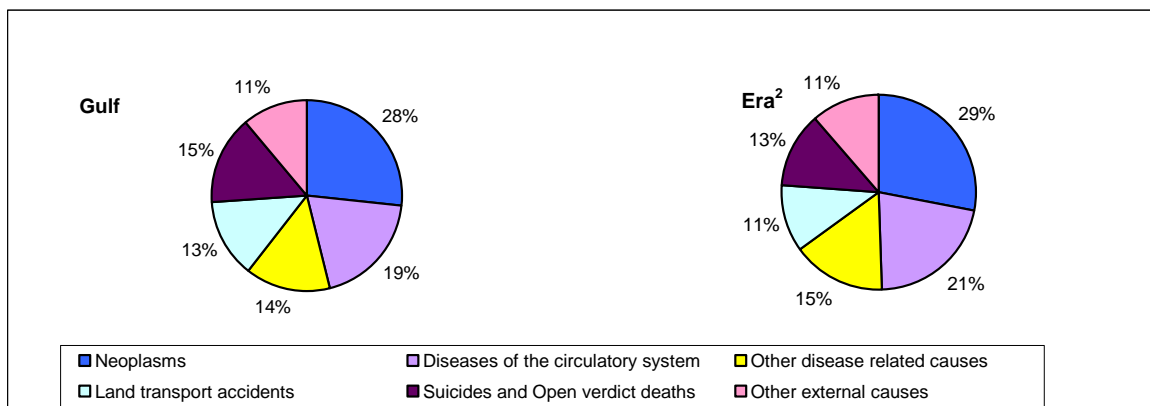
estimate of 899 respectively (RR=0.89, 95% CI: 0.81-0.98).

20. We would not expect to find any difference in the mortality rates between the Gulf and Era cohorts as they were both from the same Service population and were in Service at the same time. We would expect both cohorts to be subject to the 'healthy worker effect' (see paragraph 49 for more information). This finding will be monitored in subsequent reports to ascertain if the finding is real or has occurred by chance.
21. The main cause of disease-related deaths amongst both Gulf veterans and the age-adjusted Era comparison group was neoplasms: 353 deaths compared with an estimate of 389 respectively. There was no statistically significant difference between the number of deaths due to neoplasms in the two cohorts (RR: 0.91, 95% CI: 0.79-1.05). **Table 2** provides further details on the specific cancer sites.
22. There were 257 deaths due to diseases of the circulatory system (including ischaemic heart disease and cerebrovascular disease) among Gulf veterans compared with an estimate of 297 in the age-adjusted Era comparison group. There was no statistically significant difference between the number of deaths due to diseases of the circulatory system in the two cohorts (RR: 0.87, 95% CI: 0.74-1.03).
23. There were six deaths from motor neurone disease (MND) among Gulf veterans compared with an estimate of 11 in the age-adjusted Era comparison group. Deaths due to motor neurone disease have been separately identified as this cause of death has been of interest to Veterans groups external to the MOD.

External causes of mortality

24. **Table 1** shows that there was no statistically significant difference in the total number of deaths from external causes between Gulf veterans (n=522) and the age-adjusted Era comparison group (n=483) (RR: 1.08, 95% CI: 0.95-1.22).
25. The largest group of deaths due to external causes was transport accidents: 212 deaths among Gulf veterans compared with an estimate of 181 among the age-adjusted Era comparison group. Of these, land transport accidents accounted for 177 Gulf Veterans' deaths compared to an estimate of 152 in the Era cohort. Neither of these findings were statistically significant (**Table 1**).
26. There were 197 deaths due to intentional self-harm and events of undetermined intent (suicides and open verdict deaths) among Gulf veterans compared with an estimate of 175 among the age-adjusted Era comparison group, but this was not statistically significant (RR: 1.12, 95% CI: 0.91-1.38).

Figure 1: Deaths among UK Gulf veterans by main cause of death¹, 1 April 1991 - 31 December 2012, percentages



1. Percentages have been calculated using the total for all cause coded deaths.
2. Adjusted for the single years of age structure of the Gulf cohort at 1 January 1991.

27. **Table 2** provides the number of deaths due to neoplasms among personnel who deployed to the 1990/91 Gulf Conflict and the Era comparison group between 1 April 1991 and 31 December 2012, by cancer site. Also provided are the age-adjusted estimates of the number of deaths in the Era comparison group for each cancer site, crude mortality rate ratios and age-adjusted mortality rate ratios

(RR) with their associated confidence intervals.

28. There were no statistically significant differences in the total number of deaths due to neoplasms between the Gulf veterans (n=353) and the age-adjusted Era comparison group (n=389) (RR: 0.91, 95% CI: 0.79-1.05).
29. However, the numbers of deaths within two of the specific cancer sites were statistically significantly lower among Gulf 1 veterans than in the Era comparison group:
 - a) For malignant neoplasm (MN) of the colon there were 15 and 29 deaths respectively (RR: 0.53, 95% CI: 0.28-0.98);
 - b) For malignant neoplasm of the bronchus and lung there were 43 and 68 deaths respectively (RR: 0.62, 95% CI: 0.43-0.91). Deaths due to MN of the bronchus and lung accounted for the majority of deaths within the major cancer site 'malignant neoplasm of the respiratory and intrathoracic organs'. Therefore the overall numbers of deaths for this major cancer site were also found to be statistically significantly lower among Gulf 1 veterans than in the Era comparison group, with 48 and 71 deaths respectively (RR: 0.67, 95% CI: 0.47-0.97).

These results were also found in the March 2012 release of these statistics with a similar difference in the mortality rates between the two cohorts: MN of colon (RR:0.51, 95% CI: 0.26-0.98), MN of the bronchus and lung (RR:0.62, 95% CI: 0.42-0.93). We would not expect the Era cohort to show higher mortality rates than the Gulf cohort. Both cohorts are from a Service population who were in Service at the same time and thus both cohorts would be subject to the 'healthy worker effect' and thus we would not predict a difference between the two cohorts (see paragraph 49 for more information). These findings will continue to be monitored in subsequent reports to ascertain if they are real or have occurred by chance. (**Table 2**).

30. Please note that **Table 2** only presents specific cancer sites when there are five or more deaths in one of the cohorts. However deaths are monitored for all cancer sites e.g. within the major cancer site 'MN of genitourinary organs' three specific cancer sites are presented. Within this major site there are also a further six Gulf deaths and three Era deaths not specified due to numbers fewer than five.

Table 2: Deaths among UK Gulf veterans due to neoplasms, 1 April 1991 – 31 December 2012, numbers and rate ratios¹

Major cancer sites and specific sites with at least 5 deaths in one of the cohorts

ICD code	Cancer site	Gulf	Era	Adjusted ² Era	Crude Mortality Rate Ratio	Adjusted ² Mortality Rate Ratio	Adjusted ² 95% Confidence Interval	
C00-D48	Neoplasms	353	405	389	0.86	0.91	(0.79	1.05)
C00-C99	Malignant Neoplasms (MN)	348	400	384	0.86	0.91	(0.79	1.05)
C00-C14	MN of lip, oral cavity and pharynx	17	12	12	1.40	1.46	(0.69	3.10)
C15-C26, C48	MN of digestive organs and peritoneum	118	131[†]	128	0.89	0.95	(0.74	1.22)
C15	MN of oesophagus	31	27	27	1.13	1.24	(0.75	2.06)
C16	MN of stomach	14	19	17	0.73	0.82	(0.41	1.67)
C18	MN of colon	15	32	29	0.46	0.53	(0.28	0.98)
C19	MN of rectosigmoid junction	6	2	2	2.96	2.82	(0.61	13.14)
C20	MN of rectum	9	7	7	1.27	1.31	(0.49	3.50)
C22	Malignant neoplasm of liver and intrahepatic bile ducts	9	11	12	0.81	0.83	(0.36	1.94)
C25	MN of pancreas	23	26	27	0.87	0.87	(0.50	1.52)
C26	MN of other and ill-defined digestive organs	6	3	3	1.98	1.88	(0.49	7.22)
C30-C39	MN of respiratory and intrathoracic organs	48[†]	78	71	0.61	0.67	(0.47	0.97)
C34	MN of bronchus and lung	43 [†]	75	68	0.57	0.62	(0.43	0.91)
C40-C45, C47, C49-C50	MN of bone, connective tissue, skin and breast	31	36[†]	36	0.85	0.88	(0.54	1.42)
C43	Malignant melanoma of skin	15	18 [†]	17	0.82	0.90	(0.45	1.79)
C45	Mesothelioma	2	7	8	0.28	0.29	(0.07	1.23)
C50	MN of breast	5	6 [†]	6	0.82	0.82	(0.24	2.77)
C51-C68	MN of genitourinary organs	36	26	24	1.37	1.51	(0.90	2.52)
C56	MN of ovary	5	2	2	2.47	2.44	(0.49	12.21)
C61	MN of prostate	10	11	9	0.90	1.12	(0.46	2.73)
C64	MN of kidney, except renal pelvis	15	10	11	1.48	1.44	(0.65	3.20)
C69-C80	MN of other and unspecified sites	55	74	72	0.73	0.74	(0.52	1.06)
C71	MN of brain	34	46	45	0.73	0.74	(0.47	1.16)
C80	MN without specification of site	16	23	22	0.69	0.70	(0.37	1.34)
C81-C96	MN of lymphatic and haematopoietic tissue	41	43	41	0.94	0.99	(0.64	1.52)
C81-C85, C91.4, C96	Lymphomas	20	24	24	0.82	0.86	(0.48	1.55)
C81	Hodgkin's disease	4	6	7	0.66	0.63	(0.18	2.22)
C82-C85, C91.4, C96	Non-Hodgkin's lymphoma	16	18	17	0.88	0.94	(0.48	1.84)
C91-C95 excl C91.4	Leukaemias	18	13	13	1.37	1.36	(0.66	2.81)
C92	Myeloid leukaemia	13	6	7	2.14	2.02	(0.78	5.23)
C97	Malignant neoplasms of independent (primary) multiple sites	2	0	0	-	-	-	-
D00-D48	In situ neoplasms, benign neoplasms and neoplasms of uncertain behaviour or unspecified nature	5[†]	5	5	0.99	0.95	(0.26	3.49)

1. Where major cancer sites are not shown, there are no deaths within this group in either of the cohorts.

2. Adjusted for the single years of age structure of the Gulf cohort at 1 January 1991. The numbers may not add up to the totals shown due to rounding.

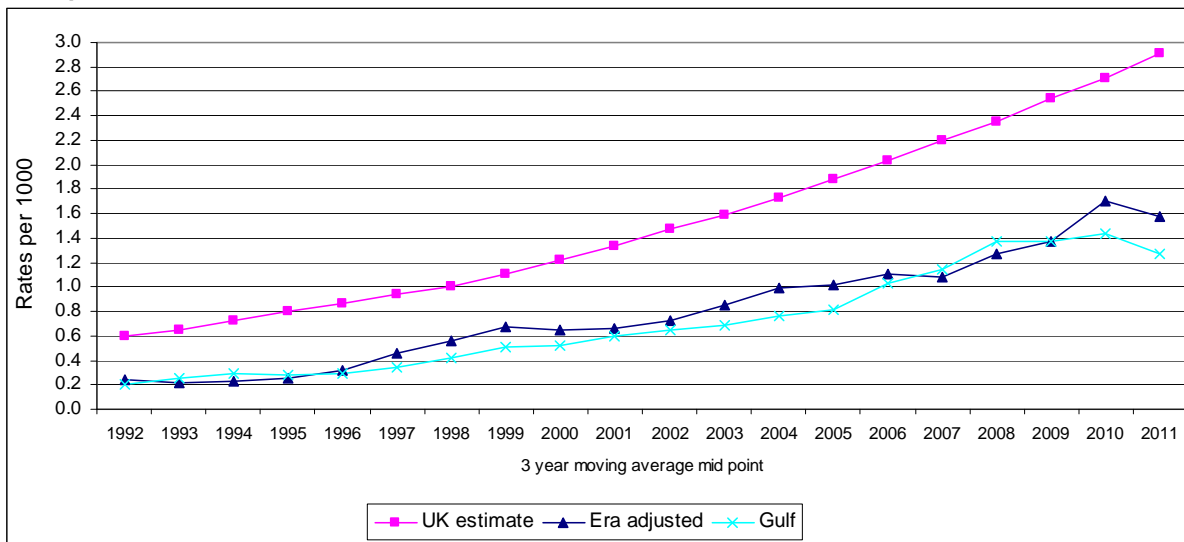
Comparison with UK General Population

Standardised Rates

31. UK general population mortality rates were applied to the age and gender profile of the Gulf cohort to estimate comparable mortality rates. There would have been an estimated 2,298 deaths among Gulf veterans if they had experienced the age and gender specific mortality rates of the UK general population, compared to the 1,392 deaths that have actually occurred between 1991 and 2012, thus there were fewer deaths than expected among Gulf 1 veterans than in the UK general population.

32. Mortality rates for disease-related causes for both Gulf veterans and the age-adjusted Era comparison group have gradually increased between 1991 and 2012 (**Figure 2**). These follow the trends in rates for disease-related causes among the UK general population. This suggests that the increase in disease-related deaths among Gulf veterans over time reflects the natural ageing of the cohort. However, the mortality rates due to disease-related causes for both Gulf veterans and the age-adjusted Era group are significantly lower than for the UK general population. This is likely to be due to the 'healthy worker effect' which is often observed in occupation studies. Individuals in the Armed Forces would be expected to show lower levels of mortality, as they were likely to have higher levels of fitness and lower levels of ill health than the general UK population (see paragraph 49).

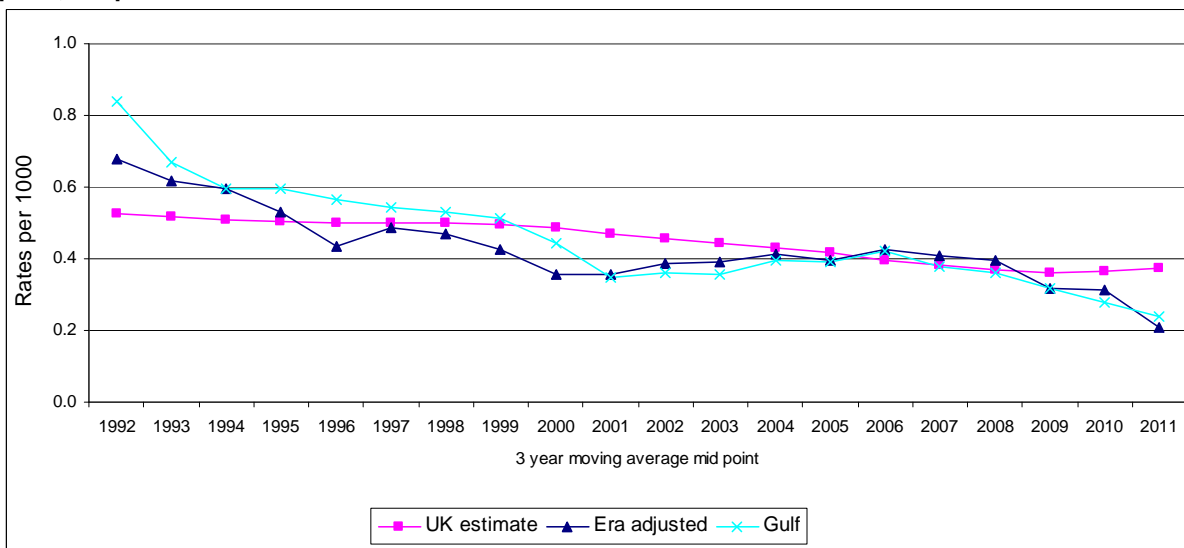
Figure 2: Gulf and Era mortality rates for disease related causes, 3-year moving average rates per 1,000 personnel^{1,2}



1. Data for 1 April 1991 – 31 December 1991 have been adjusted to a full year.
2. Mortality rates for the Era cohort have been adjusted for the single years of age structure of the Gulf cohort at 1 January 1991

33. Mortality rates for external causes of injury for both the Gulf veterans and the age-adjusted Era comparison group have decreased between 1991 and 2012 (**Figure 3**). However, comparable mortality rates for the UK general population have stayed constant during this period.

Figure 3: Gulf and Era mortality rates for external causes of mortality, 3-year moving average rates per 1,000 personnel^{1,2}



1. Data for 1 April 1991 – 31 December 1991 have been adjusted to a full year.
2. Mortality rates for the Era cohort have been adjusted for the single years of age structure of the Gulf cohort at 1 January 1991

Standardised Mortality Ratios (SMR)

34. In order to compare deaths among the Gulf and Era cohorts with those among the UK population, Standardised Mortality Ratios (SMR) have been calculated for each cohort. The year on year changes in the UK population have been taken into account in these calculations. An SMR below, equal to, or above 100 indicates that the rate for the Gulf or Era cohort is respectively below, equal to, or higher than the rate in the UK population (see '**statistical methods**' for further clarification).
35. The 95% confidence interval for a SMR provides the range of values within which we expect to find the real value of the indicator under study, with a probability of 95%. If the confidence interval for an SMR does not include 100, the result is deemed to be statistically significant.
36. Overall SMR were calculated for both the Gulf and Era cohorts covering all reported deaths from 1991 to 2012. The SMR showed that there was a statistically significant decreased risk of dying in both the Gulf (SMR=61, 95% CI:57-64) and Era (SMR=64, 95% CI:61-67) cohorts compared to the UK population (**Table 3**).

Table 3: Deaths by cause of death and cohort, 1991-2012, numbers, Standardised Mortality Ratios (SMR)¹ and 95% confidence intervals (CI)

Cause of death	Gulf cohort			Era cohort		
	Number	SMR	95% CI	Number	SMR	95% CI
All causes	1,392	61	(57 - 64)	1,501	64	(61 - 67)
All disease related deaths	799	45	(42 - 49)	934	51	(48 - 55)
Neoplasms	353	60	(54 - 67)	405	66	(60 - 73)
Circulatory	257	47	(41 - 53)	302	52	(47 - 59)
All external causes	522	101	(93 - 111)	485	96	(87 - 104)
Suicide & open verdict	197	76	(66 - 88)	176	69	(60 - 80)
Transport accidents	212	189	(165 - 217)	180	162	(140 - 188)

1. Standardised mortality ratios have been age and gender standardised

37. Specific SMR were also calculated for the most common causes of death: neoplasms, diseases of the circulatory system, transport accidents and intentional self harm and events of undetermined intent (**Table 3**).
38. **Table 4** shows that for disease related deaths there was a statistically significant decreased risk of dying in the Gulf (SMR=45, 95% CI:42-49) and Era (SMR=51, 95% CI:48-55) cohorts compared to the UK population. This statistically significant decreased risk was also found in both cohorts for deaths due to neoplasms and deaths due to diseases of the circulatory system.
39. For deaths due to external causes, there was no significant difference in the risk of dying in the Gulf (SMR=101, 95% CI:93-111) and Era (SMR=96, 95% CI:87-104) cohorts compared to the UK population. For deaths due to intentional self harm and events of undetermined intent there was a statistically significant decreased risk of dying in the Gulf (SMR=76, 95% CI:66-88) and Era (SMR=69, 95% CI:60-80) cohorts compared to the UK population.
40. However, for deaths due to transport accidents, a statistically significant increased risk of dying was found for both the Gulf (SMR=189, 95% CI:165-217) and Era (SMR=162, 95% CI:140-188) cohorts, compared to the UK population, equivalent to an increase risk of dying of 89% and 62% respectively. This finding was consistent with results presented in the National Statistic on 'Deaths in the Regular Armed Forces, 2013', which show a statistically significant increased risk of dying as a result of a land transport accident in the UK Armed Forces compared to the UK general population.

Trends over time

41. **Table 4** provides the SMR for each year from 1991 to 2012. These show that there was a statistically significant decreased risk of dying in the Gulf cohort for all years from 1993 to 2012, and in the Era cohort for all years from 1992 to 2012 compared to the UK population. The SMR for deaths during 2012 were 48 (n=87) in the Gulf cohort (95% CI: 39-60) and 57 (n=105) in the Era cohort (95% CI: 47-69). Thus, the Gulf cohort had a 52% decreased risk of dying compared to the UK population; the Era cohort had a 43% decreased risk of dying compared to the UK population.

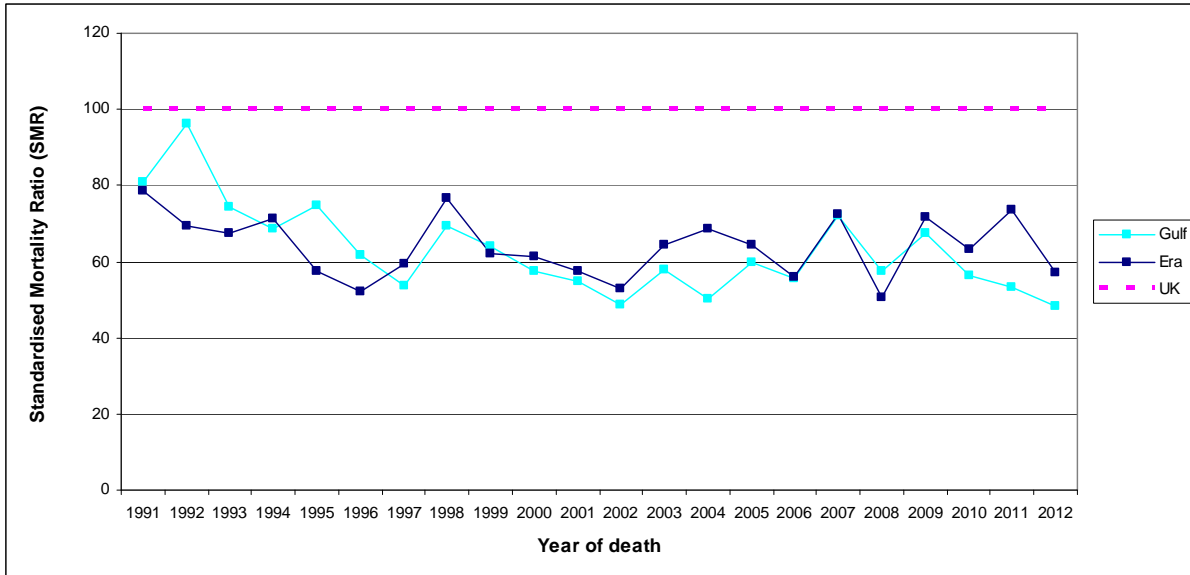
Table 4: Deaths by year and cohort, 1991-2012, numbers, Standardised Mortality Ratios (SMR)¹ and 95% confidence intervals (CI)

Year	Gulf cohort			Era cohort		
	Number	SMR	95% CI	Number	SMR	95% CI
All years	1,392	61	(57 - 64)	1,501	64	(61 - 67)
1991	47	81	(61 - 107)	47	79	(59 - 105)
1992	57	96	(74 - 125)	42	69	(51 - 94)
1993	46	74	(56 - 99)	43	67	(50 - 91)
1994	45	69	(51 - 92)	48	71	(54 - 94)
1995	52	75	(57 - 98)	41	58	(42 - 78)
1996	45	62	(46 - 83)	39	52	(38 - 71)
1997	40	54	(39 - 73)	46	60	(45 - 80)
1998	56	69	(53 - 90)	64	77	(60 - 98)
1999	54	64	(49 - 83)	54	62	(47 - 81)
2000	51	57	(44 - 76)	56	61	(47 - 80)
2001	52	55	(42 - 72)	56	57	(44 - 75)
2002	49	49	(37 - 64)	55	53	(41 - 69)
2003	62	58	(45 - 74)	71	64	(51 - 81)
2004	56	50	(39 - 65)	79	69	(55 - 86)
2005	71	60	(47 - 76)	78	64	(52 - 80)
2006	71	56	(44 - 70)	73	56	(44 - 70)
2007	94	72	(59 - 88)	97	72	(59 - 88)
2008	81	58	(46 - 72)	73	50	(40 - 63)
2009	100	67	(55 - 82)	109	72	(59 - 87)
2010	88	56	(46 - 69)	101	63	(52 - 77)
2011	88	53	(43 - 66)	124	74	(62 - 88)
2012	87	48	(39 - 60)	105	57	(47 - 69)

1. Standardised mortality ratios have been age and gender standardised

42. **Figure 4** shows the variation in the SMR for the Gulf and Era cohorts each year compared to the UK population. The SMR for the Gulf and Era cohorts have decreased between 1991 and 2011 (from 81 to 48 in the Gulf cohort and 79 to 57 in the Era cohort). **Figure 4** shows a peak in the risk of dying in the Gulf cohort in 1992, although the SMR was still lower than for the UK population.

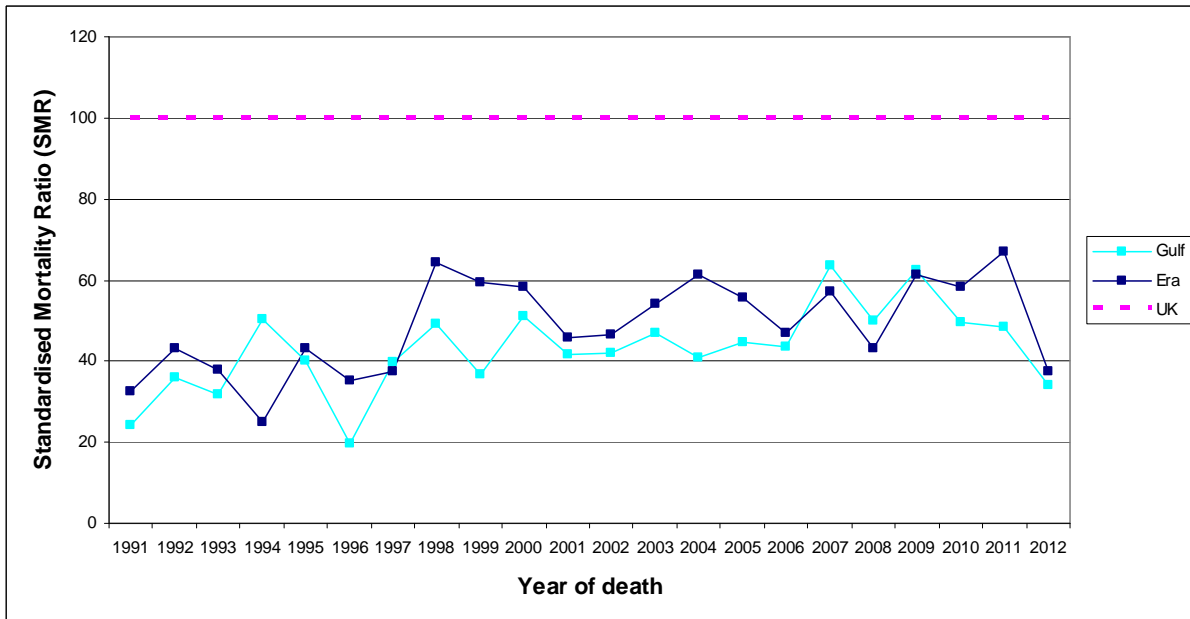
Figure 4: Deaths by year and cohort, 1991-2012, Standardised Mortality Ratios (SMR)¹



1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

43. To further explore the trends over time, **Figures 5 and 6** present the SMR over time separately for disease related deaths and deaths due to external causes. **Figure 5** shows that the risk of dying due to disease related causes was lower in both cohorts, for all years, when compared to the UK population and the trend has not changed as the Gulf and Era cohorts have aged.

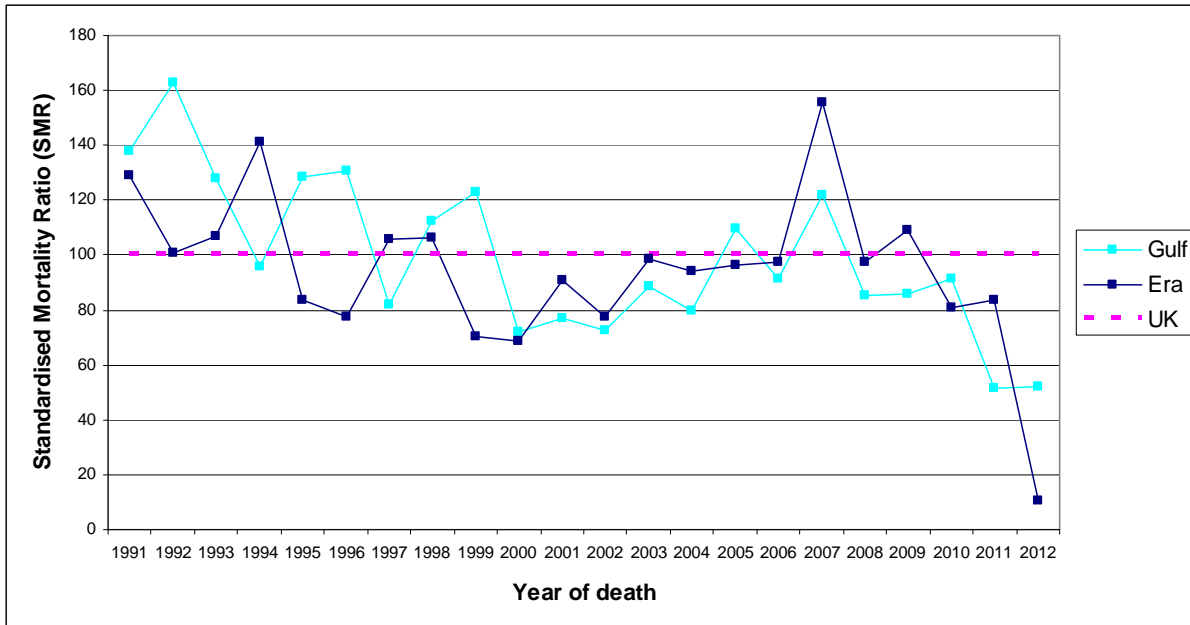
Figure 5: Disease related deaths by year and cohort, 1991-2012, Standardised Mortality Ratios (SMR)¹



1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

44. **Figure 6** shows that the higher SMR in 1992 (as shown in **Figure 4**) was due to an increased risk of deaths due to external causes, when compared to the UK population. The time trend for deaths due to external causes have changed over time: in the first three years post conflict the risk of dying from an external cause was higher in the Gulf cohort than the general population; between 1994 and 2008 the risk of dying from an external cause of injury (for both Gulf and Era cohorts) was the same as the UK general population; since 2009 the risk has been lower than in the general population.

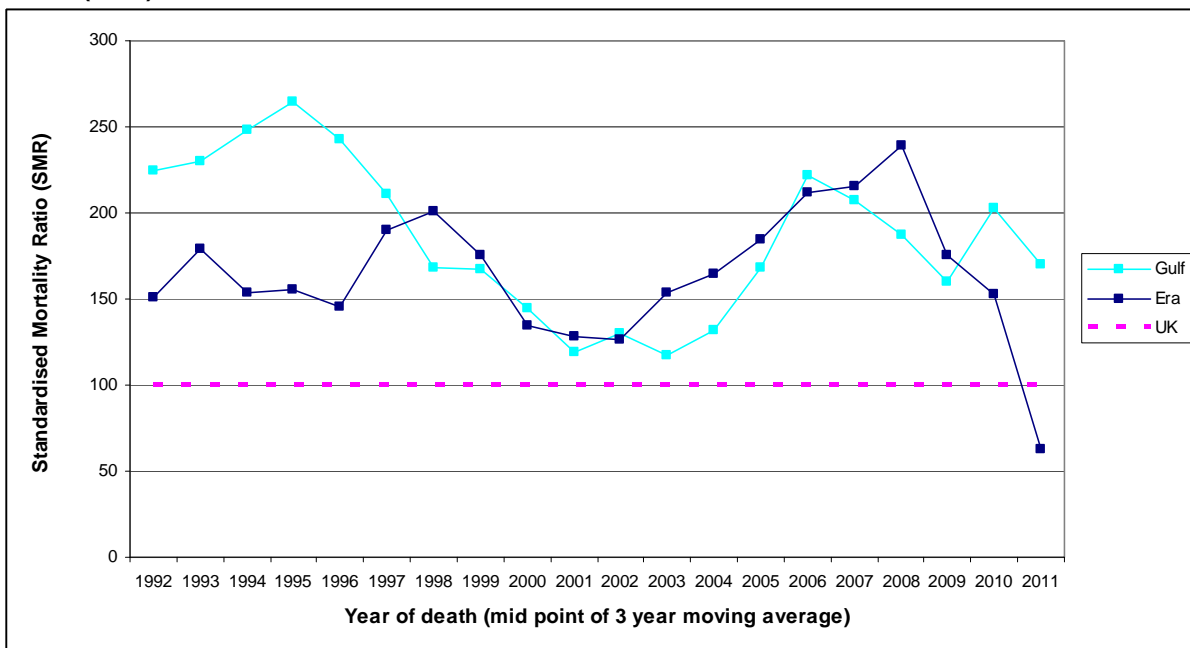
Figure 6: Deaths due to external causes by year and cohort, 1991-2012, Standardised Mortality Ratios (SMR)¹



1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

45. To investigate further the significant increased risk of dying as a result of transport accidents in the Gulf and Era cohorts, the SMR were calculated for each year from 1991 to 2012, to identify any trends over time for this cause of death. Due to the small number of deaths each year and the resulting fluctuation in SMR, three year moving averages have been calculated to smooth out the fluctuations and highlight trends over time. **Figure 7** shows the variation in the SMR for deaths due to transport accidents in the Gulf and Era cohorts each year compared to the UK population.

Figure 7: Deaths due to transport accidents by year and cohort, 1991-2012, Standardised Mortality Ratios (SMR)¹



1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

46. **Figure 7** shows that the SMR for the Gulf cohort were at their highest between 1992 and 1995, reaching a high of 264 in 1995. These higher SMR in the earlier years account for the peak in SMR in 1992 for all causes of death (**Figure 4**) and deaths due to external causes (**Figure 6**). This increased risk during the years following deployment to the Gulf may be due to an increase in risk taking behaviours following a deployment as discussed by Kings College Centre for Military Health Research (Kings Centre for Military Health Research: a ten year report, September 2006). The SMR showed another peak in both cohorts between 2006 and 2008. To investigate possible reasons for this peak, the deaths due to transport accidents that occurred in 2006 and 2007 were investigated to see whether these individuals had deployed to Iraq or Afghanistan prior to their death. Of the 33 transport accident deaths during 2006 and 2007, 13 of these individuals were still in Service when they died, and of these, eight individuals had deployed to Iraq or Afghanistan between 2001 and 2007. This investigation does not explain the peak between 2006 and 2008, however Defence Statistics will continue to monitor these trends in deaths due to transport accidents.

47. **Table 5** provides the SMR by five year age group for all deaths from 1991 to 2012. These show that there was a statistically significant decreased risk of dying in both the Gulf and Era cohorts for all age groups from 30-34 to 70+. For ages 20-24 in the Gulf cohort, there was an increased risk of dying (SMR=125, 95% CI:100-156) compared to the UK population. For all other age groups and cohorts aged 29 and under there was no statistically significant difference in the risk of dying in the Gulf and Era cohorts, compared to the UK population.

Table 5: Deaths by age group¹ and cohort, 1991-2012, numbers, Standardised Mortality Ratios (SMR)² and 95% confidence intervals (CI)

Age group	Gulf cohort			Era cohort		
	Number	SMR	95% CI	Number	SMR	95% CI
All ages	1,392	61	(57 - 64)	1,501	64	(61 - 67)
Under 20	3	121	(25 - 352)	8	152	(66 - 300)
20-24	78	125	(100 - 156)	71	115	(91 - 145)
25-29	124	88	(74 - 105)	120	87	(73 - 104)
30-34	141	65	(55 - 77)	154	72	(62 - 85)
35-39	183	60	(52 - 69)	172	58	(50 - 67)
40-44	217	56	(49 - 64)	231	62	(54 - 70)
45-49	202	56	(49 - 64)	204	57	(50 - 66)
50-54	191	61	(53 - 71)	187	60	(52 - 69)
55-59	119	51	(42 - 61)	143	59	(50 - 70)
60-64	82	54	(44 - 68)	104	64	(53 - 78)
65-69	34	41	(30 - 58)	58	53	(41 - 68)
70+	18	41	(24 - 65)	49	57	(43 - 75)

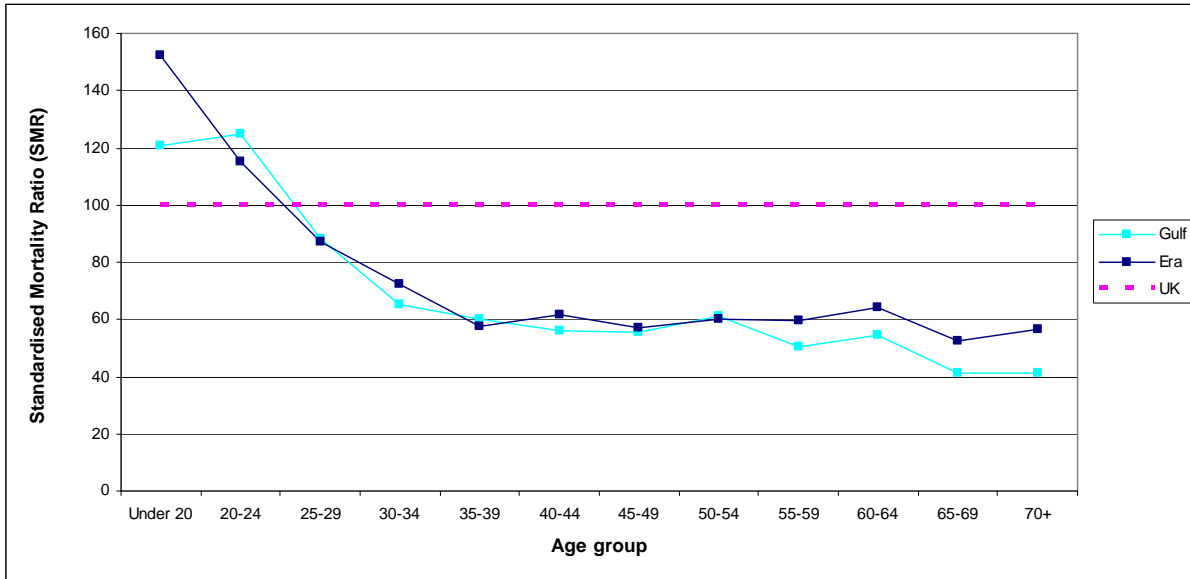
1. Age is as at date of death

2. Standardised mortality ratios have been age and gender standardised

48. **Figure 8** shows the variation in the SMR for the Gulf and Era cohorts for each five year age group, compared to the UK population. For those aged 24 and under, the SMR for the Gulf and Era cohorts were higher than for the UK population, however for all other ages the SMR were lower than for the UK population. **Figures 9 and 10** show the trends over time separately for disease related deaths and deaths due to external causes. **Figure 9** shows that the risk of dying of disease related deaths was lower than the UK population, apart from those aged under 20 in the Era cohort. Please note that this result is based on a small number of deaths in the Era cohort among those aged under 20 (n=2) and therefore should be interpreted with caution. **Figure 10** shows that the risk of dying due to external causes was higher in both cohorts for those aged under 30, when compared to the UK population. This explains the overall peak in the younger age groups in **Figure 8**, and supports the theory that there are higher numbers of deaths due to external causes in younger Service personnel. Please note that the peak shown for ages 70+ in the Era cohort in **Figure 10** is based on a small number of deaths in the Era cohort in this age group (n=3) and therefore should be interpreted with caution.

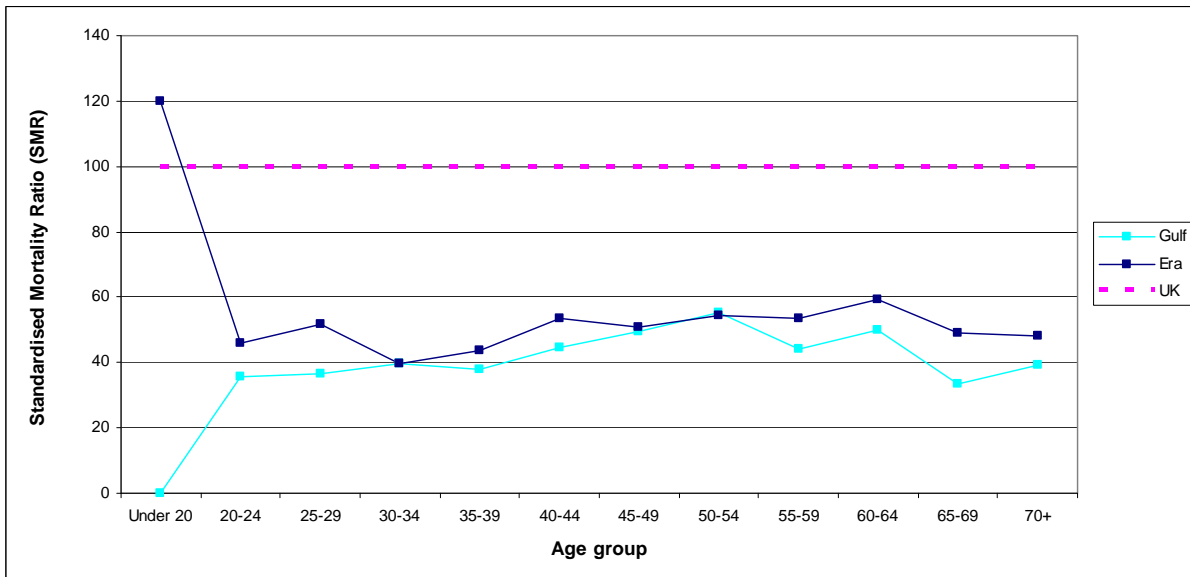
49. Overall, these comparisons show that the Gulf and Era cohorts have lower death rates than the UK general population. This may partially be explained by the 'healthy worker effect' often observed in occupational studies. This is deemed to occur when 'workers' are found to have lower mortality or other adverse health outcome rates than the general population due to the fact that certain groups of people are excluded from employment, particularly those who are ill or who have disabilities. This is to be expected in studies of Armed Forces mortality, as they are generally a highly selected group of individuals who are likely to have higher than usual levels of fitness and possibly lower levels of ill-health.

Figure 8: Deaths by age group¹ and cohort, 1991-2012, numbers, Standardised Mortality Ratios (SMR)²



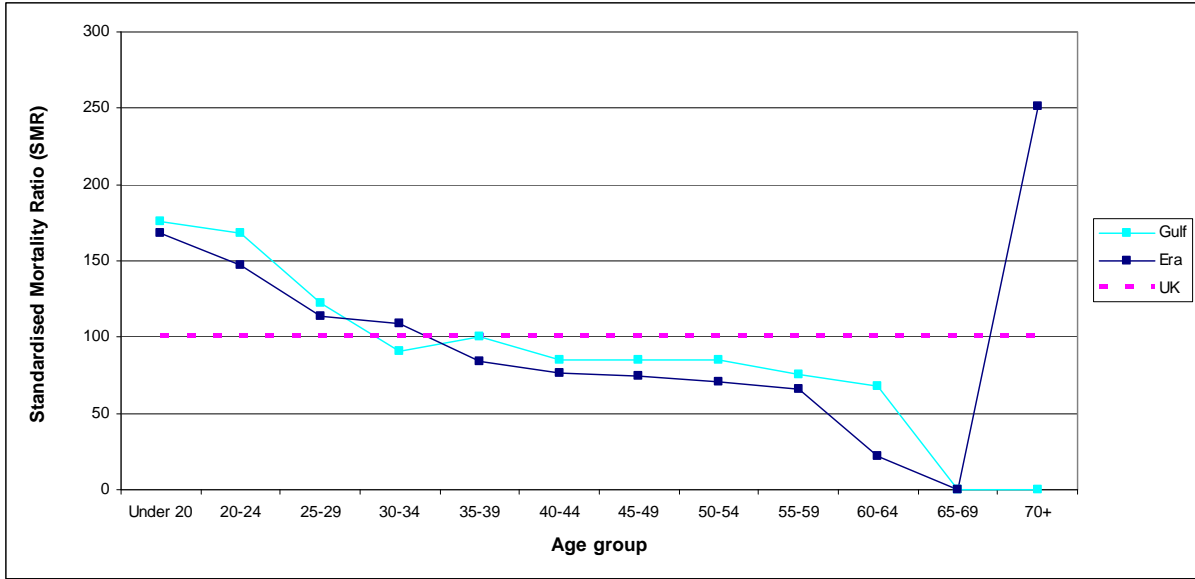
1. Age is as at date of death
2. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

Figure 9: Disease related deaths by age group¹ and cohort, 1991-2012, numbers, Standardised Mortality Ratios (SMR)¹



1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

Figure 10: Deaths due to external causes by age group¹ and cohort, 1991-2012, numbers, Standardised Mortality Ratios (SMR)¹



1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

Revisions and changes to previously published data

50. The figures presented in this Statistical Notice are from deaths reported to the Ministry of Defence (MOD) by 1 February 2013. Further deaths for the period 1 April 1991 to 31 December 2012 may be reported to the MOD before publication of the next release, in March 2014. As the information presented in each release of this is from a snapshot of data received by a certain date, these are not classified as revisions.
51. If errors are found or updates are made during the production of this report, which result in changes to published statistics, these will be corrected and the Statistical Notice republished.
52. The following changes have been made to the data since the last release of these statistics:
- Due to changes in processes to collate the deaths data for this publication, Defence Statistics have carried out validation against in-Service deaths data used to produce Defence Statistics' National Statistic on deaths in the Regular UK Armed Forces. As a result, an extra 11 deaths of members of the Gulf and Era cohorts have been identified that occurred between 1991 and 2011. These deaths were not included in Defence Statistics' regular notifications from the NHS Information Centre and were therefore not included in previous releases of these statistics. These 11 deaths (4 Gulf - 1 in 2009, 3 in 2011; 7 Era - 1 in 1994, 2 in 2008, 1 in 2010, 3 in 2011) have been included in this latest release.
 - In previous releases of these statistics deaths relating to ICD 10 cause of death code U509 were included in the category 'Other deaths for which cause data are not yet available'. These deaths relate to those where cause is known to be an injury but the circumstances surrounding it have not been confirmed i.e. undetermined death. It is not necessarily a suspected suicide or violent event, as it may also be an accident. The ONS used to code these deaths to Y339 but this incorrectly categorised them as Open verdicts so they created code U509 to allocate these deaths. Following advice from the ONS, the 5 deaths (3 Gulf in 2007, 2008 and 2011, 2 Era in 2007 and 2011) between 1991 and 2011 that were coded to U509 have now been moved to the cause category of 'Other external causes of accidental injury: Other' in **Table 1**.
 - Since the last publication of these statistics Defence Statistics have received further information on one Era cohort death in 2009 included in the cause category of 'Deaths where the inquest has been adjourned'. This death has been amended to the category of 'Complications of medical and surgical care'.

Background

53. Gulf veterans mortality data covering the period 1 April 1991 to 31 March 1999 were originally analysed by a team led by Professor Gary Macfarlane at the University of Manchester. The findings were published in Macfarlane G et al, Mortality of UK Gulf War Veterans, *The Lancet*, 2000; **356**:17-21. Updates have been regularly presented to Parliament by the MOD between July 2000 and July 2003, and published in Hansard in January and July of each year. Since January 2004 the updates have been released by Defence Statistics as a National Statistics notice with agreement by MOD ministers. These data can be found on the Defence Statistics website: www.dasa.mod.uk. Further analyses were published by Macfarlane GJ et al, Long-term mortality amongst Gulf War Veterans: is there a relationship with experiences during deployment and subsequent morbidity?, *Int J of Epi*, 2005; 34: 1403-1408.
54. Detailed analysis on the incidence of cancer among UK Gulf war veterans has been produced by Professor Gary Macfarlane and other researchers from University of Manchester, London School of Hygiene and Tropical Medicine and Kings College London. The findings were published in Macfarlane G et al, Incidence of cancer among UK Gulf veterans: cohort study, *BMJ*, 2003; **327**:1373-1376.

Glossary

55. **Gulf 1 veterans** consist of Service personnel deployed to any Gulf state between 1 September 1990 and 30 June 1991 and for the Navy afloat, all personnel aboard a ship East of the Suez canal during that period. The data do not include civilian personnel employed by the MOD (including the Royal Fleet Auxiliary, the NAAFI, MOD civil servants), by other Government Departments, or civilians working for Defence Contractors, the media or charitable and humanitarian organisations.

56. **The Era comparison group** comprises 53,143 personnel, randomly sampled from all UK Armed Forces personnel in Service on 1 January 1991 and who did not deploy to the Gulf. This group is stratified according to the 53,409 Gulf veterans to reflect the socio-demographic and military composition of the Gulf cohort in terms of age, gender, Service (Naval Service, Army, Royal Air Force), officer/other rank status, regular/reservist status, and a proxy measure for fitness. The single year age distribution among those aged 40 and over has since been found to show differences, with those in this age-group deployed to the Gulf generally younger than those in the Era group. Age adjusted estimates have been calculated using the methodology described below.

Data sources

57. The main source of information on the deaths described here is the NHS Information Centre for Health and Social Care (NHSIC) (England and Wales) and the General Register Office (GRO) for Scotland. In-Service deaths are sent to the ONS for independent coding. Coroners verdicts are provided by the NHS for deaths in England and Wales. For Scotland, accidental and violent deaths are investigated by the Procurator Fiscal.

58. Defence Statistics receive monthly updates of deaths from the NHSIC and GRO for individuals in the Gulf and Era cohorts. Sometimes Defence Statistics will be notified that an individual has died but will not be provided with a cause of death. These individuals are included in the category of 'Other deaths for which cause data are not yet available'. Defence Statistics regularly check with the NHSIC and GRO for updates on the cause of death for these records and update the cause of death once received. Please note that for deaths that occurred during 2012, there are a higher than usual number that have been reported without a cause of death. As part of our regular checks, these records have been queried with the NHSIC and GRO and the cause of death will be updated in future releases once the information is available.

59. Defence Statistics receive quarterly updates from the same sources with the latest flagging status for cohort members. This shows whether an individual is currently flagged (i.e. The individual is registered with a GP and Defence Statistics will be notified when this individual dies) or whether they have died, emigrated, or become lost to follow up. As at 31 December 2012, 99,304 individuals from the Gulf and Era cohorts remained flagged by one of the above organisations.

60. Defence Statistics follows ONS guidelines for which deaths to include in each of the cause groups on **Table 1**. In December 2004 the ONS informed Defence Statistics they were now coding deaths where the inquest has been adjourned to the ICD-10 code Y33 ("Other specified events, undetermined intent"). In the releases of these statistics prior to January 2005 these deaths were included with the Intentional self-harm and events of undetermined intent.

61. Defence Statistics receive annual updates of UK population and deaths data from the ONS, GRO and NISRA in order to make comparisons to mortality rates in the UK general population. The UK general population data for 2011 and 2012, and the UK deaths data for 2012, were not available for this report to calculate UK estimated mortality rates and standardised mortality ratios (SMR). Therefore Defence Statistics has used the 2010 data as an estimate for the 2011 and 2012 figures as there is little year on year variation for the UK figures. Thus, any patterns reported here may be subject to minor fluctuations when the 2011 data becomes available.

62. In order to calculate SMR by cause of death, additional UK death data by individual age, year, gender and cause of death were obtained from the ONS (deaths in England and Wales), GRO (deaths in Scotland) and NISRA (deaths in Northern Ireland). This data has been used for all calculations where the Gulf and Era cohorts are compared to the UK population (SMR and UK estimated mortality rates). Due to a change in 2006 by the ONS from reporting deaths that occurred each year to deaths that were registered each year, the UK deaths figures for 2006 and 2007 do not follow the expected trends in numbers of deaths by year and age. A major driver for this change by the ONS was that for an annual extract of death occurrences to be acceptably complete, it must be taken some months after the end of the data year to allow for late death registrations. Using these figures in the SMR calculations would result in incorrect results. Therefore UK deaths in 2005 have been used as an estimate for 2006, and UK deaths in 2008 have been used as an estimate for 2007. This data will be investigated prior to the next release of these statistics and any resulting changes to the data will be reported. As a result of these changes to the UK deaths data there may be minor fluctuations in some SMR and confidence intervals.

Statistical methods

63. The mortality rate ratios provided here were calculated using as denominator the total person-years at risk (the length of time each person has been in study), taking into account deaths and emigrations from the UK. People who had left the Services and subsequently emigrated were deemed to be lost to follow up because we had no means of knowing if and when they may have died. The mortality rate ratios given here differ marginally from the crude deaths ratio owing to some small differences in the number of person years at risk between the Gulf and Era comparison groups.
64. The 95% confidence interval provides the range of values within which we expect to find the real underlying value of the study indicator, with a probability of 95%. If the confidence interval does not include 1.00, the result is deemed to be statistically significant. Note that confidence intervals have been provided due to imprecision that arises, not as a result of sampling variation, but due to the 'natural' variation in Gulf and Era deaths. For the SMR calculations, it is the underlying difference between the Gulf and Era cohorts and the UK population that is of interest and the actual values observed in any one time period only give an imprecise estimate of this 'underlying risk'.
65. The small numbers of deaths used as a basis for calculations in some of the analysis may result in wide confidence intervals in the corresponding rate ratios or SMR. The impact of this is that the range in which we expect the true value of that statistic to lie is much larger, making it harder to interpret the true underlying trend. Therefore results based on small numbers should be interpreted with caution.
66. Age-adjusted estimated numbers for the Era comparison group were created by calculating the mortality rate for each single year of age at 1 January 1991 in each calendar year since 1991. This rate was applied to the equivalent numbers in each single year of age at 1 January 1991 and year of death in the Gulf population, from which deaths and emigrations from the UK were subtracted, to calculate the estimated total for each calendar year. These estimated numbers by calendar year were divided by the Gulf population, from which deaths and emigrations from the UK were subtracted, to produce the adjusted rate for **Figures 2 and 3**.
67. To enable comparisons with the UK general population, UK mortality rates have been calculated based on deaths and population data provided by the Office for National Statistics (for England and Wales), General Register Office (for Scotland) and Northern Ireland Statistics and Research Agency (for Northern Ireland). These UK mortality rates were applied to the age and gender profile of the Gulf cohort to estimate comparable mortality rates for disease related deaths and deaths due to external causes (see Figures 2 and 3). The UK deaths data were also applied to the Gulf cohort to calculate the expected number of deaths in a similar sized cohort taken from the general UK population with the same age and gender profile as that of the Gulf cohort (see para 6).
68. To enable statistical comparisons with deaths in the UK population, Standardised Mortality Ratios (SMR), adjusted for age, gender and year, were calculated. The use of SMR is a standard epidemiological technique for comparing mortality rates among an occupational cohort with a standard population. An SMR is defined as the ratio of the number of deaths *observed* in the study population to the number of deaths *expected* if the study population had the same age- and gender-specific rates as the standard population in each specific year, multiplied by 100 by convention. An SMR over (or under) 100 indicates a higher (or lower) number of observed deaths than expected (based on standard population rates). An SMR of 100 implies that there is no difference in rates when comparing the Gulf and Era cohorts with the UK population.

Data quality

69. Information on deaths in Northern Ireland was routinely notified through GRO for Scotland. However, the Central Services Agency now produce all coded death information for medical research in Northern Ireland. It is hoped that Defence Statistics will be able to receive regular updates in line with England and Wales, and Scotland in the near future for Northern Ireland to improve the timeliness of information on flagged individuals in Northern Ireland.
70. Previous versions of this report (prior to March 2008) were produced bi-annually with a 2 week allowance for analysing the data. Owing to the continued consistency of the findings and following consultation with key stakeholders, the publication of this report, and of future updates, has moved to an annual basis with a 3-month allowance for the time lags in the delivery of administrative data (publication by end March). This ensures greater accuracy of the information provided for the latest 12-month period.

71. Several findings in this Statistical Notice are based on small numbers. This is evidenced by the wide range of several confidence intervals presented in this report. We strongly recommend caution when interpreting these figures.
72. The findings presented in this notice are broadly similar to results published in March 2012 covering deaths during the period 1 April 1991 to 31 December 2011. Where differences have been found, such as the statistically significant findings noted in the Key Points, the findings will be monitored in future releases.

Strengths and weaknesses of data presented in this notice

73. A strength of this publication is that, as at 31 December 2012, 96% of surviving cohort members are still flagged by the NHS, which means that we are still able to follow up and receive death notification for a high proportion of our cohorts.
74. Deaths where the inquest has been adjourned, or where the cause of death has not yet been provided mean the final cause of death information is not always timely and complete for recent years. This can lead to revisions in the cause of death categories when further information is received (see paragraph 49 for more information about the extent of these revisions). Users should be aware of this weakness when using the information presented in this notice.
75. The information presented in this publication has been structured in such a way to release sensitive fatality information into the public domain in a way that contributes to the MOD's accountability to the British public but which doesn't compromise the operational security of UK Armed Forces personnel nor that risks breaching the rights of the families of deceased Service personnel and veterans (for which the MOD has a residual duty of care).