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 2013. These statistics are based on deaths in this time period that were reported to the Ministry of Defence (MOD) by 1 February 2014. This report updates the previous notice for deaths that occurred up to 31 December 2012 released on 28 March 2013. Information on deaths that may have occurred during the period 1 April 1991 to 31 December 2013 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). SMR are also 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 1,506 deaths among the Gulf veterans up to 31 December 2013 and 1,627 deaths in the Era comparison group, representing increases of 114 and 126 respectively since the last release of this Statistical Notice in March 2013. These increases result in an estimate of 1,583 deaths in the age-adjusted Era comparison group. (**Table 2**)

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 2**)

7. The number of disease-related deaths among Gulf veterans was statistically significantly lower than in the age-adjusted Era comparison group, with 911 deaths compared with an estimate of 1,073 respectively. This finding will be monitored in subsequent reports to ascertain if the finding is real or has occurred by chance. (**Table 2**)

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 18 and 37 deaths respectively and for malignant neoplasm of the bronchus and lung there were 49 and 89 deaths respectively. These findings will continue to be monitored in subsequent reports to ascertain if they are real or have occurred by chance. (**Table 3**)

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 2,497 deaths among Gulf veterans if they had experienced the age and gender specific mortality rates of the UK general population, compared to the 1,506 deaths that have actually occurred between 1 April 1991 and 31 December 2013. (**Figures 2 and 3**)

10. Standardised Mortality Ratios (SMR) were calculated for both the Gulf and Era cohorts covering all deaths from 1991 to 2013. 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 4**)

11. SMR have 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 77-78.

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 2013, and in the Era cohort for all years from 1992 to 2013 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 2010 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.

Background
14. 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 .Gov website: https://www.gov.uk/government/publications/causes-of-deaths-that-occurred-among-the-uk-veterans-of-the-199091-gulf-conflict 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.

15. 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
16. **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 Navy, Army and Air Force Institutes (NAAFI), MOD civil servants), by other Government Departments, or civilians working for Defence Contractors, the media or charitable and humanitarian organisations.

17. **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

18. 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.

19. 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 in the previous release (data as at 1 February 2013), for deaths that occurred during 2012, there were a higher than usual number that had been reported without a cause of death. As part of our regular checks, these records were queried with the NHSIC and GRO and the causes of death were updated for 18 of the 22 deaths in the Gulf cohort and 39 of the 42 deaths in the Era cohort.

20. 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 2013, 99,047 (93%) individuals from the Gulf and Era cohorts remained flagged by one of the above organisations.

21. Table 1 provides a breakdown of the record status of the Gulf and Era cohorts by Service

Table 1: Status of the Gulf and Era cohorts[1] by Service, Numbers

Status	All	Royal Navy	Royal Marines	Army	RAF
All	106,552	10,773	1,149	74,516	20,114
Flagged	99,047	10,046	1,066	69,226	18,709
Dead	3,133	291	32	2,157	653
Emigrated	1,250	117	11	861	261
Lost to follow up	3,122	319	40	2,272	491

1. Defence Statistics receive quarterly updates with the latest flagging status for cohort members

22. Defence Statistics follows ONS guidelines for which deaths to include in each of the cause groups on **Table 2**. 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.

23. The UK population estimates used to calculate SMR refer to the usually resident population on 30 June of each year. The usually resident population is defined by the standard United Nations definition for population estimates and includes people who reside in the area for a period of at least 12 months whatever their nationality. ONS mid-year population estimates are based on updates from the most recent census, allowing for births, deaths, net migration and ageing of the population. The UK general population data for 2013 was not available for this report to calculate standard mortality ratios (SMR), therefore, Defence Statistics has used the 2012 data as an estimate for the 2013 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 2013 data becomes available.

24. 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). In 2006 the ONS changed from reporting the number of deaths that occurred in each year to the number of deaths that were registered in each year. A major driver for this change 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. This change has little effect on annual totals but allows the output of more timely mortality data. The UK death figures reported are based on deaths registered in the data year and therefore the year in which a death is registered may not correspond to the year in which the death occurred. Therefore the UK death data used by Defence Statistics up to and including 2005 is based on deaths that occurred in the year. The UK death data used by Defence Statistics for 2007 onwards is based on deaths that were registered in the year. To produce the UK death data for 2006 Defence Statistics have followed advice provided by the ONS and used deaths that both occurred and were registered in the year. Using UK population deaths that both occurred and were registered in year resulted in an increased dominator population for the 2006 SMR calculation which resulted in a lower SMR for 2006 (when compared with the 2006 SMR reported in publications before this change in methodology). Users should note that this revised corrected methodology has brought the 2006 SMR findings in line with the SMR findings for other years.

Statistical methods

25. 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.

26. 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'.

27. 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.

28. 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**.

29. 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 9).

30. 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
31. 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.

32. 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.

33. 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.

34. The findings presented in this notice are broadly similar to results published in March 2013 covering deaths during the period 1 April 1991 to 31 December 2012. 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
35. A strength of this publication is that, as at 31 December 2013, 93% of surviving cohort members were still flagged by the NHS, which means that we are still able to follow up and receive death notification for a high proportion of the cohorts.

36. 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 19 for more information about the extent of these revisions). Users should be aware of this weakness when using the information presented in this notice.

37. 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).

38. The United Kingdom Statistics Authority has designated these statistics as National Statistics, in accordance with the Statistics and Registration Service Act 2007 and signifying compliance with the Code of Practice for Official Statistics.

39. Designation can be broadly interpreted to mean that the statistics:
    • meet identified user needs;
    • are well explained and readily accessible;
    • are produced according to sound methods; and
    • are managed impartially and objectively in the public interest.

40. Once statistics have been designated as National Statistics it is a statutory requirement that the Code of Practice shall continue to be observed.

<u>Revisions and changes to previously published data</u>

41. The figures presented in this Statistical Notice are from deaths reported to the Ministry of Defence (MOD) by 1 February 2014. Further deaths for the period 1 April 1991 to 31 December 2013 may be reported to the MOD before publication of the next release, in March 2015. 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.

42. 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.

43. Additional graphs on Deaths due to neoplasm (figure 6) and Deaths for suicide and open verdicts (figure 9) have been included in this statistical notice for the first time. Please note this data has previously been published in the official statistics notice 'A Study of Deaths among UK Armed Forces personnel deployed to the 1982 Falklands Campaign: 1982 to 2012'.

RESULTS

Comparisons between Gulf veterans and Era cohort

<u>All deaths</u>

44. **Table 2** 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 2013, 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.

45. 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.

46. There were 1,506 deaths among the Gulf veterans up to 31 December 2013 and 1,627 deaths in the Era comparison group, representing increases of 114 and 126 respectively since the last release of this Statistical Notice in March 2013. These increases resulted in an estimate of 1,583 deaths in the age-adjusted Era comparison group.

47. There was no statistically significant difference between the total number of deaths among Gulf veterans (n=1,506) and the age-adjusted Era comparison group (n=1,583) (RR: 0.95, 95% CI: 0.88-1.02).

Table 2: Deaths among UK Gulf 1 veterans[1] by cause of death[2], 1 April 1991 - 31 December 2013, numbers and rate ratios

ICD Chapter	Cause of death	Gulf	Era	Adjusted[6] Era	Crude Mortality Rate Ratio	Adjusted[6] Mortality Rate Ratio	Adjusted[6] 95% Confidence Interval	
	All deaths	**1,506**	**1,627**	**1,583**	**0.91**	**0.95**	**(0.88**	**1.02)**
	All cause coded deaths	**1,450**	**1,580**	**1,540**	**0.91**	**0.94**	**(0.88**	**1.01)**
I - XVIII	**Disease-related causes**	**911**	**1,073**	**1,035**	**0.84**	**0.88**	**(0.81**	**0.97)**
I	Certain infectious and parasitic diseases	11	10	9	1.09	1.23	(0.50	3.01)
II	Neoplasms	404	474	455	0.84	0.89	(0.78	1.02)
V	Mental and behavioural disorders	20	31	27	0.64	0.75	(0.42	1.34)
VI	Diseases of the nervous system	36	47	46	0.76	0.80	(0.52	1.24)
IX	Diseases of the circulatory system	286	334	328	0.85	0.88	(0.75	1.03)
X	Diseases of the respiratory system	34	39	36	0.86	0.93	(0.58	1.49)
XI	Diseases of the digestive system	88	92	92	0.94	0.97	(0.73	1.30)
III, IV, XII - XVIII	All other disease related causes	32	46	43	0.69	0.74	(0.46	1.18)
XX	**External causes of mortality**	**539**	**507**	**505**	**1.05**	**1.06**	**(0.94**	**1.20)**
	Transport accidents:	213	182	183	1.16	1.16	(0.95	1.42)
	Land transport accident:	177	154	154	1.14	1.14	(0.91	1.42)
	Pedestrian	17	7	8	0.58	2.29	(0.95	5.53)
	Motorcycle rider	56	51	49	1.08	1.11	(0.76	1.65)
	Car occupant	50	45	46	1.10	1.08	(0.72	1.62)
	Other[3]	54	51	51	1.05	1.05	(0.71	1.55)
	Water transport	5	3	4	1.65	1.49	(0.37	5.97)
	Air and space transport	31	25	25	1.22	1.25	(0.73	2.12)
	Other external causes of accidental injury:	94	99	94	0.94	0.95	(0.71	1.26)
	Falls	12	18	17	0.66	0.71	(0.35	1.48)
	Exposure to inanimate mechanical forces	18	18	19	0.99	0.92	(0.47	1.78)
	Accidental drowning and submersion and other accidental threats to breathing	13	13	13	0.99	0.95	(0.43	2.10)
	Accidental poisoning by and exposure to noxious substances	20	26	24	0.76	0.78	(0.42	1.43)
	Accidental exposure to other and unspecified factors	20	13	13	1.52	1.60	(0.78	3.27)
	Other	11	11	11	0.99	1.01	(0.43	2.38)
	Intentional self-harm and events of undetermined intent[4]	208	191	190	1.08	1.09	(0.90	1.34)
	Assault	7	10	10	0.69	0.65	(0.24	1.73)
	Legal intervention and operations of war	9	10	11	0.89	0.91	(0.37	2.28)
	Complications of medical care	0	2	2	-	-	-	-
	Sequelae of external causes of morbidity and mortality	0	4	3	-	-	-	-
	Deaths where the inquest has been adjourned	8	9					
	Other deaths for which cause data are not yet available[5]	**36**	**38**					
	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. 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.
4. 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.
5. Adjusted for the single years of age structure of the Gulf cohort at 1 January 1991.
6. Includes cases with insufficient information on the death certificate to provide a known cause of death.

<u>Disease-related causes</u>
48. **Table 2** shows that the number of disease-related deaths among Gulf veterans was statistically significantly lower than in the age-adjusted Era comparison group, with 911 deaths compared with an estimate of 1,035 respectively (RR=0.88, 95% CI: 0.81-0.97).

49. 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 83 for more information). This finding will be monitored in subsequent reports to ascertain if the finding is real or has occurred by chance.

50. The main cause of disease-related deaths amongst both Gulf veterans and the age-adjusted Era comparison group was neoplasms: 404 deaths compared with an estimate of 455 respectively. There was no statistically significant difference between the number of deaths due to neoplasms in the two cohorts (RR: 0.89, 95% CI: 0.78-1.02). **Table 3** provides further details on the specific cancer sites.

51. There were 286 deaths due to diseases of the circulatory system (including ischaemic heart disease and cerebrovascular disease) among Gulf veterans compared with an estimate of 328 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: 0.88, 95% CI: 0.75-1.03).

52. There were nine deaths from motor neurone disease (MND) among Gulf veterans compared with an estimate of 13 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.

<u>External causes of mortality</u>
53. **Table 2** shows that there was no statistically significant difference in the total number of deaths from external causes between Gulf veterans (n=539) and the age-adjusted Era comparison group (n=505) (RR: 1.06, 95% CI: 0.94-1.20).

54. The largest group of deaths due to external causes was transport accidents: 213 deaths among Gulf veterans compared with an estimate of 183 among the age-adjusted Era comparison group. Of these, land transport accidents accounted for 177 Gulf Veterans' deaths compared to an estimate of 154 in the Era cohort. Neither of these findings were statistically significant (**Table 2**).

55. There were 208 deaths due to intentional self-harm and events of undetermined intent (suicides and open verdict deaths) among Gulf veterans compared with an estimate of 190 among the age-adjusted Era comparison group, but this was not statistically significant (RR: 1.09, 95% CI: 0.90-1.34).

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

Figure 1: Deaths among UK Gulf veterans by main cause of death[1,2], 1 April 1991 - 31 December 2013, percentages
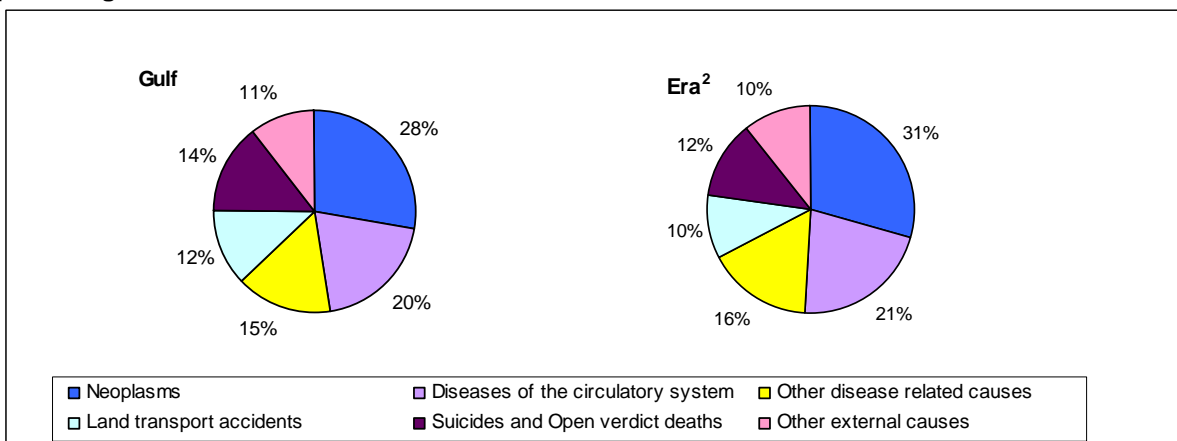
1. Percentages have been calculated using the total for all cause coded deaths.
2. Adjusted for the single years of age structure of the Gulf cohort at 1 January 1991.

57. **Table 3** 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 2013, 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.

58. There were no statistically significant differences in the total number of deaths due to neoplasms between the Gulf veterans (n=404) and the age-adjusted Era comparison group (n=455) (RR: 0.89, 95% CI: 0.78-1.02).

59. 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 18 and 33 deaths respectively (RR: 0.54, 95% CI: 0.31-0.96);
    b) For malignant neoplasm of the bronchus and lung there were 49 and 82 deaths respectively (RR: 0.60, 95% CI: 0.42-0.85). 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 54 and 87 deaths respectively (RR: 0.63, 95% CI: 0.45-0.87).

60. These results were also found in the March 2012 and March 2013 release of these statistics with a similar difference in the mortality rates between the two cohorts. In March 2013: MN of colon (RR:0.53, 95% CI: 0.28-0.98), MN of the bronchus and lung (RR:0.62, 95% CI: 0.43-0.91). 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 83 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 3**).

61. Please note that **Table 3** 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' four specific cancer sites are presented. Within this major site there are also a further three Gulf deaths not specified due to numbers fewer than five.

Table 3: Deaths among UK Gulf veterans due to neoplasms, 1 April 1991 – 31 December 2013, numbers and rate ratios[1]

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**	**404**	**474**	**455**	**0.84**	**0.89**	**(0.78**	**1.02)**
C00-C99	**Malignant Neoplasms (MN)**	**399**	**468**	**450**	**0.84**	**0.89**	**(0.78**	**1.02)**
C00-C14	**MN of lip, oral cavity and pharynx**	18	13	12	1.37	1.44	(0.70	2.97)
C15-C26, C48	**MN of digestive organs and peritoneum**	134	156	152	0.85	0.90	(0.72	1.14)
C15	MN of oesophagus	35	30	30	1.15	1.26	(0.78	2.03)
C16	MN of stomach	14	20	18	0.69	0.78	(0.39	1.56)
C18	MN of colon	18	37	33	0.48	0.54	(0.31	0.96)
C19	MN of rectosigmoid junction	6	5	5	1.19	1.23	(0.38	4.05)
C20	MN of rectum	13	9	9	1.43	1.48	(0.63	3.50)
C22	Malignant neoplasm of liver and intrahepatic bile ducts	10	14	15	0.71	0.73	(0.34	1.60)
C25	MN of pancreas	27	31	32	0.86	0.86	(0.51	1.43)
C26	MN of other and ill-defined digestive organs	6	4	5	1.48	1.41	(0.41	4.78)
C30-C39	**MN of respiratory and intrathoracic organs**	54	94	87	0.57	0.63	(0.45	0.87)
C34	MN of bronchus and lung	49	89	82	0.54	0.60	(0.42	0.85)
C40-C45, C47, C49-C50	**MN of bone, connective tissue, skin and breast**	35	37	37	0.93	0.97	(0.61	1.54)
C41	MN of bone and articular cartilage of other and unspecifies sites	5	2	2	2.47	2.37	(0.46	12.15)
C43	Malignant melanoma of skin	18	19	18	0.94	1.03	(0.54	1.96)
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**	46	32	30	1.42	1.52	(0.96	2.40)
C56	MN of ovary	5	2	2	2.47	2.44	(0.49	12.21)
C61	MN of prostate	12	14	12	0.85	0.98	(0.44	2.16)
C64	MN of kidney, except renal pelvis	19	11	12	1.71	1.67	(0.80	3.48)
C67	MN of bladder	7	5	5	1.38	1.54	(0.48	4.92)
C69-C80	**MN of other and unspecified sites**	62	84	81	0.73	0.74	(0.53	1.04)
C71	MN of brain	37	52	51	0.70	0.71	(0.46	1.09)
C80	MN without specification of site	19	26	24	0.72	0.75	(0.41	1.37)
C81-C96	**MN of lymphatic and haematopoietic tissue**	48	52	50	0.91	0.96	(0.65	1.43)
C81-C85, C91.4, C96	Lymphomas	22	30	30	0.72	0.75	(0.44	1.30)
C81	Hodgkin's disease	4	7	8	0.56	0.54	(0.16	1.84)
C82-C85, C91.4, C96	Non-Hodgkin's lymphoma	18	23	22	0.77	0.82	(0.44	1.51)
C91-C95 excl C91.4	Leukaemias	21	15	14	1.38	1.43	(0.73	2.83)
C92	Myeloid leukaemia	14	7	7	1.98	1.95	(0.79	4.83)
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	6	6	0.82	0.80	(0.23	2.82)

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

62. 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 2,497 deaths among Gulf veterans if they had experienced the age and gender specific mortality rates of the UK general population, compared to the 1,506 deaths that have actually occurred between 1991 and 2013, thus there were fewer deaths than expected among Gulf 1 veterans than in the UK general population.

63. Mortality rates for disease-related causes for both Gulf veterans and the age-adjusted Era comparison group have gradually increased between 1991 and 2013 (**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 83).

Figure 2: Gulf and Era mortality rates for disease related causes, 3-year moving average rates per 1,000 personnel[1,2]
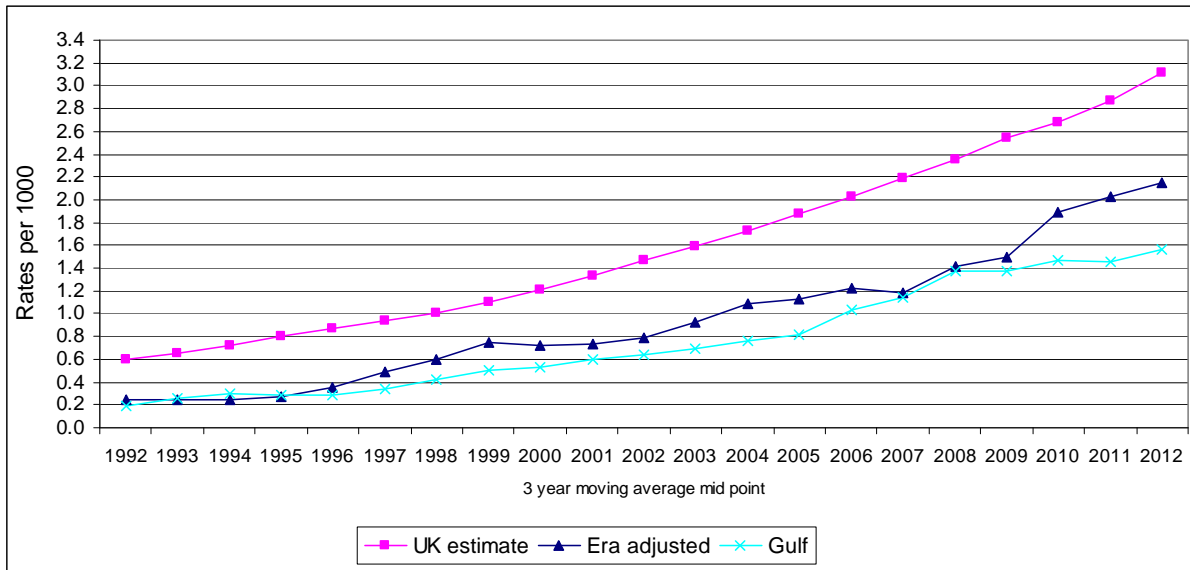
1. Data for 1 April 1991 – 31 December 1991 have been adjusted to a full year.
2. Mortality rates for the Era cohort have been adjusted for the single years of age structure of the Gulf cohort at 1 January 1991

64. Mortality rates for external causes of injury for both the Gulf veterans and the age-adjusted Era comparison group have decreased between 1991 and 2013 (**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]
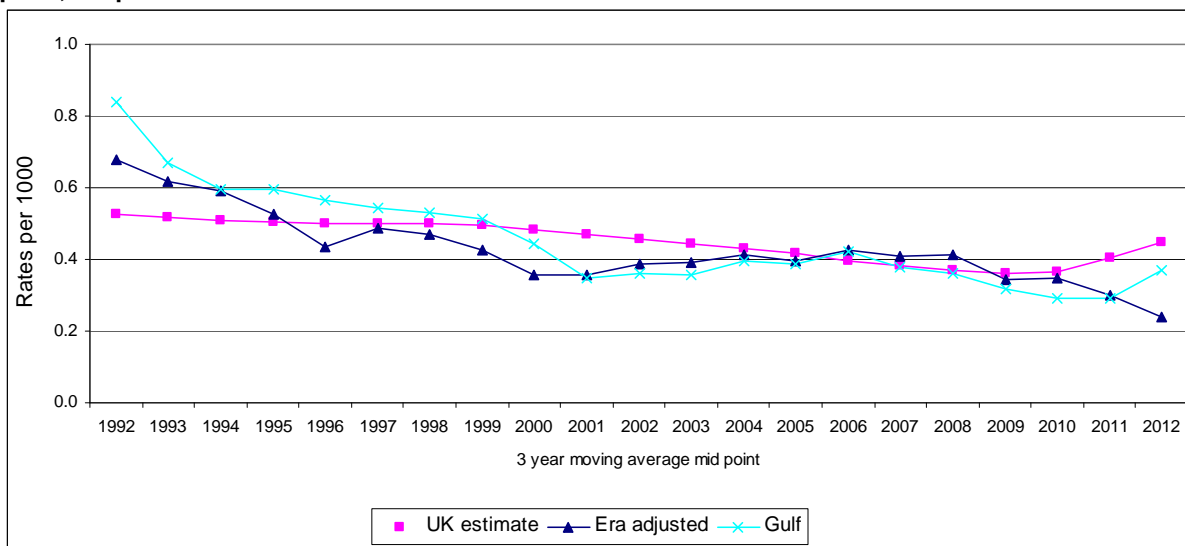
1. Data for 1 April 1991 – 31 December 1991 have been adjusted to a full year.
2. Mortality rates for the Era cohort have been adjusted for the single years of age structure of the Gulf cohort at 1 January 1991

Standardised Mortality Ratios (SMR)

65. 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 greater than the rate in the UK population (see '**statistical methods**' for further clarification).

66. 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.

67. Overall SMR were calculated for both the Gulf and Era cohorts covering all reported deaths from 1991 to 2013. The SMR showed that there was a statistically significant decreased risk of dying in both the Gulf (SMR=60, 95% CI:57-63) and Era (SMR=64, 95% CI:61-67) cohorts compared to the UK population (**Table 3**).

Table 4: Deaths by cause of death and cohort, 1991-2013, 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	**1,506**	**60**	**(57 - 63)**	**1,627**	**64**	**(61 - 67)**
All disease related deaths	**911**	**47**	**(44 - 51)**	**1,073**	**54**	**(51 - 57)**
Neoplasms	404	62	(56 - 68)	478	70	(64 - 77)
Circulatory	286	48	(43 - 54)	334	53	(48 - 59)
All external causes	**539**	**99**	**(91 - 108)**	**507**	**95**	**(87 - 103)**
Suicide & open verdict	208	76	(67 - 88)	191	71	(62 - 82)
Transport accidents	213	186	(163 - 213)	182	161	(139 - 186)

1. Standardised mortality ratios have been age and gender standardised

68. Specific SMR were also calculated for the following causes of death: neoplasms, diseases, transport accidents and intentional self harm and events of undetermined intent (**Table 4**).

69. **Table 4** shows that for disease related deaths there was a statistically significant decreased risk of dying in the Gulf (SMR=47, 95% CI:44-51) and Era (SMR=54, 95% CI:51-57) 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.

70. For deaths due to external causes, there was no significant difference in the risk of dying in the Gulf (SMR=99, 95% CI:91-108) and Era (SMR=95, 95% CI:87-103) cohorts compared to the UK population. For deaths due to intentional self harm and events of undetermined intent (suicide and open verdicts) there was a statistically significant decreased risk of dying in the Gulf (SMR=76, 95% CI:67-88) and Era (SMR=71, 95% CI:62-82) cohorts compared to the UK population.

71. However, the Gulf cohort were at a 86% statistically significant increased risk of dying as a result of a Land Transport Accident compared to the UK general population and the Era cohort at a 61% increased risk (SMR=186, 95% CI:163-213 and SMR=161, 95% CI:139-186 respectively). This finding was consistent with results presented in the 'Annual UK regular Armed Forces Land Transport Accident Deaths 1 January 2009 - 31 December 2013' Official Statistic, which shows that between 1984 and 2013, the overall rate of Land Transport Accident deaths among the UK regular Armed Forces was higher than the rate for the UK general population.

Trends over time

72. **Table 5** provides the SMR for each year from 1991 to 2013. These show that there was a statistically significant decreased risk of dying in the Gulf cohort for all years from 1993 to 2013, and in the Era cohort for all years from 1992 to 2013 compared to the UK population. For all years, the Gulf cohort had a 60% decreased risk of dying compared to the UK population (SMR=60, 95% CI: 57-63); the Era cohort had a 64% decreased risk of dying compared to the UK population (SMR=64, 95% CI: 61-67).

Table 5: Deaths by year and cohort, 1991-2013, 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	**1,506**	**60**	**(57 - 63)**	**1,627**	**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)	100	63	(52 - 77)
2011	90	55	(43 - 66)	124	75	(62 - 88)
2012	97	53	(39 - 60)	116	62	(47 - 69)
2013	102	51	(40 - 60)	116	57	(48 - 69)

1. Standardised mortality ratios have been age and gender standardised

73. **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 2013 (from an SMR of 81 to 51 in the Gulf cohort and an SMR of 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.
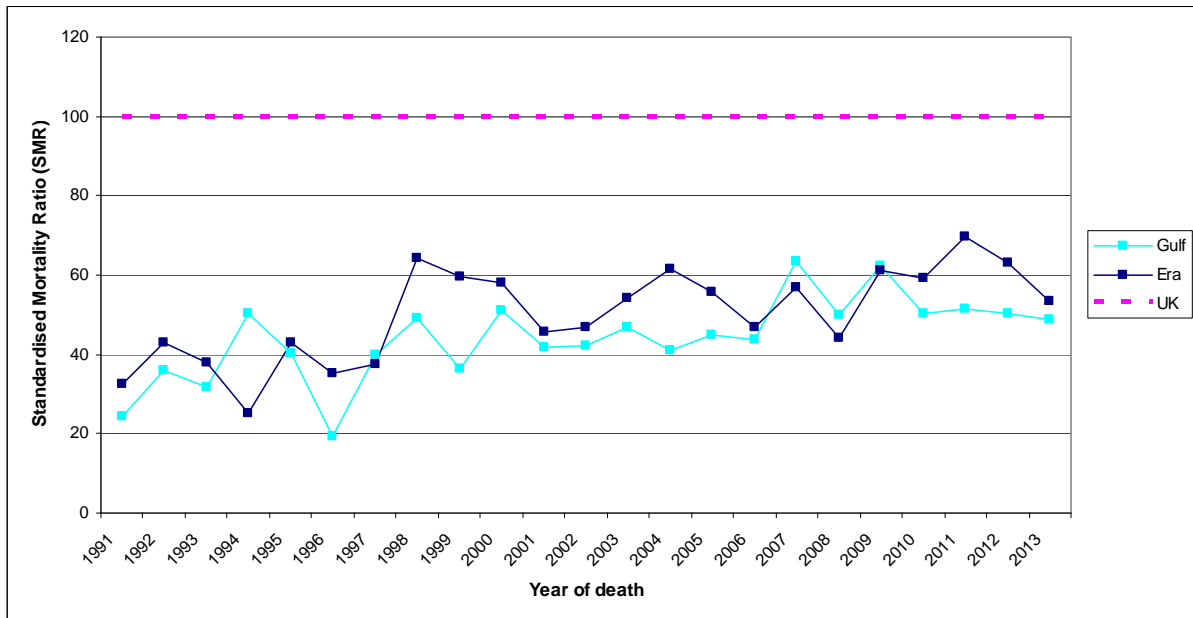
Figure 4: Deaths by year and cohort, 1991-2013, Standardised Mortality Ratios (SMR)[1]
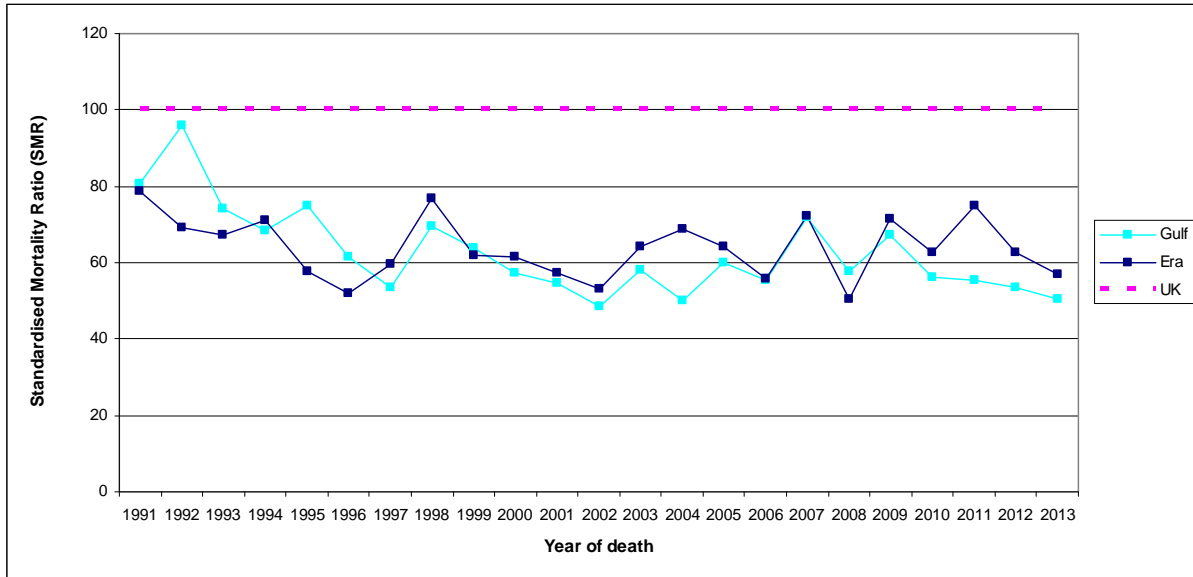
1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

74. To further explore the trends over time**, Figures 5** and **7** 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, 1991-2013, 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.

75. **Figure 6** shows that for veterans in the Gulf and Era cohorts the risk of dying from a cancer was lower than for UK general population. Since 2010 the risk of dying from cancer as a Gulf veteran has been significantly lower than the UK general population. The risk of dying from cancer as a veteran in the Era comparison group has been significantly lower than the UK general population since 2012. Three year moving averages have been calculated to smooth out the fluctuations and highlight trends over time.

Figure 6: Deaths due to neoplasm (cancer) by year[1] and cohort, 1991-2013, Standardised Mortality Ratios (SMR)[2]
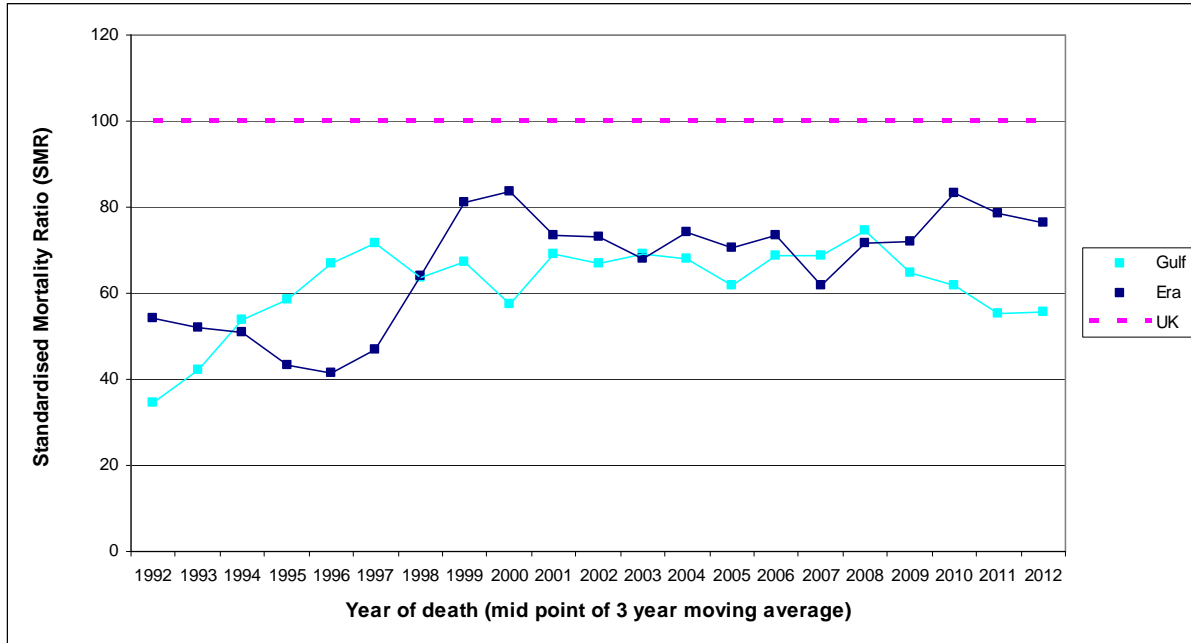
1. The year shown is the mid-point at a three year average. For example, 1992 refers to the period 1991 - 1993.
2.The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

76. **Figure 7** 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.
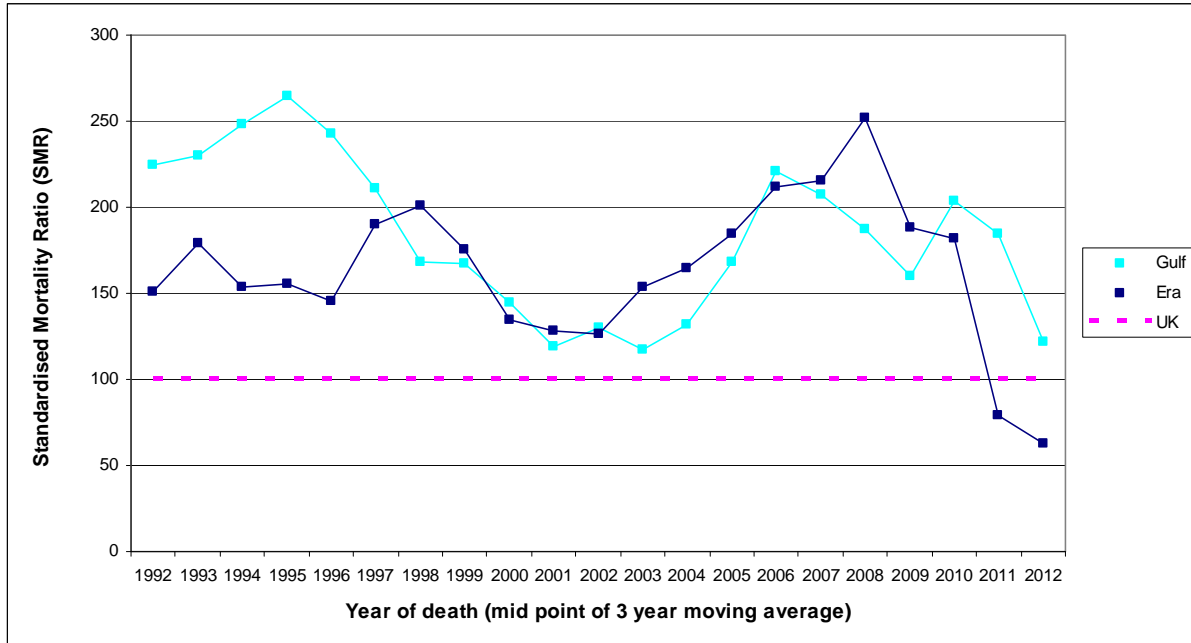
Figure 7: Deaths due to external causes by year and cohort, 1991-2013, Standardised Mortality Ratios (SMR)[1]
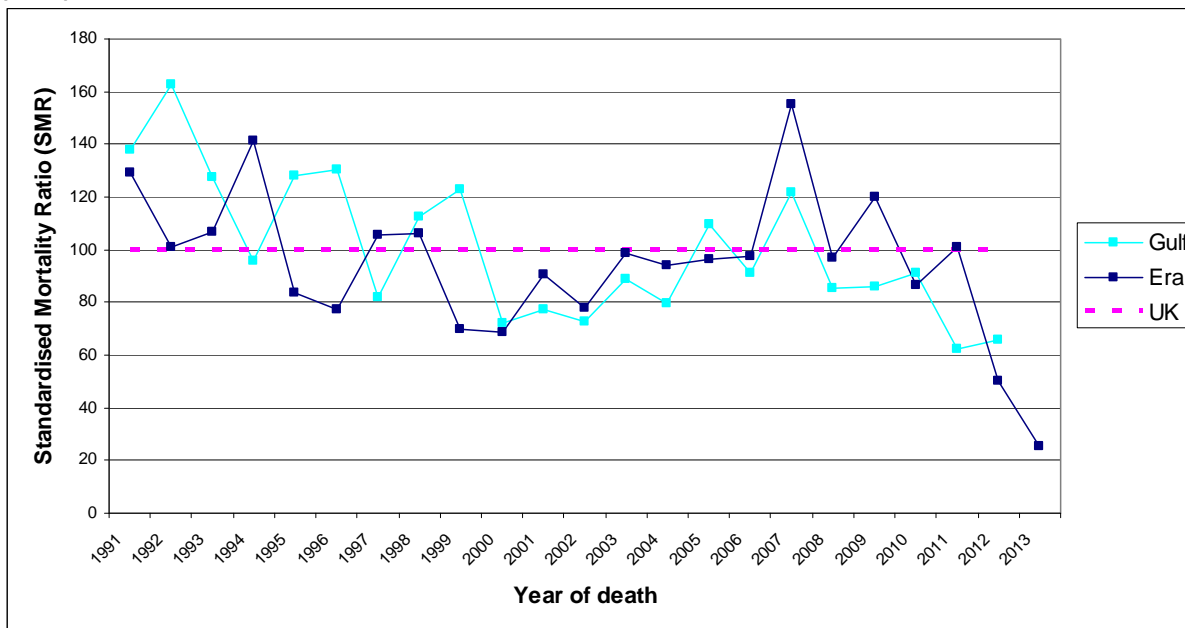
1. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

77. 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 2013, 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 8** 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 8: Deaths due to transport accidents by year[1] and cohort, 1991-2013, Standardised Mortality Ratios (SMR)[2]


1. The year shown is the mid-point at a three year average. For example, 1992 refers to the period 1991 - 1993.
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.

78. **Figure 8** shows that the SMR for deaths due to transport accidents in the Gulf cohort were at their highest between 1992 and 1995, representing a 164% increased risk of death 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 7**). 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 2009. 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 2009, however Defence Statistics will continue to monitor these trends in deaths due to transport accidents.

79. Due to an increased interest in deaths due to intentional self harm and events of undetermined intent (suicide and open verdicts) SMR have been presented. Due to the small numbers of these deaths, three year moving averages have been presented to remove some of the random variation that occurs when presenting small numbers over time. **Figure 9** shows the variation in the SMR for deaths due to intentional self harm and events of undetermined intent (suicide and open verdicts) in the Gulf and Era cohorts each year compared to the UK population.

Figure 9: Deaths due to intentional self harm & events of undetermined intent (suicide and open verdicts) by year and cohort, 1991-2013, Standardised Mortality Ratios (SMR)[1]
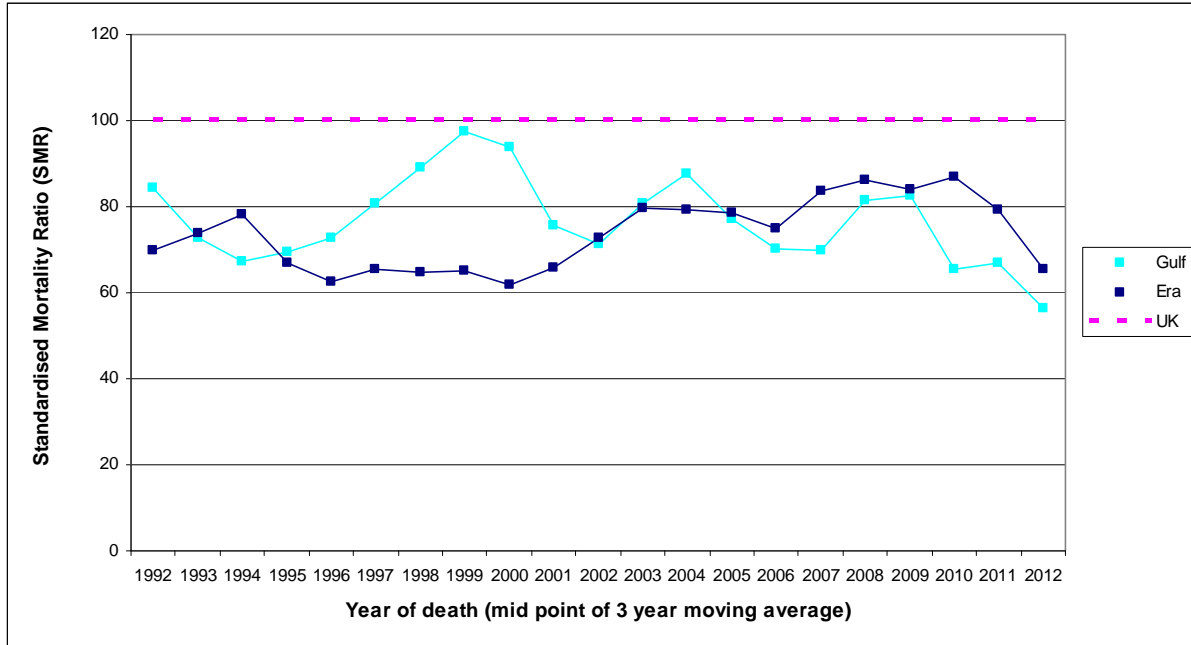
80. **Figure 9** shows that for veterans in both the Gulf and Era cohorts the risk of suicide was lower than the UK general population. In the Gulf cohort the risk of suicide was at its lowest in 2011 (SMR=40, 95% CI: 11-101) and in the Era cohort the risk was at its lowest in 2013 (SMR=44, 95% CI: 14-104). These results are based on small numbers (n=4 and n=5 for Gulf and Era cohorts respectively) so should be treated with caution.

81. **Table 6** provides the SMR by five year age group for all deaths from 1991 to 2013. 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 6: Deaths by age group[1] and cohort, 1991-2013, 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	**1,506**	**60**	**(57**	**-**	**63)**	**1,627**	**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	57	(49	-	67)
40-44	231	56	(49	-	64)	245	61	(54	-	70)
45-49	223	55	(49	-	63)	226	57	(50	-	65)
50-54	214	62	(54	-	70)	212	61	(53	-	70)
55-59	140	52	(44	-	61)	161	59	(50	-	68)
60-64	98	55	(45	-	67)	122	64	(54	-	77)
65-69	46	46	(35	-	62)	67	53	(42	-	68)
70+	25	42	(27	-	62)	69	61	(49	-	78)

1. Age is as at date of death
2. Standardised mortality ratios have been age and gender standardised

82. **Figure 10** 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 11 and 12** show the trends over time by age group separately for disease related deaths and deaths due to external causes. **Figure 11** 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 12** 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 10**, 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 12** 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.

83. 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 10: Deaths by age group[1] and cohort, 1991-2013, numbers, Standardised Mortality Ratios (SMR)[2]
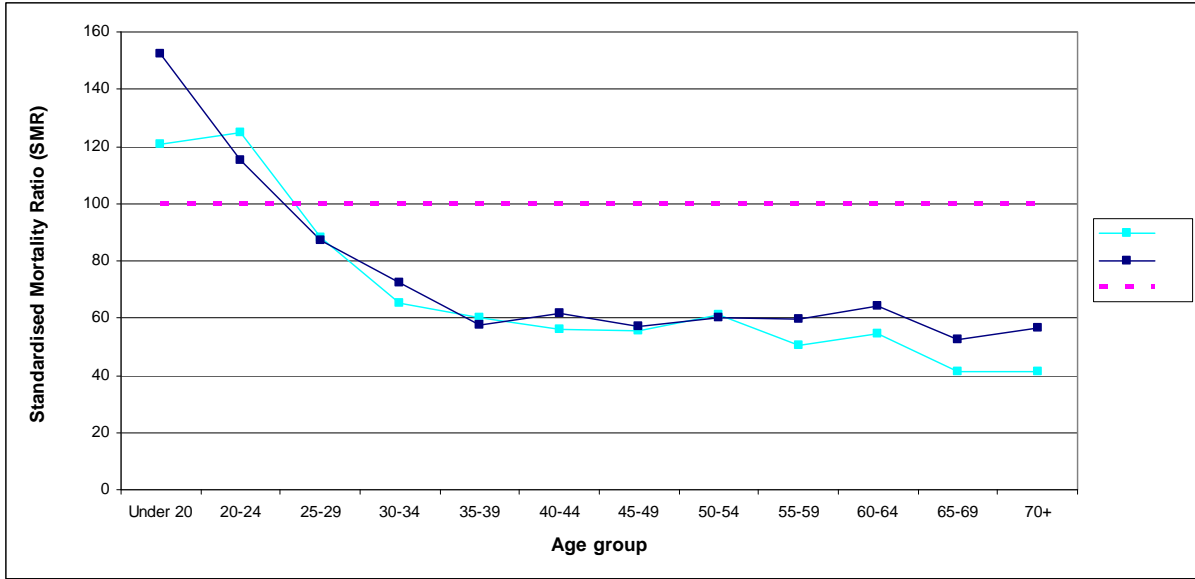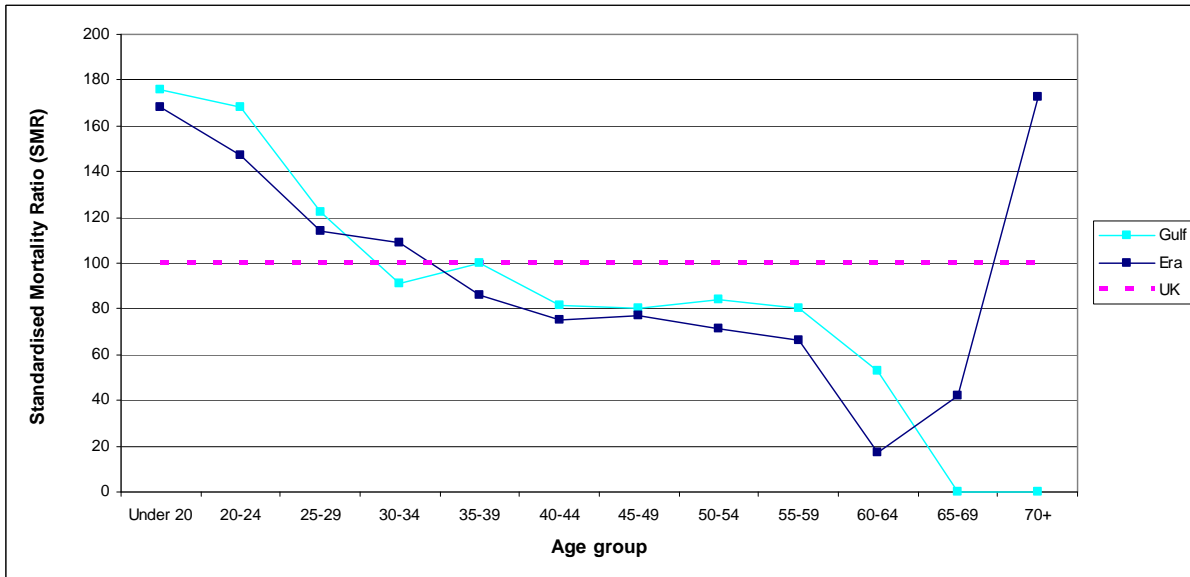

1. Age is as at date of death
2. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

Figure 11: Disease related deaths by age group[1] and cohort, 1991-2013, numbers, Standardised Mortality Ratios (SMR)[2]
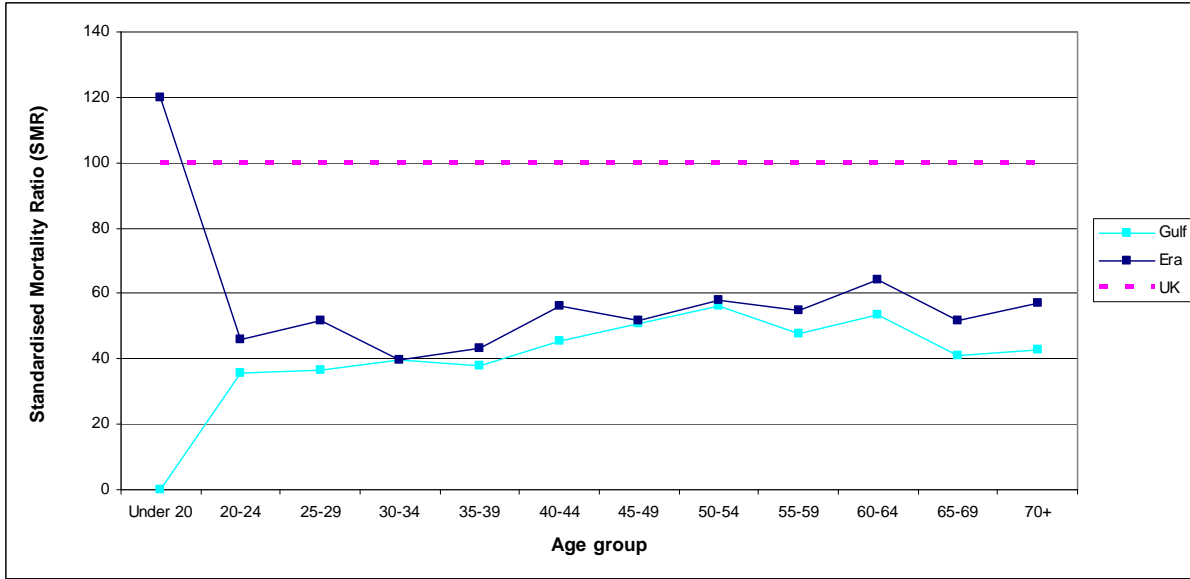
1. Age is as at date of death
2. The pink line indicates the value expected if the number of observed deaths in the Gulf and Era cohorts was the same as the number expected based on the age and gender structure of the UK population.

Figure 12: Deaths due to external causes by age group[1] and cohort, 1991-2013, 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.