

1. INTRODUCTION

This report updates the findings of the Air Force Health Study baseline mortality report [1] released on June 30, 1983. Other updates were released in 1984 [2], 1985 [3] and 1986 [4]. The reader is referred to the baseline report for information regarding the study design, the mortality determination process and previous findings.

This report differs from previous reports in that the entire Comparison population has been incorporated in the mortality determination. This expansion has allowed the application of statistical procedures that accommodate population death rates to compare observed and expected numbers of deaths with adjustment for calendar period as well as age at death, rank and occupation. Additionally, small increases in the number of Ranch Hands have occurred as additional Ranch Hands were recently determined to be eligible for inclusion in the study. As these new Ranch Hands were added to the study, newly matched Comparisons were added to the matched Comparison cohort. Thus, the group sizes in this report differ somewhat from those in previous mortality reports. These analyses also differ from those shown in previous reports because tour dates were determined for all Ranch Hands and their matched Comparisons, allowing the appropriate mortality contrasts referenced from date of tour as well as from date of birth.

Tour dates for unmatched Comparisons were randomly generated to permit analyses and report writing to take place while tour date determination for this expanded group continues. These artificial dates were produced by a random number generator and are uniformly distributed over the range November 1956 to October 1971. This range corresponds to the range of matched Comparison tour dates. Thus, while death rates referenced to tour date are only approximate for the unmatched Comparisons, they are considered adequate for reference with Ranch Hand rates. The effect of the use of these artificial tour dates for unmatched Comparisons is negligible, as evidenced by the near equivalence of Ranch Hand versus Comparison mortality contrasts both with and without the use of tour date information.

Changes in the Ranch Hand and matched Comparison cohort are documented in Table 1, which shows all additions to both groups since 1983. In Table 1, counts of matched Comparisons actually included in previous mortality reports are labeled with the heading C1-C5 and the total matched Comparison cohort is labeled C1-C10 because the Protocol specified that up to 10 Comparisons were to be matched to each Ranch Hand on date of birth, rank, race and occupation and that a random 5 from each match set were to be used as mortality Comparisons. At baseline, 1,247 Ranch Hands were identified, to which 9,982 Comparisons were matched. Of the matched 9,982 Comparisons, five in each match set were randomly selected to produce a baseline mortality Comparison cohort of 6,171 Comparisons. The total Comparison population numbers 19,101 individuals, 10,133 matched and 8,968 unmatched to Ranch Hands.

TABLE 1
Ranch Hand and Comparison Counts, 1983 - 1988

Mortality Report	Ranch Hand	C1-C5	C1-C10	All Comparisons
Baseline 30 June 83	1247	6171	9982	19101
Update 27 July 84	1256	6171	9982	19101
Update 15 July 85	1257	6171	9982	19101
Update 26 Dec 86	1257	6171	9982	19101
Current Update	1261	6250	10133	19101

The increase in the C1-C5 cohort from 6,171 to 6,250 and the increase in the C1-C10 total matched cohort from 9,982 to 10,133 occurred when 151 Comparisons were matched to the 4 newly discovered Ranch Hands and 15 previously unmatched Ranch Hands in 1988.

Since the 1986 update, the mortality determination process has been extended to the entire Comparison population to address concerns that the mortality experience of the C1-C5 matched Comparison cohort might not be representative of the mortality of all matched Comparisons. This expansion of the Comparison group to the entire Comparison population occurred after concurrence by the Advisory Committee appointed by the Agent Orange Working Group. Their decision was motivated by data, shown later in this section; that suggested that the mortality experience of the C1-C5 Comparison cohort was, purely by chance, not representative of the mortality experience of the entire matched Comparison cohort.

This report, therefore, contrasts Ranch Hand mortality with that of the entire Comparison population of 19,101 Comparisons who flew or serviced C-130 cargo aircraft in Southeast Asia during the same calendar period that the Ranch Hand unit was active in Vietnam. Except where necessary to relate to the December 1983 report, length of life is measured from the start date of the qualifying tour of duty, rather than from the birth date, as in previous reports. These new data have allowed the presentation of death rates per person-year, a new statistic in these mortality updates. To ease the transition from previous reports, Ranch Hand mortality is also contrasted with the C1-C5 subcohort of Comparisons, as in previously presented analyses. Throughout this report, C1-C5 refers to the 6,250 matched Comparisons and "all Comparisons" refers to the entire population of 19,101 Comparisons.

The analyses in this report are based on cumulative mortality as of 31 December 1987 (verified as of 15 June 1988). Table 2 shows summary counts, person-years and death rates by group (Ranch Hand, C1-C5, All Comparisons); Table 3 shows these summary statistics by group, rank and occupation. In Tables 2 through 6 and Table 8, the column headed "Rate (%)" shows percent dead ((number dead/number at risk) *100), a statistic displayed in previous mortality updates and now supplanted by death rate per 1000 person-years. Throughout this report person-years are measured from tour start date. In some tables, columns of death rates per 1000 person-years are simply headed by the word "Rate" (without the % symbol).

In the hypothetical case that the Ranch Hand mortality experience is the same as that of the Comparisons about 5% of the many statistical analyses shown in this report should be expected to produce P-values less than 0.05. The observation of significant results due to multiple testing on the same data, even when there is no group difference, is known as the multiple testing artifact and is common to all large studies. Unfortunately, there is no statistical procedure available to distinguish between those statistically significant results that arise because of multiple testing and those which may arise due to a herbicide effect. Hence, each significant result is scrutinized with regard to concomitant information to determine whether the result can be reasonably attributed to herbicide exposure.

A person-year is the length of time lived by one person in one year. The total number of person-years for a cohort is the total length of life lived by the cohort. Persons surviving to the time of data analysis contribute the time, in years, between the dates of entry into follow-up and data analysis. Persons known to have died before the date of data analysis contribute the time, in years, between the dates of entry into follow-up and death. In this study, the date of entry into follow-up is the date of the start of the first qualifying tour of duty. The date of data analysis is, effectively, 31 December 1987, the end of the 1987 calendar year. Throughout this report, person-years are rounded to the nearest year and are sometimes abbreviated as "P Y" in table headings.

TABLE 2

Summary Counts by Group, All Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	1261	74	5.87	24964	2.96
C1-C5	6250	376	6.02	126291	2.98
All Comp	19101	1039	5.44	413726	2.51

TABLE 3

Summary Counts by Group, Rank and Occupation

Flying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	441	25	5.67	8736	2.86
C1-C5	2176	121	5.56	43842	2.76
All Comp	5245	319	6.08	110304	2.89

Enlisted Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	207	12	5.80	4112	2.92
C1-C5	1035	83	8.02	20771	4.00
All Comp	2833	202	7.13	60292	3.35

All Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	648	37	5.71	12848	2.88
C1-C5	3211	204	6.35	64612	3.16
All Comp	8078	521	6.45	170596	3.05

Nonflying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	26	1	3.85	512	1.95
C1-C5	124	6	4.84	2561	2.34
All Comp	286	15	5.24	6185	2.42

Nonflying Enlisted Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	587	36	6.13	11604	3.10
C1-C5	2915	166	5.69	59117	2.81
All Comp	10737	503	4.68	236945	2.12

TABLE 3 (Cont'd)

Summary Counts by Group, Rank and Occupation

All Nonflyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	613	37	6.04	12116	3.05
C1-C5	3039	172	5.66	61679	2.79
All Comp	11023	518	4.70	243130	2.13

All Enlisted Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	794	48	6.05	15716	3.05
C1-C5	3950	249	6.30	79888	3.12
All Comp	13570	705	5.19	297237	2.37

All Officers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	467	26	5.57	9248	2.81
C1-C5	2300	127	5.52	46403	2.74
All Comp	5531	334	6.04	116489	2.87

Occupation and race-specific mortality is summarized in Table 4. Some Ranch Hand death rates in Table 4 appear unusually high. For example, the Ranch Hand death rate among Black enlisted flyers is 13.46 and the corresponding rate for all Comparison deaths in this stratum is 4.40 deaths per 1000 person-years (SMR=3.05, P=0.02). These deaths are too infrequent to compute a confidence interval. The four Ranch Hand deaths in this stratum have occurred since 1980. One of the 4 deaths was a suicide, 1 was accidental, 1 was due to a digestive system disease and 1 was due to ill-defined causes. The increased Ranch Hand death rate in this stratum therefore remains unexplained but appears unrelated to herbicide exposure.

TABLE 4

Summary Counts by Group, Race-Specific Mortality

Nonblack Pilots

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	351	20	5.70	6937	2.88
C1-C5	1749	101	5.77	35169	2.87
All Comp	3419	231	6.76	70034	3.30

TABLE 4 (Cont'd)

Summary Counts by Group, Race-Specific Mortality

Nonblack Navigators

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	82	5	6.10	1647	3.04
C1-C5	404	20	4.95	8184	2.44
All Comp	1774	87	4.90	39105	2.22

Nonblack Nonflying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	25	1	4.00	494	2.03
C1-C5	122	6	4.92	2522	2.38
All Comp	282	15	5.32	6098	2.46

Nonblack Enlisted Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	192	8	4.17	3815	2.10
C1-C5	960	72	7.50	19295	3.73
All Comp	2609	181	6.94	55523	3.26

Nonblack Nonflying Enlisted Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	534	34	6.37	10557	3.22
C1-C5	2655	152	5.73	53828	2.82
All Comp	9701	444	4.58	214206	2.07

Black Pilots

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	6	0	0.00	115	0.00
C1-C5	13	0	0.00	269	0.00
All Comp	20	1	5.00	452	2.21

TABLE 4 (Cont'd)

Summary Counts by Group, Race-Specific Mortality

Black Navigators

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	2	0	0.00	38	0.00
C1-C5	10	0	0.00	219	0.00
All Comp	32	0	0.00	714	0.00

Black Nonflying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	1	0	0.00	19	0.00
C1-C5	2	0	0.00	39	0.00
All Comp	4	0	0.00	88	0.00

Black Enlisted Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	15	4	26.67	297	13.46
C1-C5	75	11	14.67	1475	7.46
All Comp	224	21	9.38	4769	4.40

Black Nonflying Enlisted Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	53	2	3.77	1047	1.91
C1-C5	260	14	5.38	5289	2.65
All Comp	1036	59	5.69	22739	2.59

Deaths occurring during the calendar years 1986 and 1987 are shown in Tables 5 and 6. Corresponding tables for the years 1983, 1984 and 1985 are shown in the Appendix.

TABLE 5

Deaths During 1986
Summary Counts and Rates by Rank,
Occupation and Group

Flying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	425	5	1.18	422	11.84
C1-C5	2069	4	0.19	2067	1.94
All Comp	4974	21	0.42	4962	4.23

Enlisted Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	197	1	0.51	197	5.08
C1-C5	963	8	0.83	958	8.35
All Comp	2659	18	0.68	2652	6.79

All Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	622	6	0.96	619	9.70
C1-C5	3032	12	0.40	3026	3.97
All Comp	7633	39	0.51	7614	5.12

Nonflying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	25	0	0.00	25	0.00
C1-C5	121	0	0.00	121	0.00
All Comp	277	2	0.72	276	7.24

TABLE 5 (Cont'd)

Deaths During 1986

Summary Counts and Rates by Rank,
Occupation and Group

Nonflying Enlisted Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	555	3	0.54	553	5.42
C1-C5	2776	13	0.47	2770	4.69
All Comp	10306	35	0.34	10290	3.40

All Nonflyers

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	580	3	0.52	578	5.19
C1-C5	2897	13	0.45	2891	4.50
All Comp	10583	37	0.35	10566	3.50

All Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	1202	9	0.75	1197	7.52
C1-C5	5929	25	0.42	5916	4.23
All Comp	18216	76	0.42	18180	4.18

TABLE 6

Deaths During 1987

Summary Counts and Rates by Rank,
Occupation and Group

Flying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	420	4	0.95	419	9.54
C1-C5	2065	10	0.48	2061	4.85
All Comp	4953	27	0.55	4940	5.47

TABLE 6 (Cont'd)

Deaths During 1987
Summary Counts and Rates by Rank,
Occupation and Group

Enlisted Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	196	1	0.51	196	5.11
C1-C5	955	3	0.31	954	3.15
All Comp	2641	10	0.38	2635	3.79

All Flyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	616	5	0.81	615	8.13
C1-C5	3020	13	0.43	3014	4.31
All Comp	7594	37	0.49	7576	4.88

Nonflying Officers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	25	0	0.00	25	0.00
C1-C5	121	3	2.48	120	25.02
All Comp	275	4	1.45	273	14.65

Nonflying Enlisted Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	552	1	0.18	551	1.81
C1-C5	2763	14	0.51	2756	5.08
All Comp	10271	37	0.36	10254	3.61

All Nonflyers

Group	Number at Risk	Number Dead	Rate (%)	Person-years	Rate Per 1000 Person-years
Ranch Hand	577	1	0.17	576	1.74
C1-C5	2884	17	0.59	2876	5.91
All Comp	10546	41	0.39	10527	3.89

TABLE 6 (Cont'd)

Deaths During 1987
Summary Counts and Rates by Rank,
Occupation and Group

All Personnel

Group	Number at Risk	Number Dead	Rate (%)	Person- years	Rate Per 1000 Person-years
Ranch Hand	1193	6	0.50	1191	5.04
C1-C5	5904	30	0.51	5890	5.09
All Comp	18140	78	0.43	18102	4.31