CHAPTER 9

GENERAL HEALTH

INTRODUCTION

Background

The effects of heavy, acute exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD or dioxin) have been demonstrated in a number of different organ systems. It is plausible, therefore, that chronic low-dose exposure to TCDD might induce subtle, interrelated effects that are not organ-system specific, but are manifest only in general terms, or affect the state of "well-being." Numerous animal studies and studies of exposed populations have shown that many enzyme induction systems throughout the body are affected by TCDD, which may have wide-ranging results.[1-4] However, it is difficult to measure overall health objectively. For this reason, general health outcomes, as defined by this study, should be judged in context with other more specific clinical endpoints.

Baseline Summary Results

Five general health variables were included in the 1982 Baseline examination: self-perception of health, appearance of illness or distress, relative age, sedimentation rate, and percent body fat. In the analysis of the Baseline examination data, a statistically significant difference in self-perception of health was found between the Ranch Hand and Comparison groups, with a greater percentage of Ranch Hands reporting their health as fair or poor than Comparisons (20.6% vs. 14.2%). This was true in both the younger and older age groups (Est. RR: 1.82, p=0.017 for individuals 40 or less and Est. RR: 1.35, p=0.025 for individuals older than 40). Since only 9 of 1,811 individuals were reported by the examining physician as appearing ill or distressed, this designation was apparently reserved for only very ill or distressed individuals. Nevertheless, eight of the nine individuals were Ranch Hands, the difference being of borderline significance (p=0.056). Conversely, more Ranch Hands than Comparisons were reported by the examiners as appearing younger than their actual ages (4.9% vs. 2.5%, p=0.029). No overall differences in percent body fat or sedimentation rate were found, although a significant interaction between group and age for sedimentation rate was noted; younger Ranch Hands had fewer sedimentation rate abnormalities than did their Comparisons, whereas no difference was found in participants older than 40. In the exposure index analyses conducted in the Ranch Hand group, no statistically significant dose-response relationships were detected.

1985 Followup Study Summary Results

General physical health was evaluated by the same five measures used in the Baseline examination (self-perception of health, appearance of illness or distress, relative age, percent body fat, and sedimentation rate).

The Ranch Hands again rated their health as fair or poor more often than the Comparisons (9.1% vs. 7.3%, respectively), although this difference was not statistically significant. However, further analysis revealed a significant group-by-occupation interaction; differences were largely confined to the enlisted groundcrew category where the adjusted relative risk was 1.90 (p=0.003).

Ten individuals were reported as appearing acutely ill or distressed at the followup examination. In contrast to the Baseline examination, four were Ranch Hands and six were Comparisons; thus, no group difference was suggested.

Relative age, as determined by the examining physician, was not significantly different in the two groups. There was a significant group-by-occupation interaction, but none of the estimated relative risks for the occupational categories was significant.

The (geometric) mean sedimentation rates did not differ significantly, either unadjusted or after adjustment for age, race, occupation, personality score, and an age-by-personality score interaction. However, in the discrete analysis, 5.8 percent of the Ranch Hands had sedimentation rate abnormalities (>20 mm/hr), contrasted to 3.6 percent in the Comparison group. This difference was significant both unadjusted (p=0.013) and adjusted for age and personality score (p=0.011).

The mean percent body fat of the Ranch Hands was significantly lower than the Comparisons (21.10 vs. 21.54, respectively; p=0.037), and the difference was of nearly the same magnitude after adjustment for age, race, and occupation. However, both unadjusted and adjusted tests of the discretized data did not reveal significant group differences, although the percent obese (>25% body fat) was lower in the Ranch Hands than in the Comparisons.

Detailed exposure analyses were done on four general health variables (appearance of illness or distress was too sparse for testing). Only one analysis detected a significant effect, namely, a positive association between sedimentation rate abnormalities and increasing exposure in the enlisted flyer cohort. Overall, no consistent pattern of exposure effects was discernible, and the exposure findings at the 1985 followup were similar to the findings at Baseline.

Longitudinal differences between the 1982 Baseline and the 1985 followup examination were assessed by analyses of two discrete variables: self-perception of health and sedimentation rate. Analysis of self-perception of health showed no significant group differences in the change over time, with the Ranch Hand and Comparison groups reporting symmetrical improvements in their perceptions over the 3-year period. The sedimentation rate analysis, however, revealed a highly significant group difference (p=0.002), due to a reversal of findings between examinations; i.e., a significant detriment in the (younger) Comparisons at the Baseline examination versus a significant detriment in the Ranch Hands at the followup examination.

Parameters of the 1987 General Health Assessment

Dependent Variables

The 1987 general health assessment was based on questionnaire, physical examination, and laboratory examination data. The variables analyzed were identical to those in the 1982 Baseline and 1985 followup examinations.

Questionnaire Data

During the questionnaire health interview, each study participant was asked, "Compared to other people your age, would you say your health is excellent, good, fair, or poor?" This self-reported perception was analyzed as a measure of the general health status of each participant, though susceptible to varying degrees of conscious and subconscious bias.

No participants were excluded for medical reasons from the analysis of this variable.

Physical Examination Data

Three variables derived from the physical examination were analyzed in the assessment of general health. The physician at the examination recorded the appearance of illness or distress (yes/no) of the study participant. The physician also noted the appearance of the subject as younger than, older than, or the same as his stated age. To the degree that the examining physicians were kept blind to the participant's group membership, these assessments were less subject to bias than the self-perception of health.

Percent body fat, a measure of the relative body mass of an individual and calculated from height and weight recorded at the physical examination, was also analyzed. Percent body fat was calculated from a metric body mass index,[5] and the formula was

$$\text{Percent Body Fat} = \frac{\text{Weight (kg)}}{[\text{Height (m)}]^2} \times 1.264 - 13.305.$$

This variable was analyzed in both the discrete and continuous forms. For purposes of discrete analyses, percent body fat was dichotomized as lean/normal ($\leq$25%) and obese (>25%).

No participants were excluded for medical reasons from the analyses of these three variables.

Laboratory Examination Data

The erythrocyte sedimentation rate (mm/hr), measured at the laboratory examination, was analyzed. Although nonspecific, a high sedimentation rate is

a generally accepted indicator of an ongoing disease process. This variable was analyzed in both the discrete and continuous forms. The logarithmic transformation was used to enhance statistical normality for continuous analyses.

No participants were excluded for medical reasons from the analysis of this variable.

Covariates

The effects of the covariates age, race, occupation, and personality type were examined in the assessment of general health, both in pairwise associations with the dependent variables and in adjusted statistical analyses. Age, race, and occupation were matching variables and were used for analyses with all dependent variables. Age was used in its continuous form for all adjusted analyses. Personality type was used in the analysis of self-perception of health and sedimentation rate only. Personality type was determined from the Jenkins Activity Survey administered during the 1985 followup examination. This variable was derived from a discriminant-function equation based on questions that best discriminate men judged to be Type A from those judged as Type B.[6] Positive scores reflect the Type A direction and negative scores the Type B direction. The personality-type score was used in its continuous form for all adjusted analyses. Participants at the 1987 followup examination who had not attended the 1985 followup examination had missing information for personality type, as did a few participants who could not be classified in 1985, because the Jenkins Activity Survey was not administered at the 1987 followup examination.

Relation to Baseline and 1985 Followup Studies

As noted above, the same variables were analyzed for the 1987 followup study as for the Baseline and 1985 followup studies.

For longitudinal analyses, sedimentation rate was analyzed as a discrete variable. The normal range for sedimentation rate for the Baseline examination was less than or equal to 12 mm/hr; the Scripps Clinic and Research Foundation (SCRF) normal range for sedimentation rate for the 1987 followup was less than or equal to 20 mm/hr. Self-perception of health was also analyzed in the longitudinal analyses.

Statistical Methods

The basic statistical analysis methods used in this chapter are described in Chapter 7. In addition, proportional odds model analysis, also described in Chapter 7, was used.

Table 9-1 summarizes the statistical analyses performed for the 1987 general health assessment. The first part of this table describes the dependent variables (including units for laboratory measurements), the source of the data used for the analysis, the form(s) of the data (discrete and/or continuous), and cutpoints. This table also presents candidate covariates examined in adjusted Ranch Hand versus Comparison contrasts (also referred to

TABLE 9-1.

Statistical Analysis for the General Health Assessment

Dependent Variables

Variable (Units)	Data Source	Data Form	Cutpoints	Candidate Covariates	Statistical Analyses
Self-Perception of Health	Q-SR	D	Excellent Good Fair Poor	AGE RACE OCC PERS	UC:CS,PO AC:LR,PO CA:CS UE:CS,FT AE:LR L:OR
Appearance of Illness or Distress	PE	D	Yes No	AGE RACE OCC	UC:CS,FT AC:LR CA:CS,FT UE:CS,FT AE:LR
Relative Age	PE	D	Younger Same Older	AGE RACE OCC	UC:CS,PO AC:LR,PO CA:CS UE:CS,FT AE:LR
Percent Body Fat	PE	D/C	Lean/Normal: $< 25\%$ Obese: $>25\%$	AGE RACE OCC	UC:CS,FT,TT AC:LR,GLM CA:CC,TT, GLM,CS,FT UE:CS,FT, GLM AE:LR,GLM
Sedimentation Rate (mm/hr)	LAB	D/C	Normal: ≤ 20 Abnormal: >20	AGE RACE OCC PERS	UC:CS,FT,T AC:LR,GLM CA:CC,TT, GLM,CS,FT UE:CS,FT, GLM,TT AE:LR,GLM L:OR

TABLE 9-1. (continued)

Statistical Analysis for the General Health Assessment

Covariates

Variable (Abbreviations)	Data Source	Data Form	Cutpoints
Age (AGE)	MIL	D/C	Born >1942 Born 1923-1941 Born ≤1922
Race (RACE)	MIL	D	Nonblack Black
Occupation (OCC)	MIL	D	Officer Enlisted Flyer Enlisted Groundcrew
Personality Type (PERS)	PE (1985)	D/C	A Direction B Direction

Abbreviations:

Data Source:
LAB--1987 SCRF laboratory results
MIL--Air Force military records
PE (1985)--1985 SCRF physical examination
PE--1987 SCRF physical examination
Q-SR--1987 NORC questionnaire (self-reported)

Data Form:
D--Discrete analysis only
D/C--Discrete and continuous analyses for dependent variables; appropriate form for analysis (either discrete or continuous) for covariates

Statistical Analyses:
UC--Unadjusted core analyses
AC--Adjusted core analyses
CA--Dependent variable-covariate associations
UE--Unadjusted exposure index analyses
AE--Adjusted exposure index analyses
L--Longitudinal analyses

Statistical Methods:
CC--Pearson's product moment correlation coefficient
CS--Chi-square contingency table test
FT--Fisher's exact test
GLM--General linear models analysis
LR--Logistic regression analysis
OR--Chi-square test on the odds ratio
PO--Proportional odds model analysis
TT--Two-sample t-test

TABLE 9-2.

Number of Participants With Missing Data
for the General Health Assessment

Variable	Group: Analysis Use	Ranch Hand	Comparison	Total
Self-Perception of Health	DEP	0	1	1
Appearance of Illness or Distress	DEP	0	1	1
Sedimentation Rate	DEP	1	3	4
Personality Type (1985 data)	COV	39	78	117

Abbreviations: DEP--Dependent variable (missing data)
COV--Covariate (missing data)

as core analyses), exposure index analyses, and dependent variable-covariate associations. To conserve space, abbreviations are used extensively in the body of the table and are defined in footnotes.

The second part of this table provides a further description of candidate covariates. Standard abbreviations for these variables, which will be used subsequently in this chapter, are presented, as well as data source, data form, and cutpoints.

Table 9-2 provides a list of the number of participants with missing data for the dependent variables and covariates described in Table 9-1.

RESULTS

Ranch Hand and Comparison Group Contrast

Questionnaire Variable

Self-Perception of Health

Table 9-3 gives the frequency distribution of self-perception of health for the Ranch Hand and Comparison groups, as well as the estimated relative risk of reporting one's health as fair or poor. The two distributions were

TABLE 9-3.

Unadjusted Analysis for General Health Variables by Group

Variable	Statistic	Group: Ranch Hand		Group: Comparison		Contrast	Est. Relative Risk (95% C.I.)	p-Value
Self-Perception of Health	n	995		1,298		Overall		0.250
	Number/%							
	Excellent	474	47.6%	651	50.2%	Fair/Poor	1.01 (0.72,1.40)	0.975
	Good	454	45.6%	560	43.1%	vs.		
	Fair	51	5.1%	75	5.8%	Exc./Good		
	Poor	16	1.6%	12	0.9%			
Appearance of Illness or Distress	n	995		1,298				
	Number/%							
	Yes	9	0.9%	7	0.5%	Yes vs. No	1.68 (0.62,4.54)	0.300
	No	986	99.1%	1,291	99.5%			
Relative Age	n	995		1,299		Overall		0.671
	Number/%							
	Younger	11	1.1%	10	0.8%	Older	0.94 (0.66,1.35)	0.741
	Same	929	93.4%	1,213	93.4%	vs.		
	Older	55	5.5%	76	5.8%	Younger/Same		
Percent Body Fat	n	995		1,299				
	Mean	21.46		21.67			—	0.335
	95% C.I.	(21.14,21.79)		(21.39,21.95)				
	Number/%							
	Lean/Normal	803	80.7%	1,013	78.0%	Obese	0.85 (0.69,1.04)	0.111
	Obese	192	19.3%	286	22.0%	vs.		
						Lean/Normal		
Sedimentation Rate	n	994		1,296				
	Mean[a]	5.30		5.09			—	0.255
	95% C.I.[a]	(5.02,5.60)		(4.87,5.32)				
	Number/%							
	Abnormal	70	7.0%	54	4.2%	Abnormal vs.	1.74 (1.21,2.51)	0.003
	Normal	924	93.0%	1,242	95.8%	Normal		

- Estimated relative risk not applicable for continuous analysis of a variable.
ransformed from natural logarithm scale.

similar, with 6.7 percent of the members from each group reporting their health as fair or poor. Slightly fewer Ranch Hands than Comparisons reported their health as excellent, but neither the overall comparison of the frequency distributions nor a proportional odds model fit to the ordinal data revealed a significant group difference ($p=0.250$ and $p=0.267$, respectively). The downward trend in the percentage of individuals reporting their health as fair or poor noted in the 1985 followup report continued: 20.4 percent at Baseline, 9.1 percent at the 1985 followup examination, and 6.7 percent at the 1987 followup examination in the Ranch Hand group; 15.9 percent, 7.3 percent, and 6.7 percent, respectively, in the Comparisons.

Tests of association between self-perception of health and each of the covariates (age, race, occupation, and personality type) appear in Appendix F, Table F-1. These tests indicated an association of borderline significance with age ($p=0.062$), with slightly fewer individuals born in or after 1942 perceiving their health as fair or poor compared to those born between 1923 and 1941 or those born in or before 1922 (5.6% vs. 7.5% and 7.2%, respectively).

There was a highly significant association ($p<0.001$) between self-perception of health and occupation: 4.1 percent of the officers reported their health as fair or poor compared to 8.6 percent of the enlisted flyers and 8.2 percent of the enlisted groundcrew. There was also a highly significant ($p<0.001$) association with personality type. Equal percentages of Type A's and Type B's reported their health as fair or poor (6.6%), but 54.5 percent of the Type A's reported their health as excellent compared to 45.6 percent of the Type B's.

The results of adjusted analyses of self-perception of health are presented in Table 9-4. A logistic regression model with the outcome dichotomized as fair/poor or excellent/good was used to analyze this variable (age and personality type were incorporated as continuous independent variables).

There was a significant age effect ($p=0.005$) as well as a significant occupation-by-personality type interaction ($p=0.012$). In contrast to the 1985 examination, however, there was no significant interaction between group and occupation ($p=0.632$). A proportional odds model adjusting for age, race, occupation, and personality type also did not reveal any statistically significant group difference (adjusted proportional odds: 1.09, 95% C.I.: [0.92, 1.29], $p=0.305$).

Physical Examination Variables

Appearance of Illness or Distress

A total of 16 individuals were reported by the examining physicians as appearing ill or distressed (see Table 9-3). Nine were from the Ranch Hand group and seven from the Comparisons. Upon examination of the dependent variable-by-covariate associations, a significant association between the appearance of illness or distress and age was detected ($p=0.016$). All but 1 of the 16 ill or distressed individuals were born in or before 1941 (Appendix F, Table F-1).

TABLE 9-4.

Adjusted Analysis for General Health Variables by Group

Variable	Statistic	Group: Ranch Hand	Group: Comparison	Contrast	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Self-Perception of Health	n	956	1,220	Fair/Poor vs. Exc./Good	1.01 (0.72,1.42)	0.999	AGE (p=0.005) OCC*PERS (p=0.012)
Appearance of Illness or Distress	n	995	1,298	Yes vs. No	1.67 (0.62,4.52)	0.308	AGE (p=0.004)
Relative Age	n	995	1,299	Older vs. Younger/Same	0.94 (0.66,1.34)	0.726	OCC (p<0.001)
Percent Body Fat	n Adj. Mean 95% C.I.	995 21.58 (21.02,22.13)	1,299 21.80 (21.26,22.33)		—	0.314	AGE*RACE (p=0.032) AGE*OCC (p=0.002)
	n	995	1,299	Obese vs. Lean/Normal	0.84 (0.69,1.04)	0.104	AGE (p<0.001) OCC (p<0.001)
Sedimentation Rate	n Adj. Mean[a] 95% C.I.[a]	955 5.32 (5.04,5.61)	1,218 5.16 (4.92,5.42)		—	0.413	OCC (p<0.001) AGE*PERS (p=0.006)
	n	955	1,218	Abnormal vs. Normal	1.70 (1.17,2.48)	0.005	AGE (p<0.001) OCC (p=0.002) PERS (p=0.042)

— Adjusted relative risk not applicable for continuous analysis of a variable.

[a]Transformed from natural logarithm scale.

Due to the sparseness of the data, an analysis was performed adjusting only for age (in continuous form); the results are shown in Table 9-4. Age was again highly significant (p=0.004), but the adjusted relative risk was essentially unchanged from the unadjusted relative risk.

Relative Age

Table 9-3 shows very little difference between the Ranch Hand and Comparison groups in relative age. Five-and-one-half percent of the Ranch Hands appeared older than their stated age and 94.5 percent appeared younger than or the same as their stated age. In the Comparisons, 5.8 percent appeared older and 94.2 percent appeared younger than or the same as their stated age, giving an estimated relative risk slightly less than 1 for this dichotomization of the outcomes. A proportional odds model fit to the ordinal responses also did not reveal any significant group difference (estimated proportional odds: 0.90, 95% C.I.: [0.65, 1.26], p=0.544).

Examination of the covariate effects (Table F-1 of Appendix F) revealed a significant association between relative age and age itself (p<0.001) (a higher percentage of older individuals than younger individuals were reported as appearing younger than their stated age), race (p=0.039) (Blacks more often appeared younger than their stated ages than nonblacks), and occupation (p<0.001) (relatively more officers appeared younger than their stated ages and fewer appeared older than their stated ages as compared to enlisted personnel).

Logistic regression analyses detected only a significant main effect of occupation (p<0.001) (Table 9-4). The adjusted relative risk was nearly identical to the unadjusted value. A proportional odds model fit to the ordinal responses revealed significant age and occupation effects (p=0.032 and p<0.001, respectively), but no group difference was evident (adjusted proportional odds: 0.90, 95% C.I.: [0.64, 1.25], p=0.520).

Percent Body Fat

Percent body fat was analyzed both as a continuous variable and trichotomized into lean (<10%), normal (10-25%), and obese (>25%) categories. Few individuals were lean (four Ranch Hands and five Comparisons) and thus relative risk estimates and logistic regression analyses were based upon a dichotomization into obese versus lean/normal categories. Mean percent body fat was not significantly different in the two groups (21.46% in the Ranch Hands vs. 21.67% in the Comparisons). The percent obese in the Ranch Hand group was less than that in the Comparisons, but not significantly so.

Examination of dependent variable-by-covariate associations (Table F-1) found significant age and occupation effects. Percent body fat was significantly correlated with age (p=0.032), and the percent obese was highest in those born between 1923 and 1941 (p=0.008). There was no statistically significant difference in mean percent body fat across the three occupational groups, but the percent obese was higher in the enlisted flyers than in the officers and higher still in the enlisted groundcrew (p=0.007).

Adjusted analyses of the percent body fat as a continuous variable detected significant age-by-race (p=0.032) and age-by-occupation (p=0.002) interactions (Table 9-4). The adjusted means in the Ranch Hand and Comparison groups, however, were not significantly different. Discrete analyses of the percent obese detected significant age and occupation effects (p<0.001 for both), but the adjusted relative risk was not significantly different from 1.

Laboratory Examination Variable

Erythrocyte Sedimentation Rate

The erythrocyte sedimentation rate was also analyzed in both continuous and discrete forms. Histograms generated for each group were skewed markedly to the right and thus the data were analyzed after transformation to a (natural) logarithm scale, which led to more symmetrical distributions. For the discrete analysis, the values were dichotomized into abnormal (>20 mm/hr) or normal ($\leq$20 mm/hr) categories.

The group means were not significantly different, but the percent abnormal was significantly greater in the Ranch Hand group than in the Comparison group (Est. RR: 1.74, 95% C.I.: [1.21, 2.51], p=0.003). A similar finding was noted in the 1985 followup report.

Age, occupation, and personality type were all significantly associated with the sedimentation rate (Appendix F, Table F-1). Older individuals had significantly higher sedimentation rates (p<0.001), although the correlation was only 0.230. The percent abnormal increased steadily with age. Enlisted flyers exhibited the highest mean sedimentation rates and the highest percent abnormal; officers had the lowest mean and lowest percent abnormal. P-values for the association with occupation were 0.006 and 0.034 for the continuous and discrete forms of sedimentation rate, respectively. Personality type was negatively associated with sedimentation rate; 6.6 percent of Type B individuals were abnormal compared to 4.2 percent of Type A's (p=0.017).

Adjusted analyses led to essentially the same conclusions as the unadjusted analyses (Table 9-4). There was a significant occupation effect (p<0.001) and an age-by-personality type interaction (p=0.006) in the continuous analysis, but the adjusted group means were not significantly different. Logistic regression analysis revealed significant effects of age (p<0.001), occupation (p=0.002), and personality type (p=0.042), and a significant adjusted relative risk of 1.70 (95% C.I.: [1.17, 2.48], p=0.005).

Exposure Index Analysis

The exposure index, expressed in equivalent gallons of dioxin-containing herbicide potentially encountered by each Ranch Hand during his tour of duty in Vietnam, was categorized as low, medium, or high. Separate analyses were performed within each occupational cohort. (A detailed description of the exposure index can be found in Chapter 8.) The frequency distributions for each variable and associated tests and comparisons within each occupational cohort are shown in Table 9-5. "M vs. L" and "H vs. L" are the estimated

TABLE 9-5.

Unadjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index: Low	Exposure Index: Medium	Exposure Index: High	Exposure Index Contrast	Est. Relative Risk (95% C.I.)	p-Value
Self-Perception of Health	Officer	n	130	124	125	Overall[a]		0.300
		Number/%						
		Excellent	81 62.3%	89 71.8%	71 56.8%	M vs. L[a]	0.83 (0.22,3.18)	0.787
		Good	44 33.8%	31 25.0%	45 36.0%	H vs. L[a]	1.94 (0.63,5.96)	0.246
		Fair	4 3.1%	3 2.4%	6 4.8%			
		Poor	1 0.8%	1 0.8%	3 2.4%			
	Enlisted Flyer	n	55	63	53	Overall[a]		0.416
		Number/%						
		Excellent	21 38.2%	20 31.8%	23 43.4%	M vs. L[a]	0.64 (0.14,2.98)	0.569
		Good	30 54.6%	40 63.5%	24 45.3%	H vs. L[a]	1.63 (0.43,6.13)	0.472
		Fair	2 3.6%	2 3.2%	4 7.6%			
		Poor	2 3.6%	1 1.6%	2 3.8%			
	Enlisted Groundcrew	n	147	158	140	Overall[a]		0.107
		Number/%						
		Excellent	59 40.1%	57 36.1%	53 37.9%	M vs. L[a]	0.92 (0.43,1.96)	0.834
		Good	73 49.7%	86 54.4%	81 57.9%	H vs. L[a]	0.39 (0.15,1.05)	0.061
		Fair	13 8.8%	13 8.2%	4 2.9%			
		Poor	2 1.4%	2 1.3%	2 1.4%			

TABLE 9-5. (continued)

Unadjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index Low	Exposure Index Medium	Exposure Index High	Exposure Index Contrast	Est. Relative Risk (95% C.I.)	p-Value
Appearance of Illness or Distress	Officer	n	130	124	125	Overall		0.362
		Number/%						
		Yes	1 0.8%	0 0.0%	2 1.6%	M vs. L	—	0.999
		No	129 99.2%	124 100.0%	123 98.4%	H vs. L	2.10 (0.19,23.43)	0.970
	Enlisted Flyer	n	55	63	53	Overall		0.118
		Number/%						
		Yes	2 3.6%	0 0.0%	0 0.0%	M vs. L	—	0.430
		No	53 96.4%	63 100.0%	53 100.0%	H vs. L	—	0.430
	Enlisted Groundcrew	n	147	158	140	Overall		0.139
		Number/%						
		Yes	1 0.7%	0 0.0%	3 2.1%	M vs. L	—	0.964
		No	146 99.3%	158 100.0%	137 97.9%	H vs. L	3.20 (0.33,31.11)	0.586

TABLE 9-5. (continued)

Unadjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index Low	Exposure Index Medium	Exposure Index High	Exposure Index Contrast	Est. Relative Risk (95% C.I.)	p-Value
Relative Age	Officer	n	130	124	125	Overall[b]		0.368
		Number/%						
		Younger	1 0.8%	3 2.4%	3 2.4%	M vs. L[b]	0.69 (0.19,2.50)	0.569
		Same	123 94.6%	117 94.4%	120 96.0%	H vs. L[b]	0.34 (0.07,1.70)	0.187
		Older	6 4.6%	4 3.2%	2 1.6%			
	Enlisted Flyer	n	55	63	53	Overall[b]		0.289
		Number/%						
		Younger	0 0.0%	0 0.0%	0 0.0%	M vs. L[b]	0.34 (0.08,1.40)	0.136
		Same	48 87.3%	60 95.2%	49 92.4%	H vs. L[b]	0.56 (0.15,2.04)	0.379
		Older	7 12.7%	3 4.8%	4 7.6%			
	Enlisted Groundcrew	n	147	158	140	Overall[b]		0.806
		Number/%						
		Younger	3 2.0%	1 0.6%	0 0.0%	M vs. L[b]	1.30 (0.51,3.33)	0.582
		Same	136 92.5%	146 92.4%	130 92.9%	H vs. L[b]	1.34 (0.51,3.49)	0.555
		Older	8 5.4%	11 7.0%	10 7.1%			

TABLE 9-5. (continued)

Unadjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index Low	Exposure Index Medium	Exposure Index High	Exposure Index Contrast	Est. Relative Risk (95% C.I.)	p-Value
Percent Body Fat	Officer	n	130	124	125	Overall		0.997
		Mean	21.42	21.45	21.40	M vs. L	—	0.964
		95% C.I.	(20.68,22.16)	(20.51,22.38)	(20.71,22.08)	H vs. L	—	0.969
		Number/%						
		Lean/Normal	106 81.5%	103 83.1%	107 85.6%	Overall		0.677
		Obese	24 18.5%	21 16.9%	18 14.4%	M vs. L	0.90 (0.47,1.72)	0.749
						H vs. L	0.74 (0.38,1.45)	0.384
	Enlisted Flyer	n	55	63	53	Overall		0.163
		Mean	20.17	21.72	22.20	M vs. L	—	0.148
		95% C.I.	(18.94,21.39)	(20.11,23.35)	(20.59,23.80)	H vs. L	—	0.071
		Number/%						
		Lean/Normal	48 87.3%	50 79.4%	40 75.5%	Overall		0.268
		Obese	7 12.7%	13 20.6%	13 24.5%	M vs. L	1.78 (0.66,4.85)	0.258
						H vs. L	2.23 (0.81,6.12)	0.119
	Enlisted Groundcrew	n	147	158	140	Overall		0.896
		Mean	21.67	21.57	21.37	M vs. L	—	0.876
		95% C.I.	(20.80,22.53)	(20.71,22.43)	(20.47,22.27)	H vs. L	—	0.645
		Number/%						
		Lean/Normal	114 77.6%	127 80.4%	108 77.1%	Overall		0.754
		Obese	33 22.4%	31 19.6%	32 22.9%	M vs. L	0.84 (0.49,1.46)	0.542
						H vs. L	1.02 (0.59,1.78)	0.936

TABLE 9-5. (continued)

Unadjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index: Low	Exposure Index: Medium	Exposure Index: High	Exposure Index Contrast	Est. Relative Risk (95% C.I.)	p-Value
Sedimentation Rate	Officer	n	130	124	124	Overall		0.869
		Mean[c]	4.91	5.18	4.93	M vs. L	—	0.630
		95% C.I.[c]	(4.26,5.66)	(4.42,6.06)	(4.22,5.77)	H vs. L	—	0.965
		Number/%						
		Abnormal	7 5.4%	8 6.4%	4 3.2%	Overall		0.477
		Normal	123 94.6%	116 93.6%	120 96.8%	M vs. L	1.21 (0.43,3.45)	0.719
						H vs. L	0.59 (0.17,2.15)	0.401
	Enlisted Flyer	n	55	63	53	Overall		0.849
		Mean[c]	6.25	6.28	5.79	M vs. L	—	0.980
		95% C.I.[c]	(5.08,7.70)	(5.15,7.65)	(4.49,7.47)	H vs. L	—	0.634
		Number/%						
		Abnormal	5 9.1%	5 7.9%	7 13.2%	Overall		0.629
		Normal	50 90.9%	58 92.1%	46 86.8%	M vs. L	0.86 (0.24,3.15)	0.826
						H vs. L	1.52 (0.45,5.13)	0.497
	Enlisted Groundcrew	n	147	158	140	Overall		0.720
		Mean[c]	5.14	5.15	5.54	M vs. L	—	0.988
		95% C.I.[c]	(4.45,5.95)	(4.46,5.94)	(4.81,6.39)	H vs. L	—	0.479
		Number/%						
		Abnormal	12 8.2%	12 7.6%	10 7.1%	Overall		0.948
		Normal	135 91.8%	146 92.4%	130 92.9%	M vs. L	0.92 (0.40,2.13)	0.857
						H vs. L	0.86 (0.36,2.07)	0.749

[a]Outcome categories: Fair/Poor vs. Excellent/Good.
[b]Outcome categories: Older vs. Younger/Same.
[c]Transformed from natural logarithm scale.
—Estimated relative risk/confidence interval not given due to cells with zero frequency; estimated relative risk not applicable for continuous analysis of a variable.

relative risks for medium versus low exposure and high versus low exposure, respectively. The results of adjusted exposure index analyses are presented in Table 9-6. Covariates examined included age, race, and personality type; on certain occasions when data were sparse, fewer terms were retained in the final model. The final interpretation of these exposure data must await the reanalysis of the clinical data using the results of the serum dioxin assay. This report is expected in 1991.

Questionnaire Variable

Self-Perception of Health

No statistically significant differences overall, nor any significant contrasts for any of the occupational cohorts, were found.

There were also no statistically significant findings from the adjusted analyses. There was a borderline overall effect in the enlisted groundcrew category ($p=0.074$), but this was due to a relative risk for the high vs. low contrast that was less than 1, and not indicative of an increasing dose-response relationship.

Physical Examination Variables

Results from the exposure index analyses of the appearance of illness or distress, relative age appearance, and percent body fat are also given in Tables 9-5 and 9-6.

Appearance of Illness or Distress

The number of abnormalities was quite sparse for the appearance of illness or distress; none of the overall tests was statistically significant. Adjusted analyses were not carried out for this variable.

Relative Age

There were no significant dose-response relationships for relative age in either the unadjusted or adjusted analyses.

Percent Body Fat

Percent body fat was analyzed in both the continuous and discrete forms. For the unadjusted analyses, there were no significant differences among the mean percent body fat levels across the three exposure level categories in any of the three occupational cohorts, nor were significant differences obtained in any of the discrete analyses. Adjusted analyses also did not reveal any significant exposure level effects in the officers or enlisted groundcrew. When analyzed in the discrete form, there was a highly significant ($p=0.005$) exposure index-by-age interaction in the enlisted flyer cohort, however. This

TABLE 9-6.

Adjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index			Exposure Index Contrast	Adj. Relative Risk (95% C.I.)	p-Value
			Low	Medium	High			
Self-Perception of Health	Officer	n	122	121	118	Overall[a]		0.516
						M vs. L[a]	0.73 (0.18,2.87)	0.646
						H vs. L[a]	1.50 (0.46,4.95)	0.503
	Enlisted Flyer	n	53	63	51	Overall[a]		0.398
						M vs. L[a]	1.13 (0.21,6.12)	0.887
						H vs. L[a]	2.45 (0.56,10.63)	0.234
	Enlisted Groundcrew	n	144	151	133	Overall[a]		0.074
						M vs. L[a]	1.17 (0.54,2.56)	0.689
						H vs. L[a]	0.41 (0.15,1.11)	0.078
Relative Age	Officer	n	130	124	125	Overall[b]		0.332
						M vs. L[b]	0.62 (0.16,2.34)	0.478
						H vs. L[b]	0.31 (0.06,1.62)	0.165
	Enlisted Flyer	n	55	63	53	Overall[b]		0.325
						M vs. L[b]	0.36 (0.09,1.48)	0.159
						H vs. L[b]	0.55 (0.15,2.02)	0.368
	Enlisted Groundcrew	n	147	158	140	Overall[b]		0.816
						M vs. L[b]	1.27 (0.49,3.28)	0.617
						H vs. L[b]	1.34 (0.51,3.50)	0.555

TABLE 9-6. (continued)

Adjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index			Exposure Index Contrast	Adj. Relative Risk (95% C.I.)	p-Value
			Low	Medium	High			
Percent Body Fat	Officer	n	130	124	125	Overall		0.955
		Adj. Mean	20.94	20.80	20.78	M vs. L	—	0.806
		95% C.I.	(19.11,22.78)	(19.00,22.60)	(18.96,22.61)	H vs. L	—	0.781
		n	130	124	125	Overall[c]		0.534
						M vs. L[c]	0.80 (0.41,1.54)	0.497
						H vs. L[c]	0.68 (0.35,1.34)	0.271
	Enlisted Flyer	n	55	63	53	Overall		0.182
		Adj. Mean	20.51	21.91	22.54	M vs. L	—	0.198
		95% C.I.	(17.99,23.03)	(19.60,24.22)	(20.12,24.95)	H vs. L	—	0.073
		n	55	63	53	Overall[c]	****	****
						M vs. L[c]	****	****
						H vs. L[c]	****	****
	Enlisted Groundcrew	n	147	158	140	Overall		0.822
		Adj. Mean	21.35	21.33	20.99	M vs. L	—	0.972
		95% C.I.	(20.24,22.46)	(20.22,22.44)	(19.84,22.14)	H vs. L	—	0.575
		n	147	158	140	Overall[c]		0.899
						M vs. L[c]	0.89 (0.51,1.55)	0.674
						H vs. L[c]	0.99 (0.57,1.73)	0.976

TABLE 9-6. (continued)

Adjusted Exposure Index for General Health Variables by Occupation

Variable	Occupation	Statistic	Exposure Index Low	Exposure Index Medium	Exposure Index High	Exposure Index Contrast	Adj. Relative Risk (95% C.I.)	p-Value
Sedimentation Rate	Officer	n	122	121	117	Overall		0.644
		Adj. Mean[d]	5.77	5.48	5.20	M vs. L	—	0.635
		95% C.I.[d]	(4.10,8.12)	(3.92,7.65)	(3.70,7.31)	H vs. L	—	0.348
		n	122	121	117	Overall		0.400
						M vs. L	0.83 (0.28,2.49)	0.741
						H vs. L	0.41 (0.10,1.65)	0.208
	Enlisted Flyer	n	53	63	51	Overall		0.752**
		Adj. Mean**[d]	4.85	5.26	4.67	M vs. L	—	0.612**
		95% C.I.**[d]	(3.35,7.02)	(3.76,7.37)	(3.28,6.66)	H vs. L	—	0.825**
		n	53	63	51	Overall		0.703**
						M vs. L	0.94 (0.25,3.56)	0.928**
						H vs. L	1.52 (0.94,5.20)	0.509**
	Enlisted Groundcrew	n	144	151	133	Overall		0.692
		Adj. Mean[d]	4.93	5.36	5.22	M vs. L	—	0.402
		95% C.I.[d]	(4.13,5.88)	(4.48,6.41)	(4.33,6.30)	H vs. L	—	0.571
		n	144	151	133	Overall		0.634
						M vs. L	1.13 (0.46,2.78)	0.795
						H vs. L	0.72 (0.28,1.83)	0.490

[a]Outcome categories: Fair/Poor vs. Excellent/Good.
[b]Outcome categories: Older vs. Younger/Same.
[c]Outcome categories: Obese vs. Lean/Normal.
[d]Transformed from natural logarithm scale.
****Exposure index-by-covariate interaction ($p<0.01$) — adjusted mean, confidence interval, and p-value not presented.
**Exposure index-by-covariate interaction ($0.01 \leq p \leq 0.05$) — adjusted mean, confidence interval, and p-value derived from model fitted after deletion of interaction(s).
—Adjusted relative risks not applicable for continuous analysis of a variable.

interaction is explored further in Table F-2, Appendix F, where the results are presented stratified by age. There were only two individuals from the oldest age cohort, both in the medium exposure level category. For individuals born between 1923 and 1941, adjusted relative risks (adjusted for race) exceeded 1 for the medium versus low and high versus low contrasts, but were not statistically significant. In the youngest age group, 4 of 11 individuals in the high exposure level category were obese, compared to 2 of 18 in the medium exposure category and none of 11 in the low exposure category. This difference was significant (p=0.048), but the p-value should be viewed with caution due to the sparse cell sizes. The apparent increase in percent body fat with increased risk of exposure is inconsistent with a decrease in body weight expected from extrapolation of animal data.[7,8,9]

Laboratory Examination Variable

Sedimentation Rate

Unadjusted exposure index analyses for sedimentation rate did not reveal any significant dose-response relationships, when analyzed either in continuous or discrete forms. The same was true in the adjusted analyses for the officers and enlisted groundcrew. In the enlisted flyer cohort, however, there were significant exposure index-by-age and exposure index-by-race interactions (p=0.043 and p=0.050, respectively) in the continuous analysis, as well as a significant exposure index-by-age interaction (p=0.023) in the discrete analysis. These interactions are explored more fully in Appendix F, Table F-2. Since all interactions were between 0.01 and 0.05 significance levels, Table 9-6 also presents adjusted least squares means or adjusted relative risks after deleting the interaction terms from the respective model. None of these main effects analyses revealed significant exposure level effects.

Table F-2 in Appendix F gives the results of continuous analysis on (log) sedimentation rate within each race-by-age stratum (adjusting for personality type). In several cases, the numbers were quite small, but in the two strata containing modest numbers of individuals (nonblacks born between 1923 and 1941 and nonblacks born in or after 1942), there were no apparent dose-response relationships. Likewise, in discrete analyses stratified by age, no exposure index effects were suggested.

A summary of the exposure index-by-covariate interactions is presented in Table 9-7. All occurred in the enlisted flyers and three involved age (two of the three were for the same variable, analyzed in continuous and discrete forms). However, Table F-2 of Appendix F shows that tests carried out within the various strata were not statistically significant and no clear picture emerges.

Longitudinal Analysis

Two variables, self-perception of health and sedimentation rate, were investigated by longitudinal analyses between the 1982 Baseline and 1987 followup examinations. Self-perception of health was dichotomized into fair/poor and excellent/good categories. The respective laboratory norms of

TABLE 9-7.

Summary of Exposure Index-by-Covariate Interactions From Adjusted Analyses for General Health Variables*

Variable	Occupation	Covariate	p-Value
Percent Body Fat (D)	Enlisted Flyer	Age	0.005
Sedimentation Rate (C)	Enlisted Flyer	Age	0.043
Sedimentation Rate (C)	Enlisted Flyer	Race	0.050
Sedimentation Rate (D)	Enlisted Flyer	Age	0.023

D: Discrete analysis.

C: Continuous analysis.

*Refer to Table F-2 for a further investigation of these interactions.

12 or less mm/hr and more than 12 mm/hr for the Baseline sedimentation rates conducted at the Kelsey-Seybold Clinic, and 20 or less mm/hr and more than 20 mm/hr for the followup examination conducted at SCRF, were used to categorize the sedimentation rate data into normal and abnormal groups.

Table 9-8 gives the summary statistics for the two examinations, as well as the summary statistics of the 1985 followup examination, for reference purposes. As noted earlier, the decline in both groups in the percentage of individuals reporting their health as fair or poor over the three examinations is clearly seen. Table 9-9 presents tables for each group, giving the number of individuals reporting their health as fair/poor at both the Baseline and 1987 followup examinations, the number reporting their health as fair/poor at the Baseline examination and excellent/good at the 1987 followup examination, etc. The change in self-perception of health between the two examinations was not significantly different between the Ranch Hand and Comparison groups ($p=0.395$).

The data for sedimentation rate abnormalities appear in Tables 9-10 and 9-11. Fewer Ranch Hands than Comparisons were abnormal at Baseline, but a higher percentage of Ranch Hands than Comparisons were abnormal at the 1985 and 1987 followup examinations. Correspondingly, the odds ratio between the Baseline and 1987 followup was 4.0 in the Ranch Hands and less than 1.0 in the Comparisons; the difference between these odds ratios was highly significant ($p<0.001$).

TABLE 9-8.

Summary Statistics for the Longitudinal Analysis of Self-Perception of Health: 1982 Baseline, 1985 Followup, and 1987 Followup Examinations

Variable	Examination	Statistic	Group: Ranch Hand	Group: Comparison
Self-Perception of Health	1982 Baseline	Number/%		
		Fair/Poor	179 19.0%	172 15.5%
		Excellent/Good	762 81.0%	940 84.5%
	1985 Followup	Number/%		
		Fair/Poor	81 8.8%	73 6.7%
		Excellent/Good	843 91.2%	1,023 93.3%
	1987 Followup	Number/%		
		Fair/Poor	65 6.9%	72 6.5%
		Excellent/Good	876 93.1%	1,040 93.5%

Note: Summary statistics for the 1982 Baseline and the 1987 followup are based on 941 Ranch Hands and 1,112 Comparisons who participated in the 1982 Baseline and the 1987 followup examinations. Summary statistics on 924 of these Ranch Hands and 1,096 of these Comparisons who also participated in the 1985 followup are included for reference purposes only.

TABLE 9-9.

Longitudinal Analysis of Self-Perception of Health: A Contrast of 1982 Baseline and 1987 Followup Examination Abnormalities

Variable	Group	1982 Baseline Exam	1987 Followup Exam: Fair/Poor	1987 Followup Exam: Exc./Good	Odds Ratio (OR)*	p-Value (OR_{RH} vs. OR_C)
Self-Perception of Health	Ranch Hand	Fair/Poor	45	134	0.149	0.395
		Exc./Good	20	742		
	Comparison	Fair/Poor	46	126	0.206	
		Exc./Good	26	914		

*Odds Ratio: $\frac{\text{Number Excellent/Good Baseline, Fair/Poor 1987 Followup}}{\text{Number Fair/Poor Baseline, Excellent/Good 1987 Followup}}$

TABLE 9-10.

Summary Statistics for the Longitudinal Analysis of Sedimentation Rate: 1982 Baseline, 1985 Followup, and 1987 Followup Examinations

Variable	Examination	Statistic	Group: Ranch Hand	Group: Comparison
Sedimentation Rate	1982 Baseline	Number/%		
		Abnormal	33 3.5%	50 4.5%
		Normal	910 96.5%	1,060 95.5%
	1985 Followup	Number/%		
		Abnormal	53 5.7%	38 3.5%
		Normal	871 94.3%	1,058 96.5%
	1987 Followup	Number/%		
		Abnormal	66 7.0%	47 4.2%
		Normal	877 93.0%	1,063 95.8%

Note: Summary statistics for the 1982 Baseline and the 1987 followup are based on 943 Ranch Hands and 1,110 Comparisons who participated in the 1982 Baseline and the 1987 followup examinations. Summary statistics on 924 of these Ranch Hands and 1,096 of these Comparisons who also participated in the 1985 followup are included for reference purposes only.

TABLE 9-11.

Longitudinal Analysis of Sedimentation Rate: A Contrast of 1982 Baseline and 1987 Followup Examination Abnormalities

Variable	Group	1982 Baseline Exam	1987 Followup Exam: Abnormal	1987 Followup Exam: Normal	Odds Ratio (OR)*	p-Value (OR_{RH} vs. OR_C)
Sedimentation Rate	Ranch Hand	Abnormal	22	11	4.00	<0.001
		Normal	44	866		
	Comparison	Abnormal	15	35	0.91	
		Normal	32	1,028		

*Odds Ratio: $\frac{\text{Number Normal Baseline, Abnormal 1987 Followup}}{\text{Number Abnormal Baseline, Normal 1987 Followup}}$

DISCUSSION

In clinical practice, the assessment of general health must be based on subjective and objective indices. In ambulatory medicine, particularly, the presence of occult disease cannot be excluded by negative laboratory tests directed at specific organ systems. Further, in the present study, it is reasonable to assume that the self-perception of health might be influenced by a participant's perception or concern of prior herbicide exposure.

The five variables considered in this section are frequently employed by clinicians in outpatient practice. On physical examination, the facial appearance of distress or of premature aging can often alert the physician to the presence of occult disease despite the absence of abnormalities in laboratory testing.

The erythrocyte sedimentation rate can be a sensitive, if nonspecific, index of general health. Pertinent to the longitudinal design of the current study is the effect of age: a rate as high as 40 mm per hour is considered within the range of normal for age 65. Extreme elevations in the erythrocyte sedimentation rate are consistently associated with serious underlying disease, usually malignancy.

Like the erythrocyte sedimentation rate, the percent body fat is an easily measurable, objective parameter of good health. Whereas obesity is a risk factor for cardiovascular disease and can contribute to hypertension and diabetes mellitus, it is often the patient with unexplained weight loss who is clinically of concern. Among the disorders considered in the current study that can induce unintentional weight loss were metabolic diseases (such as diabetes mellitus and hyperthyroidism); occult malignancy (most often lung or colon); drug abuse (for example, alcoholism and cocaine addiction); and emotional illness (such as anxiety or depression). To the extent that it can reflect significant weight gain or loss, the percent body fat can serve as a clinical clue to the presence of occult disease.

With regard to the self-perception of health, both Ranch Hand and Comparison group distributions were similar, with 6.7 percent of the members in each group reporting fair or poor health. Also, a trend of fewer individuals reporting fair or poor health in 1987 than at the Baseline or 1985 followup studies was observed. As expected, analysis of the age covariate reveals slightly poorer self-perception of health with advancing age.

In the present study, only 16 participants were reported as appearing ill; 9 from the Ranch Hand group and 7 from the Comparisons. The total number is small and the difference was not statistically significant. In addition, the chronically ill suffered from a diverse group of illnesses, including severe anemia, diabetes, renal failure, and malignancy. No single diagnosis or group of similar diagnoses contributed to the appearance of illness or distress. As would be anticipated, there was an increased incidence of chronic illness over time.

With regard to relative age, there was no difference found between the two groups. In 1985, the mean percent body fat was lower in the Ranch Hand group than in the Comparisons, but by 1987, the difference was not statistically significant.

Though (geometric) mean sedimentation rates were very similar in the two groups, there was a statistically significant difference in the percentage of individuals with a sedimentation rate above 20 mm/hr (7.0% of the Ranch Hands vs. 4.2% of the Comparisons). However, only three participants (two Ranch Hands and one Comparison) were found to have rates in excess of 100 mm/hr. One participant, a Comparison, proved to have lung cancer and died in early 1989. In neither of the other participants was a diagnosis established during the course of the 1987 followup.

In summary, based on the current examination variables, no clinically significant group differences were found in the general health of the Ranch Hands versus the Comparisons. Some concern is raised in the overall and longitudinal analyses of the erythrocyte sedimentation rate data. In contrast to the 1982 Baseline, a higher percentage of Ranch Hands was found to have abnormally elevated (>20 mm/hr) levels in both the 1985 and 1987 followup examinations ($p=0.013$ and $p=0.003$, respectively). Though of uncertain cause, this finding raises the possibility that some clinically occult disease process may be present in the Ranch Hand cohort and highlights the need to follow the sedimentation rate in subsequent examination cycles.

SUMMARY

General health was assessed by five measures (self-perception of health, appearance of illness or distress, relative age, percent body fat, and erythrocyte sedimentation rate). Table 9-12 presents a summary of all of the unadjusted and adjusted analyses performed for these five variables.

There were no significant differences, unadjusted or adjusted for covariates, nor any significant group-by-covariate interactions, for self-perception of health, appearance of illness or distress, relative age, or percent body fat. The percentage of participants reporting their health as fair or poor was equal in the Ranch Hand and Comparison groups, namely, 6.7 percent. This percentage was slightly less than that observed at the 1985 followup examination and less than half of that noted at the Baseline examination.

Sixteen individuals were reported by their examining physicians as appearing acutely ill or distressed at the 1987 Followup, nine (0.9%) from the Ranch Hand group and seven (0.5%) from the Comparisons. Relative age was likewise distributed similarly in the two groups, with 5.5 percent of the Ranch Hands and 5.8 percent of the Comparisons appearing older than their stated ages, and approximately 1 percent in each group appearing younger than their stated ages.

Only nine individuals (four Ranch Hands and five Comparisons) were lean (<10% body fat); 19.3 percent of the Ranch Hands and 22.0 percent of the Comparisons were obese (>25% body fat). The mean percent body fat was 21.6 in the Ranch Hands and 21.8 in the Comparisons. These means were not significantly different.

Continuous analyses of sedimentation rate did not reveal a significant group difference. Geometric mean values were 5.3 mm/hr in the Ranch Hands and 5.1 mm/hr in the Comparisons. However, there was a highly significant group

TABLE 9-12.

Overall Summary Results of Unadjusted and Adjusted Group Contrast Analyses of General Health Variables

Variable	Unadjusted		Adjusted		Direction of Results
	Discrete	Continuous	Discrete	Continuous	
Questionnaire					
Self-Perception of Health	NS	--	NS	--	
Physical Examination					
Appearance of Illness/Distress	NS	--	NS	--	
Relative Age	NS	--	NS	--	
Percent Body Fat	NS	NS	NS	NS	
Laboratory					
Sedimentation Rate	0.003	NS	0.005	NS	RH>C

--Analysis not performed.
NS: Not significant (p>0.05).
RH>C: Ranch Hand percent abnormal greater than Comparison percent abnormal.

difference in the percentage of individuals with an abnormal sedimentation rate (>20 mm/hr): 7.0 percent of the Ranch Hands compared to 4.2 percent of the Comparisons (Est. RR: 1.74, 95% C.I.: [1.21, 2.51], p=0.003). The relative risk was essentially unchanged after adjustment for age, race, occupation, and personality type (Adj. RR: 1.70). A significant group difference in the percentage of individuals with an abnormal sedimentation rate was also found at the 1985 followup examination, but not at the Baseline examination.

Unadjusted exposure index analyses did not detect any significant dose-response relationships in any of the occupational cohorts (officers, enlisted flyers, enlisted groundcrew). Adjusted exposure index analyses did reveal a significant exposure index-by-age interaction for percent body fat within the enlisted flyers and significant exposure index-by-age and exposure index-by-race interactions for sedimentation rate, also within the enlisted flyers. Further examination of these interactions, however, did not reveal significant dose-response relationships except for percent body fat among individuals born in or after 1942 (p=0.048, based upon small numbers). None of the 11

individuals in the low exposure category was obese, compared to 2 of 18 in the medium exposure category and 4 of 11 in the high exposure category.

Longitudinal analyses of self-perception of health and sedimentation rate found no significant difference for health perception, with a similar decline in both groups over time in the percentage of individuals reporting their health as fair or poor. For sedimentation rate, there was a significant group difference in the change from the Baseline to the 1987 followup examination: four times as many Ranch Hands went from normal at Baseline to abnormal at the 1987 followup than vice versa, whereas roughly equal numbers shifted in each direction among the Comparisons. The clinical implication of the statistical difference in this nonspecific medical parameter is unclear, and its relevance to the health of the Ranch Hand group must be evaluated in the light of the results in the other clinical areas.

CHAPTER 9

REFERENCES

1. Shoaf, C.R. 1988. 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity mechanisms. Toxicology Letters 42:1-3.

2. Decaprio, A.P., D.N. McMartin, P.W. O'Keefe, R. Rej, J.B. Silkworth, and L.S. Kaminsky. 1968. Subchronic oral toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin in the guinea pig: Comparisons with a PCB-containing transformer fluid pyrolysate. Fund. Appl. Toxicol. 6:454-463.

3. Mocarelli, P., A. Marocchi, P. Brambilla, P. Gerthoux, D.S. Young, and N. Mantel. 1986. Clinical laboratory manifestations of exposure to dioxin in children. J. Am. Med. Assoc. 256(19):2687-2695.

4. Stehr, P.A., G. Stein, H. Falk, E. Sampson, S.J. Smith, K. Steinberg, K. Webb, S. Ayres, W. Schramm, H.D. Donnel, and W.B. Gedney. 1986. A pilot epidemiologic study of possible health effects associated with 2,3,7,8-tetrachlorodibenzo-p-dioxin contaminations in Missouri. Arch. Environ. Health 41(1):16-22.

5. Knapik, J.J., A.R.L. Burse, and J.A. Vogel. 1983. Height, weight, percent body fat, and indices of adiposity or young men and women entering the army. Aviation, Space, and Environmental Medicine 54:223-231.

6. Jenkins, C.D., R.H. Roseman, and S.J. Zyzanski. 1974. Prediction of clinical coronary heart disease by a test for the coronary-prone behavior pattern. New Eng. J. Med. 290(23):1271-1275.

7. McConnell, E.E., J.A. Moore, and D.W. Dalgard. 1978. Toxicity of 2,3,7,8-TCDD in Rhesus monkeys following a single oral dose. Toxicol. Appl. Pharmacol. 4391:175-187.

8. McNulty, W.P. 1977. Toxicity of 2,3,7,8-TCDD for Rhesus monkeys: Brief report. Bull. Environ. Contam. Toxicol. 18(1):108-109.

9. Case, A.A., and J.R. Coffman. 1973. Waste oil: Toxic for horses. Vet. Clin. North Am. 3(2):273-277.