

Table 13-59. Analysis of Transferrin (Continuous) (mg/dl) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Mean ^a	Adj. Mean ^{ab}	Difference of Adj. Mean vs. Comparisons (95% C.I.) ^c		p-Value ^d
Comparison	1,194	249.5	249.5			
Background RH	376	250.9	250.9	1.4 --		0.480
Low RH	236	251.9	251.9	2.4 --		0.328
High RH	240	256.0	255.9	6.4 --		0.010
Low plus High RH	476	254.0	253.9	4.4 --		0.019

^a Transformed from natural logarithm scale.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin.

^c Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.

^d P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adj. Mean ^a	Difference of Adj. Mean vs. Comparisons (95% C.I.) ^b		p-Value ^c
Comparison	1,193	243.0			
Background RH	374	245.2	2.2 --		0.282
Low RH	235	246.1	3.1 --		0.200
High RH	238	247.9	4.9 --		0.050
Low plus High RH	473	247.0	4.0 --		0.032

^a Transformed from natural logarithm scale.

^b Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.

^c P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log ₂ (1987 Dioxin +1)		
1987 Dioxin	n	Mean ^a	R ²	Adjusted Slope (Std. Error) ^b	p-Value
Low	283	251.0	0.004	0.005 (0.003)	0.082
Medium	285	251.4			
High	284	255.3			

^a Transformed from natural logarithm scale.

^b Slope and standard error based on natural logarithm of transferrin versus log₂ (1987 dioxin + 1).

Note: Low = \leq 7.9 ppt; Medium = $>$ 7.9–19.6 ppt; High = $>$ 19.6 ppt.

Table 13-59. Analysis of Transferrin (Continuous) (mg/dl) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for \log_2 (1987 Dioxin + 1)		
1987 Dioxin	n	Adj. Mean ^a	R ²	Adjusted Slope (Std. Error) ^b	p-Value
Low	283	247.6	0.014	0.003 (0.004)	0.385
Medium	283	247.8			
High	281	249.9			

^a Transformed from natural logarithm scale.

^b Slope and standard error based on natural logarithm of transferrin versus \log_2 (1987 dioxin + 1).

Note: Low = ≤ 7.9 ppt; Medium = > 7.9 – 19.6 ppt; High = > 19.6 ppt.

The unadjusted and adjusted Model 2 results were not significant (Table 13-59(c,d): $p>0.59$ for each analysis). The unadjusted Model 3 analysis revealed Ranch Hands in the high dioxin category and Ranch Hands in the low and high dioxin categories combined to be significantly different from Comparisons (Table 13-59(e): difference of means=6.4 mg/dl, $p=0.010$; difference of means=4.4 mg/dl, $p=0.019$, respectively). The adjusted analysis revealed the same two contrasts to be significant: Ranch Hands in the high dioxin category versus Comparisons and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-59(f): difference of adjusted means=4.9 mg/dl, $p=0.050$; difference of adjusted means=4.0 mg/dl, $p=0.032$, respectively). The adjusted mean levels of transferrin for Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 247.9 mg/dl, 247.0 mg/dl, and 243.0 mg/dl, respectively.

A marginally significant association between 1987 dioxin and transferrin was shown in the unadjusted Model 4 analysis (Table 13-59(g): slope=0.005, $p=0.082$). After covariate adjustment, the results became nonsignificant (Table 13-59(h): $p=0.385$).

13.2.2.3.51 Transferrin (Discrete)

Both the unadjusted and adjusted Model 1 analyses of transferrin revealed a significant overall group difference between Ranch Hands and Comparisons (Table 13-60(a,b): Est. RR=0.73, $p=0.036$; Adj. RR=0.71, $p=0.027$, respectively). The percentage of low transferrin values among the Ranch Hands was 8.1 versus 10.9 for Comparisons. After stratifying by occupation, both the unadjusted and adjusted Model 1 analyses showed marginally significant differences between Ranch Hands and Comparisons within the officer stratum (Table 13-60(a,b): Est. RR=0.64, $p=0.083$; Adj. RR=0.63, $p=0.070$, respectively). The percentage of low transferrin values among Ranch Hand officers was 7.1 versus 10.6 among Comparison officers.

Table 13-60. Analysis of Transferrin (Discrete)**(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED**

Occupational Category	Group	n	Number (%)	Est. Relative Risk (95% C.I.)	p-Value
			Low		
<i>All</i>	<i>Ranch Hand</i>	859	70 (8.1)	0.73 (0.54,0.98)	0.036
	<i>Comparison</i>	1,231	134 (10.9)		
Officer	Ranch Hand	340	24 (7.1)	0.64 (0.39,1.06)	0.083
	Comparison	490	52 (10.6)		
Enlisted Flyer	Ranch Hand	150	15 (10.0)	0.87 (0.43,1.75)	0.691
	Comparison	185	21 (11.4)		
Enlisted Groundcrew	Ranch Hand	369	31 (8.4)	0.74 (0.47,1.17)	0.202
	Comparison	556	61 (11.0)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
<i>All</i>	0.71 (0.52,0.97)	0.027
Officer	0.63 (0.38,1.04)	0.070
Enlisted Flyer	0.83 (0.41,1.68)	0.601
Enlisted Groundcrew	0.74 (0.47,1.18)	0.208

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for \log_2 (Initial Dioxin) ^a		
Initial Dioxin	n	Number (%) Low	Estimated Relative Risk (95% C.I.) ^b	p-Value	
Low	158	15 (9.5)	0.99 (0.77,1.27)	0.931	
Medium	159	13 (8.2)			
High	159	11 (6.9)			

^a Adjusted for percent body fat at the time of the blood measurement of dioxin.^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

Analysis Results for \log_2 (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.) ^a	p-Value
473	0.93 (0.69,1.24)	0.615

^a Relative risk for a twofold increase in initial dioxin.

Table 13-60. Analysis of Transferrin (Discrete) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Low	Est. Relative Risk (95% C.I.) ^a	p-Value
Comparison	1,194	133 (11.1)		
Background RH	376	31 (8.2)	0.72 (0.48,1.09)	0.121
Low RH	236	23 (9.7)	0.86 (0.54,1.37)	0.526
High RH	240	16 (6.7)	0.57 (0.33,0.97)	0.039
Low plus High RH	476	39 (8.2)	0.70 (0.48,1.02)	0.062

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.) ^a	p-Value
Comparison	1,193		
Background RH	374	0.73 (0.48,1.11)	0.142
Low RH	235	0.78 (0.49,1.26)	0.311
High RH	238	0.57 (0.32,0.99)	0.045
Low plus High RH	473	0.66 (0.45,0.98)	0.039

^a Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics		Analysis Results for Log ₂ (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Low	Estimated Relative Risk (95% C.I.) ^a
Low	283	21 (7.4)	1.03 (0.88,1.22)
Medium	285	26 (9.1)	
High	284	23 (8.1)	

^a Relative risk for a twofold increase in 1987 dioxin.

Note: Low = \leq 7.9 ppt; Medium = $>$ 7.9–19.6 ppt; High = $>$ 19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log ₂ (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.) ^a
847	1.03 (0.85,1.24)

^a Relative risk for a twofold increase in 1987 dioxin.

No significant association between initial dioxin and transferrin was found in the unadjusted or adjusted Model 2 analyses (Table 13-60(c,d): $p>0.61$ for each analysis). The unadjusted Model 3 analysis of transferrin revealed significant differences between Ranch Hands in the high dioxin category and Comparisons, as well as between Ranch Hands in the low and high dioxin categories combined and Comparisons (Table 13-60(e): Est. RR=0.57, $p=0.039$; Est. RR=0.70, $p=0.062$, respectively). The same contrasts were significant after adjusting for covariates (Table 13-60(f): Adj. RR=0.57, $p=0.045$, for Ranch Hands in the high dioxin category versus Comparisons; Adj. RR=0.66, $p=0.039$, for Ranch Hands in the low and high dioxin categories combined versus Comparisons). The percentages of low transferrin values among Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 6.7, 8.2, and 11.1, respectively. The unadjusted and adjusted Model 4 analyses were nonsignificant (Table 13-60(g,h): $p>0.71$ for each analysis).

13.2.3 Longitudinal Analysis

Longitudinal analyses were conducted on AST, ALT, GGT, cholesterol, HDL cholesterol, the cholesterol-HDL ratio, and triglycerides to examine whether changes across time differed with respect to group membership (Model 1), initial dioxin (Model 2), and categorized dioxin (Model 3). Model 4 was not examined in longitudinal analyses because 1987 dioxin, the measure of exposure in these models, changes over time and is not available for all participants for 1982 or 1997.

Discrete and continuous analyses were performed for all variables. The longitudinal analyses for all of these variables investigated the difference between the 1982 and 1997 examinations. These analyses were used to investigate the temporal effects of dioxin during the 15-year period between 1982 and 1997.

The longitudinal analysis for these variables in their continuous form examined the paired difference between the measurements from 1982 and 1997. These paired differences measured the change in these variables over time. Each of the three models used in the longitudinal analysis was adjusted for age and the dependent variable as measured in 1982 (see Chapter 7, Statistical Methods).

Participants who were abnormal in 1982 were not included in the longitudinal analysis of discrete dependent variables. The purpose of the longitudinal analysis was to examine the effects of dioxin exposure across time. Participants who were abnormal in 1982 were not considered to be at risk for developing the condition, because the condition already existed at the time of the first collection of data for the AFHS (1982). Only participants who were normal at the 1982 examination were considered to be at risk for developing the disease; therefore the rate of abnormalities under this restriction approximates an incidence rate between 1982 and 1997. That is, an incidence rate is a measure of the rate at which people without a condition develop the condition during a specified period of time (67). Summary statistics are provided for reference purposes for the 1985, 1987, and 1992 examinations.

The longitudinal analyses of discrete variables examined relative risks at the 1997 examination for participants who were classified as normal at the 1982 examination. The adjusted relative risks estimated from each of the three models were used to investigate the change in the dependent variable over time. All three models were adjusted for age; Models 2 and 3 also were adjusted for the percentage of body fat at the time of the blood measurement of dioxin.

The cutpoints for all of these variables except the cholesterol-HDL ratio differed between examinations. The cutpoints changed between examinations because a different laboratory was used to perform the analysis or because an upgrade in the equipment used caused a change in the reference values. This upgrade in equipment may have affected the mean level or the percent abnormal for the dependent variable between examinations. These cutpoints were used for determining abnormal and normal classifications for each of the respective examinations and are shown in Table 13-61.

Table 13-61. Normal Ranges from Air Force Health Study Examinations for Dependent Variables Used in Longitudinal Analysis

Dependent Variable (Units)	Examination				
	1982	1985	1987	1992	1997
AST (U/l)	≤41	≤47	≤47	≤50	≤37
ALT (U/l)	≤45	≤36	≤36	≤55	≤65
GGT (U/l)	≤85	≤85	≤85	≤51	≤85
Cholesterol (mg/dl)	≤240	≤250	≤250	≤250	≤260
	(Age <40)	(Age <45)	(Age <45)	(Age <45)	(Age <50)
	≤265	≤260	≤260	≤260	≤250
	(Age ≥40)	(Age 45–69)	(Age 45–69)	(Age 45–69)	(Age ≥50) ^a
		≤250	≤250	≤250	
		(Age ≥70)	(Age ≥70)	(Age ≥70)	
HDL (mg/dl)	≥25	≥30	≥30	≥30	≥32
	(Age <50)	(Age <40)	(Age <40)	(Age <40)	
	≥32	≥25	≥25	≥25	
	(Age ≥50)	(Age 40–44)	(Age 40–44)	(Age 40–44)	
		≥30	≥30	≥30	
		(Age ≥45)	(Age ≥45)	(Age ≥45)	
Triglycerides (mg/dl)	≤150	≤320	≤320	≤320	≤200
	(Age <40)	(Age <55)	(Age <55)	(Age <55)	
	≤160	≤290	≤290	≤290	
	(Age 40–49)	(Age 55–64)	(Age 55–64)	(Age 55–64)	
	≤190	≤260	≤260	≤260	
	(Age ≥50)	(Age ≥65)	(Age ≥65)	(Age ≥65)	

^a Cutpoint lower for cholesterol for older participants per manufacturer's recommendation.

13.2.3.1 Laboratory Examination Variables

13.2.3.1.1 AST (Continuous)

The analyses in each of Models 1 through 3 did not reveal a significant association between dioxin and the change in mean AST levels between 1982 and 1997 (Table 13-62(a–c): $p>0.37$ for each analysis).

Table 13-62. Longitudinal Analysis of AST (U/I) (Continuous)**(a) MODEL 1: RANCH HANDS VS. COMPARISONS**

Occupational Category	Group	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
All	<i>Ranch Hand</i>	32.61 (804)	33.33 (787)	25.50 (778)	23.03 (778)	22.99 (804)	-9.62	-0.03	0.859
	<i>Comparison</i>	32.48 (956)	33.47 (938)	25.34 (929)	23.59 (933)	22.89 (956)	-9.59		
Officer	Ranch Hand	32.69 (309)	34.01 (304)	25.85 (301)	23.69 (300)	23.29 (309)	-9.40	0.15	0.897
	Comparison	32.86 (377)	33.57 (371)	25.76 (363)	24.00 (370)	23.31 (377)	-9.55		
Enlisted Flyer	Ranch Hand	31.89 (146)	32.24 (143)	24.47 (141)	21.14 (143)	22.19 (146)	-9.69	0.47	0.710
	Comparison	33.02 (142)	33.53 (141)	25.10 (140)	23.30 (138)	22.87 (142)	-10.16		
Enlisted Groundcrew	Ranch Hand	32.84 (349)	33.18 (340)	25.63 (336)	23.28 (335)	23.06 (349)	-9.78	-0.34	0.687
	Comparison	31.98 (437)	33.36 (426)	25.08 (426)	23.32 (425)	22.54 (437)	-9.44		

^a Transformed from natural logarithm scale.^b Difference between 1997 and 1982 examination means after transformation to original scale.^c P-value is based on analysis of natural logarithm of AST; results adjusted for natural logarithm of AST in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-62. Longitudinal Analysis of AST (U/l) (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin	Initial Dioxin Category Summary Statistics					Analysis Results for \log_2 (Initial Dioxin) ^b	
	Mean ^a /(n) Examination					Adjusted Slope (Std. Error)	p-Value
	1982	1985	1987	1992	1997		
Low	33.11 (151)	34.06 (147)	25.46 (150)	22.57 (146)	23.39 (151)	-0.004 (0.012)	0.731
Medium	33.39 (156)	34.46 (154)	26.08 (152)	23.18 (152)	23.64 (156)		
High	33.54 (151)	33.33 (148)	25.86 (146)	23.82 (148)	23.56 (151)		

^a Transformed from natural logarithm scale.

^b Results based on difference between natural logarithm of 1997 AST and natural logarithm of 1982 AST versus \log_2 (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 AST, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	32.46 (929)	33.50 (913)	25.35 (903)	23.54 (907)	22.87 (929)	-9.59		
Background	31.70 (340)	32.54 (333)	25.13 (325)	22.78 (327)	22.22 (340)	-9.48	0.11	0.574
RH	32.75 (226)	34.41 (220)	25.59 (222)	23.05 (218)	23.40 (226)	-9.34	0.25	0.373
Low RH	33.94 (232)	33.51 (229)	26.00 (226)	23.32 (228)	23.65 (232)	-10.29	-0.70	0.911
High RH	33.35 (458)	33.95 (449)	25.80 (448)	23.19 (446)	23.53 (458)	9.82	-0.23	0.520
Low plus								
High RH								

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of 1997 AST; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 AST, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.2 AST (Discrete)

All longitudinal analyses of the participants with high AST levels in 1997 that were normal in 1982 were nonsignificant (Table 13-63(a-c): $p>0.15$ for each analysis).

Table 13-63. Longitudinal Analysis of AST (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High/(n) Examination				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	99 (12.3) (804)	51 (6.5) (787)	31 (4.0) (778)	21 (2.7) (778)	60 (7.5) (804)
	<i>Comparison</i>	122 (12.8) (956)	70 (7.5) (938)	26 (2.8) (929)	31 (3.3) (933)	60 (6.3) (956)
Officer	Ranch Hand	34 (11.0) (309)	24 (7.9) (304)	14 (4.7) (301)	11 (3.7) (300)	21 (6.8) (309)
	Comparison	52 (13.8) (377)	24 (6.5) (371)	13 (3.6) (363)	14 (3.8) (370)	23 (6.1) (377)
Enlisted Flyer	Ranch Hand	16 (11.0) (146)	7 (4.9) (143)	4 (2.8) (141)	1 (0.7) (143)	10 (6.8) (146)
	Comparison	20 (14.1) (142)	13 (9.2) (141)	5 (3.6) (140)	6 (4.3) (138)	12 (8.5) (142)
Enlisted Groundcrew	Ranch Hand	49 (14.0) (349)	20 (5.9) (340)	13 (3.9) (336)	9 (2.7) (335)	29 (8.3) (349)
	Comparison	50 (11.4) (437)	33 (7.7) (426)	8 (1.9) (426)	11 (2.6) (425)	25 (5.7) (437)

Occupational Category	Group	Normal in 1982			Adj. Relative Risk (95% C.I.) ^a	p-Value ^a
		n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^a		
<i>All</i>	<i>Ranch Hand</i>	705	35 (5.0)	1.13 (0.70,1.81)	0.614	
	<i>Comparison</i>	834	37 (4.4)			
Officer	Ranch Hand	275	11 (4.0)	0.87 (0.39,1.93)	0.735	
	Comparison	325	15 (4.6)			
Enlisted Flyer	Ranch Hand	130	6 (4.6)	0.69 (0.23,2.05)	0.506	
	Comparison	122	8 (6.6)			
Enlisted Groundcrew	Ranch Hand	300	18 (6.0)	1.68 (0.82,3.45)	0.153	
	Comparison	387	14 (3.6)			

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal AST level in 1982 (see Chapter 7, Statistical Methods).

Table 13-63. Longitudinal Analysis of AST (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Low	17 (11.3) (151)	11 (7.5) (147)	6 (4.0) (150)	4 (2.7) (146)	11 (7.3) (151)
Medium	30 (19.2) (156)	11 (7.1) (154)	4 (2.6) (152)	4 (2.6) (152)	20 (12.8) (156)
High	23 (15.2) (151)	11 (7.4) (148)	7 (4.8) (146)	4 (2.7) (148)	14 (9.3) (151)

Initial Dioxin Category Summary Statistics		Analysis Results for Log_2 (Initial Dioxin) ^a		
Normal in 1982				
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.L.) ^b	p-Value
Low	134	6 (4.5)	1.18 (0.87, 1.59)	0.297
Medium	126	11 (8.7)		
High	128	9 (7.0)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal AST level in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	118 (12.7) (929)	69 (7.6) (913)	25 (2.8) (903)	30 (3.3) (907)	59 (6.4) (929)
Background RH	27 (7.9) (340)	18 (5.4) (333)	14 (4.3) (325)	9 (2.8) (327)	14 (4.1) (340)
Low RH	26 (11.5) (226)	19 (8.6) (220)	9 (4.1) (222)	8 (3.7) (218)	19 (8.4) (226)
High RH	44 (19.0) (232)	14 (6.1) (229)	8 (3.5) (226)	4 (1.8) (228)	26 (11.2) (232)
Low plus High RH	70 (15.3) (458)	33 (7.3) (449)	17 (3.8) (448)	12 (2.7) (446)	45 (9.8) (458)

Table 13-63. Longitudinal Analysis of AST (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.I.) ^a	p-Value ^b
	n in 1997	Number (%) High in 1997		
Comparison	811	37 (4.6)		
Background RH	313	8 (2.6)	0.59 (0.27,1.30)	0.193
Low RH	200	12 (6.0)	1.34 (0.68,2.63)	0.395
High RH	188	14 (7.4)	1.58 (0.83,3.00)	0.166
Low plus High RH	388	26 (6.7)	1.45 (0.86,2.44)	0.162

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal AST level in 1982 (see Chapter 7, Statistical Methods).

13.2.3.1.3 ALT (Continuous)

Models 1 and 2 of the longitudinal analyses of ALT in its continuous form revealed no significant association between the change in mean AST levels and dioxin (Table 13-64(a,b): $p>0.21$). Model 3 analysis of the change in mean ALT levels between 1982 and 1997 revealed two marginally significant contrasts: Ranch Hands in the low dioxin category versus Comparisons and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-64(c): difference of examination mean change=1.02 U/l, $p=0.054$; difference of examination mean change=0.72 U/l, $p=0.094$, respectively). The examination mean changes for Ranch Hands in the low dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 22.84 U/l, 22.54 U/l, and 21.82 U/l, respectively.

Table 13-64. Longitudinal Analysis of ALT (U/l) (Continuous)**(a) MODEL 1: RANCH HANDS VS. COMPARISONS**

Occupational Category	Group	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
<i>All</i>	<i>Ranch Hand</i>	19.84 (804)	21.66 (787)	20.52 (778)	27.12 (778)	42.55 (804)	22.71	0.89	0.214
	<i>Comparison</i>	20.38 (956)	22.53 (938)	20.49 (929)	27.91 (933)	42.20 (956)	21.82		
Officer	<i>Ranch Hand</i>	19.71 (309)	21.96 (304)	20.53 (301)	27.01 (300)	41.93 (309)	22.22	0.99	0.295
	<i>Comparison</i>	20.32 (377)	21.97 (371)	20.35 (363)	27.39 (370)	41.55 (377)	21.23		
Enlisted Flyer	<i>Ranch Hand</i>	18.69 (146)	20.85 (143)	19.83 (141)	25.15 (143)	41.33 (146)	22.63	0.77	0.910
	<i>Comparison</i>	20.59 (142)	22.01 (141)	19.84 (140)	28.03 (138)	42.45 (142)	21.86		
Enlisted Groundcrew	<i>Ranch Hand</i>	20.46 (349)	21.73 (340)	20.79 (336)	28.10 (335)	43.63 (349)	23.17	0.85	0.377
	<i>Comparison</i>	20.37 (437)	23.20 (426)	20.82 (426)	28.33 (425)	42.69 (437)	22.32		

^a Transformed from natural logarithm scale.^b Difference between 1997 and 1982 examination means after transformation to original scale.^c P-value is based on analysis of natural logarithm of ALT; results adjusted for natural logarithm of ALT in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-64. Longitudinal Analysis of ALT (U/l) (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin	Initial Dioxin Category Summary Statistics					Analysis Results for Log ₂ (Initial Dioxin) ^b	
	Mean ^a /(n) Examination					Adjusted Slope (Std. Error)	p-Value
	1982	1985	1987	1992	1997		
Low	20.29 (151)	22.08 (147)	20.15 (150)	26.54 (146)	42.36 (151)	-0.007 (0.010)	0.444
Medium	21.76 (156)	24.10 (154)	21.94 (152)	28.72 (152)	44.95 (156)		
High	22.96 (151)	23.82 (148)	23.07 (146)	30.13 (148)	45.27 (151)		

^a Transformed from natural logarithm scale.

^b Results based on difference between natural logarithm of 1997 ALT and natural logarithm of 1982 ALT versus log₂ (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 ALT, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	20.34 (929)	22.49 (913)	20.46 (903)	27.87 (907)	42.16 (929)	21.82		
Background	17.53 (340)	19.62 (33)	19.01 (325)	25.36 (327)	40.39 (340)	22.87	1.05	0.751
Low RH	20.46 (226)	23.08 (220)	20.50 (222)	27.51 (218)	43.30 (226)	22.84	1.02	0.054
High RH	22.86 (232)	23.57 (229)	22.90 (226)	29.36 (228)	45.07 (232)	22.20	0.38	0.503
Low plus	21.64 (458)	23.33 (449)	21.67 (448)	28.44 (446)	44.18 (458)	22.54	0.72	0.094
High RH								

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of 1997 ALT; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 ALT, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.4 ALT (Discrete)

Examination of Models 1 and 2 of the longitudinal analyses for discretized ALT did not find a significant association between dioxin and the percentage of participants with normal ALT values in 1982 and high ALT values in 1997 (Table 13-65(a,b): $p>0.19$ for each analysis).

Table 13-65. Longitudinal Analysis of ALT (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High/(n) Examination				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	59 (7.3) 804	107 (13.6) (787)	92 (11.8) (778)	45 (5.8) (778)	65 (8.1) (804)
	<i>Comparison</i>	67 (7.0) (956)	133 (14.2) (938)	92 (9.9) (929)	64 (6.9) (933)	68 (7.1) (956)
Officer	<i>Ranch Hand</i>	23 (7.4) (309)	46 (15.1) (304)	38 (12.6) (301)	19 (6.3) (300)	20 (6.5) (309)
	<i>Comparison</i>	26 (6.9) (377)	45 (12.1) (371)	39 (10.7) (363)	20 (5.4) (370)	16 (4.2) (377)
Enlisted Flyer	<i>Ranch Hand</i>	10 (6.8) (146)	15 (10.5) (143)	14 (9.9) (141)	7 (4.9) (143)	15 (10.3) (146)
	<i>Comparison</i>	11 (7.7) (142)	19 (13.5) (141)	9 (6.4) (140)	11 (8.0) (138)	15 (10.6) (142)
Enlisted Groundcrew	<i>Ranch Hand</i>	26 (7.4) (349)	46 (13.5) (340)	40 (11.9) (336)	19 (5.7) (335)	30 (8.6) (349)
	<i>Comparison</i>	30 (6.9) (437)	69 (16.2) (426)	44 (10.3) (426)	33 (7.8) (425)	37 (8.5) (437)

Occupational Category	Group	Normal in 1982			Adj. Relative Risk (95% C.I.) ^a	p-Value ^a
		n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^a		
<i>All</i>	<i>Ranch Hand</i>	745	43 (5.8)	0.92 (0.61,1.39)	0.690	
	<i>Comparison</i>	889	56 (6.3)			
Officer	<i>Ranch Hand</i>	286	14 (4.9)	1.53 (0.70,3.39)	0.289	
	<i>Comparison</i>	351	12 (3.4)			
Enlisted Flyer	<i>Ranch Hand</i>	136	11 (8.1)	0.87 (0.37,2.06)	0.749	
	<i>Comparison</i>	131	12 (9.2)			
Enlisted Groundcrew	<i>Ranch Hand</i>	323	18 (5.6)	0.67 (0.37,1.23)	0.195	
	<i>Comparison</i>	407	32 (7.9)			

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal ALT level in 1982 (see Chapter 7, Statistical Methods).

Table 13-65. Longitudinal Analysis of ALT (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Low	12 (7.9) (151)	20 (13.6) (147)	11 (7.3) (150)	4 (2.7) (146)	10 (6.6) (151)
Medium	10 (6.4) (156)	21 (13.6) (154)	22 (14.5) (152)	13 (8.6) (152)	21 (13.5) (156)
High	19 (12.6) (151)	27 (18.2) (148)	22 (15.1) (146)	13 (8.8) (148)	19 (12.6) (151)

Initial Dioxin Category Summary Statistics		Analysis Results for \log_2 (Initial Dioxin) ^a		
Normal in 1982				
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Low	139	8 (5.8)	1.05 (0.78,1.40)	0.750
Medium	146	14 (9.6)		
High	132	10 (7.6)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal ALT level in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	65 (7.0) (929)	129 (14.1) (913)	90 (10.0) (903)	60 (6.6) (907)	67 (7.2) (929)
Background RH	17 (5.0) (340)	38 (11.4) (333)	36 (11.1) (325)	14 (4.3) (327)	14 (4.1) (340)
Low RH	17 (7.5) (226)	30 (13.6) (220)	21 (9.5) (222)	10 (4.6) (218)	20 (8.8) (226)
High RH	24 (10.3) (232)	38 (16.6) (229)	34 (15.0) (226)	20 (8.8) (228)	30 (12.9) (232)
Low plus High RH	41 (9.0) (458)	68 (15.1) (449)	55 (12.3) (448)	30 (6.7) (446)	50 (10.9) (458)

Table 13-65. Longitudinal Analysis of ALT (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.I.) ^{a,b}	p-Value ^b
	n in 1997	Number (%) High in 1997		
Comparison	864	56 (6.5)		
Background RH	323	10 (3.1)	0.55 (0.27,1.10)	0.089
Low RH	209	15 (7.2)	1.23 (0.68,2.24)	0.495
High RH	208	17 (8.2)	1.04 (0.59,1.85)	0.889
Low plus High RH	417	32 (7.7)	1.13 (0.72,1.79)	0.591

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had an normal ALT level in 1982 (see Chapter 7, Statistical Methods).

The Model 3 analysis of the percentage of participants with high ALT levels in 1997 and normal ALT levels in 1982 revealed a marginally significant difference between Ranch Hands in the background dioxin category and Comparisons (Table 13-65(c): Adj. RR=0.55, p=0.089). Of the Comparisons with normal ALT levels in 1982, 6.5 percent had high ALT levels in 1997, whereas 3.1 percent of Ranch Hands in the background dioxin category with normal ALT levels in 1982 had high ALT levels in 1997.

13.2.3.1.5 GGT (Continuous)

The analyses in each of Models 1 through 3 did not reveal a significant association between dioxin and the change in mean GGT levels (Table 13-66(a-c): p>0.26 for each analysis).

Table 13-66. Longitudinal Analysis of GGT (U/l) (Continuous)**(a) MODEL 1: RANCH HANDS VS. COMPARISONS**

Occupational Category	Group	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
<i>All</i>	<i>Ranch Hand</i>	38.12 (804)	31.57 (787)	32.05 (778)	32.38 (778)	43.70 (804)	5.57	0.74	0.266
	<i>Comparison</i>	37.44 (955)	31.53 (937)	31.30 (928)	31.61 (932)	42.27 (955)	4.83		
Officer	Ranch Hand	36.62 (309)	30.88 (304)	31.40 (301)	31.54 (300)	42.13 (309)	5.51	0.41	0.567
	Comparison	36.09 (377)	30.25 (371)	30.70 (363)	31.24 (370)	41.19 (377)	5.10		
Enlisted Flyer	Ranch Hand	38.58 (146)	31.70 (143)	31.74 (141)	30.77 (143)	44.65 (146)	6.07	1.99	0.698
	Comparison	41.81 (142)	34.81 (141)	33.64 (140)	34.67 (138)	45.89 (142)	4.08		
Enlisted Groundcrew	Ranch Hand	39.31 (349)	32.13 (340)	32.77 (336)	33.88 (335)	44.73 (349)	5.42	0.61	0.442
	Comparison	37.28 (436)	31.63 (425)	31.08 (425)	30.99 (424)	42.09 (436)	4.81		

^a Transformed from natural logarithm scale.^b Difference between 1997 and 1982 examination means after transformation to original scale.^c P-value is based on analysis of natural logarithm of GGT; results adjusted for natural logarithm of GGT in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-66. Longitudinal Analysis of GGT (U/l) (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin Category	Initial Dioxin Category Summary Statistics					Analysis Results for \log_2 (Initial Dioxin) ^b	
	Mean ^a /(n) Examination					Adjusted Slope (Std. Error)	p-Value
	1982	1985	1987	1992	1997		
Low	41.42 (151)	33.83 (147)	32.52 (150)	32.74 (146)	43.50 (151)	-0.009 (0.017)	0.579
Medium	42.17 (156)	35.47 (154)	36.50 (152)	36.72 (152)	48.93 (156)		
High	41.69 (151)	33.53 (148)	34.54 (146)	35.61 (148)	46.45 (151)		

^a Transformed from natural logarithm scale.

^b Results based on difference between natural logarithm of 1997 GGT and natural logarithm of 1982 GGT versus \log_2 (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 GGT, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	37.10 (928)	31.17 (912)	30.95 (902)	31.19 (906)	41.92 (928)	4.82		
Background	33.22 (340)	28.00 (333)	28.71 (325)	28.90 (327)	39.90 (340)	6.69	1.87	0.363
RH								
Low RH	40.41 (226)	33.57 (220)	32.97 (222)	33.56 (218)	44.00 (226)	3.58	-1.24	0.686
High RH	43.12 (232)	34.98 (229)	36.05 (226)	36.45 (228)	48.59 (232)	5.48	0.66	0.276
Low plus	41.76 (458)	34.28 (449)	34.49 (448)	35.01 (446)	46.27 (458)	4.51	-0.31	0.330
High RH								

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of 1997 GGT; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 GGT, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.6 GGT (Discrete)

The longitudinal analyses in Models 1 through 3 did not reveal a significant association between the change in discretized GGT values and dioxin (Table 13-67(a-c): $p>0.10$).

Table 13-67. Longitudinal Analysis of GGT (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High/(n) Examination				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	68 (8.5) (804)	58 (7.4) (787)	57 (7.3) (778)	155 (19.9) (778)	84 (10.4) (804)
	<i>Comparison</i>	81 (8.5) (955)	76 (8.1) (937)	60 (6.5) (928)	163 (17.5) (932)	94 (9.8) (955)
Officer	Ranch Hand	26 (8.4) (309)	21 (6.9) (304)	24 (8.0) (301)	56 (18.7) (300)	27 (8.7) (309)
	Comparison	31 (8.2) (377)	27 (7.3) (371)	23 (6.3) (363)	64 (17.3) (370)	32 (8.5) (377)
Enlisted Flyer	Ranch Hand	15 (10.3) (146)	11 (7.7) (143)	13 (9.2) (141)	25 (17.5) (143)	23 (15.8) (146)
	Comparison	16 (11.3) (142)	17 (12.1) (141)	15 (10.7) (140)	29 (21.0) (138)	21 (14.8) (142)
Enlisted Groundcrew	Ranch Hand	27 (7.7) (349)	26 (7.6) (340)	20 (6.0) (336)	74 (22.1) (335)	34 (9.7) (349)
	Comparison	34 (7.8) (436)	32 (7.5) (425)	22 (5.2) (425)	70 (16.5) (424)	41 (9.4) (436)

Occupational Category	Group	Normal in 1982			Adj. Relative Risk (95% C.I.) ^a	p-Value ^a
		n in 1997	Number (%) High in 1997			
<i>All</i>	<i>Ranch Hand</i>	736	48 (6.5)		1.02 (0.69,1.53)	0.909
	<i>Comparison</i>	874	56 (6.4)			
Officer	Ranch Hand	283	13 (4.6)		1.01 (0.48,2.14)	0.982
	Comparison	346	16 (4.6)			
Enlisted Flyer	Ranch Hand	131	16 (12.2)		1.12 (0.52,2.41)	0.768
	Comparison	126	14 (11.1)			
Enlisted Groundcrew	Ranch Hand	322	19 (5.9)		0.90 (0.49,1.66)	0.731
	Comparison	402	26 (6.5)			

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal GGT level in 1982 (see Chapter 7, Statistical Methods).

Table 13-67. Longitudinal Analysis of GGT (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Low	17 (11.3) (151)	12 (8.2) (147)	10 (6.7) (150)	26 (17.8) (146)	16 (10.6) (151)
	15 (9.6) (156)	12 (7.8) (154)	14 (9.2) (152)	39 (25.7) (152)	27 (17.3) (156)
Medium	17 (11.3) (151)	14 (9.5) (148)	13 (8.9) (146)	33 (22.3) (148)	17 (11.3) (151)

Initial Dioxin Category Summary Statistics		Analysis Results for \log_2 (Initial Dioxin) ^a		
Normal in 1982				
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Low	134	8 (6.0)	1.03 (0.78,1.35)	0.860
Medium	141	19 (13.5)		
High	134	8 (6.0)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal GGT level in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	74 (8.0) (928)	71 (7.8) (912)	55 (6.1) (902)	151 (16.7) (906)	89 (9.6) (928)
Background RH	17 (5.0) (340)	19 (5.7) (333)	19 (5.8) (325)	55 (16.8) (327)	22 (6.5) (340)
Low RH	22 (9.7) (226)	16 (7.3) (220)	15 (6.8) (222)	43 (19.7) (218)	27 (11.9) (226)
High RH	27 (11.6) (232)	22 (9.6) (229)	22 (9.7) (226)	55 (24.1) (228)	33 (14.2) (232)
Low plus High RH	49 (10.7) (458)	38 (8.5) (449)	37 (8.3) (448)	98 (22.0) (446)	60 (13.1) (458)

Table 13-67. Longitudinal Analysis of GGT (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.L.) ^{a,b}	p-Value ^b
	n in 1997	Number (%) High in 1997		
Comparison	854	55 (6.4)		
Background RH	323	12 (3.7)	0.58 (0.31,1.11)	0.101
Low RH	204	15 (7.4)	1.19 (0.66,2.16)	0.569
High RH	205	20 (9.8)	1.46 (0.85,2.52)	0.173
Low plus High RH	409	35 (8.6)	1.32 (0.84,2.06)	0.224

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal GGT level in 1982 (see Chapter 7, Statistical Methods).

13.2.3.1.7 Cholesterol (Continuous)

The Model 1 analysis of the change in mean cholesterol levels did not uncover a significant difference between overall Ranch Hands and Comparisons (Table 13-68(a): $p=0.877$). Stratifying by occupation showed marginally significant group differences in the officers and enlisted groundcrew strata (Table 13-68(a): difference of examination mean change = -3.8 mg/dl, $p=0.075$, for officers; difference of examination mean change = 6.5 mg/dl, $p=0.082$, for enlisted groundcrew). Among the officers, the Ranch Hand mean decreased by 6.5 mg/dl between 1982 and 1997 versus a mean decrease of 2.7 mg/dl for Comparisons. Among the enlisted groundcrew, the Ranch Hands had a mean increase of 4.0 mg/dl between 1982 and 1997 versus a mean decrease of 2.5 mg/dl for Comparisons. Model 2 and 3 analyses did not show any significant relations between dioxin and the change in mean cholesterol levels (Table 13-68(b,c): $p>0.12$ for each analysis).

Table 13-68. Longitudinal Analysis of Cholesterol (mg/dl) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
<i>All</i>	<i>Ranch Hand</i>	212.3 (804)	214.9 (787)	216.0 (778)	215.9 (778)	210.8 (804)	-1.5	2.0	0.877
	<i>Comparison</i>	215.8 (956)	217.2 (938)	215.8 (929)	216.0 (933)	212.4 (956)	-3.5		
Officer	Ranch Hand	212.2 (309)	215.4 (304)	215.9 (301)	214.3 (300)	205.7 (309)	-6.5	-3.8	0.075
	Comparison	213.6 (377)	215.2 (371)	214.6 (363)	213.0 (370)	210.8 (377)	-2.7		
Enlisted Flyer	Ranch Hand	217.4 (146)	220.0 (143)	218.6 (141)	219.8 (143)	213.5 (146)	-3.9	4.4	0.838
	Comparison	224.7 (142)	222.5 (141)	221.8 (140)	221.8 (138)	216.4 (142)	-8.3		
Enlisted Groundcrew	Ranch Hand	210.3 (349)	212.4 (340)	214.9 (336)	215.8 (335)	214.3 (349)	4.0	6.5	0.082
	Comparison	214.9 (437)	217.3 (426)	214.9 (426)	216.9 (425)	212.4 (437)	-2.5		

^a Transformed from square root scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of square root of cholesterol; results adjusted for square root of cholesterol in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-68. Longitudinal Analysis of Cholesterol (mg/dl) (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin	Initial Dioxin Category Summary Statistics					Analysis Results for \log_2 (Initial Dioxin) ^b	
	1982	1985	1987	1992	1997	Adjusted Slope (Std. Error)	p-Value
Low	213.4 (151)	216.4 (147)	216.9 (150)	215.5 (146)	205.6 (151)	0.063 (0.041)	0.128
Medium	212.5 (156)	215.7 (154)	217.0 (152)	215.8 (152)	213.8 (156)		
High	218.6 (151)	219.0 (148)	219.0 (146)	220.8 (148)	217.9 (151)		

^a Transformed from square root scale.

^b Results based on difference between square root of 1997 cholesterol and square root of 1982 cholesterol versus \log_2 (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, square root of 1982 cholesterol, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a (n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	215.5 (929)	217.2 (913)	215.7 (903)	215.8 (907)	212.3 (929)	-3.2		
Background	208.9 (340)	212.1 (333)	214.0 (325)	214.1 (327)	208.8 (340)	-0.1	3.1	0.800
Low RH	212.8 (226)	215.8 (220)	215.7 (222)	216.4 (218)	208.0 (226)	-4.8	-1.6	0.410
High RH	216.7 (232)	218.2 (229)	219.5 (226)	218.2 (228)	216.7 (232)	0.0	3.2	0.168
Low plus	214.8 (458)	217.0 (449)	217.6 (448)	217.3 (446)	212.4 (458)	-2.4	0.8	0.704
High RH								

^a Transformed from square root scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of square root of 1997 cholesterol; results adjusted for percent body fat at the date of the blood measurement of dioxin, square root of 1982 cholesterol, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.8 Cholesterol (Discrete)

The Model 1 analysis of the percentage of participants with high cholesterol levels in 1997 did not uncover a significant difference between overall Ranch Hands and Comparisons (Table 13-69(a): $p=0.323$). Stratifying by occupation showed a significant group difference in the enlisted groundcrew stratum (Table 13-69(a): Adj. RR=1.68, $p=0.031$). For enlisted groundcrew with normal cholesterol levels in 1982, 15.6 percent of the Ranch Hands and 9.9 percent of the Comparisons had high cholesterol levels in 1997.

Table 13-69. Longitudinal Analysis of Cholesterol (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High/(n) Examination				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	<i>121 (15.0)</i> (804)	<i>127 (16.1)</i> (787)	<i>131 (16.8)</i> (778)	<i>108 (13.9)</i> (778)	<i>121 (15.0)</i> (804)
	<i>Comparison</i>	<i>156 (16.3)</i> (956)	<i>170 (18.1)</i> (938)	<i>135 (14.5)</i> (929)	<i>121 (13.0)</i> (933)	<i>142 (14.9)</i> (956)
Officer	Ranch Hand	34 (11.0) (309)	49 (16.1) (304)	49 (16.3) (301)	35 (11.7) (300)	36 (11.7) (309)
	Comparison	43 (11.4) (377)	53 (14.3) (371)	43 (11.8) (363)	40 (10.8) (370)	53 (14.1) (377)
Enlisted Flyer	Ranch Hand	27 (18.5) (146)	27 (18.9) (143)	30 (21.3) (141)	26 (18.2) (143)	21 (14.4) (146)
	Comparison	29 (20.4) (142)	34 (24.1) (141)	27 (19.3) (140)	19 (13.8) (138)	21 (14.8) (142)
Enlisted Groundcrew	Ranch Hand	60 (17.2) (349)	51 (15.0) (340)	52 (15.5) (336)	47 (14.0) (335)	64 (18.3) (349)
	Comparison	84 (19.2) (437)	83 (19.5) (426)	65 (15.3) (426)	62 (14.6) (425)	68 (15.6) (437)

Occupational Category	Group	Normal in 1982			Adj. Relative Risk (95% C.L.) ^a	p-Value ^a
		n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.L.) ^a		
<i>All</i>	<i>Ranch Hand</i>	683	81 (11.9)	<i>1.18 (0.85,1.63)</i>	<i>0.323</i>	
	<i>Comparison</i>	800	82 (10.3)			
Officer	Ranch Hand	275	25 (9.1)	0.83 (0.48,1.41)	0.483	
	Comparison	334	36 (10.8)			
Enlisted Flyer	Ranch Hand	119	11 (9.2)	0.94 (0.39,2.27)	0.896	
	Comparison	113	11 (9.7)			
Enlisted Groundcrew	Ranch Hand	289	45 (15.6)	1.68 (1.05,2.70)	0.031	
	Comparison	353	35 (9.9)			

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal cholesterol level in 1982 (see Chapter 7, Statistical Methods).

Table 13-69. Longitudinal Analysis of Cholesterol (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Low	18 (11.9) (151)	25 (17.0) (147)	25 (16.7) (150)	19 (13.0) (146)	18 (11.9) (151)
Medium	24 (15.4) (156)	25 (16.2) (154)	23 (15.1) (152)	21 (13.8) (152)	29 (18.6) (156)
High	39 (25.8) (151)	26 (17.6) (148)	23 (15.8) (146)	27 (18.2) (148)	30 (19.9) (151)

Initial Dioxin Category Summary Statistics		Analysis Results for \log_2 (Initial Dioxin) ^a		
Normal in 1982				
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Low	133	14 (10.5)	1.23 (0.98, 1.54)	0.072
Medium	132	21 (15.9)		
High	112	20 (17.9)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal cholesterol level in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	150 (16.1) (929)	165 (18.1) (913)	131 (14.5) (903)	115 (12.7) (907)	138 (14.9) (929)
Background RH	40 (11.8) (340)	51 (15.3) (333)	60 (18.5) (325)	40 (12.2) (327)	44 (12.9) (340)
Low RH	29 (12.8) (226)	37 (16.8) (220)	35 (15.8) (222)	31 (14.2) (218)	31 (13.7) (226)
High RH	52 (22.4) (232)	39 (17.0) (229)	36 (15.9) (226)	36 (15.8) (228)	46 (19.8) (232)
Low plus High RH	81 (17.7) (458)	76 (16.9) (449)	71 (15.8) (448)	67 (15.0) (446)	77 (16.8) (458)

Table 13-69. Longitudinal Analysis of Cholesterol (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.I.) ^a	p-Value ^b
	n in 1997	Number (%) High in 1997		
Comparison	779	80 (10.3)		
Background RH	300	26 (8.7)	0.75 (0.47,1.20)	0.236
Low RH	197	24 (12.2)	1.24 (0.76,2.02)	0.393
High RH	180	31 (17.2)	2.04 (1.29,3.24)	0.002
Low plus High RH	377	55 (14.6)	1.57 (1.08,2.29)	0.018

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal cholesterol level in 1982 (see Chapter 7, Statistical Methods).

The Model 2 longitudinal analysis revealed a marginally significant association between initial dioxin and high cholesterol levels in 1997 (Table 13-69(b): Adj. RR=1.23, p=0.072). The percentages of participants who had normal cholesterol levels in 1982 and high cholesterol levels in 1997 were 10.5, 15.9, and 17.9 in the low, medium, and high initial dioxin categories, respectively.

Model 3 analysis of the change in cholesterol values from normal in 1982 to high in 1997 revealed two significant contrasts: Ranch Hands in the high dioxin category versus Comparisons and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-69(c): Adj. RR=2.04, p=0.002; Adj. RR=1.57, p=0.018, respectively). Of the Comparisons, 10.3 percent had normal cholesterol levels in 1982 and high cholesterol levels in 1997. Of the Ranch Hands, 17.2 percent in the high dioxin category and 14.6 percent in the low and high dioxin categories combined had normal cholesterol levels in 1982 and high cholesterol levels in 1997.

13.2.3.1.9 HDL Cholesterol (Continuous)

The longitudinal analyses in Models 1 through 3 did not reveal a significant association between dioxin and the change in mean HDL cholesterol levels (Table 13-70(a-c): p>0.10 for each analysis).

Table 13-70. Longitudinal Analysis of HDL Cholesterol (mg/dl) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Mean ^a (n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
<i>All</i>	<i>Ranch Hand</i>	44.61 (798)	44.66 (781)	45.43 (772)	40.85 (763)	45.03 (798)	0.42	0.57	0.235
	<i>Comparison</i>	44.89 (955)	44.90 (937)	45.45 (928)	40.60 (926)	44.74 (955)	-0.15		
Officer	Ranch Hand	45.96 (306)	46.24 (301)	46.94 (298)	42.59 (293)	46.91 (306)	0.95	0.28	0.844
	Comparison	46.31 (377)	46.43 (371)	47.05 (363)	41.90 (367)	46.98 (377)	0.67		
Enlisted Flyer	Ranch Hand	42.99 (145)	42.99 (142)	44.26 (140)	40.48 (138)	44.86 (145)	1.87	1.49	0.146
	Comparison	43.14 (142)	43.51 (141)	44.41 (140)	40.28 (136)	43.53 (142)	0.38		
Enlisted Groundcrew	Ranch Hand	44.13 (347)	44.00 (338)	44.61 (334)	39.52 (332)	43.50 (347)	-0.63	0.37	0.527
	Comparison	44.27 (436)	44.06 (425)	44.47 (425)	39.60 (423)	43.27 (436)	-1.00		

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of HDL cholesterol; results adjusted for natural logarithm of HDL cholesterol in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-70. Longitudinal Analysis of HDL Cholesterol (mg/dl) (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin	Initial Dioxin Category Summary Statistics					Analysis Results for Log ₂ (Initial Dioxin) ^b	
	Mean ^a /(n) Examination					Adjusted Slope (Std. Error)	p-Value
1982	1985	1987	1992	1997			
Low	44.90 (149)	44.49 (145)	45.38 (148)	41.26 (144)	45.14 (149)	0.007 (0.008)	0.382
Medium	43.22 (154)	43.05 (152)	43.71 (150)	39.43 (148)	43.51 (154)		
High	42.38 (150)	42.38 (147)	43.37 (145)	38.86 (144)	43.39 (150)		

^a Transformed from natural logarithm scale.

^b Results based on difference between natural logarithm of 1997 HDL cholesterol and natural logarithm of 1982 HDL cholesterol versus log₂ (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 HDL cholesterol, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	44.90 (928)	44.80 (912)	45.37 (902)	40.54 (901)	44.65 (928)	-0.24		
Background RH	46.06 (339)	46.57 (332)	47.32 (324)	42.43 (322)	46.44 (339)	0.38	0.62	0.437
Low RH	44.89 (224)	44.77 (218)	45.54 (220)	41.52 (215)	45.07 (224)	0.18	0.42	0.598
High RH	42.15 (229)	41.91 (226)	42.81 (223)	38.26 (221)	42.97 (229)	0.83	1.07	0.105
Low plus	43.48	43.29	44.14	39.83	44.00	0.52	0.76	0.161
High RH	(453)	(444)	(443)	(436)	(453)			

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of 1997 HDL cholesterol; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 HDL cholesterol, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.10 HDL Cholesterol (Discrete)

Analyses of Models 1 through 3 showed no significant relations between dioxin and the percentage of participants with low HDL cholesterol values in 1997 (Table 13-71(a-c): $p>0.19$ for each analysis).

Table 13-71. Longitudinal Analysis of HDL Cholesterol (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Low/(n)				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	21 (2.6) (798)	30 (3.8) (781)	24 (3.1) (772)	82 (10.7) (763)	67 (8.4) (798)
	<i>Comparison</i>	20 (2.1) (955)	33 (3.5) (937)	22 (2.4) (928)	80 (8.6) (926)	74 (7.7) (955)
Officer	Ranch Hand	9 (2.9) (306)	11 (3.7) (301)	7 (2.3) (298)	31 (10.6) (293)	16 (5.2) (306)
	Comparison	10 (2.7) (377)	13 (3.5) (371)	4 (1.1) (363)	28 (7.6) (367)	19 (5.0) (377)
Enlisted Flyer	Ranch Hand	4 (2.8) (145)	8 (5.6) (142)	8 (5.7) (140)	12 (8.7) (138)	16 (11.0) (145)
	Comparison	4 (2.8) (142)	8 (5.7) (141)	6 (4.3) (140)	14 (10.3) (136)	15 (10.6) (142)
Enlisted Groundcrew	Ranch Hand	8 (2.3) (347)	11 (3.3) (338)	9 (2.7) (334)	39 (11.7) (332)	35 (10.1) (347)
	Comparison	6 (1.4) (436)	12 (2.8) (425)	12 (2.8) (425)	38 (9.0) (423)	40 (9.2) (436)

Occupational Category	Group	Normal in 1982		Adj. Relative Risk (95% C.I.) ^a	p-Value ^a
		n in 1997	Number (%) Low in 1997		
<i>All</i>	<i>Ranch Hand</i>	777	57 (7.3)	1.06 (0.73,1.53)	0.760
	<i>Comparison</i>	935	65 (7.0)		
Officer	Ranch Hand	297	13 (4.4)	0.94 (0.45,1.97)	0.872
	Comparison	367	17 (4.6)		
Enlisted Flyer	Ranch Hand	141	15 (10.6)	1.25 (0.56,2.78)	0.584
	Comparison	138	12 (8.7)		
Enlisted Groundcrew	Ranch Hand	339	29 (8.6)	1.03 (0.62,1.71)	0.920
	Comparison	430	36 (8.4)		

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal HDL cholesterol level in 1982 (see Chapter 7, Statistical Methods).

Table 13-71. Longitudinal Analysis of HDL Cholesterol (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) Low/(n) Examination				
	1982	1985	1987	1992	1997
Low	2 (1.3) (149)	5 (3.4) (145)	2 (1.4) (148)	13 (9.0) (144)	13 (8.7) (149)
Medium	4 (2.6) (154)	7 (4.6) (152)	4 (2.7) (150)	16 (10.8) (148)	15 (9.7) (154)
High	3 (2.0) (150)	7 (4.8) (147)	6 (4.1) (145)	16 (11.1) (144)	9 (6.0) (150)

Initial Dioxin Category Summary Statistics			Analysis Results for \log_2 (Initial Dioxin) ^a	
Normal in 1982		Number (%) Low in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Initial Dioxin	n in 1997	Number (%) Low in 1997		
Low	147	12 (8.2)	0.82 (0.60,1.12)	0.192
Medium	150	13 (8.7)		
High	147	7 (4.8)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal HDL cholesterol level in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) Low/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	20 (2.2) (928)	33 (3.6) (912)	22 (2.4) (902)	78 (8.7) (901)	73 (7.9) (928)
Background RH	12 (3.5) (339)	11 (3.3) (332)	11 (3.4) (324)	34 (10.6) (322)	30 (8.8) (339)
Low RH	6 (2.7) (224)	10 (4.6) (218)	3 (1.4) (220)	19 (8.8) (215)	19 (8.5) (224)
High RH	3 (1.3) (229)	9 (4.0) (226)	9 (4.0) (223)	26 (11.8) (221)	18 (7.9) (229)
Low plus High RH	9 (2.0) (453)	19 (4.3) (444)	12 (2.7) (443)	45 (10.3) (436)	37 (8.2) (453)

Table 13-71. Longitudinal Analysis of HDL Cholesterol (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.I.) ^a	p-Value ^b
	n in 1997	Number (%) Low in 1997		
Comparison	908	64 (7.0)		
Background RH	327	25 (7.6)	1.25 (0.77,2.03)	0.374
Low RH	218	16 (7.3)	1.03 (0.58,1.83)	0.926
High RH	226	16 (7.1)	0.85 (0.47,1.52)	0.581
Low plus High RH	444	32 (7.2)	0.93 (0.60,1.46)	0.759

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal HDL cholesterol level in 1982 (see Chapter 7, Statistical Methods).

13.2.3.1.11 Cholesterol-HDL Ratio (Continuous)

The Models 1 through 3 analyses did not reveal a significant association between the cholesterol-HDL ratio and dioxin (Table 13-72(a-c): p>0.23 for each analysis).

Table 13-72. Longitudinal Analysis of Cholesterol-HDL Ratio (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
<i>All</i>	<i>Ranch Hand</i>	4.71 (798)	4.77 (781)	4.71 (772)	5.23 (763)	4.65 (798)	-0.06	-0.01	0.519
	<i>Comparison</i>	4.77 (955)	4.80 (937)	4.71 (928)	5.27 (926)	4.71 (955)	-0.05		
Officer	Ranch Hand	4.58 (306)	4.62 (301)	4.56 (298)	4.99 (293)	4.36 (306)	-0.22	-0.10	0.237
	Comparison	4.57 (377)	4.60 (371)	4.53 (363)	5.04 (367)	4.45 (377)	-0.12		
Enlisted Flyer	Ranch Hand	5.00 (145)	5.06 (142)	4.88 (140)	5.32 (138)	4.72 (145)	-0.28	-0.06	0.255
	Comparison	5.16 (142)	5.06 (141)	4.95 (140)	5.45 (136)	4.94 (142)	-0.22		
Enlisted Groundcrew	Ranch Hand	4.71 (347)	4.79 (338)	4.78 (334)	5.42 (332)	4.89 (347)	0.18	0.12	0.400
	Comparison	4.81 (436)	4.89 (425)	4.79 (425)	5.43 (423)	4.87 (436)	0.06		

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of cholesterol-HDL ratio; results adjusted for natural logarithm of cholesterol-HDL ratio in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-72. Longitudinal Analysis of Cholesterol-HDL Ratio (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin Category	Initial Dioxin Category Summary Statistics					Analysis Results for \log_2 (Initial Dioxin) ^b	
	Mean ^a /(n) Examination					Adjusted Slope (Std. Error)	p-Value
Initial Dioxin	1982	1985	1987	1992	1997		
Low	4.70 (149)	4.81 (145)	4.73 (148)	5.17 (144)	4.51 (149)	0.005 (0.008)	0.589
Medium	4.85 (154)	4.98 (152)	4.93 (150)	5.43 (148)	4.88 (154)		
High	5.10 (150)	5.12 (147)	5.02 (145)	5.59 (144)	4.98 (150)		

^a Transformed from natural logarithm scale.

^b Results based on difference between natural logarithm of 1997 cholesterol-HDL ratio and natural logarithm of 1982 GGT versus \log_2 (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 cholesterol-HDL ratio, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	4.76 (928)	4.81 (912)	4.71 (902)	5.28 (901)	4.72 (928)	-0.04		
Background	4.50 (339)	4.52 (332)	4.48 (324)	4.99 (322)	4.47 (339)	-0.03	0.01	0.473
RH								
Low RH	4.69 (224)	4.77 (218)	4.69 (220)	5.16 (215)	4.57 (224)	-0.12	-0.08	0.281
High RH	5.08 (229)	5.17 (226)	5.10 (223)	5.64 (221)	5.01 (229)	-0.06	-0.02	0.971
Low plus	4.88 (453)	4.97 (444)	4.89 (443)	5.40 (436)	4.79 (453)	-0.09	-0.05	0.505
High RH								

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of 1997 cholesterol-HDL ratio; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 cholesterol-HDL ratio, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.12 Cholesterol-HDL Ratio (Discrete)

The longitudinal analyses in Models 1 through 3 did not reveal a significant association between dioxin and the percentage of participants who had a normal cholesterol-HDL ratio in 1982 and a high cholesterol-HDL ratio in 1997 (Table 13-73(a-c): $p>0.10$ for each analysis).

Table 13-73. Longitudinal Analysis of Cholesterol-HDL Ratio (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High(n) Examination				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	350 (43.9) (798)	352 (45.1) (781)	335 (43.4) (772)	432 (56.6) (763)	324 (40.6) (798)
	<i>Comparison</i>	423 (44.3) (955)	415 (44.3) (937)	401 (43.2) (928)	533 (57.6) (926)	404 (42.3) (955)
Officer	Ranch Hand	120 (39.2) (306)	132 (43.9) (301)	124 (41.6) (298)	144 (49.1) (293)	99 (32.4) (306)
	Comparison	151 (40.1) (377)	140 (37.7) (371)	134 (36.9) (363)	182 (49.6) (367)	117 (31.0) (377)
Enlisted Flyer	Ranch Hand	74 (51.0) (145)	69 (48.6) (142)	61 (43.6) (140)	83 (60.1) (138)	56 (38.6) (145)
	Comparison	77 (54.2) (142)	71 (50.4) (141)	76 (54.3) (140)	84 (61.8) (136)	71 (50.0) (142)
Enlisted Groundcrew	Ranch Hand	156 (45.0) (347)	151 (44.7) (338)	150 (44.9) (334)	205 (61.7) (332)	169 (48.7) (347)
	Comparison	195 (44.7) (436)	204 (48.0) (425)	191 (44.9) (425)	267 (63.1) (423)	216 (49.5) (436)

Occupational Category	Group	Normal in 1982		
		n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^a
<i>All</i>	<i>Ranch Hand</i>	448	90 (20.1)	0.82 (0.60,1.12)
	<i>Comparison</i>	532	125 (23.5)	0.206
Officer	Ranch Hand	186	27 (14.5)	1.00 (0.58,1.74)
	Comparison	226	33 (14.6)	0.996
Enlisted Flyer	Ranch Hand	71	16 (22.5)	0.81 (0.37,1.78)
	Comparison	65	17 (26.2)	0.598
Enlisted Groundcrew	Ranch Hand	191	47 (24.6)	0.72 (0.47,1.10)
	Comparison	241	75 (31.1)	0.131

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal cholesterol-HDL ratio in 1982 (see Chapter 7, Statistical Methods).

Table 13-73. Longitudinal Analysis of Cholesterol-HDL Ratio (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS—INITIAL DIOXIN

Initial Dioxin	Number (%) High(n) Examination				
	1982	1985	1987	1992	1997
Low	61 (40.9) (149)	66 (45.5) (145)	65 (43.9) (148)	79 (54.9) (144)	51 (34.2) (149)
Medium	74 (48.1) (154)	75 (49.3) (152)	73 (48.7) (150)	97 (65.5) (148)	72 (46.8) (154)
High	82 (54.7) (150)	78 (53.1) (147)	74 (51.0) (145)	92 (63.9) (144)	78 (52.0) (150)

Initial Dioxin Category Summary Statistics			Analysis Results for \log_2 (Initial Dioxin) ^a	
Normal in 1982		Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Low	88	15 (17.0)	1.15 (0.89, 1.48)	0.278
Medium	80	21 (26.3)		
High	68	17 (25.0)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal cholesterol-HDL ratio in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High(n) Examination				
	1982	1985	1987	1992	1997
Comparison	407 (43.9) (928)	406 (44.5) (912)	391 (43.3) (902)	518 (57.5) (901)	395 (42.6) (928)
Background RH	131 (38.6) (339)	130 (39.2) (332)	120 (37.0) (324)	160 (49.7) (322)	119 (35.1) (339)
Low RH	91 (40.6) (224)	93 (42.7) (218)	94 (42.7) (220)	120 (55.8) (215)	80 (35.7) (224)
High RH	126 (55.0) (229)	126 (55.8) (226)	118 (52.9) (223)	148 (67.0) (221)	121 (52.8) (229)
Low plus High RH	217 (47.9) (453)	219 (49.3) (444)	212 (47.9) (443)	268 (61.5) (436)	201 (44.4) (453)

Table 13-73. Longitudinal Analysis of Cholesterol-HDL Ratio (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.I.) ^{ab}	p-Value ^b
	n in 1997	Number (%) High in 1997		
Comparison	521	124 (23.8)		
Background RH	208	35 (16.8)	0.70 (0.46, 1.07)	0.102
Low RH	133	25 (18.8)	0.74 (0.45, 1.20)	0.216
High RH	103	28 (27.2)	1.03 (0.63, 1.68)	0.899
Low plus High RH	236	53 (22.5)	0.85 (0.59, 1.24)	0.408

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal cholesterol-HDL ratio in 1982 (see Chapter 7, Statistical Methods).

13.2.3.1.13 Triglycerides (Continuous)

The Model 1 analysis of the change in triglyceride levels did not uncover a significant difference between overall Ranch Hands and Comparisons or within each occupational stratum (Table 13-74(a): $p>0.12$ for each contrast). The Model 2 analysis did not reveal a significant association between the change in triglyceride levels and initial dioxin (Table 13-74(b): $p=0.751$).

Model 3 analysis of the change in mean triglyceride levels between 1982 and 1997 revealed two significant contrasts: Ranch Hands in the high dioxin category versus Comparisons and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-74(c): difference of examination mean change=11.8 mg/dl, $p=0.020$; difference of examination mean change=5.4 mg/dl, $p=0.094$, respectively). The examination mean changes for Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 13.1 mg/dl, 6.7 mg/dl, and 1.3 mg/dl, respectively.

Table 13-74. Longitudinal Analysis of Triglycerides (mg/dl) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
		1982	1985	1987	1992	1997			
<i>All</i>	<i>Ranch Hand</i>	118.8 (803)	117.1 (786)	120.2 (777)	146.6 (777)	122.7 (803)	4.0	3.2	0.478
	<i>Comparison</i>	120.9 (956)	119.1 (938)	119.4 (929)	146.1 (933)	121.8 (956)	0.8		
Officer	Ranch Hand	118.8 (308)	116.3 (303)	115.1 (300)	143.1 (299)	113.7 (308)	-5.1	-1.0	0.780
	Comparison	115.5 (377)	111.9 (371)	111.8 (363)	137.7 (370)	111.4 (377)	-4.1		
Enlisted Flyer	Ranch Hand	129.1 (146)	122.7 (143)	126.7 (141)	145.0 (143)	125.0 (146)	-4.1	-8.5	0.177
	Comparison	134.2 (142)	130.4 (141)	130.0 (140)	157.3 (138)	138.6 (142)	4.4		
Enlisted Groundcrew	Ranch Hand	114.6 (349)	115.5 (340)	122.3 (336)	150.4 (335)	130.3 (349)	15.7	11.3	0.128
	Comparison	121.6 (437)	122.1 (426)	122.8 (426)	150.0 (425)	126.1 (437)	4.4		

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of triglycerides; results adjusted for natural logarithm of triglycerides in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Table 13-74. Longitudinal Analysis of Triglycerides (mg/dl) (Continuous) (Continued)

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN

Initial Dioxin	Initial Dioxin Category Summary Statistics					Analysis Results for Log ₂ (Initial Dioxin) ^b	
	Mean ^a /(n) Examination					Adjusted Slope (Std. Error)	p-Value
	1982	1985	1987	1992	1997		
Low	122.1 (151)	120.8 (147)	120.1 (150)	143.2 (146)	117.6 (151)	0.006 (0.020)	0.751
Medium	129.2 (156)	129.1 (154)	142.9 (152)	163.3 (152)	141.4 (156)		
High	129.5 (151)	133.2 (148)	133.6 (146)	161.1 (148)	143.0 (151)		

^a Transformed from natural logarithm scale.

^b Results based on difference between natural logarithm of 1997 triglycerides and natural logarithm of 1982 triglycerides versus log₂ (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 triglycerides and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Mean ^a /(n) Examination					Exam. Mean Change ^b	Difference of Exam. Mean Change	p-Value ^c
	1982	1985	1987	1992	1997			
Comparison	120.1 (929)	118.7 (913)	118.7 (903)	145.4 (907)	121.4 (929)	1.3		
Background	107.7 (339)	103.7 (332)	105.5 (324)	134.4 (326)	108.6 (339)	0.8	-0.5	0.377
Low RH	119.8 (226)	120.4 (220)	120.5 (222)	144.0 (218)	120.8 (226)	1.0	-0.3	0.820
High RH	134.3 (232)	135.0 (229)	144.1 (226)	167.8 (228)	147.3 (232)	13.1	11.8	0.020
Low plus	126.9 (458)	127.6 (449)	131.9 (448)	155.7 (446)	133.6 (458)	6.7	5.4	0.094
High RH								

^a Transformed from natural logarithm scale.

^b Difference between 1997 and 1982 examination means after transformation to original scale.

^c P-value is based on analysis of natural logarithm of 1997 triglycerides; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 triglycerides, and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin ≤ 10 ppt.

Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

13.2.3.1.14 Triglycerides (Discrete)

The Model 1 analysis of the percentage of participants with a normal triglyceride level in 1982 and a high triglyceride level in 1997 did not show a significant difference between overall Ranch Hands and Comparisons or within each occupational stratum (Table 13-75(a): $p>0.12$ for each contrast).

Table 13-75. Longitudinal Analysis of Triglycerides (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High(n) Examination				
		1982	1985	1987	1992	1997
<i>All</i>	<i>Ranch Hand</i>	248 (30.9) (803)	58 (7.4) (786)	59 (7.6) (777)	88 (11.3) (777)	179 (22.3) (803)
	<i>Comparison</i>	313 (32.7) (956)	61 (6.5) (938)	60 (6.5) (929)	84 (9.0) (933)	203 (21.2) (956)
Officer	<i>Ranch Hand</i>	84 (27.3) (308)	30 (9.9) (303)	21 (7.0) (300)	33 (11.0) (299)	53 (17.2) (308)
	<i>Comparison</i>	113 (30.0) (377)	24 (6.5) (371)	25 (6.9) (363)	32 (8.6) (370)	62 (16.4) (377)
Enlisted Flyer	<i>Ranch Hand</i>	55 (37.7) (146)	14 (9.8) (143)	12 (8.5) (141)	20 (14.0) (143)	30 (20.5) (146)
	<i>Comparison</i>	52 (36.6) (142)	10 (7.1) (141)	9 (6.4) (140)	11 (8.0) (138)	42 (29.6) (142)
Enlisted Groundcrew	<i>Ranch Hand</i>	109 (31.2) (349)	14 (4.1) (340)	26 (7.7) (336)	35 (10.4) (335)	96 (27.5) (349)
	<i>Comparison</i>	148 (33.9) (437)	27 (6.3) (426)	26 (6.1) (426)	41 (9.6) (425)	99 (22.7) (437)

Occupational Category	Group	Normal in 1982			Adj. Relative Risk (95% C.I.) ^a	p-Value ^a
		n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^a		
<i>All</i>	<i>Ranch Hand</i>	555	66 (11.9)	1.31 (0.90,1.89)	0.159	
	<i>Comparison</i>	643	60 (9.3)			
Officer	<i>Ranch Hand</i>	224	20 (8.9)	1.44 (0.73,2.82)	0.291	
	<i>Comparison</i>	264	17 (6.4)			
Enlisted Flyer	<i>Ranch Hand</i>	91	8 (8.8)	0.69 (0.26,1.80)	0.443	
	<i>Comparison</i>	90	11 (12.2)			
Enlisted Groundcrew	<i>Ranch Hand</i>	240	38 (15.8)	1.48 (0.89,2.46)	0.127	
	<i>Comparison</i>	289	32 (11.1)			

^a Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal triglyceride level in 1982 (see Chapter 7, Statistical Methods).

Table 13-75. Longitudinal Analysis of Triglycerides (Discrete) (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Low	49 (32.5) (151)	13 (8.8) (147)	9 (6.0) (150)	14 (9.6) (146)	36 (23.8) (151)
Medium	56 (35.9) (156)	16 (10.4) (154)	16 (10.5) (152)	25 (16.4) (152)	44 (28.2) (156)
High	56 (37.1) (151)	11 (7.4) (148)	18 (12.3) (146)	19 (12.8) (148)	49 (32.5) (151)

Initial Dioxin Category Summary Statistics		Analysis Results for \log_2 (Initial Dioxin) ^a		
Normal in 1982				
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.) ^b	p-Value
Low	102	14 (13.7)	1.07 (0.83,1.38)	0.608
Medium	100	12 (12.0)		
High	95	19 (20.0)		

^a Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

^b Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal triglyceride level in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	300 (32.3) (929)	58 (6.4) (913)	57 (6.3) (903)	80 (8.8) (907)	195 (21.0) (929)
Background RH	83 (24.5) (339)	17 (5.1) (332)	16 (4.9) (324)	30 (9.2) (326)	46 (13.6) (339)
Low RH	75 (33.2) (226)	20 (9.1) (220)	14 (6.3) (222)	21 (9.6) (218)	52 (23.0) (226)
High RH	86 (37.1) (232)	20 (8.7) (229)	29 (12.8) (226)	37 (16.2) (228)	77 (33.2) (232)
Low plus High RH	161 (35.2) (458)	40 (8.9) (449)	43 (9.6) (448)	58 (13.0) (446)	129 (28.2) (458)

Table 13-75. Longitudinal Analysis of Triglycerides (Discrete) (Continued)

Dioxin Category	Normal in 1982		Adj. Relative Risk (95% C.I.) ^a	p-Value ^b
	n in 1997	Number (%) High in 1997		
Comparison	629	58 (9.2)		
Background RH	256	19 (7.4)	0.88 (0.51,1.52)	0.649
Low RH	151	17 (11.3)	1.29 (0.72,2.30)	0.390
High RH	146	28 (19.2)	1.97 (1.19,3.26)	0.008
Low plus High RH	297	45 (15.2)	1.59 (1.04,2.44)	0.034

^a Relative risk and confidence interval relative to Comparisons.

^b Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin \leq 10 ppt.

Background (Ranch Hand): 1987 Dioxin \leq 10 ppt.

Low (Ranch Hand): 1987 Dioxin $>$ 10 ppt, 10 ppt $<$ Initial Dioxin \leq 94 ppt.

High (Ranch Hand): 1987 Dioxin $>$ 10 ppt, Initial Dioxin $>$ 94 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had a normal triglyceride level in 1982 (see Chapter 7, Statistical Methods).

The Model 2 analysis did not reveal a significant association between the change in triglyceride levels and initial dioxin (Table 13-75(b): $p=0.608$). Model 3 analysis of the change in triglyceride values from normal in 1982 to high in 1997 revealed two significant contrasts: Ranch Hands in the high dioxin category versus Comparisons and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-75(c): Adj. RR=1.97, $p=0.008$; Adj. RR=1.59, $p=0.034$, respectively). Of the Comparisons, 9.2 percent had normal triglyceride levels in 1982 and high triglyceride levels in 1997. Of the Ranch Hands, 19.2 percent in the high dioxin category and 15.2 percent in the low and high dioxin categories combined had normal triglyceride levels in 1982 and high triglyceride levels in 1997.

13.3 DISCUSSION

The historical, physical examination, and laboratory parameters included in the gastrointestinal assessment are well established in clinical practice as screening tools in the outpatient investigation of digestive disorders. In the diagnosis of digestive disorders, it is important to recognize the limitations of the history and physical examination. Rather than pointing to a particular diagnosis, digestive symptoms are frequently nonspecific and intermittent. In this setting, even the best-designed medical history questionnaire can be subject to error. "Ulcer" and "colitis" are diagnoses that are commonly reported but often not accurately established. As a common target organ for situational stress, the bowel frequently gives rise to symptoms that can be severe but that are functional in nature and resolve over time. These caveats highlight the importance of the type of medical record verification conducted in the current study.

The physical examination of the gastrointestinal system is often of limited value and can be misleading in the differential diagnosis. For example, the detection of enlargement of the liver in the obese patient is unreliable. In obstructive airway disease, with hyperinflation of the lungs and flattening of the

diaphragms, the liver edge may descend abnormally below the right costal margin in the absence of hepatomegaly. The span of the liver by palpation or percussion is often an unreliable index of liver size.

Data collected in the laboratory can provide early insight into the presence of occult liver disease despite the limitations in the history and physical examination. The four hepatic enzymes analyzed as dependent variables (AST, ALT, GGT, and LDH) are commonly ordered in the outpatient setting. These enzymes, of which GGT is the most sensitive, are present in high intracellular concentration. They also are elevated in fatty infiltration of the liver associated with obesity and in virtually all toxic, inflammatory, and neoplastic diseases with hepatic involvement.

The hepatic enzymes are used in the detection and follow-up of parenchymal liver disease. The serum alkaline phosphatase and bilirubin are reflective of hepatobiliary function and are elevated in "cholestatic" or "obstructive" diseases. Although present in virtually all organ systems, the serum alkaline phosphatase in the adult population under study is of dual origin and close to a even mixture of liver- and bone-derived fractions. An elevated alkaline phosphatase is not diagnostic of liver disease and may occur in a broad range of unrelated clinical conditions including drug-induced cholestasis, Paget's disease (3% of males over age 40), neoplasia with metastases to bone, and congestive heart failure.

Similarly, the bilirubin measurements are subject to numerous hereditary and acquired disorders unrelated to intrinsic hepatic disease. The benign hyperbilirubinemia of Gilbert's syndrome will occur in 5 percent of the population under study. Many medications, including over-the-counter preparations, have been implicated in the overproduction of bilirubin that occurs in the hemolytic reactions associated with glucose-6-phosphate dehydrogenase deficiency that may be present in up to 15 percent of Black American males.

In this follow-up examination, with two exceptions, none of the analyses of historical (verified medical records review) or physical examination variables revealed any significant group differences or evidence for liver disease associated with the 1987 body burden of dioxin. Consistent with the 1992 examinations, Ranch Hands were significantly less likely than Comparisons to have a history of jaundice (1.4% vs. 2.9%), a finding that is consistent with the highly significant ($p<0.001$) inverse dose-response pattern in the model relating this variable to 1987 serum dioxin. Also consistent with the 1992 follow-up examination, Ranch Hands were more likely than Comparisons to have a history of other liver disorders, primarily based on enlisted groundcrew (30.8% vs. 25.2%). An increasing history of other liver disorders as dioxin levels increased also was observed. Twelve percent of this category of "other liver disorders" comprised participants with nonspecific laboratory test elevations at previous examinations.

The laboratory data examined can be divided broadly into parenchymal (serum enzymes), hepatobiliary (serum bilirubin and alkaline phosphatase), lipid or carbohydrate indices, and a 10-element protein profile including prealbumin, albumin, α -1-acid glycoprotein, α -1-antitrypsin, α -2-macroglobulin, apolipoprotein B, C3 complement, C4 complement, haptoglobin, and transferrin. The components of the protein profile were selected to provide a comprehensive reflection of multiple organ systems involved in homeostasis and to investigate the possibility of a subclinical inflammatory process that might be associated with prior TCDD exposure or the current body burden of dioxin. Produced in the liver, the proteins measured are most sensitive to hepatic function but also provide a reliable assessment of nutritional status. Selected proteins (α -1-acid glycoprotein, α -1-antitrypsin, and haptoglobin) are nonspecifically elevated in association with inflammation, whereas reductions in the C3 and C4 complement indices are associated with immune system responses.

Few of the laboratory analyses revealed any significant differences between the Ranch Hand and Comparison cohorts. Ranch Hands continued to have a slightly higher mean alkaline phosphatase than

Comparisons by continuous analysis. In the analyses relating alkaline phosphatase to the initial and the 1987 body burden of dioxin within Ranch Hands, a marginally significant inverse relation was noted. In the analyses of laboratory data in discrete form, no significant group differences were defined.

The analyses of two protein variables in continuous form, α -1-antitrypsin and haptoglobin, yielded statistically significant ($p=0.002$ for both variables) overall group differences with Ranch Hands adversely affected. In neither instance was there any evidence for an association with 1987 serum dioxin levels and, by all discrete analyses, the prevalence of abnormalities was similar in each cohort.

Several analyses yielded results that have been documented consistently in prior examinations. Although no overall group differences were defined by both continuous and discrete analyses, three of four liver enzymes—ALT, AST, and GGT—revealed significant positive associations with 1987 serum dioxin levels. Similar results were noted as well in the analysis of serum triglycerides. These results, while consistent with a dose-response effect, might be explained as well on the basis of the hyperlipidemia and fatty infiltration of the liver that occur in association with obesity. A causal relation with prior dioxin exposure remains to be established.

Dependent variable-covariate associations yielded results similar to those documented in previous examinations and that are well established in clinical practice. Highly significant positive correlations were noted relating lifetime alcohol consumption with the history of chronic liver disease and cirrhosis, the finding of enlargement of the liver upon physical examination, and an elevation in GGT, the most sensitive liver enzyme. The mean creatine phosphokinase level in Blacks was almost twice as high as in non-Blacks, a finding that was noted in both the 1987 and 1992 examinations and that appears to be race- and gender-specific.

Throughout 15 years of observation, the longitudinal analyses have yielded marginally significant results in several of the laboratory indices, most of which were similar to those documented in the 1992 examination. Although no significant overall group differences were identified, a consistent gradual reduction in serum AST occurred in both Ranch Hands and Comparisons across all occupational and exposure categories. In the analyses of ALT in discrete form, Ranch Hand enlisted groundcrew, those most heavily exposed to dioxin, remained less likely than Comparisons to have abnormal elevations in this index (5.6% vs. 7.9%, respectively) in 1997. Relative to Comparisons, the increase in mean serum triglyceride levels over time was most pronounced in Ranch Hands in the highest serum dioxin category in a pattern consistent with a dose-response effect (13.1 mg vs. 1.3 mg; $p=0.020$). Finally, Ranch Hands in the enlisted groundcrew occupational stratum whose cholesterol levels were normal in 1982 were significantly more likely than Comparisons to develop abnormal elevations in 1997 (15.6% vs. 9.9%), an effect most pronounced in those participants with the highest levels of serum dioxin relative to Comparisons (17.2% vs. 10.3%).

Data analyzed for the gastrointestinal assessment confirm observations that would be anticipated in clinical practice and reflect no apparent increase in organ-specific morbidity in Ranch Hands relative to Comparisons. Although the results cited above are consistent with a subtle effect of dioxin on lipid metabolism, an association with body habitus and obesity cannot be excluded.

13.4 SUMMARY

13.4.1 Model 1: Group Analysis

The adjusted group analysis for medical records variables revealed a significant difference between Ranch Hands and Comparisons over all occupational strata for jaundice. Comparisons had a greater history of jaundice than Ranch Hands.

The adjusted Model 1 analyses of the continuous variables found that Ranch Hands had significantly higher mean levels of alkaline phosphatase, α -1-antitrypsin, haptoglobin, and transferrin than Comparisons. In the discrete analyses, significantly more Ranch Hands than Comparisons had high haptoglobin levels and more Comparisons than Ranch Hands had evidence of prior hepatitis B infection and low transferrin values.

After stratifying by occupation, the adjusted analyses revealed significantly lower mean levels of serum amylase, apolipoprotein B, and C4 complement among the Ranch Hand officers versus Comparison officers. In the discrete analysis, more Comparison officers than Ranch Hand officers had prior hepatitis B infection. Ranch Hand enlisted flyers had a significantly lower percentage of high apolipoprotein B values than Comparison enlisted flyers.

The adjusted analysis of the continuous variables showed that among the enlisted groundcrew, the Ranch Hand mean levels of alkaline phosphatase, α -1-acid glycoprotein, α -1-antitrypsin, and haptoglobin were significantly higher than the corresponding Comparison group mean levels. The adjusted discrete analyses found significantly more high triglyceride levels and low prealbumin levels among enlisted groundcrew Ranch Hands than among enlisted groundcrew Comparisons. A significantly smaller prevalence of serological evidence of prior hepatitis B infection was seen for Ranch Hand enlisted groundcrew versus Comparison enlisted groundcrew.

The results of all unadjusted and adjusted Model 1 analyses are summarized in Table 13-76.

Table 13-76. Summary of Group Analysis (Model 1) for Gastrointestinal Variables (Ranch Hands vs. Comparisons)

Variable	UNADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Medical Records				
Uncharacterized Hepatitis (D)	NS	NS	NS	NS
Jaundice (Unspecified) (D)	-0.025	ns*	NS	ns*
Chronic Liver Disease and Cirrhosis (Alcohol-related) (D)	NS	NS	ns	ns
Chronic Liver Disease and Cirrhosis (Non-alcohol-related) (D)	NS	NS	ns	NS
Liver Abscess and Sequelae of Chronic Liver Disease (D)	NS	ns	--	NS
Enlarged Liver (Hepatomegaly) (D)	ns	ns	NS	ns*
Other Liver Disorders (D)	NS*	NS	NS	NS*
Physical Examination				
Current Hepatomegaly (D)	NS	NS	NS	NS

Table 13-76. Summary of Group Analysis (Model 1) for Gastrointestinal Variables (Ranch Hands vs. Comparisons) (Continued)

Variable	UNADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Laboratory				
AST (C)	NS	NS	ns	NS
AST (D)	NS	NS	ns	NS
ALT (C)	NS	NS	ns	NS
ALT (D)	NS	NS	ns	ns
GGT (C)	NS	NS	ns	NS
GGT (D)	NS	NS	NS	ns
Alkaline Phosphatase (C)	+0.024	NS	NS	+0.030
Alkaline Phosphatase (D)	NS	ns	NS	NS*
Total Bilirubin (C)	ns	NS	ns	NS
Total Bilirubin (D)	ns	ns	NS	ns
Direct Bilirubin (D)	ns	ns	--	ns
Lactic Dehydrogenase (C)	NS	ns	ns	NS
Lactic Dehydrogenase (D)	ns	ns	NS	ns
Cholesterol (C)	ns	ns	ns	NS
Cholesterol (D)	NS	ns	ns	NS
HDL Cholesterol (C) ^a	NS	ns	NS	ns
HDL Cholesterol (D)	NS	NS	NS	NS
Cholesterol-HDL Ratio (C)	ns	ns	ns	NS
Cholesterol-HDL Ratio (D)	NS	NS	ns	NS
Triglycerides (C)	NS	NS	ns	NS
Triglycerides (D)	NS	NS	ns	NS*
Creatine Phosphokinase (C)	NS	NS	ns	NS
Creatine Phosphokinase (D)	ns	ns	ns	NS
Serum Amylase (C)	NS	-0.048	NS	NS
Serum Amylase (D)	ns	ns*	NS	NS
Antibodies for Hepatitis A (D)	ns	NS	NS	ns
Serological Evidence of Prior Hepatitis B Infection (D)	-0.001	-0.031	ns*	-0.036
Current Hepatitis B (D)	ns	--	--	ns
Antibodies for Hepatitis C (D)	ns	ns	ns	ns
Antibodies for Hepatitis D (D)	--	--	--	--
Stool Hemoccult (D)	ns	ns	ns	ns
Prealbumin (C) ^a	ns	ns	NS	ns
Prealbumin (D)	NS	NS	NS	NS*
Albumin (C) ^a	ns	ns	NS	NS
Albumin (D)	ns	NS	ns	ns
α -1-Acid Glycoprotein (C)	NS	ns	ns	+0.044
α -1-Acid Glycoprotein (D)	NS	ns	NS	NS
α -1-Antitrypsin (C):	+0.002	NS	NS	+0.001
Low vs. Normal	ns	NS	NS	ns
High vs. Normal	NS	NS	ns	NS
α -2-Macroglobulin (C)	ns	ns	ns	ns
α -2-Macroglobulin (D)	ns	ns	ns	ns
Apolipoprotein B (C)	ns	ns*	ns	NS
Apolipoprotein B (D)	ns*	ns	-0.007	NS
C3 Complement (C) ^a	NS	NS	ns	NS
C3 Complement (D)	ns	ns	ns	NS

Table 13-76. Summary of Group Analysis (Model 1) for Gastrointestinal Variables (Ranch Hands vs. Comparisons) (Continued)

Variable	UNADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
C4 Complement (C) ^a	ns	-0.024	NS*	ns
C4 Complement (D)	NS	NS	ns	--
Haptoglobin (C)	+0.002	NS	NS	+0.016
Haptoglobin (D)	+0.017	NS	NS	NS*
Transferrin (C) ^a	+0.044	NS	NS	NS*
Transferrin (D)	-0.036	ns*	ns	ns

Note: NS or ns: Not significant ($p>0.10$).

NS* or ns*: Marginally significant ($0.05 < p \leq 0.10$).

C: Continuous analysis.

D: Discrete analysis.

+: Relative risk ≥ 1.00 for discrete analysis; difference of means nonnegative for continuous analysis.

-: Relative risk < 1.00 for discrete analysis; difference of means negative for continuous analysis.

--: Analysis not performed because of the sparse number of participants with an abnormality.

^a Negative difference considered adverse for this variable.

P-value given if $p \leq 0.05$.

A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or differences of means nonnegative for continuous analysis. A lowercase "ns" denotes relative risk less than 1.00 for discrete analyses or difference of means negative for continuous analysis.

Variable	ADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Medical Records				
Uncharacterized Hepatitis (D)	NS	NS	NS	NS
Jaundice (Unspecified) (D)	-0.028	ns	NS	ns*
Chronic Liver Disease and Cirrhosis (Alcohol-related) (D)	ns	NS	ns	ns
Chronic Liver Disease and Cirrhosis (Non-alcohol-related) (D)	NS	NS	ns	NS
Liver Abscess and Sequelae of Chronic Liver Disease (D)	NS	--	--	--
Enlarged Liver (Hepatomegaly) (D)	ns	ns	NS	ns*
Other Liver Disorders (D)	NS*	NS	ns	NS*
Physical Examination				
Current Hepatomegaly (D)	NS	NS	--	NS
Laboratory				
AST (C)	NS	NS	ns	NS
AST (D)	NS	NS	ns	NS
ALT (C)	NS	NS	ns	NS
ALT (D)	NS	NS	ns	ns
GGT (C)	NS	NS	NS	NS
GGT (D)	NS	NS	NS	ns
Alkaline Phosphatase (C)	+0.016	NS	NS	+0.021
Alkaline Phosphatase (D)	NS	ns	NS	NS*
Total Bilirubin (C)	NS	NS	ns	NS
Total Bilirubin (D)	ns	ns	NS	ns
Direct Bilirubin (D)	ns	ns	--	--

Table 13-76. Summary of Group Analysis (Model 1) for Gastrointestinal Variables (Ranch Hands vs. Comparisons) (Continued)

Variable	ADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Lactic Dehydrogenase (C)	NS	ns	ns	NS
Lactic Dehydrogenase (D)	ns	ns	NS	ns
Cholesterol (C)	ns	ns	ns	NS
Cholesterol (D)	NS	ns	NS	NS
HDL Cholesterol (C) ^a	NS	ns	NS*	ns
HDL Cholesterol (D)	NS	NS	ns	NS
Cholesterol-HDL Ratio (C)	ns	ns	ns*	NS
Cholesterol-HDL Ratio (D)	NS	NS	ns*	NS
Triglycerides (C)	NS	NS	ns	NS
Triglycerides (D)	NS	NS	ns	+0.047
Creatine Phosphokinase (C)	NS	NS	ns	NS
Creatine Phosphokinase (D)	ns	ns	ns	NS
Serum Amylase (C)	ns	-0.037	NS	NS
Serum Amylase (D)	ns	ns*	NS	NS
Antibodies for Hepatitis A (D)	ns	ns	NS	ns
Serological Evidence of Prior Hepatitis B Infection (D)	<0.001	-0.024	ns*	-0.035
Current Hepatitis B (D)	ns	--	--	ns
Antibodies for Hepatitis C (D)	ns	ns	ns	ns
Antibodies for Hepatitis D (D)	--	--	--	--
Stool Hemoccult (D)	ns	ns	ns	ns
Prealbumin (C) ^a	ns	ns	NS	ns
Prealbumin (D)	NS	NS	NS	+0.043
Albumin (C) ^a	ns	ns	NS	NS
Albumin (D)	ns	NS	--	--
α -1-Acid Glycoprotein (C)	NS	ns	NS	+0.030
α -1-Acid Glycoprotein (D)	NS	ns	NS	NS*
α -1-Antitrypsin (C)	+0.001	NS	NS*	+<0.001
α -1-Antitrypsin (D):				
Low vs. Normal	ns	NS	--	ns
High vs. Normal	NS	--	ns	NS
α -2-Macroglobulin (C)	ns	ns	ns	ns
α -2-Macroglobulin (D)	ns	ns	ns	NS
Apolipoprotein B (C)	ns	-0.048	ns	NS
Apolipoprotein B (D)	ns*	ns	-0.005	NS
C3 Complement (C) ^a	NS	NS	ns	NS
C3 Complement (D)	ns	ns	ns	NS
C4 Complement (C) ^a	ns	-0.017	NS	ns
C4 Complement (D)	NS	NS	--	--
Haptoglobin (C)	+0.003	NS	NS	+0.016
Haptoglobin (D)	+0.020	NS	NS	NS*
Transferrin (C) ^a	+0.037	NS	NS	NS*
Transferrin (D)	-0.027	ns*	ns	ns

Table 13-76. Summary of Group Analysis (Model 1) for Gastrointestinal Variables (Ranch Hands vs. Comparisons) (Continued)

Note: NS or ns: Not significant ($p>0.10$).

NS* or ns*: Marginally significant ($0.05 < p \leq 0.10$).

C: Continuous analysis.

D: Discrete analysis.

+: Relative risk ≥ 1.00 for discrete analysis; difference of means nonnegative for continuous analysis.

-: Relative risk < 1.00 for discrete analysis; difference of means negative for continuous analysis.

--: Analysis not performed because of the sparse number of participants with an abnormality.

^a Negative difference considered adverse for this variable.

P-value given if $p \leq 0.05$.

A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or differences of means nonnegative for continuous analysis. A lowercase "ns" denotes relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis.

13.4.2 Model 2: Initial Dioxin Analysis

Model 2 analyses of medical records variables revealed a significant positive association between initial dioxin and other liver disorders.

Adjusted Model 2 analysis of the laboratory examination variables revealed a significant positive association between initial dioxin and the discrete form of ALT. A significant inverse association was seen between initial dioxin and the discrete form of HDL cholesterol in the adjusted analysis.

The results of all unadjusted and adjusted Model 2 analyses are summarized in Table 13-77.

Table 13-77. Summary of Initial Dioxin Analysis (Model 2) for Gastrointestinal Variables (Ranch Hands Only)

Variable	Unadjusted	Adjusted
Medical Records		
Uncharacterized Hepatitis (D)	NS	NS
Jaundice (Unspecified) (D)	NS	NS
Chronic Liver Disease and Cirrhosis (Alcohol-related) (D)	NS	NS
Chronic Liver Disease and Cirrhosis (Non-alcohol-related) (D)	NS	NS
Liver Abscess and Sequelae of Chronic Liver Disease (D)	NS	NS
Enlarged Liver (Hepatomegaly) (D)	ns	ns
Other Liver Disorders (D)	NS	+0.022
Physical Examination		
Current Hepatomegaly (D)	ns	ns
Laboratory		
AST (C)	NS	NS
AST (D)	NS	NS
ALT (C)	NS	NS
ALT (D)	NS	+0.049
GGT (C)	NS	NS
GGT (D)	NS	NS
Alkaline Phosphatase (C)	ns	ns*
Alkaline Phosphatase (D)	ns	NS
Total Bilirubin (C)	ns	NS

Table 13-77. Summary of Initial Dioxin Analysis (Model 2) for Gastrointestinal Variables (Ranch Hands Only) (Continued)

Variable	Unadjusted	Adjusted
Total Bilirubin (D)	ns	ns
Direct Bilirubin (D)	--	--
Lactic Dehydrogenase (C)	ns	NS
Lactic Dehydrogenase (D)	ns	ns
Cholesterol (C)	+0.005	NS
Cholesterol (D)	+0.036	NS*
HDL Cholesterol (C) ^a	ns	NS
HDL Cholesterol (D)	ns	-0.029
Cholesterol-HDL Ratio (C)	+0.003	NS
Cholesterol-HDL Ratio (D)	+0.002	NS
Triglycerides (C)	NS	NS
Triglycerides (D)	NS	ns
Creatine Phosphokinase (C)	NS	ns
Creatine Phosphokinase (D)	NS	NS
Serum Amylase (C)	ns*	ns*
Serum Amylase (D)	ns	NS
Antibodies for Hepatitis A (D)	ns	NS
Serological Evidence of Prior Hepatitis B Infection (D)	NS	ns
Current Hepatitis B (D)	ns	ns
Antibodies for Hepatitis C (D)	ns	ns
Antibodies for Hepatitis D (D)	--	--
Stool Hemoccult (D)	ns	ns
Prealbumin (C) ^a	ns	ns
Prealbumin (D)	NS	NS*
Albumin (C) ^a	NS	ns
Albumin (D)	--	--
α -1-Acid Glycoprotein (C)	NS	ns*
α -1-Acid Glycoprotein (D)	NS	ns
α -1-Antitrypsin (C)	NS*	NS
α -1-Antitrypsin (D):		
Low vs. Normal	ns	ns
High vs. Normal	NS	ns
α -2-Macroglobulin (C)	ns	NS
α -2-Macroglobulin (D)	NS	NS*
Apolipoprotein B (C)	+0.009	NS
Apolipoprotein B (D)	NS*	NS
C3 Complement (C) ^a	+0.023	NS
C3 Complement (D)	NS	NS
C4 Complement (C) ^a	ns	ns
C4 Complement (D)	--	--
Haptoglobin (C)	NS	ns
Haptoglobin (D)	NS	ns
Transferrin (C) ^a	NS	ns
Transferrin (D)	ns	ns

Table 13-77. Summary of Initial Dioxin Analysis (Model 2) for Gastrointestinal Variables (Ranch Hands Only) (Continued)

Note: NS or ns: Not significant ($p>0.10$).

NS* or ns*: Marginally significant ($0.05 < p \leq 0.10$).

C: Continuous analysis.

D: Discrete analysis.

+: Relative risk ≥ 1.00 for discrete analysis; slope nonnegative for continuous analysis.

-: Relative risk < 1.00 for discrete analysis.

--: Analysis not performed because of the sparse number of Ranch Hands with an abnormality.

^a Negative slope considered adverse for this variable.

P-value given if $p \leq 0.05$.

A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or slope nonnegative for continuous analysis. A lowercase "ns" denotes relative risk less than 1.00 for discrete analysis or slope negative for continuous analysis.

13.4.3 Model 3: Categorized Dioxin Analysis

Adjusted Model 3 analyses revealed a significantly higher percentage of other liver disorders among Ranch Hands in the high dioxin category than among Comparisons.

The adjusted results of the Ranch Hands in the high dioxin category versus Comparisons contrast revealed Ranch Hands had significantly higher mean levels of GGT, triglycerides, α -1-antitrypsin, and transferrin than Comparisons. The discrete analyses for AST, triglycerides, and prealbumin were also significant, with Ranch Hands in the high dioxin category having a higher prevalence of abnormal values than Comparisons. In addition, significantly less serological evidence of prior hepatitis B and low transferrin levels were noted in Ranch Hands in the high dioxin category than in Comparisons.

The adjusted result of the contrast between Ranch Hands in the low and high dioxin categories combined versus Comparisons revealed that Ranch Hands had significantly higher mean levels of ALT, GGT, α -1-antitrypsin, haptoglobin, and transferrin than Comparisons. The discrete analyses for AST and triglycerides were also significant, with Ranch Hands in the low and high dioxin categories combined having a greater prevalence of high values than Comparisons. In addition, significantly less serological evidence of prior hepatitis B and low transferrin levels were noted in the Ranch Hands in the low and high dioxin categories combined than in Comparisons.

The adjusted analyses also found several significant differences for the contrast between Ranch Hands in the background dioxin category versus Comparisons. Ranch Hands had significantly higher mean levels of alkaline phosphatase, α -1-antitrypsin, and haptoglobin than Comparisons. The discrete analyses for HDL cholesterol and haptoglobin were also significant, with Ranch Hands in the background dioxin category having a higher prevalence of abnormal values than Comparisons. In addition, significantly fewer Ranch Hands in the background dioxin category had serological evidence of prior hepatitis B and high apolipoprotein B levels than did Comparisons.

The results of all unadjusted and adjusted Model 3 analyses are summarized in Table 13-78.