percent among the Comparisons. There were no Ranch Hands in the low dioxin category. Unadjusted chi-square tests of association revealed a significantly smaller percentage of Ranch Hands in the low dioxin category with jaundice than Comparisons (Table 13-4(e): p=0.017). A significantly smaller percentage of Ranch Hands in the low and high dioxin categories combined also had jaundice than did Comparisons (Table 13-4(e): p=0.001).

The unadjusted and adjusted Model 4 analyses revealed a significant relation between 1987 dioxin and jaundice (Table 13-4(g,h): Est. RR=0.44, p<0.001; Adj. RR=0.39, p<0.001, respectively). The percentages of participants with jaundice in the low, medium, and high 1987 dioxin categories were 2.8, 1.1, and 0.4, respectively.

13.2.2.1.3 Acute Necrosis of the Liver

Only one participant had an acute necrosis of the liver. The participant was a non-Black, Comparison officer. Further statistical analysis was not performed.

13.2.2.1.4 Chronic Liver Disease and Cirrhosis (Alcohol-related)

All unadjusted and adjusted analyses of alcohol-related chronic liver disease and cirrhosis were nonsignificant (Table 13-5(a–h): p>0.22 for all analyses).

Table 13-5. Analysis of Chronic Liver Disease and Cirrhosis (Alcohol-related)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***815***	***39 (4.8)***	***1.01 (0.67,1.54)***	***0.958***
	Comparison	***1,183***	***56 (4.7)***		
Officer	Ranch Hand	326	15 (4.6)	1.58 (0.75,3.32)	0.229
	Comparison	472	14 (3.0)		
Enlisted Flyer	Ranch Hand	138	7 (5.1)	0.75 (0.29,1.95)	0.553
	Comparison	180	12 (6.7)		
Enlisted Groundcrew	Ranch Hand	351	17 (4.8)	0.85 (0.46,1.57)	0.602
	Comparison	531	30 (5.6)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***0.93 (0.60,1.45)***	***0.762***
Officer	1.50 (0.71,3.19)	0.290
Enlisted Flyer	0.70 (0.26,1.88)	0.474
Enlisted Groundcrew	0.75 (0.39,1.45)	0.390

Table 13-5. Analysis of Chronic Liver Disease and Cirrhosis (Alcohol-related) (Continued)

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	152	7 (4.6)	1.06 (0.78,1.45)	0.708
Medium	151	8 (5.3)		
High	144	8 (5.6)		

[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
444	1.06 (0.72,1.57)	0.765

[a] Relative risk for a twofold increase in initial dioxin.

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,147	54 (4.7)		
Background RH	361	16 (4.4)	0.97 (0.55,1.73)	0.924
Low RH	226	11 (4.9)	1.02 (0.53,1.99)	0.946
High RH	221	12 (5.4)	1.12 (0.59,2.14)	0.725
Low plus High RH	447	23 (5.1)	1.07 (0.65,1.77)	0.788

[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 ≤ 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.

Table 13-5. Analysis of Chronic Liver Disease and Cirrhosis (Alcohol-related) (Continued)

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,146		
Background RH	358	1.03 (0.56,1.90)	0.914
Low RH	225	0.95 (0.48,1.91)	0.894
High RH	219	0.88 (0.43,1.81)	0.734
Low plus High RH	444	0.92 (0.54,1.57)	0.755

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	273	12 (4.4)	1.10 (0.89,1.37)	0.368
Medium	269	15 (5.6)		
High	266	12 (4.5)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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]	p-Value
802	1.09 (0.84,1.41)	0.506

[a] Relative risk for a twofold increase in 1987 dioxin.

13.2.2.1.5 Chronic Liver Disease and Cirrhosis (Non-alcohol-related)

All results from analysis of non-alcohol-related chronic liver disease and cirrhosis were nonsignificant (Table 13-6(a–h): p>0.21 for all analyses).

Table 13-6. Analysis of Chronic Liver Disease and Cirrhosis (Non-alcohol-related)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***870***	***14 (1.6)***	***1.44 (0.68,3.04)***	***0.336***
	Comparison	***1,250***	***14 (1.1)***		
Officer	Ranch Hand	341	5 (1.5)	2.43 (0.58,10.18)	0.226
	Comparison	493	3 (0.6)		
Enlisted Flyer	Ranch Hand	151	2 (1.3)	0.82 (0.14,4.99)	0.832
	Comparison	187	3 (1.6)		
Enlisted Groundcrew	Ranch Hand	378	7 (1.9)	1.33 (0.48,3.69)	0.589
	Comparison	570	8 (1.4)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.43 (0.68,3.03)***	***0.348***
Officer	2.47 (0.58,10.52)	0.219
Enlisted Flyer	0.77 (0.13,4.71)	0.777
Enlisted Groundcrew	1.32 (0.47,3.69)	0.598

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	160	2 (1.3)	1.02 (0.61,1.70)	0.949
Medium	162	4 (2.5)		
High	160	2 (1.3)		

[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
479	1.04 (0.61,1.76)	0.897

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with a history of non-alcohol-related chronic liver disease and cirrhosis.

Table 13-6. Analysis of Chronic Liver Disease and Cirrhosis (Non-alcohol-related) (Continued)

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,212	14 (1.2)		
Background RH	381	6 (1.6)	1.64 (0.62,4.34)	0.321
Low RH	239	3 (1.3)	1.01 (0.29,3.58)	0.986
High RH	243	5 (2.1)	1.52 (0.53,4.32)	0.433
Low plus High RH	482	8 (1.7)	1.24 (0.50,3.06)	0.639

[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 ≤ 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.

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,211		
Background RH	378	1.89 (0.68,5.25)	0.223
Low RH	238	1.15 (0.32,4.12)	0.829
High RH	241	1.37 (0.47,4.00)	0.568
Low plus High RH	479	1.26 (0.51,3.12)	0.625

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	288	4 (1.4)	1.05 (0.73,1.49)	0.803
Medium	287	4 (1.4)		
High	288	6 (2.1)		

[a] Relative risk for a twofold increase in 1987 dioxin.

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

Table 13-6. Analysis of Chronic Liver Disease and Cirrhosis (Non-alcohol-related) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
857	1.02 (0.68,1.54)	0.920

[a] Relative risk for a twofold increase in 1987 dioxin.

13.2.2.1.6 Liver Abscess and Sequelae of Chronic Liver Disease

A sparse number of abnormalities restricted the analysis of liver abscess and sequelae of chronic liver disease. One non-Black, Ranch Hand enlisted groundcrew and one non-Black, Comparison officer were noted to have a liver abscess and sequelae of chronic liver disease. No significant relations with dioxin were noted in any of the Models 1 through 4 analyses (Table 13-7(a–h): p>0.16 for all analyses performed).

Table 13-7. Analysis of Liver Abscess and Sequelae of Chronic Liver Disease

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***870***	***1 (0.1)***	***1.44 (0.09,23.03)***	***0.798***
	Comparison	***1,251***	***1 (0.1)***		
Officer	Ranch Hand	341	0 (0.0)	--	0.999[a]
	Comparison	494	1 (0.2)		
Enlisted Flyer	Ranch Hand	151	0 (0.0)	--	--
	Comparison	187	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	378	1 (0.3)	--	0.836[a]
	Comparison	570	0 (0.0)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a history of a liver abscess and sequelae of chronic liver disease.
--: Results not presented because of the sparse number of participants with a liver abscess and sequelae of chronic liver disease.

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.45 (0.09,23.24)***	***0.795***
Officer	--	--
Enlisted Flyer	--	--
Enlisted Groundcrew	--	--

--: Results not presented because of the sparse number of participants with a liver abscess and sequelae of chronic liver disease.

Note: Results are not adjusted for race and occupation because of the sparse number of participants with a liver abscess and sequelae of chronic liver disease.

Table 13-7. Analysis of Liver Abscess and Sequelae of Chronic Liver Disease (Continued)

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	160	0 (0.0)	1.99 (0.64,6.25)	0.277
Medium	162	0 (0.0)		
High	160	1 (0.6)		

[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.)	p-Value
479	2.09 (0.61,7.19)	0.277

Note: Results are adjusted only for percent body fat at the time of the blood measurement of dioxin, age, and lifetime alcohol history because of the sparse number of Ranch Hands with a liver abscess and sequelae of chronic liver disease.

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,213	1 (0.1)		
Background RH	381	0 (0.0)	--	0.999[c]
Low RH	239	0 (0.0)	--	0.999[c]
High RH	243	1 (0.4)	5.44 (0.33,89.44)	0.236
Low plus High RH	482	1 (0.2)	--	0.999[c]

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] P-value determined using a chi-square test with continuity correction because of the sparse number of Ranch Hands with a liver abscess and sequelae of chronic liver disease.
--: Results not presented because of the sparse number of Ranch Hands with a liver abscess and sequelae of chronic liver disease.

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.

Table 13-7. Analysis of Liver Abscess and Sequelae of Chronic Liver Disease (Continued)

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)	p-Value
Comparison	1,212		
Background RH	378	--	--
Low RH	238	--	--
High RH	241	7.76 (0.38,158.28)	0.183
Low plus High RH	479	--	--

--: Analyses not performed because of the sparse number of Ranch Hands with a liver abscess and sequelae of chronic liver disease.

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.

Results are not adjusted for race and occupation because of the sparse number of Ranch Hands with a liver abscess and sequelae of chronic liver disease.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	288	0 (0.0)	2.30 (0.71,7.43)	0.162
Medium	287	0 (0.0)		
High	288	1 (0.3)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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.)	p-Value
857	2.05 (0.68,6.15)	0.212

Note: Results are adjusted only for age and lifetime alcohol history because of the sparse number of Ranch Hands with a liver abscess and sequelae of chronic liver disease.

13.2.2.1.7 Enlarged Liver (Hepatomegaly)

The unadjusted and adjusted Model 1 analyses of the prevalence of enlarged liver revealed no group differences when combining all occupations (Table 13-8(a,b): p>0.33 for each analysis). After stratifying by occupation, a marginally significant difference was seen between Ranch Hand and Comparison enlisted groundcrew (Table 13-8(a,b): Est. RR=0.30, p=0.056; Adj. RR=0.29, p=0.057, respectively). Among the enlisted groundcrew, 0.8 percent of the Ranch Hands had an enlarged liver versus 2.6 percent of the Comparisons. No significant results were seen in the Model 2, Model 3, or Model 4 analyses (Table 13-8(c–h): p>0.15 for all analyses).

Table 13-8. Analysis of Enlarged Liver (Hepatomegaly)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***869***	***14 (1.6)***	***0.74 (0.39,1.42)***	***0.361***
	Comparison	***1,249***	***27 (2.2)***		
Officer	Ranch Hand	341	5 (1.5)	0.80 (0.27,2.40)	0.689
	Comparison	492	9 (1.8)		
Enlisted Flyer	Ranch Hand	151	6 (4.0)	2.54 (0.62,10.32)	0.193
	Comparison	187	3 (1.6)		
Enlisted Groundcrew	Ranch Hand	377	3 (0.8)	0.30 (0.09,1.03)	0.056
	Comparison	570	15 (2.6)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***0.73 (0.38,1.41)***	***0.339***
Officer	0.78 (0.26,2.36)	0.662
Enlisted Flyer	2.53 (0.62,10.38)	0.198
Enlisted Groundcrew	0.29 (0.08,1.03)	0.057

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	160	2 (1.3)	0.96 (0.56,1.65)	0.880
Medium	162	4 (2.5)		
High	159	2 (1.3)		

[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
478	0.91 (0.46,1.80)	0.790

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with a history of an enlarged liver.

Table 13-8. Analysis of Enlarged Liver (Hepatomegaly) (Continued)

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,211	26 (2.1)		
Background RH	381	6 (1.6)	0.75 (0.31,1.86)	0.540
Low RH	239	2 (0.8)	0.38 (0.09,1.62)	0.191
High RH	242	6 (2.5)	1.12 (0.46,2.78)	0.798
Low plus High RH	481	8 (1.7)	0.66 (0.27,1.61)	0.357

[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 ≤ 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.

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,210		
Background RH	378	0.80 (0.32,2.01)	0.630
Low RH	238	0.35 (0.08,1.51)	0.159
High RH	240	1.09 (0.42,2.79)	0.864
Low plus High RH	478	0.62 (0.25,1.54)	0.302

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	288	4 (1.4)	0.94 (0.65,1.35)	0.731
Medium	287	4 (1.4)		
High	287	6 (2.1)		

[a] Relative risk for a twofold increase in 1987 dioxin.

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

Table 13-8. Analysis of Enlarged Liver (Hepatomegaly) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
856	0.93 (0.60,1.46)	0.753

[a] Relative risk for a twofold increase in 1987 dioxin.

13.2.2.1.8 Other Liver Disorders

Both the unadjusted and adjusted Model 1 analyses revealed marginally significant differences between Ranch Hands and Comparisons over all occupations (Table 13-9(a,b): Est. RR=1.20, p=0.067; Adj. RR=1.19, p=0.090, respectively). The percentage of Ranch Hands with other liver disorders was 28.8 versus 25.2 for Comparisons. Stratifying by occupation revealed a marginally significant difference between Ranch Hands and Comparisons within the enlisted groundcrew stratum for both the unadjusted and adjusted analyses (Table 13-9(a,b): Est. RR=1.32, p=0.062; Adj. RR=1.31, p=0.073, respectively). Of the enlisted groundcrew Ranch Hands, 30.8 percent had other liver disorders versus 25.2 percent of the Comparisons.

Table 13-9. Analysis of Other Liver Disorders

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***866***	***249 (28.8)***	***1.20 (0.99,1.46)***	***0.067***
	Comparison	***1,240***	***312 (25.2)***		
Officer	Ranch Hand	338	93 (27.5)	1.15 (0.84,1.57)	0.399
	Comparison	486	121 (24.9)		
Enlisted Flyer	Ranch Hand	151	40 (26.5)	1.04 (0.64,1.70)	0.864
	Comparison	187	48 (25.7)		
Enlisted Groundcrew	Ranch Hand	377	116 (30.8)	1.32 (0.99,1.76)	0.062
	Comparison	567	143 (25.2)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.19 (0.97,1.45)***	***0.090***
Officer	1.15 (0.83,1.57)	0.400
Enlisted Flyer	0.98 (0.60,1.61)	0.933
Enlisted Groundcrew	1.31 (0.98,1.75)	0.073

Table 13-9. Analysis of Other Liver Disorders (Continued)

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	159	39 (24.5)	1.12 (0.97,1.30)	0.119
Medium	162	53 (32.7)		
High	160	55 (34.4)		

[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
478	1.23 (1.03,1.47)	0.022

[a] Relative risk for a twofold increase in initial dioxin.

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,202	299 (24.9)		
Background RH	378	99 (26.2)	1.15 (0.88,1.50)	0.318
Low RH	238	64 (26.9)	1.09 (0.80,1.50)	0.578
High RH	243	83 (34.2)	1.49 (1.10,2.00)	0.009
Low plus High RH	481	147 (30.6)	1.28 (1.01,1.62)	0.042

[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: Current Dioxin ≤ 10 ppt.
Background (Ranch Hand): Current Dioxin ≤ 10 ppt.
Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): Current 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	1,201		
Background RH	375	1.13 (0.86,1.49)	0.371
Low RH	237	1.05 (0.76,1.45)	0.757
High RH	241	1.52 (1.11,2.08)	0.009
Low plus High RH	478	1.27 (1.00,1.62)	0.055

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
Comparison: Current Dioxin ≤ 10 ppt.
Background (Ranch Hand): Current Dioxin ≤ 10 ppt.
Low (Ranch Hand): Current Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): Current Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 13-9. Analysis of Other Liver Disorders (Continued)

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	286	73 (25.5)	1.10 (1.00,1.22)	0.055
Medium	285	76 (26.7)		
High	288	97 (33.7)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤ 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]	p-Value
853	1.11 (0.99,1.25)	0.077

[a] Relative risk for a twofold increase in 1987 dioxin.

The unadjusted Model 2 analysis did not reveal a significant association between initial dioxin and other liver disorders (Table 13-9(c): p=0.119). After adjusting for covariates, the results became significant (Table 13-9(d): Adj. RR=1.23, p=0.022). The percentages of other liver disorders in the low, medium, and high initial dioxin categories were 24.5, 32.7, and 34.4, respectively.

The unadjusted Model 3 analysis of other liver disorders 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 13-9(e): Est. RR=1.49, p=0.009; Est. RR=1.28, p=0.042, respectively). The same contrasts were significant after adjusting for covariates (Table 13-9(f): Adj. RR=1.52, p=0.009, for Ranch Hands in the high dioxin category versus Comparisons; Adj. RR=1.27, p=0.055, for Ranch Hands in the low and high dioxin categories combined versus Comparisons). The percentages of other liver disorders among Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 34.2, 30.6, and 24.9, respectively.

Both the unadjusted and adjusted Model 4 analyses revealed marginally significant positive associations between 1987 dioxin and other liver disorders (Table 13-9(g,h): Est. RR=1.10, p=0.055; Adj. RR=1.11, p=0.077, respectively). The percentages of other liver disorders in the low, medium, and high 1987 dioxin categories were 25.5, 26.7, and 33.7, respectively.

13.2.2.2 Physical Examination Variables

13.2.2.2.1 Current Hepatomegaly

All unadjusted and adjusted analyses of current hepatomegaly, as assessed by a physician at the 1997 physical examination, were nonsignificant for Models 1 through 4 (Table 13-10: p>0.10 for each analysis).

Table 13-10. Analysis of Current Hepatomegaly

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***860***	***10 (1.2)***	***2.06 (0.78,5.43)***	***0.141***
	Comparison	***1,231***	***7 (0.6)***		
Officer	Ranch Hand	340	4 (1.2)	2.90 (0.53,15.95)	0.220
	Comparison	490	2 (0.4)		
Enlisted Flyer	Ranch Hand	150	2 (1.3)	--	0.389[a]
	Comparison	185	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	370	4 (1.1)	1.20 (0.32,4.51)	0.783
	Comparison	556	5 (0.9)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with current hepatomegaly.
--: Results not presented because of the sparse number of participants with current hepatomegaly.

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

Occupational Category	Adjusted Relative Risk (95% C.I.)[a]	p-Value
All	***2.13 (0.80,5.67)***	***0.127***
Officer	3.17 (0.57,17.56)	0.187
Enlisted Flyer	--	--
Enlisted Groundcrew	1.18 (0.31,4.51)	0.805

--: Results not presented because of the sparse number of participants with current hepatomegaly.

Note: Results are not adjusted for race because of the sparse number of participants with current hepatomegaly.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	3 (1.9)	0.69 (0.36,1.31)	0.223
Medium	159	3 (1.9)		
High	160	1 (0.6)		

[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
474	0.66 (0.30,1.45)	0.279

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of participants with current hepatomegaly.

Table 13-10. Analysis of Current Hepatomegaly (Continued)

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	7 (0.6)		
Background RH	376	3 (0.8)	1.53 (0.39,5.99)	0.543
Low RH	236	3 (1.3)	2.10 (0.54,8.23)	0.284
High RH	241	4 (1.7)	2.58 (0.74,8.97)	0.136
Low plus High RH	477	7 (1.5)	2.33 (0.80,6.76)	0.119

[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 ≤ 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.

(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	1.64 (0.40,6.69)	0.489
Low RH	235	2.26 (0.57,9.01)	0.247
High RH	239	2.62 (0.70,9.84)	0.154
Low plus High RH	474	2.44 (0.82,7.24)	0.109

[a] Relative risk and confidence interval relative to Comparisons.

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.

Results are not adjusted for race because of the sparse number of participants with current hepatomegaly.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	3 (1.1)	1.04 (0.69,1.58)	0.853
Medium	285	3 (1.1)		
High	285	4 (1.4)		

[a] Relative risk for a twofold increase in 1987 dioxin.

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

Table 13-10. Analysis of Current Hepatomegaly (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
848	1.05 (0.64,1.74)	0.838

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race because of the sparse number of participants with current hepatomegaly.

13.2.2.3 Laboratory Examination Variables

13.2.2.3.1 AST (Continuous)

Model 1 showed no significant difference in mean AST levels between Ranch Hands and Comparisons in either the unadjusted or adjusted analysis (Table 13-11(a,b): p>0.44 for all contrasts). The unadjusted and adjusted analyses for Model 2 did not reveal any significant relations between initial dioxin and AST levels (Table 13-11(c,d): p>0.49 in both analyses).

Table 13-11. Analysis of AST (U/l) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***859***	***23.01***	***0.13 --***	***0.705***
	Comparison	***1,231***	***22.88***		
Officer	Ranch Hand	340	23.40	0.06 --	0.914
	Comparison	490	23.34		
Enlisted Flyer	Ranch Hand	150	22.17	–0.32 --	0.696
	Comparison	185	22.48		
Enlisted Groundcrew	Ranch Hand	369	22.99	0.39 --	0.447
	Comparison	556	22.60		

[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.

Table 13-11. Analysis of AST (U/l) (Continuous) (Continued)

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

Occupational Category	Group	n	Adj. Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***854***	***23.36***	***0.18 --***	***0.597***
	Comparison	***1,229***	***23.17***		
Officer	Ranch Hand	340	23.88	0.08 --	0.885
	Comparison	489	23.80		
Enlisted Flyer	Ranch Hand	148	22.79	–0.09 --	0.916
	Comparison	184	22.87		
Enlisted Groundcrew	Ranch Hand	366	23.32	0.37 --	0.470
	Comparison	556	22.95		

[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.

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	158	23.39	23.50	0.011	0.003 (0.012)	0.813
Medium	159	23.71	23.72			
High	159	23.43	23.32			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of AST versus log_2 (initial dioxin).

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	158	24.76	0.057	0.010 (0.014)	0.493
Medium	158	25.53			
High	157	24.99			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of AST versus log_2 (initial dioxin).

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

Table 13-11. Analysis of AST (U/l) (Continuous) (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	22.85	22.84		
Background RH	376	22.34	22.54	–0.30 --	0.501
Low RH	236	23.45	23.39	0.55 --	0.306
High RH	240	23.56	23.36	0.52 --	0.334
Low plus High RH	476	23.51	23.37	0.53 --	0.193

[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 ≤ 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.

(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	23.23		
Background RH	374	22.76	–0.47 --	0.305
Low RH	235	23.93	0.70 --	0.207
High RH	238	24.17	0.94 --	0.100
Low plus High RH	473	24.05	0.82 --	0.055

[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 ≤ 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.

(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	22.29	0.005	0.017 (0.008)	0.033
Medium	285	23.30			
High	284	23.38			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of AST versus log_2 (1987 dioxin + 1).

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

Table 13-11. Analysis of AST (U/l) (Continuous) (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	22.72	0.036	0.028 (0.009)	0.002
Medium	283	24.06			
High	281	24.66			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of AST versus log_2 (1987 dioxin + 1).

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

The Model 3 unadjusted analysis of AST showed no significant difference between any of the Ranch Hand categories and the Comparison group (Table 13-11(e): p>0.19 for all contrasts). After covariate adjustment, a marginally significant difference between the mean AST of Ranch Hands in the high dioxin category and the Comparison mean was revealed (Table 13-11(f): difference of adjusted means=0.94 U/l, p=0.100). The adjusted mean levels of AST for Ranch Hands in the high dioxin category and the Comparison group were 24.17 U/l and 23.23 U/l, respectively. A marginally significant difference between Ranch Hands in the low and high dioxin categories combined and the Comparisons also was seen after covariate adjustment (Table 13-11(f): difference of adjusted means=0.82 U/l, p=0.055). The adjusted mean levels of AST for Ranch Hands in the low and high dioxin categories combined and the Comparison group were 24.05 U/l and 23.23 U/l, respectively.

In Model 4, the unadjusted analysis found a significant positive association between AST in its continuous form and 1987 dioxin levels (Table 13-11(g): slope=0.017, p=0.033). The adjusted Model 4 analysis revealed a significant association between AST levels and 1987 dioxin levels (Table 13-11(h): adjusted slope=0.028, p=0.002). The adjusted mean AST levels in the low, medium, and high 1987 dioxin categories were 22.72 U/l, 24.06 U/l, and 24.66 U/l, respectively.

13.2.2.3.2 AST (Discrete)

The unadjusted and adjusted Model 1 analyses did not show a significant group difference in the percentage of individuals with high AST levels (Table 13-12(a,b): p>0.25 for all contrasts).

Table 13-12. Analysis of AST (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***63 (7.3)***	***1.11 (0.79,1.56)***	***0.552***
	Comparison	***1,231***	***82 (6.7)***		
Officer	Ranch Hand	340	24 (7.1)	1.09 (0.63,1.88)	0.765
	Comparison	490	32 (6.5)		
Enlisted Flyer	Ranch Hand	150	10 (6.7)	0.75 (0.33,1.72)	0.501
	Comparison	185	16 (8.6)		
Enlisted Groundcrew	Ranch Hand	369	29 (7.9)	1.31 (0.78,2.19)	0.304
	Comparison	556	34 (6.1)		

Table 13-12. Analysis of AST (Discrete) (Continued)

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.14 (0.81,1.61)***	***0.448***
Officer	1.09 (0.63,1.89)	0.763
Enlisted Flyer	0.84 (0.36,1.92)	0.671
Enlisted Groundcrew	1.35 (0.81,2.28)	0.252

(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 (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	11 (7.0)	1.08 (0.86,1.36)	0.498
Medium	159	20 (12.6)		
High	159	14 (8.8)		

[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	1.13 (0.86,1.50)	0.380

[a] Relative risk for a twofold increase in initial dioxin.

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

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	79 (6.6)		
Background RH	376	17 (4.5)	0.72 (0.42,1.24)	0.241
Low RH	236	19 (8.1)	1.21 (0.72,2.04)	0.476
High RH	240	26 (10.8)	1.60 (1.00,2.56)	0.051
Low plus High RH	476	45 (9.5)	1.39 (0.95,2.05)	0.094

[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 ≤ 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.

Table 13-12. Analysis of AST (Discrete) (Continued)

(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	0.70 (0.40,1.22)	0.212
Low RH	235	1.28 (0.75,2.18)	0.360
High RH	238	1.79 (1.08,2.96)	0.024
Low plus High RH	473	1.51 (1.02,2.26)	0.041

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	11 (3.9)	1.26 (1.06,1.48)	0.008
Medium	285	23 (8.1)		
High	284	28 (9.9)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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]	p-Value
847	1.38 (1.12,1.71)	0.002

[a] Relative risk for a twofold increase in 1987 dioxin.

In Model 2, neither the unadjusted nor adjusted analyses showed significant associations between AST and initial dioxin (Table 13-12(c,d): p≥0.38 for both analyses).

The unadjusted Model 3 analysis of AST in its discrete form revealed two marginally 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 13-12(e): Est. RR=1.60, p=0.051; Est. RR=1.39, p=0.094, respectively). Similarly, the adjusted analysis showed a significant difference between Ranch Hands in the high dioxin category and Comparisons (Table 13-12(f): Adj. RR=1.79, p=0.024), as well as between the Ranch Hands in the low and high dioxin categories combined and Comparisons (Adj. RR=1.51, p=0.041). The percentages of individuals with high levels of AST among the Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 10.8, 9.5, and 6.6, respectively.

The unadjusted analysis for Model 4 showed a significant association between AST in its discrete form and 1987 dioxin (Table 13-12(g): Est. RR=1.26, p=0.008). Similarly, the adjusted analysis revealed significant results (Adj. RR=1.38, p=0.002). The percentages of participants with high AST levels in the low, medium, and high 1987 dioxin categories were 3.9, 8.1, and 9.9, respectively.

13.2.2.3.3 ALT (Continuous)

All Model 1 and 2 analyses of ALT in its continuous form showed nonsignificant results (Table 13-13(a–d): p>0.19 for each analysis).

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

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***859***	***42.58***	***0.13 --***	***0.803***
	Comparison	***1,231***	***42.45***		
Officer	Ranch Hand	340	42.21	0.42 --	0.613
	Comparison	490	41.79		
Enlisted Flyer	Ranch Hand	150	41.21	−1.38 --	0.290
	Comparison	185	42.59		
Enlisted Groundcrew	Ranch Hand	369	43.50	0.51 --	0.537
	Comparison	556	42.99		

[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.

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

Occupational Category	Group	n	Adj. Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***854***	***42.29***	***0.20 --***	***0.707***
	Comparison	***1,229***	***42.09***		
Officer	Ranch Hand	340	42.75	0.61 --	0.460
	Comparison	489	42.14		
Enlisted Flyer	Ranch Hand	148	41.72	−1.12 --	0.386
	Comparison	184	42.84		
Enlisted Groundcrew	Ranch Hand	366	41.96	0.30 --	0.698
	Comparison	556	41.66		

[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.

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

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	158	42.39	42.65	0.036	0.013 (0.010)	0.199
Medium	159	44.97	45.00			
High	159	45.02	44.72			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of ALT versus log_2 (initial dioxin).

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	158	44.34	0.094	0.011 (0.012)	0.357
Medium	158	47.03			
High	157	46.08			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of ALT versus log_2 (initial dioxin).

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

(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	42.41	42.37		
Background RH	376	40.74	41.32	–1.05 --	0.129
Low RH	236	43.32	43.14	0.77 --	0.368
High RH	240	44.91	44.27	1.90 --	0.027
Low plus High RH	476	44.12	43.71	1.34 --	0.041

[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 ≤ 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.

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

(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	42.21		
Background RH	374	41.31	–0.90 --	0.192
Low RH	235	43.65	1.44 --	0.084
High RH	238	43.62	1.41 --	0.098
Low plus High RH	473	43.63	1.42 --	0.026

[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 ≤ 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.

(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	41.17	0.023	0.029 (0.007)	<0.001
Medium	285	41.87			
High	284	44.82			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of ALT versus log_2 (1987 dioxin + 1).

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

(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	40.98	0.079	0.033 (0.007)	<0.001
Medium	283	42.50			
High	281	45.28			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of ALT versus log_2 (1987 dioxin + 1).

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

The unadjusted Model 3 analysis of ALT 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 13-13(e): difference of means=1.90 U/l, p=0.027; difference of means=1.34 U/l, p=0.041, respectively).

After covariate adjustment, the Model 3 analysis of ALT revealed marginally significant differences between the adjusted mean of Ranch Hands in the low dioxin category and the Comparison adjusted mean (Table 13-13(f): difference of adjusted means=1.44 U/l, p=0.084) and between the adjusted mean of Ranch Hands in the high dioxin category and the Comparison adjusted mean (difference of adjusted means=1.41 U/l, p=0.098). Ranch Hands in the low and high dioxin categories combined also were significantly different from the Comparisons in the adjusted analysis (difference of adjusted means=1.42 U/l, p=0.026). Ranch Hands in the low and high dioxin categories combined had higher mean ALT levels (43.65 U/l and 43.62 U/l) than did the Comparisons (42.21 U/l).

The unadjusted and adjusted analyses for Model 4 each showed significant positive associations between ALT in its continuous form and 1987 dioxin (Table 13-13(g,h): slope=0.029, p<0.001, unadjusted; slope=0.033, p<0.001, adjusted). The adjusted mean ALT levels in the low, medium, and high 1987 dioxin categories were 40.98 U/l, 42.50 U/l, and 45.28 U/l, respectively.

13.2.2.3.4 ALT (Discrete)

The Model 1 analyses of ALT in its discrete form revealed no significant differences between Ranch Hands and Comparisons when examined across all occupations and within each occupation (Table 13-14(a,b): p>0.13 for each contrast).

Table 13-14. Analysis of ALT (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***68 (7.9)***	***1.13 (0.81,1.57)***	***0.468***
	Comparison	***1,231***	***87 (7.1)***		
Officer	Ranch Hand	340	23 (6.8)	1.54 (0.85,2.82)	0.157
	Comparison	490	22 (4.5)		
Enlisted Flyer	Ranch Hand	150	15 (10.0)	0.97 (0.48,1.98)	0.935
	Comparison	185	19 (10.3)		
Enlisted Groundcrew	Ranch Hand	369	30 (8.1)	0.98 (0.61,1.59)	0.938
	Comparison	556	46 (8.3)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.12 (0.80,1.57)***	***0.495***
Officer	1.58 (0.86,2.89)	0.138
Enlisted Flyer	0.97 (0.46,2.01)	0.927
Enlisted Groundcrew	0.97 (0.60,1.57)	0.889

Table 13-14. Analysis of ALT (Discrete) (Continued)

(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 (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	10 (6.3)	1.17 (0.95,1.45)	0.140
Medium	159	21 (13.2)		
High	159	19 (11.9)		

[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	1.32 (1.00,1.73)	0.049

[a] Relative risk for a twofold increase in initial dioxin.

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

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	85 (7.1)		
Background RH	376	17 (4.5)	0.67 (0.39,1.15)	0.145
Low RH	236	20 (8.5)	1.18 (0.71,1.97)	0.522
High RH	240	30 (12.5)	1.74 (1.11,2.71)	0.015
Low plus High RH	476	50 (10.5)	1.43 (0.99,2.08)	0.058

[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 ≤ 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.

(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	0.71 (0.41,1.23)	0.223
Low RH	235	1.30 (0.77,2.18)	0.323
High RH	238	1.53 (0.95,2.45)	0.080
Low plus High RH	473	1.41 (0.96,2.07)	0.079

[a] Relative risk and confidence interval relative to Comparisons.

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.

Table 13-14. Analysis of ALT (Discrete) (Continued)

(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 (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	15 (5.3)	1.33 (1.13,1.56)	0.001
Medium	285	18 (6.3)		
High	284	34 (12.0)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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]	p-Value
847	1.48 (1.20,1.83)	<0.001

[a] Relative risk for a twofold increase in 1987 dioxin.

The association between initial dioxin and ALT examined in the unadjusted Model 2 analysis revealed nonsignificant results (Table 13-14(c): p=0.140). After covariate adjustment, a significant association was revealed (Table 13-14(d): Adj. RR=1.32, p=0.049). The percentages of high ALT levels in the low, medium, and high initial dioxin categories were 6.3, 13.2, and 11.9, respectively.

The unadjusted Model 3 analysis of ALT in its discrete form 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 13-14(e): Est. RR=1.74, p=0.015; Est. RR=1.43, p=0.058, respectively). The percentages of individuals with high ALT levels among Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 12.5, 10.5, and 7.1, respectively. The same two contrasts were marginally significant after adjusting for covariates (Table 13-14(f): Adj. RR=1.53, p=0.080; Adj. RR=1.41, p=0.079).

The Model 4 unadjusted and adjusted analyses each revealed a significant association between 1987 dioxin and ALT in its discrete form (Table 13-14(g,h): Est. RR=1.33, p=0.001; Adj. RR=1.48, p<0.001). The percentages of participants with high ALT values in the low, medium, and high 1987 dioxin categories were 5.3, 6.3, and 12.0, respectively.

13.2.2.3.5 GGT (Continuous)

All analysis results from Models 1 and 2 of GGT were nonsignificant (Table 13-15(a–d): p>0.22 for each analysis). The unadjusted Model 3 analysis of GGT 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 13-15(e): difference of means=5.17 U/l, p=0.003; difference of means=3.46 U/l, p=0.007, respectively). The same contrasts were significant after adjusting for covariates (Table 13-15(f): difference of adjusted means=5.00 U/l, p=0.006, for Ranch Hands in the high dioxin category versus Comparisons; difference of adjusted means=3.71 U/l, p=0.006, for Ranch Hands in the low and high dioxin categories combined versus Comparisons). The adjusted mean GGT levels for Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 50.40 U/l, 49.11 U/l, and 45.40 U/l, respectively.

A significant association was revealed between GGT and 1987 dioxin in the Model 4 unadjusted analysis (Table 13-15(g): slope=0.040, p=0.002). Similarly, the adjusted analysis found a significant association between GGT levels and 1987 dioxin (Table 13-15(h): adjusted slope=0.042, p=0.003). The adjusted mean GGT levels were 42.89 U/l for the low dioxin category, 45.65 U/l for the medium dioxin category, and 50.85 U/l for the high dioxin category.

Table 13-15. Analysis of GGT (U/l) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***859***	***43.62***	***1.01 --***	***0.340***
	Comparison	***1,231***	***42.61***		
Officer	Ranch Hand	340	42.32	1.57 --	0.332
	Comparison	490	40.74		
Enlisted Flyer	Ranch Hand	150	44.45	–0.84 --	0.758
	Comparison	185	45.29		
Enlisted Groundcrew	Ranch Hand	369	44.52	1.09 --	0.506
	Comparison	556	43.44		

[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.

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

Occupational Category	Group	n	Adj. Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***854***	***46.80***	***1.33 --***	***0.223***
	Comparison	***1,229***	***45.47***		
Officer	Ranch Hand	340	45.24	1.62 --	0.331
	Comparison	489	43.62		
Enlisted Flyer	Ranch Hand	148	48.28	0.62 --	0.826
	Comparison	184	47.66		
Enlisted Groundcrew	Ranch Hand	366	46.67	1.28 --	0.439
	Comparison	556	45.39		

[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.

Table 13-15. Analysis of GGT (U/l) (Continuous) (Continued)

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	158	43.87	44.19	0.013	0.004 (0.019)	0.823
Medium	159	48.89	48.92			
High	159	46.22	45.86			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of GGT versus log_2 (initial dioxin).

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	158	48.46	0.097	0.008 (0.022)	0.709
Medium	158	52.52			
High	157	50.18			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of GGT versus log_2 (initial dioxin).

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

(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	42.26	42.21		
Background RH	376	39.99	40.81	–1.40 --	0.296
Low RH	236	44.27	43.99	1.78 --	0.283
High RH	240	48.36	47.38	5.17 --	0.003
Low plus High RH	476	46.29	45.67	3.46 --	0.007

[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 ≤ 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.

Table 13-15. Analysis of GGT (U/l) (Continuous) (Continued)

(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	45.40		
Background RH	374	44.67	-0.73 --	0.606
Low RH	235	47.84	2.43 --	0.159
High RH	238	50.40	5.00 --	0.006
Low plus High RH	473	49.11	3.71 --	0.006

[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 ≤ 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.

(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	40.35	0.012	0.040 (0.013)	0.002
Medium	285	42.53			
High	284	47.59			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of GGT versus log_2 (1987 dioxin + 1).

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

(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	42.89	0.103	0.042 (0.014)	0.003
Medium	283	45.65			
High	281	50.85			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of GGT versus log_2 (1987 dioxin + 1).

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

13.2.2.3.6 GGT (Discrete)

The unadjusted and adjusted analysis results for Models 1 and 2 showed no significant results (Table 13-16(a–d): $p \geq 0.31$ for each analysis).

A marginally significant difference between Ranch Hands in the low and high dioxin categories combined and Comparisons was revealed in both the unadjusted and adjusted Model 3 analyses (Table 13-16(e,f): Est. RR=1.33, p=0.094, for the unadjusted analysis; Adj. RR=1.38, p=0.065, for the adjusted analysis). The percentage of abnormal GGT values among Ranch Hands in the low and high dioxin categories combined was 13.0 versus 9.8 among the Comparisons.

Table 13-16. Analysis of GGT (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***89 (10.4)***	***1.03 (0.77,1.38)***	***0.831***
	Comparison	***1,231***	***124 (10.1)***		
Officer	Ranch Hand	340	31 (9.1)	1.23 (0.75,2.02)	0.419
	Comparison	490	37 (7.6)		
Enlisted Flyer	Ranch Hand	150	23 (15.3)	1.16 (0.63,2.14)	0.637
	Comparison	185	25 (13.5)		
Enlisted Groundcrew	Ranch Hand	369	35 (9.5)	0.83 (0.54,1.29)	0.419
	Comparison	556	62 (11.2)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.08 (0.80,1.45)***	***0.604***
Officer	1.24 (0.75,2.06)	0.399
Enlisted Flyer	1.39 (0.73,2.65)	0.310
Enlisted Groundcrew	0.86 (0.55,1.35)	0.512

(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 (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	17 (10.8)	1.00 (0.81,1.22)	0.964
Medium	159	28 (17.6)		
High	159	17 (10.7)		

[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.

Table 13-16. Analysis of GGT (Discrete) (Continued)

(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	1.06 (0.82,1.37)	0.669

[a] Relative risk for a twofold increase in initial dioxin.

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

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	117 (9.8)		
Background RH	376	25 (6.6)	0.70 (0.45,1.10)	0.122
Low RH	236	29 (12.3)	1.27 (0.82,1.96)	0.283
High RH	240	33 (13.8)	1.38 (0.91,2.10)	0.127
Low plus High RH	476	62 (13.0)	1.33 (0.95,1.84)	0.094

[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 ≤ 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.

(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	0.77 (0.48,1.23)	0.273
Low RH	235	1.42 (0.91,2.22)	0.127
High RH	238	1.35 (0.86,2.11)	0.186
Low plus High RH	473	1.38 (0.98,1.95)	0.065

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	21 (7.4)	1.17 (1.01,1.35)	0.034
Medium	285	27 (9.5)		
High	284	39 (13.7)		

[a] Relative risk for a twofold increase in 1987 dioxin.

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

Table 13-16. Analysis of GGT (Discrete) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
847	1.27 (1.05,1.53)	0.012

[a] Relative risk for a twofold increase in 1987 dioxin.

In Model 4, both unadjusted and adjusted analyses showed significant positive associations with 1987 dioxin (Table 13-16(g,h): Est. RR=1.17, p=0.034; Adj. RR=1.27, p=0.012, respectively). The percentages of high GGT levels in the low, medium, and high 1987 dioxin categories were 7.4, 9.5, and 13.7, respectively.

13.2.2.3.7 Alkaline Phosphatase (Continuous)

Both the unadjusted and adjusted Model 1 analyses of alkaline phosphatase revealed significant overall group differences (Table 13-17(a,b): difference of means=2.16 U/l, p=0.024; difference of adjusted means=2.32 U/l, p=0.016). The overall adjusted mean alkaline phosphatase values were 82.77 U/l and 80.46 U/l for Ranch Hands and Comparisons, respectively. After stratifying by occupation, unadjusted and adjusted analyses revealed group differences within the enlisted groundcrew stratum (unadjusted: difference of means=3.18 U/l, p=0.030; adjusted: difference of adjusted means=3.43 U/l, p=0.021). Within the enlisted groundcrew stratum, the Ranch Hands had an adjusted mean alkaline phosphatase of 85.11 U/l versus 81.68 U/l for the Comparisons.

Table 13-17. Analysis of Alkaline Phosphatase (U/l) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***859***	***81.81***	***2.16 --***	***0.024***
	Comparison	***1,231***	***79.65***		
Officer	Ranch Hand	340	78.44	1.70 --	0.241
	Comparison	490	76.74		
Enlisted Flyer	Ranch Hand	150	83.79	0.34 --	0.889
	Comparison	185	83.45		
Enlisted Groundcrew	Ranch Hand	369	84.22	3.18 --	0.030
	Comparison	556	81.04		

[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.

Table 13-17. Analysis of Alkaline Phosphatase (U/l) (Continuous) (Continued)

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

Occupational Category	Group	n	Adj. Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*856*	*82.77*	*2.32 --*	*0.016*
	Comparison	*1,229*	*80.46*		
Officer	Ranch Hand	340	78.68	1.80 --	0.215
	Comparison	489	76.88		
Enlisted Flyer	Ranch Hand	149	84.06	0.58 --	0.811
	Comparison	184	83.47		
Enlisted Groundcrew	Ranch Hand	367	85.11	3.43 --	0.021
	Comparison	556	81.68		

[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.

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	158	81.73	81.97	0.009	–0.004 (0.009)	0.646
Medium	159	83.60	83.63			
High	159	80.51	80.25			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of alkaline phosphatase versus log_2 (initial dioxin).

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	158	80.72	0.037	–0.021 (0.011)	0.053
Medium	158	79.95			
High	158	75.04			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of alkaline phosphatase versus log_2 (initial dioxin).

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

Table 13-17. Analysis of Alkaline Phosphatase (U/l) (Continuous) (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	79.58	79.57		
Background RH	376	81.35	81.50	1.93 --	0.130
Low RH	236	82.39	82.34	2.78 --	0.070
High RH	240	81.50	81.36	1.79 --	0.238
Low plus High RH	476	81.94	81.85	2.28 --	0.051

[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 ≤ 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.

(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	80.38		
Background RH	375	83.86	3.48 --	0.008
Low RH	235	83.18	2.79 --	0.071
High RH	239	80.32	–0.06 --	0.967
Low plus High RH	474	81.72	1.34 --	0.255

[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 ≤ 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.

(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	81.36	<0.001	–0.004 (0.006)	0.555
Medium	285	81.39			
High	284	82.29			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of alkaline phosphatase versus log_2 (1987 dioxin + 1).

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

Table 13-17. Analysis of Alkaline Phosphatase (U/l) (Continuous) (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	80.95	0.042	–0.021 (0.007)	0.003
Medium	284	80.09			
High	282	77.40			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of alkaline phosphatase versus log_2 (1987 dioxin + 1).

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

The Model 2 unadjusted analysis of alkaline phosphatase was nonsignificant (Table 13-17(c): p=0.646). The adjusted analysis revealed a marginally significant inverse association between alkaline phosphatase and initial dioxin (Table 13-17(d): adjusted slope=–0.021, p=0.053). Mean alkaline phosphatase levels in the low, medium, and high initial dioxin categories were 80.72 U/l, 79.95 U/l, and 75.04 U/l, respectively.

The unadjusted Model 3 analysis of alkaline phosphatase revealed two marginally significant contrasts: Ranch Hands in the low dioxin category versus Comparisons (Table 13-17(e): difference of means=2.78 U/l, p=0.070) and Ranch Hands in the low and high dioxin categories combined versus Comparisons (difference of means=2.28 U/l, p=0.051). The adjusted analysis showed significant differences between Ranch Hands in the background dioxin category and Comparisons (Table 13-17(f): difference of adjusted means=3.48 U/l, p=0.008), as well as a marginally significant difference between Ranch Hands in the low dioxin category and Comparisons (difference of adjusted means=2.79 U/l, p=0.071). Ranch Hands in the background and low dioxin categories had higher mean alkaline phosphatase levels than the Comparisons (83.86 U/l for the Ranch Hands in the background dioxin category and 83.18 U/l for the Ranch Hands in the low dioxin category versus 80.38 U/l for Comparisons).

The unadjusted analysis of Model 4 showed no significant association between alkaline phosphatase and 1987 dioxin levels (Table 13-17(g): p=0.555). After covariate adjustment, a significant inverse relation was revealed (Table 13-17(h): adjusted slope=–0.021, p=0.003). The adjusted mean alkaline phosphatase values in the low, medium, and high 1987 dioxin categories were 80.95 U/l, 80.09 U/l, and 77.40 U/l, respectively.

13.2.2.3.8 Alkaline Phosphatase (Discrete)

The unadjusted and adjusted Model 1 analyses of alkaline phosphatase in its discrete form showed no overall group difference between Ranch Hands and Comparisons (Table 13-18(a,b): p>0.33 for each analysis). Stratifying by occupation revealed a marginally significant group difference within the enlisted groundcrew stratum for both the unadjusted and adjusted analyses (Table 13-18(a,b): Est. RR=2.30, p=0.071; Adj. RR=2.46, p=0.053). The percentage of enlisted groundcrew with high alkaline phosphatase levels among the Ranch Hands was 3.3 percent versus 1.4 percent among the Comparisons. All analyses for Models 2 and 3 were nonsignificant (Table 13-18(c–f): p>0.10 for each analysis).

Table 13-18. Analysis of Alkaline Phosphatase (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***22 (2.6)***	***1.32 (0.74,2.37)***	***0.352***
	Comparison	***1,231***	***24 (1.9)***		
Officer	Ranch Hand	340	4 (1.2)	0.47 (0.15,1.48)	0.200
	Comparison	490	12 (2.4)		
Enlisted Flyer	Ranch Hand	150	6 (4.0)	1.89 (0.52,6.81)	0.333
	Comparison	185	4 (2.2)		
Enlisted Groundcrew	Ranch Hand	369	12 (3.3)	2.30 (0.93,5.69)	0.071
	Comparison	556	8 (1.4)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.34 (0.74,2.42)***	***0.332***
Officer	0.45 (0.14,1.41)	0.172
Enlisted Flyer	2.03 (0.56,7.40)	0.284
Enlisted Groundcrew	2.46 (0.99,6.13)	0.053

(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 (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	3 (1.9)	0.99 (0.60,1.65)	0.971
Medium	159	4 (2.5)		
High	159	2 (1.3)		

[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
474	1.04 (0.61,1.76)	0.897

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results not adjusted for occupation because of the sparse number of participants with a high alkaline phosphatase level.

Table 13-18. Analysis of Alkaline Phosphatase (Discrete) (Continued)

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

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	21 (1.8)		
Background RH	376	12 (3.2)	1.76 (0.85,3.63)	0.127
Low RH	236	4 (1.7)	0.97 (0.33,2.86)	0.960
High RH	240	5 (2.1)	1.24 (0.46,3.33)	0.670
Low plus High RH	476	9 (1.9)	1.10 (0.50,2.43)	0.815

[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 ≤ 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.

(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	375	1.85 (0.88,3.90)	0.104
Low RH	235	0.91 (0.31,2.71)	0.871
High RH	239	1.23 (0.44,3.41)	0.688
Low plus High RH	474	1.06 (0.48,2.37)	0.883

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	9 (3.2)	0.79 (0.58,1.09)	0.144
Medium	285	6 (2.1)		
High	284	6 (2.1)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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]	p-Value
849	0.69 (0.50,0.94)	0.020

[a] Relative risk for a twofold increase in 1987 dioxin.

The Model 4 unadjusted analysis did not show significant results (Table 13-18(g): p=0.144). The adjusted analysis revealed a significant inverse relation between alkaline phosphatase and 1987 dioxin levels (Table 13-18(h): Adj. RR=0.69, p=0.020). The percentages of abnormal alkaline phosphatase values in the low, medium, and high 1987 dioxin categories were 3.2, 2.1, and 2.1, respectively.

13.2.2.3.9 Total Bilirubin (Continuous)

All unadjusted and adjusted Model 1 through Model 4 analyses of total bilirubin in its continuous form were nonsignificant (Table 13-19(a–h): p>0.36 for each analysis).

Table 13-19. Analysis of Total Bilirubin (mg/dl) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***859***	***0.518***	***–0.002 --***	***0.857***
	Comparison	***1,231***	***0.520***		
Officer	Ranch Hand	340	0.546	0.003 --	0.887
	Comparison	490	0.543		
Enlisted Flyer	Ranch Hand	150	0.489	–0.023 --	0.365
	Comparison	185	0.513		
Enlisted Groundcrew	Ranch Hand	369	0.506	0.003 --	0.869
	Comparison	556	0.503		

[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.

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

Occupational Category	Group	n	Adj. Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***854***	***0.511***	***–0.000 --***	***0.963***
	Comparison	***1,229***	***0.511***		
Officer	Ranch Hand	340	0.528	0.000 --	0.993
	Comparison	489	0.528		
Enlisted Flyer	Ranch Hand	148	0.487	–0.018 --	0.482
	Comparison	184	0.505		
Enlisted Groundcrew	Ranch Hand	366	0.512	0.006 --	0.727
	Comparison	556	0.507		

[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.

Table 13-19. Analysis of Total Bilirubin (mg/dl) (Continuous) (Continued)

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[a,b]	R^2	Slope (Std. Error)[c]	p-Value
Low	158	0.524	0.527	0.013	–0.014 (0.016)	0.368
Medium	159	0.503	0.503			
High	159	0.514	0.510			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of total bilirubin versus log_2 (initial dioxin).

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	158	0.522	0.038	0.004 (0.019)	0.822
Medium	158	0.511			
High	157	0.532			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of total bilirubin versus log_2 (initial dioxin).

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

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

Dioxin Category	n	Mean[a]	Adj. Mean[a,b]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[c]	p-Value[d]
Comparison	1,194	0.520	0.520		
Background RH	376	0.523	0.526	0.006 --	0.673
Low RH	236	0.517	0.516	–0.004 --	0.828
High RH	240	0.510	0.506	–0.014 --	0.418
Low plus High RH	476	0.513	0.511	–0.009 --	0.500

[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 ≤ 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.

Table 13-19. Analysis of Total Bilirubin (mg/dl) (Continuous) (Continued)

(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	0.517		
Background RH	374	0.515	–0.002 --	0.901
Low RH	235	0.514	–0.003 --	0.884
High RH	238	0.520	0.003 --	0.861
Low plus High RH	473	0.517	0.000 --	0.981

[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 ≤ 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.

(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	0.526	0.001	–0.007 (0.011)	0.499
Medium	285	0.518			
High	284	0.509			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of total bilirubin versus log_2 (1987 dioxin + 1).

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

(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	0.521	0.023	0.008 (0.012)	0.519
Medium	283	0.516			
High	281	0.532			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of total bilirubin versus log_2 (1987 dioxin + 1).

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

13.2.2.3.10 Total Bilirubin (Discrete)

All analysis results of total bilirubin in its dichotomous form were nonsignificant (Table 13-20(a–h): p>0.11 for each analysis).

Table 13-20. Analysis of Total Bilirubin (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*46 (5.4)*	*0.86 (0.59,1.25)*	*0.430*
	Comparison	*1,231*	*76 (6.2)*		
Officer	Ranch Hand	340	22 (6.5)	0.90 (0.52,1.56)	0.707
	Comparison	490	35 (7.1)		
Enlisted Flyer	Ranch Hand	150	8 (5.3)	1.10 (0.41,2.93)	0.846
	Comparison	185	9 (4.9)		
Enlisted Groundcrew	Ranch Hand	369	16 (4.3)	0.74 (0.40,1.37)	0.342
	Comparison	556	32 (5.8)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.86 (0.58,1.25)*	*0.420*
Officer	0.90 (0.52,1.57)	0.723
Enlisted Flyer	1.15 (0.43,3.08)	0.779
Enlisted Groundcrew	0.71 (0.38,1.33)	0.286

(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 (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	12 (7.6)	0.77 (0.54,1.09)	0.118
Medium	159	5 (3.1)		
High	159	7 (4.4)		

[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	0.75 (0.49,1.13)	0.154

[a] Relative risk for a twofold increase in initial dioxin.

Table 13-20. Analysis of Total Bilirubin (Discrete) (Continued)

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

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	74 (6.2)		
Background RH	376	21 (5.6)	0.91 (0.55,1.51)	0.724
Low RH	236	15 (6.4)	1.02 (0.58,1.81)	0.940
High RH	240	9 (3.8)	0.58 (0.29,1.18)	0.131
Low plus High RH	476	24 (5.0)	0.77 (0.47,1.25)	0.286

[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 ≤ 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.

(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	0.88 (0.53,1.47)	0.619
Low RH	235	1.03 (0.58,1.84)	0.919
High RH	238	0.59 (0.27,1.27)	0.175
Low plus High RH	473	0.78 (0.47,1.29)	0.331

[a] Relative risk and confidence interval relative to Comparisons.

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.

(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 (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	18 (6.4)	0.89 (0.72,1.10)	0.275
Medium	285	15 (5.3)		
High	284	12 (4.2)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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]	p-Value
847	0.94 (0.73,1.21)	0.646

[a] Relative risk for a twofold increase in 1987 dioxin.

13.2.2.3.11 Direct Bilirubin

In each of the unadjusted and adjusted analyses of Models 1 through 4, no significant associations were seen between dioxin and direct bilirubin (Table 13-21(a–h): p>0.19 for each contrast). Because of a sparse number of participants with a high direct bilirubin level, the analysis was limited in some of the models.

Table 13-21. Analysis of Direct Bilirubin

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***1 (0.1)***	***0.29 (0.03,2.45)***	***0.196***
	Comparison	***1,231***	***5 (0.4)***		
Officer	Ranch Hand	340	1 (0.3)	0.48 (0.05,4.62)	0.524
	Comparison	490	3 (0.6)		
Enlisted Flyer	Ranch Hand	150	0 (0.0)	--	--
	Comparison	185	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	369	0 (0.0)	--	0.667[a]
	Comparison	556	2 (0.4)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a high direct bilirubin level.
--: Results not presented because of the sparse number of participants with a high direct bilirubin level.

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***0.32 (0.04,2.82)***	***0.254***
Officer	0.50 (0.05,4.90)	0.551
Enlisted Flyer	--	--
Enlisted Groundcrew	--	--

--: Results not presented because of the sparse number of participants with a high direct bilirubin level.

Note: Results for analysis across all occupational categories are not adjusted for occupation because of the sparse number of participants with a high direct bilirubin level.

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	0 (0.0)	--	--
Medium	159	0 (0.0)		
High	159	0 (0.0)		

[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.
--: Results not presented because of the sparse number of Ranch Hands with a high direct bilirubin level.

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

Table 13-21. Analysis of Direct Bilirubin (Continued)

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

Analysis Results for Log_2 (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.)	p-Value
--	--	--

--: Results not presented because of the sparse number of Ranch Hands with a high direct bilirubin level.

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

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	5 (0.4)		
Background RH	376	1 (0.3)	0.88 (0.10,7.75)	0.906
Low RH	236	0 (0.0)	--	0.695[c]
High RH	240	0 (0.0)	--	0.686[c]
Low plus High RH	476	0 (0.0)	--	0.359[c]

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] P-value determined using a chi-square test with continuity correction because of the sparse number of Ranch Hands with a high direct bilirubin level.

--: Results not presented because of the sparse number of Ranch Hands with a high direct bilirubin level.

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.

(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	1.09 (0.12,10.31)	0.937
Low RH	235	--	--
High RH	238	--	--
Low plus High RH	473	--	--

[a] Relative risk and confidence interval relative to Comparisons.

--: Results not presented because of the sparse number of Ranch Hands with a high direct bilirubin level.

Note: RH = Raneh 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.

Results are not adjusted for occupation because of the sparse number of Ranch Hands with a high direct bilirubin level.

Table 13-21. Analysis of Direct Billrubin (Continued)

(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 (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	0 (0.0)	0.78 (0.18,3.33)	0.735
Medium	285	1 (0.4)		
High	284	0 (0.0)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤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]	p-Value
847		0.79 (0.17,3.72)	0.764

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are adjusted only for age and lifetime alcohol history because of the sparse number of Ranch Hands with a high direct bilirubin level.

13.2.2.3.12 Lactic Dehydrogenase (Continuous)

The unadjusted and adjusted analyses of Models 1 through 4 showed no significant associations between dioxin and lactic dehydrogenase in its continuous form (Table 13-22(a–h): p>0.18 for each analysis).

Table 13-22. Analysis of Lactic Dehydrogenase (U/l) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***859***	***154.0***	***0.3 --***	***0.822***
	Comparison	***1,229***	***153.8***		
Officer	Ranch Hand	340	153.9	–0.5 --	0.799
	Comparison	489	154.4		
Enlisted Flyer	Ranch Hand	150	152.3	–0.3 --	0.927
	Comparison	184	152.5		
Enlisted Groundcrew	Ranch Hand	369	154.9	1.2 --	0.488
	Comparison	556	153.7		

[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.

Table 13-22. Analysis of Lactic Dehydrogenase (U/l) (Continuous) (Continued)

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

Occupational Category	Group	n	Adj. Mean[a]	Difference of Adj. Means (95% C.L.)[b]	p-Value[c]
All	***Ranch Hand***	***854***	***155.3***	***0.3 --***	***0.790***
	Comparison	***1,227***	***155.0***		
Officer	Ranch Hand	340	154.8	–0.6 --	0.768
	Comparison	488	155.3		
Enlisted Flyer	Ranch Hand	148	153.1	–0.8 --	0.787
	Comparison	183	153.9		
Enlisted Groundcrew	Ranch Hand	366	157.8	1.5 --	0.397
	Comparison	556	156.3		

[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.

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	158	155.7	156.0	0.009	–0.001 (0.006)	0.908
Medium	159	152.4	152.4			
High	159	156.0	155.6			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of lactic dehydrogenase versus log_2 (initial dioxin).

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	158	159.1	0.036	0.000 (0.007)	0.979
Medium	158	156.8			
High	157	160.1			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of lactic dehydrogenase versus log_2 (initial dioxin).

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

Table 13-22. Analysis of Lactic Dehydrogenase (U/l) (Continuous) (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	1,192	153.8	153.7		
Background RH	376	153.1	154.3	0.6 --	0.693
Low RH	236	153.9	153.6	–0.1 --	0.941
High RH	240	155.4	154.1	0.4 --	0.816
Low plus High RH	476	154.7	153.8	0.1 --	0.916

[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 ≤ 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.

(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	1,192	155.5		
Background RH	374	156.1	0.6 --	0.737
Low RH	235	155.0	–0.5 --	0.774
High RH	238	156.8	1.3 --	0.528
Low plus High RH	473	155.9	0.4 --	0.812

[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 ≤ 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.

(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	152.7	0.002	0.005 (0.004)	0.211
Medium	285	155.3			
High	284	153.9			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of lactic dehydrogenase versus log_2 (1987 dioxin + 1).

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

Table 13-22. Analysis of Lactic Dehydrogenase (U/l) (Continuous) (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	154.3	0.015	0.006 (0.005)	0.187
Medium	283	156.4			
High	281	155.4			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of lactic dehydrogenase versus log_2 (1987 dioxin + 1).

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

13.2.2.3.13 Lactic Dehydrogenase (Discrete)

Lactic dehydrogenase in its dichotomized form showed nonsignificant results in all of the Models 1 through 4 unadjusted and adjusted analyses (Table 13-23(a–h): p>0.21 for each analysis).

Table 13-23. Analysis of Lactic Dehydrogenase (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***81 (9.4)***	***0.89 (0.66,1.19)***	***0.424***
	Comparison	***1,229***	***129 (10.5)***		
Officer	Ranch Hand	340	32 (9.4)	0.85 (0.54,1.36)	0.506
	Comparison	489	53 (10.8)		
Enlisted Flyer	Ranch Hand	150	13 (8.7)	1.07 (0.49,2.32)	0.866
	Comparison	184	15 (8.2)		
Enlisted Groundcrew	Ranch Hand	369	36 (9.8)	0.88 (0.57,1.35)	0.555
	Comparison	556	61 (11.0)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***0.90 (0.67,1.21)***	***0.479***
Officer	0.86 (0.54,1.37)	0.530
Enlisted Flyer	1.03 (0.47,2.24)	0.945
Enlisted Groundcrew	0.90 (0.58,1.39)	0.625

Table 13-23. Analysis of Lactic Dehydrogenase (Discrete) (Continued)

(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 (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	17 (10.8)	0.96 (0.75,1.21)	0.709
Medium	159	10 (6.3)		
High	159	16 (10.1)		

[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	0.98 (0.74,1.30)	0.889

[a] Relative risk for a twofold increase in initial dioxin.

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

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,192	123 (10.3)		
Background RH	376	36 (9.6)	1.05 (0.71,1.57)	0.794
Low RH	236	21 (8.9)	0.81 (0.50,1.33)	0.406
High RH	240	22 (9.2)	0.77 (0.47,1.25)	0.291
Low plus High RH	476	43 (9.0)	0.79 (0.55,1.15)	0.214

[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 ≤ 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.

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,191		
Background RH	374	1.07 (0.72,1.61)	0.729
Low RH	235	0.80 (0.48,1.31)	0.366
High RH	238	0.81 (0.49,1.34)	0.416
Low plus High RH	473	0.80 (0.55,1.17)	0.255

[a] Relative risk and confidence interval relative to Comparisons.

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.