

**Table 13-42. Analysis of Prealbumin (Discrete) (Continued)**

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |          |                           |  |                |
|---|----------|---------------------------|--|----------------|
| <b>Dioxin Category</b>  | <b>n</b> | <b>Number (%)<br/>Low</b> | <b>Est. Relative Risk<br/>(95% C.I.)<sup>a,b</sup></b> | <b>p-Value</b> |
| Comparison  | 1,194    | 10 (0.8)                  |  |                |
| Background RH   | 376      | 6 (1.6)                   | 1.94 (0.69,5.41)                                       | 0.207          |
| Low RH  | 236      | 1 (0.4)                   | 0.50 (0.06,3.95)                                       | 0.513          |
| High RH   | 240      | 5 (2.1)                   | 2.50 (0.84,7.42)                                       | 0.099          |
| Low plus High RH  | 476      | 6 (1.3)                   | 1.13 (0.33,3.90)                                       | 0.849          |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> 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.

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |          |  |                |
|---|----------|--|----------------|
| <b>Dioxin Category</b>  | <b>n</b> | <b>Adjusted Relative Risk<br/>(95% C.I.)<sup>a</sup></b> | <b>p-Value</b> |
| Comparison  | 1,193    |  |                |
| Background RH   | 374      | 1.74 (0.61,5.01)   | 0.302          |
| Low RH  | 235      | 0.49 (0.06,3.93)   | 0.506          |
| High RH   | 238      | 4.34 (1.25,15.05)  | 0.021          |
| Low plus High RH  | 473      | 1.48 (0.41,5.32)   | 0.552          |

<sup>a</sup> 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.

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |          |                           |   |                |
|--|----------|---------------------------|---|----------------|
| <b>1987 Dioxin Category Summary Statistics</b>             |          |                           | <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |                |
| <b>1987 Dioxin</b>   | <b>n</b> | <b>Number (%)<br/>Low</b> | <b>Estimated Relative Risk<br/>(95% C.I.)<sup>a</sup></b>     | <b>p-Value</b> |
| Low  | 283      | 4 (1.4)                   | 1.02 (0.69,1.49)  | 0.931          |
| Medium   | 285      | 3 (1.1)                   |   |                |
| High   | 284      | 5 (1.8)                   |   |                |

<sup>a</sup> 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 13-42. Analysis of Prealbumin (Discrete) (Continued)**

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |   |         |
|--|---|---------|
| Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)  |   |         |
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 847  | 1.00 (0.63, 1.60)                                 | 0.993   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

No significant relation between prealbumin and initial dioxin was found in the unadjusted Model 2 analysis (Table 13-42(c):  $p=0.203$ ). A marginally significant relation was found in the adjusted analysis (Table 13-42(d): Adj. RR=1.76,  $p=0.081$ ), indicating an increased prevalence of low prealbumin levels as initial dioxin increased. In the Model 3 unadjusted analysis of prealbumin, a marginally significant difference was revealed between Ranch Hands in the high dioxin category and the Comparison group (Table 13-42(e): Est. RR=2.50,  $p=0.099$ ). The same contrast was significant in the adjusted analysis (Table 13-42(f): Adj. RR=4.34,  $p=0.021$ ). Of the Ranch Hands in the high dioxin category, 2.1 percent had low prealbumin levels versus 0.8 percent of the Comparisons. The Model 4 unadjusted and adjusted analyses were nonsignificant (Table 13-42(g,h):  $p>0.93$  for each analysis).

#### 13.2.2.3.34 Albumin (Continuous)

All unadjusted and adjusted Model 1 and 2 analyses were nonsignificant (Table 13-43(a–d):  $p>0.18$  for each analysis).

**Table 13-43. Analysis of Albumin (mg/dl) (Continuous)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |         |                                   |         |
|--|------------|-------|---------|-----------------------------------|---------|
| Occupational Category  | Group      | n     | Mean    | Difference of Means<br>(95% C.I.) | p-Value |
| All  | Ranch Hand | 859   | 4,195.6 | -5.6 (-34.9, 23.8)                | 0.709   |
|  | Comparison | 1,231 | 4,201.2 |                                   |         |
| Officer  | Ranch Hand | 340   | 4,172.9 | -31.8 (-78.3, 14.8)               | 0.181   |
|  | Comparison | 490   | 4,204.6 |                                   |         |
| Enlisted Flyer   | Ranch Hand | 150   | 4,190.0 | 30.1 (-42.4, 102.5)               | 0.416   |
|  | Comparison | 185   | 4,159.9 |                                   |         |
| Enlisted Groundcrew  | Ranch Hand | 369   | 4,218.8 | 7.0 (-37.3, 51.2)                 | 0.758   |
|  | Comparison | 556   | 4,211.9 |                                   |         |

**Table 13-43. Analysis of Albumin (mg/dl) (Continuous) (Continued)**

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |            |       |           |                                     |         |
|--|------------|-------|-----------|-------------------------------------|---------|
| Occupational Category                                      | Group      | n     | Adj. Mean | Difference of Adj. Means (95% C.I.) | p-Value |
| All  | Ranch Hand | 854   | 4,180.8   | -3.0 (-32.1,26.0)                   | 0.837   |
|  | Comparison | 1,229 | 4,183.8   |                                     |         |
| Officer  | Ranch Hand | 340   | 4,163.1   | -28.9 (-74.9,17.1)                  | 0.218   |
|  | Comparison | 489   | 4,192.1   |                                     |         |
| Enlisted Flyer   | Ranch Hand | 148   | 4,201.9   | 37.0 (-35.0,109.0)                  | 0.314   |
|  | Comparison | 184   | 4,164.9   |                                     |         |
| Enlisted Groundcrew  | Ranch Hand | 366   | 4,190.5   | 5.8 (-38.1,49.6)                    | 0.797   |
|  | Comparison | 556   | 4,184.7   |                                     |         |

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |         |                        |  |                    |         |
|---|-----|---------|------------------------|--|--------------------|---------|
| Initial Dioxin Category Summary Statistics                    |     |         |                        | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |                    |         |
| Initial Dioxin  | n   | Mean    | Adj. Mean <sup>a</sup> | R <sup>2</sup>   | Slope (Std. Error) | p-Value |
| Low   | 158 | 4,170.0 | 4,164.4                | 0.023  | 13.830 (10.970)    | 0.208   |
| Medium  | 159 | 4,163.0 | 4,162.4                |  |                    |         |
| High  | 159 | 4,221.3 | 4,227.5                |  |                    |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

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

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |     |           |  |                         |         |
|---|-----|-----------|--|-------------------------|---------|
| Initial Dioxin Category Summary Statistics                  |     |           | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |                         |         |
| Initial Dioxin  | n   | Adj. Mean | R <sup>2</sup>   | Adj. Slope (Std. Error) | p-Value |
| Low   | 158 | 4,148.8   | 0.054  | -1.264 (12.791)         | 0.921   |
| Medium  | 158 | 4,133.0   |  |                         |         |
| High  | 157 | 4,169.0   |  |                         |         |

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

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |       |         |                        |   |                                  |
|---|-------|---------|------------------------|---|----------------------------------|
| Dioxin Category   | n     | Mean    | Adj. Mean <sup>a</sup> | Difference of Adj. Mean vs. Comparisons (95% C.I.)                              | p-Value                          |
| Comparison  | 1,194 | 4,199.1 | 4,199.7                | 0.9 (-37.7,39.6)<br>-44.5 (-90.8,1.8)<br>29.2 (-16.9,75.3)<br>-7.3 (-42.6,28.0) | 0.962<br>0.060<br>0.215<br>0.685 |
| Background RH   | 376   | 4,212.2 | 4,200.6                |   |                                  |
| Low RH  | 236   | 4,151.7 | 4,155.3                |   |                                  |
| High RH   | 240   | 4,217.3 | 4,228.9                |   |                                  |
| Low plus High RH  | 476   | 4,184.8 | 4,192.4                |   |                                  |

<sup>a</sup> 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 13-43. Analysis of Albumin (mg/dl) (Continuous) (Continued)**

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

| Dioxin Category  | n     | Adj. Mean | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) | p-Value |
|------------------|-------|-----------|--|---------|
| Comparison       | 1,193 | 4,183.0   |  |         |
| Background RH    | 374   | 4,187.9   | 5.0 (–34.0,43.9)   | 0.803   |
| Low RH           | 235   | 4,154.2   | –28.7 (–74.7,17.3)                                       | 0.221   |
| High RH          | 238   | 4,200.2   | 17.2 (–30.0,64.4)  | 0.476   |
| Low plus High RH | 473   | 4,177.3   | –5.6 (–41.0,29.8)  | 0.755   |

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 <sub>2</sub> (1987 Dioxin + 1) |                                |         |
|---|-----|---------|---|--------------------------------|---------|
| 1987 Dioxin                             | n   | Mean    | R <sup>2</sup>  | Adjusted Slope<br>(Std. Error) | p-Value |
| Low                                     | 283 | 4,227.5 | <0.001  | –2.471 (7.678)                 | 0.748   |
| Medium                                  | 285 | 4,153.4 |   |                                |         |
| High                                    | 284 | 4,210.1 |   |                                |         |

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 <sub>2</sub> (1987 Dioxin + 1) |                                |         |
|---|-----|-----------|---|--------------------------------|---------|
| 1987 Dioxin                             | n   | Adj. Mean | R <sup>2</sup>  | Adjusted Slope<br>(Std. Error) | p-Value |
| Low                                     | 283 | 4,223.1   | 0.040   | –11.121 (8.711)                | 0.202   |
| Medium                                  | 283 | 4,157.9   |   |                                |         |
| High                                    | 281 | 4,181.3   |   |                                |         |

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

The unadjusted Model 3 analysis showed a marginally significant difference between Ranch Hands in the low dioxin category and Comparisons (Table 13-43(e): difference of means=–44.5 mg/dl, p=0.060). No significant differences were noted in the adjusted Model 3 analysis of albumin (Table 13-43(f): p>0.22 for each contrast). In the Model 4 unadjusted and adjusted analyses of albumin, no significant associations with 1987 dioxin were found (Table 13-43(g,h): p>0.20 for each analysis).

**13.2.2.3.35 Albumin (Discrete)**

Because of a sparse number of low albumin values among the participants, some analyses were not possible. Table 13-44 contains the results of these analyses. Unadjusted chi-square tests of association in Model 3 revealed a significantly smaller percentage of Ranch Hands in the low and high dioxin categories combined with a low albumin level than Comparisons (Table 13-44(e): p=0.099). All other analyses in Models 1 through 4 were nonsignificant (Table 13-44(a–h): p≥0.17 for all other analyses).

**Table 13-44. Analysis of Albumin (Discrete)**

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

| Occupational Category | Group             | n     | Number (%)<br>Low | Est. Relative Risk<br>(95% C.I.) | p-Value            |
|-----------------------|-------------------|-------|-------------------|----------------------------------|--------------------|
| <i>All</i>            | <i>Ranch Hand</i> | 859   | 3 (0.3)           | 0.43 (0.12,1.56)                 | 0.170              |
|                       | <i>Comparison</i> | 1,231 | 10 (0.8)          |                                  |                    |
| Officer               | Ranch Hand        | 340   | 3 (0.9)           | 1.08 (0.24,4.86)                 | 0.919              |
|                       | Comparison        | 490   | 4 (0.8)           |                                  |                    |
| Enlisted Flyer        | Ranch Hand        | 150   | 0 (0.0)           | --                               | 0.999 <sup>a</sup> |
|                       | Comparison        | 185   | 1 (0.5)           |                                  |                    |
| Enlisted Groundcrew   | Ranch Hand        | 369   | 0 (0.0)           | --                               | 0.171 <sup>a</sup> |
|                       | Comparison        | 556   | 5 (0.9)           |                                  |                    |

<sup>a</sup> P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a low albumin level.

--: Results not presented because of the sparse number of participants with a low albumin level.

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

| Occupational Category | Adjusted Relative Risk<br>(95% C.I.) | p-Value |
|-----------------------|--------------------------------------|---------|
| <i>All</i>            | 0.45 (0.12,1.65)                     | 0.200   |
| Officer               | 1.08 (0.24,4.91)                     | 0.918   |
| Enlisted Flyer        | --                                   | --      |
| Enlisted Groundcrew   | --                                   | --      |

--: Results not presented because of the sparse number of participants with a low albumin level.

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

| Initial Dioxin Category Summary Statistics |     |                   | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
|--|-----|-------------------|---|---------|
| Initial Dioxin                             | n   | Number (%)<br>Low | Estimated Relative Risk<br>(95% C.I.) <sup>b</sup>                  | p-Value |
| Low  | 158 | 0 (0.0)           | --  | --      |
| Medium                                     | 159 | 0 (0.0)           |   |         |
| High                                       | 159 | 0 (0.0)           |   |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

--: Results not presented because of the sparse number of Ranch Hands with a low albumin level.

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

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

| Analysis Results for Log <sub>2</sub> (Initial Dioxin) |   |         |
|--|---|---------|
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| --   | --  | --      |

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

--: Results not presented because of the sparse number of Ranch Hands with a low albumin level.

**Table 13-44. Analysis of Albumin (Discrete) (Continued)**

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

| Dioxin Category  | n     | Number (%)<br>Low | Est. Relative Risk<br>(95% C.I.) <sup>a,b</sup> | p-Value            |
|------------------|-------|-------------------|---|--------------------|
| Comparison       | 1,194 | 10 (0.8)          |   |                    |
| Background RH    | 376   | 2 (0.5)           | 0.68 (0.15,3.14)                                | 0.618              |
| Low RH           | 236   | 0 (0.0)           | --  | 0.325 <sup>c</sup> |
| High RH          | 240   | 0 (0.0)           | --  | 0.318 <sup>c</sup> |
| Low plus High RH | 476   | 0 (0.0)           | --  | 0.099 <sup>c</sup> |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> P-value determined using a chi-square test with continuity correction because of the sparse number of Ranch Hands with a low albumin level.

--: Results not presented because of the sparse number of Ranch Hands with a low albumin 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<br>(95% C.I.) <sup>a</sup> | p-Value |
|------------------|-------|---|---------|
| Comparison       | 1,193 |   |         |
| Background RH    | 374   | 0.67 (0.14,3.20)                                  | 0.611   |
| Low RH           | 235   | --  | --      |
| High RH          | 238   | --  | --      |
| Low plus High RH | 473   | --  | --      |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

--: Results not presented because of the sparse number of Ranch Hands with a low albumin 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.

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

| 1987 Dioxin Category Summary Statistics |     |                   | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |         |
|---|-----|-------------------|---|---------|
| 1987 Dioxin                             | n   | Number (%)<br>Low | Estimated Relative Risk<br>(95% C.I.) <sup>a</sup>      | p-Value |
| Low                                     | 283 | 1 (0.4)           | 0.68 (0.24,1.96)  | 0.465   |
| Medium                                  | 285 | 1 (0.4)           |   |         |
| High                                    | 284 | 0 (0.0)           |   |         |

<sup>a</sup> 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 13-44. Analysis of Albumin (Discrete) (Continued)**

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |   |         |
|--|---|---------|
| Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)  |   |         |
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 847  | 0.52 (0.09,3.01)                                  | 0.442   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race, occupation, and industrial chemical exposure because of the sparse number of participants with a low albumin level.

#### 13.2.2.3.36 $\alpha$ -1-Acid Glycoprotein (Continuous)

The Model 1 unadjusted and adjusted analyses of  $\alpha$ -1-acid glycoprotein revealed no overall difference between Ranch Hands and Comparisons (Table 13-45(a,b):  $p>0.46$  for each analysis). After stratifying by occupation, a significant difference between Ranch Hands and Comparisons was discovered among the enlisted groundcrew for both the unadjusted and adjusted analyses (Table 13-45(a,b): difference of means=2.61 mg/dl,  $p=0.044$ , for the unadjusted analysis; difference of adjusted means=2.76 mg/dl,  $p=0.030$ , for the adjusted analysis). The adjusted mean  $\alpha$ -1-acid glycoprotein level among the Ranch Hand enlisted groundcrew was 86.86 mg/dl versus 84.10 mg/dl among the Comparison enlisted groundcrew.

The unadjusted Model 2 analysis was not significant (Table 13-45(c):  $p=0.992$ ). After covariate adjustment, a marginally significant inverse relation between  $\alpha$ -1-acid glycoprotein and initial dioxin was detected (Table 13-45(d): adjusted slope=-0.016,  $p=0.086$ ). The adjusted mean  $\alpha$ -1-acid glycoprotein levels in the low, medium, and high initial dioxin categories were 82.09 mg/dl, 83.12 mg/dl, and 79.32 mg/dl, respectively.

**Table 13-45. Analysis of  $\alpha$ -1-Acid Glycoprotein (mg/dl) (Continuous)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                   |  |                      |
|--|------------|-------|-------------------|--|----------------------|
| Occupational Category  | Group      | n     | Mean <sup>a</sup> | Difference of Means<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| All  | Ranch Hand | 859   | 84.65             | 0.50 --  | 0.550                |
|  | Comparison | 1,231 | 84.15             |  |                      |
| Officer  | Ranch Hand | 340   | 80.89             | -1.33 --                                       | 0.298                |
|  | Comparison | 490   | 82.22             |  |                      |
| Enlisted Flyer   | Ranch Hand | 150   | 85.49             | -0.38 --                                       | 0.855                |
|  | Comparison | 185   | 85.88             |  |                      |
| Enlisted Groundcrew  | Ranch Hand | 369   | 87.92             | 2.61 --  | 0.044                |
|  | Comparison | 556   | 85.31             |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

**Table 13-45. Analysis of  $\alpha$ -1-Acid Glycoprotein (mg/dl) (Continuous) (Continued)**

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

| Occupational Category | Group      | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|-----------------------|------------|-------|------------------------|--|----------------------|
| All                   | Ranch Hand | 854   | 83.11                  | 0.60 --  | 0.464                |
|                       | Comparison | 1,229 | 82.51                  |  |                      |
| Officer               | Ranch Hand | 340   | 78.64                  | -1.43 --   | 0.248                |
|                       | Comparison | 489   | 80.08                  |  |                      |
| Enlisted Flyer        | Ranch Hand | 148   | 83.83                  | 0.15 --  | 0.942                |
|                       | Comparison | 184   | 83.68                  |  |                      |
| Enlisted Groundcrew   | Ranch Hand | 366   | 86.86                  | 2.76 --  | 0.030                |
|                       | Comparison | 556   | 84.10                  |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> 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 <sub>2</sub> (Initial Dioxin) <sup>b</sup> |                                 |         |
|--|-----|-------------------|-------------------------|---|---------------------------------|---------|
| Initial Dioxin                             | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>  | Slope (Std. Error) <sup>c</sup> | p-Value |
| Low  | 158 | 84.39             | 84.41                   | <0.001  | 0.000 (0.008)                   | 0.992   |
| Medium                                     | 159 | 87.88             | 87.88                   |   |                                 |         |
| High                                       | 159 | 85.33             | 85.32                   |   |                                 |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on natural logarithm of  $\alpha$ -1-acid glycoprotein versus log<sub>2</sub> (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 <sub>2</sub> (Initial Dioxin) |                                      |         |
|--|-----|------------------------|--|--------------------------------------|---------|
| Initial Dioxin                             | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>   | Adj. Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 158 | 82.09                  | 0.046  | -0.016 (0.009)                       | 0.086   |
| Medium                                     | 158 | 83.12                  |  |                                      |         |
| High                                       | 157 | 79.32                  |  |                                      |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of  $\alpha$ -1-acid glycoprotein versus log<sub>2</sub> (initial dioxin).

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



**Table 13-45. Analysis of  $\alpha$ -1-Acid Glycoprotein (mg/dl) (Continuous) (Continued)**

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

| Dioxin Category  | n     | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>c</sup> | p-Value <sup>d</sup> |
|------------------|-------|-------------------|-------------------------|---|----------------------|
| Comparison       | 1,194 | 84.28             | 84.29                   |   |                      |
| Background RH    | 376   | 83.12             | 83.02                   | -1.27 --  | 0.256                |
| Low RH           | 236   | 84.79             | 84.82                   | 0.53 --   | 0.692                |
| High RH          | 240   | 86.92             | 87.02                   | 2.73 --   | 0.045                |
| Low plus High RH | 476   | 85.86             | 85.92                   | 1.63 --   | 0.114                |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

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

<sup>d</sup> P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

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

| Dioxin Category  | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|------------------|-------|------------------------|---|----------------------|
| Comparison       | 1,193 | 82.72                  |   |                      |
| Background RH    | 374   | 82.67                  | -0.05 --  | 0.961                |
| Low RH           | 235   | 83.42                  | 0.70 --   | 0.600                |
| High RH          | 238   | 83.78                  | 1.06 --   | 0.436                |
| Low plus High RH | 473   | 83.60                  | 0.88 --   | 0.389                |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

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

| 1987 Dioxin Category Summary Statistics |     |                   | Analysis Results for Log <sub>2</sub> (1987 Dioxin +1) |   |         |
|---|-----|-------------------|--|---|---------|
| 1987 Dioxin                             | n   | Mean <sup>a</sup> | R <sup>2</sup>   | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low                                     | 283 | 83.77             | 0.001  | 0.005 (0.005)                               | 0.336   |
| Medium                                  | 285 | 83.02             |  |   |         |
| High                                    | 284 | 87.18             |  |   |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of  $\alpha$ -1-acid glycoprotein versus log<sub>2</sub> (1987 dioxin + 1).

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

**Table 13-45. Analysis of  $\alpha$ -1-Acid Glycoprotein (mg/dl) (Continuous) (Continued)**

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |                        |   |  |         |
|--|-----|------------------------|---|--|---------|
| 1987 Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 82.64                  | 0.056   | -0.012 (0.006)                           | 0.049   |
| Medium   | 283 | 80.92                  |   |  |         |
| High   | 281 | 81.52                  |   |  |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of  $\alpha$ -1-acid glycoprotein versus log<sub>2</sub> (1987 dioxin + 1).

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

In the Model 3 unadjusted analysis of  $\alpha$ -1-acid glycoprotein, a significant difference between Ranch Hands in the high dioxin category and Comparisons was found (Table 13-45(e): difference of means=2.73 mg/dl,  $p=0.045$ ). The adjusted analysis showed no significant contrasts between each of the dioxin categories and Comparisons (Table 13-45(f):  $p>0.38$  for each contrast).

No significant association between  $\alpha$ -1-acid glycoprotein and 1987 dioxin was revealed in the unadjusted Model 4 analysis (Table 13-45(g):  $p=0.336$ ). After covariate adjustment, a significant inverse relation was found (Table 13-45(h): adjusted slope=-0.012,  $p=0.049$ ). The mean  $\alpha$ -1-acid glycoprotein levels in the low, medium, and high 1987 dioxin categories were 82.64 mg/dl, 80.92 mg/dl, and 81.52 mg/dl, respectively.

#### 13.2.2.3.37 $\alpha$ -1-Acid Glycoprotein (Discrete)

The unadjusted analysis of  $\alpha$ -1-acid glycoprotein in Model 1 did not show a significant group difference between Ranch Hands and Comparisons overall or after stratifying by occupation (Table 13-46(a):  $p>0.10$  for each contrast). The adjusted analysis revealed a marginally significant difference between Ranch Hands and Comparisons among the enlisted groundcrew stratum (Table 13-46(b): Adj. RR=1.86,  $p=0.066$ ). The percentage of Ranch Hand enlisted groundcrew with high  $\alpha$ -1-acid glycoprotein levels was 5.4 versus 3.2 of Comparison enlisted groundcrew.

**Table 13-46. Analysis of  $\alpha$ -1-Acid Glycoprotein (Discrete)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                 |                               |         |
|--|------------|-------|-----------------|-------------------------------|---------|
| Occupational Category  | Group      | n     | Number (%) High | Est. Relative Risk (95% C.I.) | p-Value |
| All  | Ranch Hand | 859   | 37 (4.3)        | 1.34 (0.85,2.11)              | 0.209   |
|  | Comparison | 1,231 | 40 (3.2)        |                               |         |
| Officer  | Ranch Hand | 340   | 8 (2.4)         | 0.76 (0.32,1.82)              | 0.542   |
|  | Comparison | 490   | 15 (3.1)        |                               |         |
| Enlisted Flyer   | Ranch Hand | 150   | 9 (6.0)         | 1.62 (0.59,4.47)              | 0.348   |
|  | Comparison | 185   | 7 (3.8)         |                               |         |
| Enlisted Groundcrew  | Ranch Hand | 369   | 20 (5.4)        | 1.71 (0.89,3.28)              | 0.105   |
|  | Comparison | 556   | 18 (3.2)        |                               |         |

**Table 13-46. Analysis of  $\alpha$ -1-Acid Glycoprotein (Discrete) (Continued)**

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

| Occupational Category | Adjusted Relative Risk<br>(95% C.I.) | p-Value |
|-----------------------|--------------------------------------|---------|
| All                   | 1.39 (0.88,2.21)                     | 0.163   |
| Officer               | 0.73 (0.31,1.76)                     | 0.487   |
| Enlisted Flyer        | 1.78 (0.64,4.95)                     | 0.270   |
| Enlisted Groundcrew   | 1.86 (0.96,3.60)                     | 0.066   |

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

| Initial Dioxin Category Summary Statistics |     |                    | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
|--|-----|--------------------|---|---------|
| Initial Dioxin                             | n   | Number (%)<br>High | Estimated Relative Risk<br>(95% C.I.) <sup>b</sup>                  | p-Value |
| Low  | 158 | 6 (3.8)            | 1.00 (0.72,1.38)  | 0.991   |
| Medium                                     | 159 | 10 (6.3)           |   |         |
| High                                       | 159 | 7 (4.4)            |   |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> 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 <sub>2</sub> (Initial Dioxin) |   |         |
|--|---|---------|
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 473  | 0.92 (0.63,1.35)                                  | 0.684   |

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

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

| Dioxin Category  | n     | Number (%)<br>High | Est. Relative Risk<br>(95% C.I.) <sup>ab</sup> | p-Value |
|------------------|-------|--------------------|--|---------|
| Comparison       | 1,194 | 39 (3.3)           |  |         |
| Background RH    | 376   | 13 (3.5)           | 1.00 (0.52,1.90)                               | 0.992   |
| Low RH           | 236   | 11 (4.7)           | 1.47 (0.74,2.91)                               | 0.272   |
| High RH          | 240   | 12 (5.0)           | 1.65 (0.85,3.21)                               | 0.141   |
| Low plus High RH | 476   | 23 (4.8)           | 1.56 (0.92,2.64)                               | 0.101   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> 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 13-46. Analysis of  $\alpha$ -1-Acid Glycoprotein (Discrete) (Continued)**

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |   |         |
|---|-------|---|---------|
| Dioxin Category   | n     | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| Comparison  | 1,193 |   |         |
| Background RH   | 374   | 1.12 (0.58,2.16)                                  | 0.745   |
| Low RH  | 235   | 1.47 (0.73,2.94)                                  | 0.279   |
| High RH   | 238   | 1.54 (0.77,3.08)                                  | 0.222   |
| Low plus High RH  | 473   | 1.50 (0.88,2.58)                                  | 0.138   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                    |   |
|--|-----|--------------------|---|
| 1987 Dioxin Category Summary Statistics                    |     |                    | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)       |
| 1987 Dioxin  | n   | Number (%)<br>High | Estimated Relative Risk<br>(95% C.I.) <sup>a</sup><br>p-Value |
| Low  | 283 | 11 (3.9)           | 1.00 (0.80,1.25)<br>0.986                                     |
| Medium   | 285 | 9 (3.2)            |   |
| High   | 284 | 16 (5.6)           |   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |   |  |   |
|--|---|--|---|
|  |   |  | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> |  | p-Value   |
| 847  | 0.87 (0.68,1.11)                                  |  | 0.261   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

All unadjusted and adjusted analyses in Models 2 through 4 showed no significant relation between dioxin and dichotomized  $\alpha$ -1-acid glycoprotein (Table 13-46(c–h):  $p > 0.10$  for each analysis).

#### 13.2.2.3.38 $\alpha$ -1-Antitrypsin (Continuous)

Both the unadjusted and adjusted Model 1 analyses of  $\alpha$ -1-antitrypsin revealed significant overall group differences (Table 13-47(a,b): difference of means=3.5 mg/dl,  $p=0.002$ ; difference of adjusted means=3.6 mg/dl,  $p=0.001$ , respectively). The adjusted mean  $\alpha$ -1-antitrypsin level was 146.7 mg/dl for all Ranch Hands and 143.1 mg/dl for all Comparisons. After stratifying by occupation, the unadjusted and adjusted analyses each showed a significant difference between Ranch Hands and Comparisons among the enlisted groundcrew (Table 13-47(a,b): difference of means=5.5 mg/dl,  $p=0.001$ , unadjusted; difference of adjusted means=5.9 mg/dl,  $p < 0.001$ , adjusted). In addition, stratifying by occupation in the adjusted analysis revealed a marginally significant difference between Ranch Hands and Comparisons within the

enlisted flyer stratum (Table 13-47(b): difference of adjusted means=4.7 mg/dl,  $p=0.086$ ). The adjusted mean  $\alpha$ -1-antitrypsin levels for Ranch Hands and Comparisons in the enlisted flyer stratum were 150.5 mg/dl and 145.9 mg/dl, respectively. Within the enlisted groundcrew stratum, the adjusted mean  $\alpha$ -1-antitrypsin levels were 151.5 mg/dl and 145.6 mg/dl for Ranch Hands and Comparisons, respectively.

**Table 13-47. Analysis of  $\alpha$ -1-Antitrypsin (mg/dl) (Continuous)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |                   |       |                   |   |                      |
|--|-------------------|-------|-------------------|---|----------------------|
| Occupational Category  | Group             | n     | Mean <sup>a</sup> | Difference of Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| <i>All</i>   | <i>Ranch Hand</i> | 859   | 150.0             | 3.5 --                                      | 0.002                |
|  | <i>Comparison</i> | 1,231 | 146.5             |   |                      |
| Officer  | Ranch Hand        | 340   | 143.9             | 0.9 --                                      | 0.609                |
|  | Comparison        | 490   | 143.0             |   |                      |
| Enlisted Flyer   | Ranch Hand        | 150   | 155.3             | 4.2 --                                      | 0.136                |
|  | Comparison        | 185   | 151.1             |   |                      |
| Enlisted Groundcrew  | Ranch Hand        | 369   | 153.5             | 5.5 --                                      | 0.001                |
|  | Comparison        | 556   | 148.0             |   |                      |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |                   |       |                        |  |                      |
|--|-------------------|-------|------------------------|--|----------------------|
| Occupational Category                                      | Group             | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| <i>All</i>   | <i>Ranch Hand</i> | 854   | 146.7                  | 3.6 --   | 0.001                |
|  | <i>Comparison</i> | 1,229 | 143.1                  |  |                      |
| Officer  | Ranch Hand        | 340   | 138.6                  | 0.7 --   | 0.693                |
|  | Comparison        | 489   | 137.9                  |  |                      |
| Enlisted Flyer   | Ranch Hand        | 148   | 150.5                  | 4.7 --   | 0.086                |
|  | Comparison        | 184   | 145.9                  |  |                      |
| Enlisted Groundcrew  | Ranch Hand        | 366   | 151.5                  | 5.9 --   | <0.001               |
|  | Comparison        | 556   | 145.6                  |  |                      |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

**Table 13-47. Analysis of  $\alpha$ -1-Antitrypsin (mg/dl) (Continuous) (Continued)**

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                   |                         |   |                                 |         |
|---|-----|-------------------|-------------------------|---|---------------------------------|---------|
| Initial Dioxin Category Summary Statistics                    |     |                   |                         | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>b</sup> |                                 |         |
| Initial Dioxin  | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>  | Slope (Std. Error) <sup>c</sup> | p-Value |
| Low   | 158 | 148.4             | 148.2                   | 0.013   | 0.066 (0.036)                   | 0.071   |
| Medium  | 159 | 153.8             | 153.7                   |   |                                 |         |
| High  | 159 | 151.8             | 152.1                   |   |                                 |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on square root of  $\alpha$ -1-antitrypsin versus log<sub>2</sub> (initial dioxin).

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

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |     |                        |  |  |                                      |         |
|---|-----|------------------------|--|--|--------------------------------------|---------|
| Initial Dioxin Category Summary Statistics                  |     |                        |  | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |                                      |         |
| Initial Dioxin  | n   | Adj. Mean <sup>a</sup> |  | R <sup>2</sup>   | Adj. Slope (Std. Error) <sup>b</sup> | p-Value |
| Low   | 158 | 145.0                  |  | 0.101  | 0.023 (0.041)                        | 0.582   |
| Medium  | 158 | 148.8                  |  |  |                                      |         |
| High  | 157 | 145.6                  |  |  |                                      |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of  $\alpha$ -1-antitrypsin versus log<sub>2</sub> (initial dioxin).

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

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |       |                   |                         |   |  |                      |
|---|-------|-------------------|-------------------------|---|--|----------------------|
| Dioxin Category   | n     | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean vs. Comparisons (95% C.I.) <sup>c</sup> |  | p-Value <sup>d</sup> |
| Comparison  | 1,194 | 146.8             | 146.8                   |   |  |                      |
| Background RH   | 376   | 148.0             | 147.9                   | 1.1 --  |  | 0.470                |
| Low RH  | 236   | 148.8             | 148.9                   | 2.1 --  |  | 0.244                |
| High RH   | 240   | 153.8             | 154.0                   | 7.2 --  |  | <0.001               |
| Low plus High RH  | 476   | 151.3             | 151.4                   | 4.6 --  |  | 0.001                |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>d</sup> P-value is based on difference of means on square root scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

**Table 13-47. Analysis of  $\alpha$ -1-Antitrypsin (mg/dl) (Continuous) (Continued)**

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |                        |   |                      |
|---|-------|------------------------|---|----------------------|
| Dioxin Category   | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| Comparison  | 1,193 | 143.8                  |   |                      |
| Background RH   | 374   | 147.2                  | 3.4 --  | 0.024                |
| Low RH  | 235   | 145.5                  | 1.7 --  | 0.339                |
| High RH   | 238   | 148.4                  | 4.6 --  | 0.011                |
| Low plus High RH  | 473   | 147.0                  | 3.2 --  | 0.020                |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                   | <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |   |         |
|--|-----|-------------------|---|---|---------|
| 1987 Dioxin Category Summary Statistics                    |     |                   |   |   |         |
| 1987 Dioxin  | n   | Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 148.3             | 0.003   | 0.040 (0.025)                               | 0.109   |
| Medium   | 285 | 148.2             |   |   |         |
| High   | 284 | 153.1             |   |   |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of  $\alpha$ -1-antitrypsin versus log<sub>2</sub> (1987 dioxin + 1).

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |                        | <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |   |         |
|--|-----|------------------------|---|---|---------|
| 1987 Dioxin Category Summary Statistics                  |     |                        |   |   |         |
| 1987 Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 147.2                  | 0.102   | -0.047 (0.027)                              | 0.089   |
| Medium   | 283 | 145.2                  |   |   |         |
| High   | 281 | 145.0                  |   |   |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of  $\alpha$ -1-antitrypsin versus log<sub>2</sub> (1987 dioxin + 1).

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

The unadjusted Model 2 analysis revealed a marginally significant positive association between  $\alpha$ -1-antitrypsin and initial dioxin (Table 13-47(c): slope=0.066, p=0.071). After adjusting for covariates, the relation became nonsignificant (Table 13-47(d): p=0.582).

The unadjusted Model 3 analysis revealed a marginally significant difference in mean  $\alpha$ -1-antitrypsin levels 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 13-47(e): difference of means=7.2 mg/dl,  $p<0.001$ ; difference of means=4.6 mg/dl,  $p=0.001$ , respectively).

Three significant contrasts were found in the adjusted Model 3 analysis of  $\alpha$ -1-antitrypsin: Ranch Hands in the background dioxin category versus Comparisons (Table 13-47(f): difference of adjusted means=3.4 mg/dl,  $p=0.024$ ), Ranch Hands in the high dioxin category versus Comparisons (difference of adjusted means=4.6 mg/dl,  $p=0.011$ ), and Ranch Hands in the low and high dioxin categories combined versus Comparisons (difference of adjusted means=3.2 mg/dl,  $p=0.020$ ). The adjusted mean  $\alpha$ -1-antitrypsin levels for Ranch Hands in the background dioxin category, Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 147.2 mg/dl, 148.4 mg/dl, 147.0 mg/dl, and 143.8 mg/dl, respectively.

The unadjusted Model 4 analysis results were nonsignificant (Table 13-47(g):  $p=0.109$ ). After adjusting for covariates, a marginally significant inverse relation between  $\alpha$ -1-antitrypsin and 1987 dioxin was seen (Table 13-47(g): adjusted slope=-0.047,  $p=0.089$ ). The adjusted mean  $\alpha$ -1-antitrypsin levels in the low, medium, and high 1987 dioxin categories were 147.2 mg/dl, 145.2 mg/dl, and 145.0 mg/dl, respectively.

#### 13.2.2.3.39 $\alpha$ -1-Antitrypsin (Discrete)

All unadjusted and adjusted results for Models 1 through 4 did not reveal a significant association between the percentage of individuals with low  $\alpha$ -1-antitrypsin levels and dioxin or between the percentage of individuals with high  $\alpha$ -1-antitrypsin levels and dioxin (Table 13-48(a-h):  $p>0.11$  for all analyses).



Table 13-48. Analysis of  $\alpha$ -1-Antitrypsin (Discrete)

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

| Occupational Category | Group             | n     | Number (%)   |              |               | Abnormal Low vs. Normal       |         | Abnormal High vs. Normal      |                    |
|-----------------------|-------------------|-------|--------------|--------------|---------------|-------------------------------|---------|-------------------------------|--------------------|
|                       |                   |       | Abnormal Low | Normal       | Abnormal High | Est. Relative Risk (95% C.I.) | p-Value | Est. Relative Risk (95% C.I.) | p-Value            |
| <i>All</i>            | <i>Ranch Hand</i> | 859   | 11 (1.3)     | 840 (97.8)   | 8 (0.9)       | 0.88 (0.41,1.87)              | 0.737   | 2.30 (0.75,7.06)              | 0.145              |
|                       | <i>Comparison</i> | 1,231 | 18 (1.5)     | 1,208 (98.1) | 5 (0.4)       |                               |         |                               |                    |
| Officer               | Ranch Hand        | 340   | 8 (2.4)      | 330 (97.1)   | 2 (0.6)       | 1.06 (0.42,2.65)              | 0.908   | --                            | 0.327 <sup>a</sup> |
|                       | Comparison        | 490   | 11 (2.2)     | 479 (97.8)   | 0 (0.0)       |                               |         |                               |                    |
| Enlisted              | Ranch Hand        | 150   | 1 (0.7)      | 148 (98.7)   | 1 (0.7)       | 1.23 (0.08,19.83)             | 0.884   | 0.61 (0.07,5.25)              | 0.657              |
| Flyer                 | Comparison        | 185   | 1 (0.5)      | 182 (98.4)   | 2 (1.1)       |                               |         |                               |                    |
| Enlisted              | Ranch Hand        | 369   | 2 (0.5)      | 362 (98.1)   | 5 (1.4)       | 0.50 (0.10,2.51)              | 0.403   | 2.52 (0.61,10.42)             | 0.202              |
| Groundcrew            | Comparison        | 556   | 6 (1.1)      | 547 (98.4)   | 3 (0.5)       |                               |         |                               |                    |

<sup>a</sup> P-value determined using a chi-square test with continuity correction because of the sparse number of participants with abnormal high  $\alpha$ -1-antitrypsin levels.

--: Results not presented because of the sparse number of participants with abnormal high  $\alpha$ -1-antitrypsin levels.

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

| Occupational Category | Abnormal Low vs. Normal       |         | Abnormal High vs. Normal      |         |
|-----------------------|-------------------------------|---------|-------------------------------|---------|
|                       | Adj. Relative Risk (95% C.I.) | p-Value | Adj. Relative Risk (95% C.I.) | p-Value |
| <i>All</i>            | 0.81 (0.37,1.78)              | 0.606   | 2.51 (0.80,7.90)              | 0.116   |
| Officer               | 1.10 (0.44,2.78)              | 0.834   | --                            | --      |
| Enlisted Flyer        | --                            | --      | 0.73 (0.08,6.49)              | 0.778   |
| Enlisted Groundcrew   | 0.47 (0.10,2.34)              | 0.358   | 2.69 (0.63,11.58)             | 0.183   |

--: Results not presented because of the sparse number of participants with abnormal  $\alpha$ -1-antitrypsin levels.

Note: Results are not adjusted for race because of the sparse number of participants with abnormal  $\alpha$ -1-antitrypsin levels.

**Table 13-48. Analysis of  $\alpha$ -1-Antitrypsin (Discrete) (Continued)**

**(c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED**

| Initial Dioxin Category Summary Statistics |     |              |            |               | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |  |         |
|--|-----|--------------|------------|---------------|---|---------|--|---------|
| Initial Dioxin Category                    | n   | Number (%)   |            |               | Abnormal Low vs. Normal   |         | Abnormal High vs. Normal                   |         |
|  |     | Abnormal Low | Normal     | Abnormal High | Est. Relative Risk (95% C.I.) <sup>b</sup>                          | p-Value | Est. Relative Risk (95% C.I.) <sup>b</sup> | p-Value |
| Low  | 158 | 1 (0.6)      | 156 (98.7) | 1 (0.6)       | 0.83 (0.37,1.90)  | 0.667   | 1.05 (0.39,2.80)                           | 0.925   |
| Medium                                     | 159 | 2 (1.3)      | 156 (98.1) | 1 (0.6)       |   |         |  |         |
| High                                       | 159 | 1 (0.6)      | 157 (98.7) | 1 (0.6)       |   |         |  |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> 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 <sub>2</sub> (Initial Dioxin) |  |         |  |         |
|--|--|---------|--|---------|
| n  | Abnormal Low vs. Normal                    |         | Abnormal High vs. Normal                   |         |
|  | Adj. Relative Risk (95% C.I.) <sup>a</sup> | p-Value | Adj. Relative Risk (95% C.I.) <sup>a</sup> | p-Value |
| 473  | 0.75 (0.30,1.84)                           | 0.526   | 0.80 (0.21,3.00)                           | 0.735   |

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race, occupation, current wine consumption, and degreasing chemical exposure because of the sparse number of participants with abnormal  $\alpha$ -1-antitrypsin levels.

**Table 13-48. Analysis of  $\alpha$ -1-Antitrypsin (Discrete) (Continued)**

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

| Dioxin Category  | n     | Number (%)   |              |               | Abnormal Low vs. Normal                     |         | Abnormal High vs. Normal                    |         |
|------------------|-------|--------------|--------------|---------------|---|---------|---|---------|
|                  |       | Abnormal Low | Normal       | Abnormal High | Est. Relative Risk (95% C.I.) <sup>ab</sup> | p-Value | Est. Relative Risk (95% C.I.) <sup>ab</sup> | p-Value |
| Comparison       | 1,194 | 17 (1.4)     | 1,172 (98.2) | 5 (0.4)       |   |         |   |         |
| Background RH    | 376   | 7 (1.9)      | 364 (96.8)   | 5 (1.3)       | 1.14 (0.47,2.79)                            | 0.772   | 2.48 (0.70,8.77)                            | 0.158   |
| Low RH           | 236   | 2 (0.8)      | 233 (98.7)   | 1 (0.4)       | 0.61 (0.14,2.67)                            | 0.513   | 1.03 (0.11,9.33)                            | 0.976   |
| High RH          | 240   | 2 (0.8)      | 236 (98.3)   | 2 (0.8)       | 0.68 (0.16,2.98)                            | 0.610   | 3.49 (0.64,19.06)                           | 0.149   |
| Low plus High RH | 476   | 4 (0.8)      | 469 (98.5)   | 3 (0.6)       | 0.65 (0.22,1.93)                            | 0.434   | 1.91 (0.42,8.72)                            | 0.404   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

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

| Dioxin Category  | n     | Abnormal Low vs. Normal                    |         | Abnormal High vs. Normal                   |         |
|------------------|-------|--|---------|--|---------|
|                  |       | Adj. Relative Risk (95% C.I.) <sup>a</sup> | p-Value | Adj. Relative Risk (95% C.I.) <sup>a</sup> | p-Value |
| Comparison       | 1,193 |  |         |  |         |
| Background RH    | 374   | 0.78 (0.30,2.01)                           | 0.602   | 2.76 (0.74,10.35)                          | 0.131   |
| Low RH           | 235   | 0.76 (0.17,3.35)                           | 0.712   | 1.16 (0.13,10.62)                          | 0.895   |
| High RH          | 238   | 1.41 (0.28,7.06)                           | 0.677   | 2.64 (0.43,16.23)                          | 0.295   |
| Low plus High RH | 473   | 1.03 (0.32,3.31)                           | 0.955   | 1.75 (0.36,8.53)                           | 0.486   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

Results are not adjusted for race because of the sparse number of participants with abnormal  $\alpha$ -1-antitrypsin levels.

Table 13-48. Analysis of  $\alpha$ -1-Antitrypsin (Discrete) (Continued)

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

| 1987 Dioxin Category Summary Statistics |     |              |            |               | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |         |  |         |
|---|-----|--------------|------------|---------------|---|---------|--|---------|
| 1987 Dioxin Category                    | n   | Number (%)   |            |               | Abnormal Low vs. Normal                                 |         | Abnormal High vs. Normal                   |         |
|   |     | Abnormal Low | Normal     | Abnormal High | Est. Relative Risk (95% C.I.) <sup>a</sup>              | p-Value | Est. Relative Risk (95% C.I.) <sup>a</sup> | p-Value |
| Low                                     | 283 | 5 (1.8)      | 274 (96.8) | 4 (1.4)       | 0.76 (0.49,1.19)  | 0.229   | 0.80 (0.48,1.33)                           | 0.393   |
| Medium                                  | 285 | 3 (1.1)      | 280 (98.2) | 2 (0.7)       |   |         |  |         |
| High                                    | 284 | 3 (1.1)      | 279 (98.2) | 2 (0.7)       |   |         |  |         |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

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

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

| Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |  |         |
|---|--|---------|--|---------|
| n   | Abnormal Low vs. Normal                    |         | Abnormal High vs. Normal                   |         |
|   | Adj. Relative Risk (95% C.I.) <sup>a</sup> | p-Value | Adj. Relative Risk (95% C.I.) <sup>a</sup> | p-Value |
| 847   | 0.84 (0.52,1.37)                           | 0.486   | 0.75 (0.44,1.29)                           | 0.302   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race and occupation because of the sparse number of participants with abnormal  $\alpha$ -1-antitrypsin levels.

### 13.2.2.3.40 $\alpha$ -2-Macroglobulin (Continuous)

All unadjusted and adjusted analyses of Models 1 through 4 showed no significant associations between dioxin and  $\alpha$ -2-macroglobulin in its continuous form (Table 13-49(a-h):  $p > 0.23$  for each analysis).

**Table 13-49. Analysis of  $\alpha$ -2-Macroglobulin (mg/dl) (Continuous)**

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

| Occupational Category | Group             | n     | Mean <sup>a</sup> | Difference of Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|-----------------------|-------------------|-------|-------------------|---|----------------------|
| <i>All</i>            | <i>Ranch Hand</i> | 859   | 170.6             | -0.7 --                                     | 0.726                |
|                       | <i>Comparison</i> | 1,231 | 171.3             |   |                      |
| Officer               | Ranch Hand        | 340   | 170.6             | -0.4 --                                     | 0.901                |
|                       | Comparison        | 490   | 171.0             |   |                      |
| Enlisted Flyer        | Ranch Hand        | 150   | 177.0             | -0.4 --                                     | 0.935                |
|                       | Comparison        | 185   | 177.4             |   |                      |
| Enlisted Groundcrew   | Ranch Hand        | 369   | 168.1             | -1.5 --                                     | 0.608                |
|                       | Comparison        | 556   | 169.6             |   |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> 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 <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|-----------------------|-------------------|-------|------------------------|--|----------------------|
| <i>All</i>            | <i>Ranch Hand</i> | 854   | 161.9                  | -0.9 --  | 0.610                |
|                       | <i>Comparison</i> | 1,229 | 162.8                  |  |                      |
| Officer               | Ranch Hand        | 340   | 154.5                  | -1.2 --  | 0.643                |
|                       | Comparison        | 489   | 155.7                  |  |                      |
| Enlisted Flyer        | Ranch Hand        | 148   | 163.8                  | -1.9 --  | 0.664                |
|                       | Comparison        | 184   | 165.7                  |  |                      |
| Enlisted Groundcrew   | Ranch Hand        | 366   | 167.4                  | -0.2 --  | 0.951                |
|                       | Comparison        | 556   | 167.6                  |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

**Table 13-49. Analysis of  $\alpha$ -2-Macroglobulin (mg/dl) (Continuous) (Continued)**

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                   |                         |   |                                    |         |
|---|-----|-------------------|-------------------------|---|------------------------------------|---------|
| Initial Dioxin Category Summary Statistics                    |     |                   |                         | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>b</sup> |                                    |         |
| Initial Dioxin  | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>  | Slope<br>(Std. Error) <sup>c</sup> | p-Value |
| Low   | 158 | 168.1             | 168.1                   | <0.001  | -0.004 (0.009)                     | 0.698   |
| Medium  | 159 | 175.3             | 175.3                   |   |                                    |         |
| High  | 159 | 167.4             | 167.4                   |   |                                    |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on natural logarithm of  $\alpha$ -2-macroglobulin versus log<sub>2</sub> (initial dioxin).

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

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |     |                        |  |  |   |         |
|---|-----|------------------------|--|--|---|---------|
| Initial Dioxin Category Summary Statistics                  |     |                        |  | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |   |         |
| Initial Dioxin  | n   | Adj. Mean <sup>a</sup> |  | R <sup>2</sup>   | Adj. Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low   | 158 | 154.2                  |  | 0.135  | 0.009 (0.010)                           | 0.368   |
| Medium  | 158 | 163.5                  |  |  |   |         |
| High  | 157 | 161.3                  |  |  |   |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of  $\alpha$ -2-macroglobulin versus log<sub>2</sub> (initial dioxin).

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

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |       |                   |                         |   |  |                      |
|---|-------|-------------------|-------------------------|---|--|----------------------|
| Dioxin Category   | n     | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>c</sup> |  | p-Value <sup>d</sup> |
| Comparison  | 1,194 | 171.2             | 171.2                   |   |  |                      |
| Background RH   | 376   | 170.2             | 170.2                   | -1.0 --   |  | 0.706                |
| Low RH  | 236   | 170.2             | 170.2                   | -1.0 --   |  | 0.747                |
| High RH   | 240   | 170.2             | 170.2                   | -1.0 --   |  | 0.741                |
| Low plus High RH  | 476   | 170.2             | 170.2                   | -1.0 --   |  | 0.669                |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

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

<sup>d</sup> P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

**Table 13-49. Analysis of  $\alpha$ -2-Macroglobulin (mg/dl) (Continuous) (Continued)**

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |                        |   |                      |
|---|-------|------------------------|---|----------------------|
| Dioxin Category   | n     | ADJ. Mean <sup>a</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| Comparison  | 1,193 | 163.2                  |   |                      |
| Background RH   | 374   | 162.2                  | -1.0 --   | 0.683                |
| Low RH  | 235   | 159.9                  | -3.3 --   | 0.232                |
| High RH   | 238   | 163.3                  | 0.1 --  | 0.959                |
| Low plus High RH  | 473   | 161.6                  | -1.6 --   | 0.461                |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

| (g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED |     |                   |  |   |         |
|---|-----|-------------------|--|---|---------|
| 1987 Dioxin Category Summary Statistics             |     |                   | Analysis Results for Log <sub>2</sub> (1987 Dioxin +1) |   |         |
| 1987 Dioxin   | n   | Mean <sup>a</sup> | R <sup>2</sup>   | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low   | 283 | 169.9             | <0.001   | -0.004 (0.006)                              | 0.522   |
| Medium  | 285 | 170.6             |  |   |         |
| High  | 284 | 170.2             |  |   |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of  $\alpha$ -2-macroglobulin versus log<sub>2</sub> (1987 dioxin + 1).

Note: Low =  $\leq$ 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 <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin                                       | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low   | 283 | 162.9                  | 0.131   | -0.005 (0.006)                           | 0.390   |
| Medium  | 283 | 161.1                  |   |  |         |
| High  | 281 | 162.8                  |   |  |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of  $\alpha$ -2-macroglobulin versus log<sub>2</sub> (1987 dioxin + 1).

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

### 13.2.2.3.41 $\alpha$ -2-Macroglobulin (Discrete)

The unadjusted and adjusted Model 1 analyses of  $\alpha$ -2-macroglobulin were nonsignificant (Table 13-50(a,b):  $p > 0.15$  for each analysis). The unadjusted Model 2 analysis was not significant (Table 13-50(c):  $p = 0.254$ ), but the adjusted analysis was marginally significant (Table 13-50(d): Adj. RR=1.48,  $p = 0.072$ ).

The unadjusted Model 3 analysis revealed a marginally significant difference in high  $\alpha$ -2-macroglobulin levels between Ranch Hands in the background dioxin category and Comparisons (Table 13-50(e): Est. RR=0.46,  $p = 0.080$ ). The percentage of Ranch Hands in the background category with high  $\alpha$ -2-macroglobulin levels was 1.6 versus 3.8 for Comparisons. The same contrast was marginally significant in the adjusted Model 3 analysis (Table 13-50(f): Adj. RR=0.45,  $p = 0.079$ ).

**Table 13-50. Analysis of  $\alpha$ -2-Macroglobulin (Discrete)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                 |                               |         |
|--|------------|-------|-----------------|-------------------------------|---------|
| Occupational Category  | Group      | n     | Number (%) High | Est. Relative Risk (95% C.I.) | p-Value |
| All  | Ranch Hand | 859   | 24 (2.8)        | 0.72 (0.44,1.19)              | 0.199   |
|  | Comparison | 1,231 | 47 (3.8)        |                               |         |
| Officer  | Ranch Hand | 340   | 8 (2.4)         | 0.63 (0.27,1.47)              | 0.287   |
|  | Comparison | 490   | 18 (3.7)        |                               |         |
| Enlisted Flyer   | Ranch Hand | 150   | 5 (3.3)         | 0.55 (0.19,1.61)              | 0.271   |
|  | Comparison | 185   | 11 (5.9)        |                               |         |
| Enlisted Groundcrew  | Ranch Hand | 369   | 11 (3.0)        | 0.92 (0.43,1.97)              | 0.827   |
|  | Comparison | 556   | 18 (3.2)        |                               |         |

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |                                   |         |
|--|-----------------------------------|---------|
| Occupational Category                                      | Adjusted Relative Risk (95% C.I.) | p-Value |
| All  | 0.70 (0.42,1.16)                  | 0.157   |
| Officer  | 0.59 (0.25,1.40)                  | 0.234   |
| Enlisted Flyer   | 0.46 (0.15,1.39)                  | 0.169   |
| Enlisted Groundcrew  | 1.01 (0.46,2.19)                  | 0.988   |

Note: Results are not adjusted for race because of the sparse number of participants with high  $\alpha$ -2-macroglobulin levels.

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                 |   |         |
|---|-----|-----------------|---|---------|
| Initial Dioxin Category Summary Statistics                    |     |                 | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
| Initial Dioxin  | n   | Number (%) High | Estimated Relative Risk (95% C.I.) <sup>b</sup>                     | p-Value |
| Low   | 158 | 2 (1.3)         | 1.22 (0.87,1.71)  | 0.254   |
| Medium  | 159 | 10 (6.3)        |   |         |
| High  | 159 | 5 (3.1)         |   |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

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



**Table 13-50. Analysis of  $\alpha$ -2-Macroglobulin (Discrete) (Continued)**

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |   |         |
|---|---|---------|
| Analysis Results for Log <sub>2</sub> (Initial Dioxin)      |   |         |
| n   | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 473   | 1.48 (0.96,2.27)                                  | 0.072   |

<sup>a</sup> 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 high  $\alpha$ -2-macroglobulin levels.

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |       |                    |  |         |
|---|-------|--------------------|--|---------|
| Dioxin Category   | n     | Number (%)<br>High | Est. Relative Risk<br>(95% C.I.) <sup>ab</sup> | p-Value |
| Comparison  | 1,194 | 45 (3.8)           |  |         |
| Background RH   | 376   | 6 (1.6)            | 0.46 (0.19,1.10)                               | 0.080   |
| Low RH  | 236   | 7 (3.0)            | 0.75 (0.33,1.69)                               | 0.492   |
| High RH   | 240   | 10 (4.2)           | 1.00 (0.49,2.03)                               | 0.999   |
| Low plus High RH  | 476   | 17 (3.6)           | 0.87 (0.49,1.55)                               | 0.632   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |   |         |
|---|-------|---|---------|
| Dioxin Category   | n     | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| Comparison  | 1,193 |   |         |
| Background RH   | 374   | 0.45 (0.19,1.10)                                  | 0.079   |
| Low RH  | 235   | 0.61 (0.27,1.40)                                  | 0.246   |
| High RH   | 238   | 1.09 (0.51,2.31)                                  | 0.823   |
| Low plus High RH  | 473   | 0.82 (0.45,1.49)                                  | 0.511   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

Results are not adjusted for race because of the sparse number of participants with high  $\alpha$ -2-macroglobulin levels.

**Table 13-50. Analysis of  $\alpha$ -2-Macroglobulin (Discrete) (Continued)**

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                    |   |
|--|-----|--------------------|---|
| 1987 Dioxin Category Summary Statistics                    |     |                    | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)           |
| 1987 Dioxin  | n   | Number (%)<br>High | Estimated Relative Risk<br>(95% C.I.) <sup>a</sup><br><br>p-Value |
| Low  | 283 | 3 (1.1)            | 1.37 (1.06,1.77)<br><br>0.020                                     |
| Medium   | 285 | 8 (2.8)            |   |
| High   | 284 | 12 (4.2)           |   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |   |   |
|--|-----|---|---|
|  |     |   | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |
|  | n   | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value   |
|  | 847 | 1.50 (1.08,2.08)                                  | 0.014   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race because of the sparse number of participants with high  $\alpha$ -2-macroglobulin levels.

Both the unadjusted and adjusted Model 4 analyses revealed significant associations between  $\alpha$ -2-macroglobulin and 1987 dioxin (Table 13-50(g,h): Est. RR=1.37,  $p=0.020$ ; Adj. RR=1.50,  $p=0.014$ , respectively). The percentages of participants with high  $\alpha$ -2-macroglobulin values in the low, medium, and high 1987 dioxin categories were 1.1, 2.8, and 4.2, respectively.

#### 13.2.2.3.42 Apolipoprotein B (mg/dl) (Continuous)

The Model 1 analysis of apolipoprotein B did not show a significant overall difference between Ranch Hands and Comparisons in either the unadjusted or adjusted analyses (Table 13-51(a,b):  $p>0.27$  for each analysis). After stratifying by occupation, a significant difference between Ranch Hands and Comparisons was discovered among the officers in both the unadjusted and adjusted analyses (Table 13-51(a,b): difference of means= $-3.3$  mg/dl,  $p=0.053$ , for the unadjusted analysis; difference of adjusted means= $-3.3$  mg/dl,  $p=0.048$ , for the adjusted analysis). The adjusted mean apolipoprotein B level among the Ranch Hand officers was 105.9 mg/dl versus 109.2 mg/dl among the Comparison officers.

**Table 13-51. Analysis of Apolipoprotein B (mg/dl) (Continuous)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |                   |       |                   |   |                      |
|--|-------------------|-------|-------------------|---|----------------------|
| Occupational Category  | Group             | n     | Mean <sup>a</sup> | Difference of Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| <i>All</i>   | <i>Ranch Hand</i> | 859   | 110.5             | -1.1 --                                     | 0.320                |
|  | <i>Comparison</i> | 1,231 | 111.5             |   |                      |
| Officer  | Ranch Hand        | 340   | 106.4             | -3.3 --                                     | 0.053                |
|  | Comparison        | 490   | 109.6             |   |                      |
| Enlisted Flyer   | Ranch Hand        | 150   | 113.2             | -2.0 --                                     | 0.463                |
|  | Comparison        | 185   | 115.2             |   |                      |
| Enlisted Groundcrew  | Ranch Hand        | 369   | 113.1             | 1.2 --                                      | 0.479                |
|  | Comparison        | 556   | 112.0             |   |                      |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |                   |       |                        |  |                      |
|--|-------------------|-------|------------------------|--|----------------------|
| Occupational Category                                      | Group             | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| <i>All</i>   | <i>Ranch Hand</i> | 854   | 110.6                  | -1.2 --  | 0.275                |
|  | <i>Comparison</i> | 1,229 | 111.8                  |  |                      |
| Officer  | Ranch Hand        | 340   | 105.9                  | -3.3 --  | 0.048                |
|  | Comparison        | 489   | 109.2                  |  |                      |
| Enlisted Flyer   | Ranch Hand        | 148   | 112.9                  | -2.2 --  | 0.413                |
|  | Comparison        | 184   | 115.1                  |  |                      |
| Enlisted Groundcrew  | Ranch Hand        | 366   | 112.6                  | 1.2 --   | 0.457                |
|  | Comparison        | 556   | 111.4                  |  |                      |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                   |                         | <b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>b</sup></b> |                                 |         |
|---|-----|-------------------|-------------------------|--|---------------------------------|---------|
| Initial Dioxin Category Summary Statistics                    |     |                   |                         |  |                                 |         |
| Initial Dioxin  | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>   | Slope (Std. Error) <sup>c</sup> | p-Value |
| Low   | 158 | 107.1             | 107.0                   | 0.014  | 0.107 (0.041)                   | 0.009   |
| Medium  | 159 | 113.9             | 113.9                   |  |                                 |         |
| High  | 159 | 114.5             | 114.6                   |  |                                 |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on square root of apolipoprotein B versus log<sub>2</sub> (initial dioxin).

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

**Table 13-51. Analysis of Apolipoprotein B (mg/dl) (Continuous) (Continued)**

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |     |                        |  |   |         |
|---|-----|------------------------|--|---|---------|
| Initial Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |   |         |
| Initial Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>   | Adj. Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low   | 158 | 108.5                  | 0.033  | 0.061 (0.048)                           | 0.209   |
| Medium  | 158 | 113.8                  |  |   |         |
| High  | 157 | 113.2                  |  |   |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of apolipoprotein B versus log<sub>2</sub> (initial dioxin).

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

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |       |                   |                         |   |                      |
|---|-------|-------------------|-------------------------|---|----------------------|
| Dioxin Category   | n     | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>c</sup> | p-Value <sup>d</sup> |
| Comparison  | 1,194 | 111.5             | 111.5                   |   |                      |
| Background RH   | 376   | 108.8             | 108.8                   | –2.7 --   | 0.057                |
| Low RH  | 236   | 108.9             | 108.9                   | –2.6 --   | 0.131                |
| High RH   | 240   | 114.7             | 114.6                   | 3.1 --  | 0.073                |
| Low plus High RH  | 476   | 111.8             | 111.8                   | 0.3 --  | 0.843                |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>d</sup> P-value is based on difference of means on square root 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.

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |                        |   |                      |
|---|-------|------------------------|---|----------------------|
| Dioxin Category   | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| Comparison  | 1,193 | 112.0                  |   |                      |
| Background RH   | 374   | 110.0                  | –2.0 --   | 0.170                |
| Low RH  | 235   | 109.5                  | –2.5 --   | 0.154                |
| High RH   | 238   | 113.6                  | 1.6 --  | 0.358                |
| Low plus High RH  | 473   | 111.6                  | –0.4 --   | 0.761                |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root 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 13-51. Analysis of Apolipoprotein B (mg/dl) (Continuous) (Continued)**

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                   |   |  |         |
|--|-----|-------------------|---|--|---------|
| 1987 Dioxin Category Summary Statistics                    |     |                   | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin  | n   | Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 109.2             | 0.011   | 0.083 (0.027)                            | 0.002   |
| Medium   | 285 | 108.0             |   |  |         |
| High   | 284 | 114.2             |   |  |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of apolipoprotein B versus log<sub>2</sub> (1987 dioxin + 1).

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |                        |   |  |         |
|--|-----|------------------------|---|--|---------|
| 1987 Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 111.0                  | 0.023   | 0.046 (0.031)                            | 0.142   |
| Medium   | 283 | 109.0                  |   |  |         |
| High   | 281 | 112.9                  |   |  |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of apolipoprotein B versus log<sub>2</sub> (1987 dioxin + 1).

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

The unadjusted Model 2 analysis revealed a significant relation between initial dioxin and apolipoprotein B (Table 13-51(c): slope=0.107, p=0.009). The adjusted analysis results were not significant (Table 13-51(d): p=0.209).

The unadjusted Model 3 analysis revealed two marginally significant contrasts: Ranch Hands in the background dioxin category versus Comparisons and Ranch Hands in the high dioxin category versus Comparisons (Table 13-51(e): difference of means=–2.7 mg/dl, p=0.057; difference of means=3.1 mg/dl, p=0.073, respectively). After adjusting for covariates, no contrasts were significant (Table 13-51(f): p>0.15 for each contrast).

The Model 4 unadjusted analysis of apolipoprotein B revealed a significant association with 1987 dioxin (Table 13-51(g): slope=0.083, p=0.002). The adjusted analysis was nonsignificant (Table 13-51(h): p=0.142).

The reference range between 1992 and 1997 decreased according to the manufacturer's recommendation. Consequently, the mean levels shown in Table 13-51 are less than the 1992 mean levels.

#### 13.2.2.3.43 Apolipoprotein B (Discrete)

Both the unadjusted and adjusted Model 1 analyses of apolipoprotein B in its dichotomous form revealed marginally significant overall group differences (Table 13-52(a,b): Est. RR=0.86, p=0.087; Adj. RR=0.85, p=0.073, respectively). After stratifying by occupation, unadjusted and adjusted analyses revealed group differences within the enlisted flyer stratum (Table 13-52(a,b): Est. RR=0.55, p=0.007; Adj. RR=0.53, p=0.005, respectively). The percentage of participants in the Ranch Hand group with high

apolipoprotein B values was 49.2 versus 53.0 for Comparisons. Within the enlisted flyer stratum, 48.0 percent of the Ranch Hands had high apolipoprotein B values versus 62.7 percent of the Comparisons. The unadjusted Model 2 analysis revealed a marginally significant association between apolipoprotein B and initial dioxin (Table 13-52(c): Est. RR=1.14, p=0.059). The adjusted analysis showed no significant results (Table 13-52(d): p=0.456).

**Table 13-52. Analysis of Apolipoprotein B (Discrete)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                    |                                  |         |
|--|------------|-------|--------------------|----------------------------------|---------|
| Occupational Category  | Group      | n     | Number (%)<br>High | Est. Relative Risk<br>(95% C.I.) | p-Value |
| All  | Ranch Hand | 859   | 423 (49.2)         | 0.86 (0.72,1.02)                 | 0.087   |
|  | Comparison | 1,231 | 653 (53.0)         |                                  |         |
| Officer  | Ranch Hand | 340   | 149 (43.8)         | 0.80 (0.61,1.06)                 | 0.114   |
|  | Comparison | 490   | 242 (49.4)         |                                  |         |
| Enlisted Flyer   | Ranch Hand | 150   | 72 (48.0)          | 0.55 (0.35,0.85)                 | 0.007   |
|  | Comparison | 185   | 116 (62.7)         |                                  |         |
| Enlisted Groundcrew  | Ranch Hand | 369   | 202 (54.7)         | 1.07 (0.82,1.39)                 | 0.615   |
|  | Comparison | 556   | 295 (53.1)         |                                  |         |

  

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |                                      |         |
|--|--------------------------------------|---------|
| Occupational Category                                      | Adjusted Relative Risk<br>(95% C.I.) | p-Value |
| All  | 0.85 (0.71,1.02)                     | 0.073   |
| Officer  | 0.80 (0.61,1.06)                     | 0.115   |
| Enlisted Flyer   | 0.53 (0.34,0.82)                     | 0.005   |
| Enlisted Groundcrew  | 1.07 (0.82,1.40)                     | 0.603   |

  

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                    |   |         |
|---|-----|--------------------|---|---------|
| Initial Dioxin Category Summary Statistics                    |     |                    | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
| Initial Dioxin  | n   | Number (%)<br>High | Estimated Relative Risk<br>(95% C.I.) <sup>b</sup>                  | p-Value |
| Low   | 158 | 73 (46.2)          | 1.14 (0.99,1.31)  | 0.059   |
| Medium  | 159 | 84 (52.8)          |   |         |
| High  | 159 | 88 (55.3)          |   |         |

  

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |   |         |
|---|---|---------|
| Analysis Results for Log <sub>2</sub> (Initial Dioxin)      |   |         |
| n   | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 473   | 1.06 (0.90,1.25)                                  | 0.456   |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

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

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

**Table 13-52. Analysis of Apolipoprotein B (Discrete) (Continued)**

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |          |                            |   |                |
|---|----------|----------------------------|---|----------------|
| <b>Dioxin Category</b>  | <b>n</b> | <b>Number (%)<br/>High</b> | <b>Est. Relative Risk<br/>(95% C.I.)<sup>ab</sup></b> | <b>p-Value</b> |
| Comparison  | 1,194    | 636 (53.3)                 |   |                |
| Background RH   | 376      | 174 (46.3)                 | 0.75 (0.60,0.95)                                      | 0.017          |
| Low RH  | 236      | 113 (47.9)                 | 0.81 (0.61,1.07)                                      | 0.132          |
| High RH   | 240      | 132 (55.0)                 | 1.08 (0.81,1.42)                                      | 0.606          |
| Low plus High RH  | 476      | 245 (51.5)                 | 0.93 (0.75,1.16)                                      | 0.524          |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> 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.

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |          |  |                |
|---|----------|--|----------------|
| <b>Dioxin Category</b>  | <b>n</b> | <b>Adjusted Relative Risk<br/>(95% C.I.)<sup>a</sup></b> | <b>p-Value</b> |
| Comparison  | 1,193    |  |                |
| Background RH   | 374      | 0.79 (0.62,1.00)   | 0.050          |
| Low RH  | 235      | 0.82 (0.62,1.09)   | 0.164          |
| High RH   | 238      | 0.97 (0.73,1.30)   | 0.849          |
| Low plus High RH  | 473      | 0.89 (0.72,1.11)   | 0.305          |

<sup>a</sup> 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.

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |          |                            |   |                |
|--|----------|----------------------------|---|----------------|
| <b>1987 Dioxin Category Summary Statistics</b>             |          |                            | <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |                |
| <b>1987<br/>Dioxin</b>                                     | <b>n</b> | <b>Number (%)<br/>High</b> | <b>Estimated Relative Risk<br/>(95% C.I.)<sup>a</sup></b>     | <b>p-Value</b> |
| Low  | 283      | 135 (47.7)                 | 1.12 (1.02,1.23)  | 0.017          |
| Medium   | 285      | 130 (45.6)                 |   |                |
| High   | 284      | 154 (54.2)                 |   |                |

<sup>a</sup> 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 13-52. Analysis of Apolipoprotein B (Discrete) (Continued)**

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |   |         |
|--|---|---------|
| Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1)  |   |         |
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 847  | 1.07 (0.96,1.18)                                  | 0.242   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Model 3 revealed significant relations between Ranch Hands in the background dioxin category and Comparisons for both the unadjusted and adjusted analyses (Table 13-52(e,f): Est. RR=0.75, p=0.017; Adj. RR=0.79, p=0.050, respectively). The percentage of high apolipoprotein B values among the Ranch Hands in the background dioxin category was 46.3 versus 53.3 for Comparisons.

The unadjusted Model 4 analysis of apolipoprotein B showed a significant association with 1987 dioxin (Table 13-52(g): Est. RR=1.12, p=0.017). After adjusting for covariates, the relation became nonsignificant (Table 13-52(h): p=0.242).

The reference range between 1992 and 1997 decreased according to the manufacturer's recommendation. The change may explain partially the decrease in the percentage of participants with high apolipoprotein B levels between 1992 and 1997.

#### 13.2.2.3.44 C3 Complement (mg/dl) (Continuous)

The unadjusted and adjusted Model 1 analyses of C3 complement in its continuous form revealed no significant group differences (Table 13-53(a,b): p>0.50 for each analysis).

**Table 13-53. Analysis of C3 Complement (mg/dl) (Continuous)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                   |  |                      |
|--|------------|-------|-------------------|--|----------------------|
| Occupational Category  | Group      | n     | Mean <sup>a</sup> | Difference of Means<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| All  | Ranch Hand | 859   | 118.9             | 0.4 --   | 0.640                |
|  | Comparison | 1,231 | 118.5             |  |                      |
| Officer  | Ranch Hand | 340   | 114.9             | 0.3 --   | 0.814                |
|  | Comparison | 490   | 114.6             |  |                      |
| Enlisted Flyer   | Ranch Hand | 150   | 120.3             | -0.4 --  | 0.862                |
|  | Comparison | 185   | 120.7             |  |                      |
| Enlisted Groundcrew  | Ranch Hand | 369   | 122.1             | 0.8 --   | 0.537                |
|  | Comparison | 556   | 121.3             |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.



**Table 13-53. Analysis of C3 Complement (mg/dl) (Continuous) (Continued)**

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |            |       |                        |  |                      |
|--|------------|-------|------------------------|--|----------------------|
| Occupational Category                                      | Group      | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| All  | Ranch Hand | 854   | 120.2                  | 0.2 --   | 0.837                |
|  | Comparison | 1,229 | 120.0                  |  |                      |
| Officer  | Ranch Hand | 340   | 116.5                  | 0.4 --   | 0.765                |
|  | Comparison | 489   | 116.1                  |  |                      |
| Enlisted Flyer   | Ranch Hand | 148   | 120.8                  | -1.4 --  | 0.505                |
|  | Comparison | 184   | 122.2                  |  |                      |
| Enlisted Groundcrew  | Ranch Hand | 366   | 122.8                  | 0.6 --   | 0.668                |
|  | Comparison | 556   | 122.3                  |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                   |                         | <b>Analysis Results for Log<sub>2</sub> (Initial Dioxin)<sup>b</sup></b> |                                 |         |
|---|-----|-------------------|-------------------------|--|---------------------------------|---------|
| Initial Dioxin Category Summary Statistics                    |     |                   |                         | R <sup>2</sup>   | Slope (Std. Error) <sup>c</sup> | p-Value |
| Initial Dioxin  | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> |  |                                 |         |
| Low   | 158 | 118.3             | 118.8                   | 0.071  | 0.012 (0.005)                   | 0.023   |
| Medium  | 159 | 123.6             | 123.7                   |  |                                 |         |
| High  | 159 | 124.0             | 123.4                   |  |                                 |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on natural logarithm of C3 complement versus log<sub>2</sub> (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 <sub>2</sub> (Initial Dioxin) |   |         |  |
| Initial Dioxin                                       | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>   | Adj. Slope<br>(Std. Error) <sup>b</sup> | p-Value |  |
| Low  | 158 | 119.1                  | 0.083  | 0.009 (0.006)                           | 0.145   |  |
| Medium   | 158 | 123.9                  |  |   |         |  |
| High   | 157 | 122.7                  |  |   |         |  |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of C3 complement versus log<sub>2</sub> (initial dioxin).

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

**Table 13-53. Analysis of C3 Complement (mg/dl) (Continuous) (Continued)**

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

| Dioxin Category  | n     | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>c</sup> | p-Value <sup>d</sup> |
|------------------|-------|-------------------|-------------------------|---|----------------------|
| Comparison       | 1,194 | 118.5             | 118.5                   |   |                      |
| Background RH    | 376   | 115.2             | 116.7                   | -1.8 --   | 0.107                |
| Low RH           | 236   | 120.0             | 119.5                   | 1.0 --  | 0.399                |
| High RH          | 240   | 123.9             | 122.3                   | 3.8 --  | 0.003                |
| Low plus High RH | 476   | 122.0             | 120.9                   | 2.4 --  | 0.013                |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

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

<sup>d</sup> 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 <sup>a</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|------------------|-------|------------------------|---|----------------------|
| Comparison       | 1,193 | 120.1                  |   |                      |
| Background RH    | 374   | 119.5                  | -0.6 --   | 0.594                |
| Low RH           | 235   | 121.0                  | 0.9 --  | 0.518                |
| High RH          | 238   | 121.8                  | 1.7 --  | 0.217                |
| Low plus High RH | 473   | 121.4                  | 1.3 --  | 0.213                |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> 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 <sub>2</sub> (1987 Dioxin +1) |   |         |
|---|-----|-------------------|--|---|---------|
| 1987 Dioxin                             | n   | Mean <sup>a</sup> | R <sup>2</sup>   | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low                                     | 283 | 115.1             | 0.040  | 0.021 (0.004)                               | <0.001  |
| Medium                                  | 285 | 117.8             |  |   |         |
| High                                    | 284 | 124.1             |  |   |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of C3 complement versus log<sub>2</sub> (1987 dioxin + 1).

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

**Table 13-53. Analysis of C3 Complement (mg/dl) (Continuous) (Continued)**

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |                        |   |  |         |
|--|-----|------------------------|---|--|---------|
| 1987 Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 117.6                  | 0.067   | 0.017 (0.004)                            | <0.001  |
| Medium   | 283 | 119.6                  |   |  |         |
| High   | 281 | 124.6                  |   |  |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of C3 complement versus log<sub>2</sub> (1987 dioxin + 1).

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

A significant relation was found between initial dioxin and C3 complement in the unadjusted Model 2 analysis (Table 13-53(c): slope=0.012, p=0.023). The adjusted analysis was nonsignificant (Table 13-53(d): p=0.145).

The unadjusted Model 3 analysis revealed a significant difference in mean C3 complement levels 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 13-53(e): difference of means=3.8 mg/dl, p=0.003; difference of means=2.4 mg/dl, p=0.013, respectively). The adjusted analysis showed no significant differences between any of the Ranch Hand categories and Comparisons (Table 13-53(f): p>0.21 for each contrast).

Both the unadjusted and adjusted Model 4 analyses revealed significant associations between C3 complement and 1987 dioxin (Table 13-53(g,h): slope=0.021, p<0.001; adjusted slope=0.017, p<0.001, respectively). The adjusted mean C3 complement levels in the low, medium, and high 1987 dioxin categories were 117.6 mg/dl, 119.6 mg/dl, 124.6 mg/dl, respectively.

#### 13.2.2.3.45 C3 Complement (Discrete)

The unadjusted and adjusted Model 1 analyses showed no significant difference in the percentage of low C3 complement values between Ranch Hands and Comparisons (Table 13-54(a,b): p>0.19 for each analysis).

**Table 13-54. Analysis of C3 Complement (Discrete)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                   |                                  |         |
|--|------------|-------|-------------------|----------------------------------|---------|
| Occupational Category  | Group      | n     | Number (%)<br>Low | Est. Relative Risk<br>(95% C.I.) | p-Value |
| All  | Ranch Hand | 859   | 15 (1.7)          | 0.76 (0.41,1.44)                 | 0.398   |
|  | Comparison | 1,231 | 28 (2.3)          |                                  |         |
| Officer  | Ranch Hand | 340   | 6 (1.8)           | 0.61 (0.23,1.61)                 | 0.317   |
|  | Comparison | 490   | 14 (2.9)          |                                  |         |
| Enlisted Flyer   | Ranch Hand | 150   | 1 (0.7)           | 0.24 (0.03,2.09)                 | 0.197   |
|  | Comparison | 185   | 5 (2.7)           |                                  |         |
| Enlisted Groundcrew  | Ranch Hand | 369   | 8 (2.2)           | 1.35 (0.51,3.52)                 | 0.544   |
|  | Comparison | 556   | 9 (1.6)           |                                  |         |

**Table 13-54. Analysis of C3 Complement (Discrete) (Continued)**

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

| Occupational Category | Adjusted Relative Risk<br>(95% C.I.) | p-Value |
|-----------------------|--------------------------------------|---------|
| All                   | 0.79 (0.42,1.50)                     | 0.474   |
| Officer               | 0.62 (0.23,1.63)                     | 0.333   |
| Enlisted Flyer        | 0.27 (0.03,2.33)                     | 0.233   |
| Enlisted Groundcrew   | 1.41 (0.54,3.71)                     | 0.487   |

Note: Results are not adjusted for race because of the sparse number of participants with low C3 complement levels.

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

| Initial Dioxin Category Summary Statistics |     |                   | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
|--|-----|-------------------|---|---------|
| Initial Dioxin                             | n   | Number (%)<br>Low | Estimated Relative Risk<br>(95% C.I.) <sup>b</sup>                  | p-Value |
| Low  | 158 | 1 (0.6)           | 1.06 (0.45,2.49)  | 0.898   |
| Medium                                     | 159 | 1 (0.6)           |   |         |
| High                                       | 159 | 1 (0.6)           |   |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> 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 <sub>2</sub> (Initial Dioxin) |   |         |
|--|---|---------|
| n  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 473  | 1.01 (0.39,2.62)                                  | 0.977   |

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race and occupation because of the sparse number of Ranch Hands with low C3 complement levels.

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

| Dioxin Category  | n     | Number (%)<br>Low | Est. Relative Risk<br>(95% C.I.) <sup>ab</sup> | p-Value |
|------------------|-------|-------------------|--|---------|
| Comparison       | 1,194 | 26 (2.2)          |  |         |
| Background RH    | 376   | 12 (3.2)          | 1.28 (0.63,2.57)                               | 0.495   |
| Low RH           | 236   | 1 (0.4)           | 0.20 (0.03,1.46)                               | 0.111   |
| High RH          | 240   | 2 (0.8)           | 0.44 (0.10,1.86)                               | 0.261   |
| Low plus High RH | 476   | 3 (0.6)           | 0.29 (0.08,1.04)                               | 0.057   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> 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 13-54. Analysis of C3 Complement (Discrete) (Continued)**

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |          |  |                |
|---|----------|--|----------------|
| <b>Dioxin Category</b>  | <b>n</b> | <b>Adjusted Relative Risk<br/>(95% C.I.)<sup>a</sup></b> | <b>p-Value</b> |
| Comparison  | 1,193    |  |                |
| Background RH   | 374      | 1.25 (0.61,2.57)   | 0.536          |
| Low RH  | 235      | 0.21 (0.03,1.57)   | 0.128          |
| High RH   | 238      | 0.49 (0.11,2.17)   | 0.351          |
| Low plus High RH  | 473      | 0.32 (0.09,1.16)   | 0.083          |

<sup>a</sup> 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 low C3 complement levels.

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |          |                           |   |
|--|----------|---------------------------|---|
| <b>1987 Dioxin Category Summary Statistics</b>             |          |                           | <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |
| <b>1987 Dioxin</b>   | <b>n</b> | <b>Number (%)<br/>Low</b> | <b>Estimated Relative Risk<br/>(95% C.I.)<sup>a</sup></b>     |
| Low  | 283      | 10 (3.5)                  | 0.61 (0.41,0.91)  |
| Medium   | 285      | 3 (1.1)                   |   |
| High   | 284      | 2 (0.7)                   |   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b>      |  |                |  |
|---|--|----------------|--|
| <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |  |                |  |
| <b>n</b>  | <b>Adjusted Relative Risk<br/>(95% C.I.)<sup>a</sup></b> | <b>p-Value</b> |  |
| 847   | 0.57 (0.39,0.84)   | 0.004          |  |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with low C3 complement levels.

The Model 2 unadjusted and adjusted analyses results were nonsignificant (Table 13-54(c,d):  $p > 0.89$  for each analysis). Both the unadjusted and adjusted Model 3 analyses revealed marginally significant differences between Ranch Hands in the low and high dioxin categories combined and Comparisons (Table 13-54(e,f): Est. RR=0.29,  $p=0.057$ ; Adj. RR=0.32,  $p=0.083$ , respectively). The percentage of low C3 complement values for Ranch Hands in the low and high dioxin categories combined was 0.6 versus 2.2 in the Comparison category.

The Model 4 unadjusted and adjusted analyses each revealed a significant association between C3 complement and 1987 dioxin (Table 13-54(g,h): Est. RR=0.61,  $p=0.011$ ; Adj. RR=0.57,  $p=0.004$ ,

respectively). The percentages of low C3 complement values in the low, medium, and high 1987 dioxin categories were 3.5, 1.1, and 0.7, respectively.

#### 13.2.2.3.46 C4 Complement (Continuous)

The Model 1 unadjusted analysis of C4 complement showed no overall group differences (Table 13-55(a,b):  $p > 0.33$  for each analysis). Stratifying by occupation revealed a significant difference between Ranch Hand and Comparison officers, as well as enlisted flyers (Table 13-55(a): difference of means =  $-0.81$  mg/dl,  $p = 0.024$ , for the officer stratum; difference of means =  $1.02$  mg/dl,  $p = 0.076$ , for the enlisted flyer stratum). After adjusting for covariates, a significant difference between Ranch Hands and Comparisons was noted only among the officer stratum (Table 13-55(b): difference of adjusted means =  $-0.90$  mg/dl,  $p = 0.017$ ). The adjusted mean C4 complement value for Ranch Hand officers was 26.02 mg/dl versus 26.91 mg/dl for Comparison officers.

**Table 13-55. Analysis of C4 Complement (mg/dl) (Continuous)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                   |   |                      |
|--|------------|-------|-------------------|---|----------------------|
| Occupational Category  | Group      | n     | Mean <sup>a</sup> | Difference of Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| All  | Ranch Hand | 859   | 25.71             | $-0.20$ --                                  | 0.395                |
|  | Comparison | 1,231 | 25.91             |   |                      |
| Officer  | Ranch Hand | 340   | 24.73             | $-0.81$ --                                  | 0.024                |
|  | Comparison | 490   | 25.54             |   |                      |
| Enlisted Flyer   | Ranch Hand | 150   | 26.52             | $1.02$ --                                   | 0.076                |
|  | Comparison | 185   | 25.50             |   |                      |
| Enlisted Groundcrew  | Ranch Hand | 369   | 26.31             | $-0.06$ --                                  | 0.862                |
|  | Comparison | 556   | 26.38             |   |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |            |       |                        |  |                      |
|--|------------|-------|------------------------|--|----------------------|
| Occupational Category                                      | Group      | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| All  | Ranch Hand | 854   | 26.98                  | $-0.23$ --                                       | 0.333                |
|  | Comparison | 1,229 | 27.21                  |  |                      |
| Officer  | Ranch Hand | 340   | 26.02                  | $-0.90$ --                                       | 0.017                |
|  | Comparison | 489   | 26.91                  |  |                      |
| Enlisted Flyer   | Ranch Hand | 148   | 27.74                  | $0.98$ --  | 0.104                |
|  | Comparison | 184   | 26.77                  |  |                      |
| Enlisted Groundcrew  | Ranch Hand | 366   | 27.61                  | $-0.06$ --                                       | 0.876                |
|  | Comparison | 556   | 27.67                  |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

**Table 13-55. Analysis of C4 Complement (mg/dl) (Continuous) (Continued)**

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

| Initial Dioxin Category Summary Statistics |     |                   |                         | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>b</sup> |                                 |         |
|--|-----|-------------------|-------------------------|---|---------------------------------|---------|
| Initial Dioxin                             | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>  | Slope (Std. Error) <sup>c</sup> | p-Value |
| Low  | 158 | 25.70             | 25.72                   | 0.002   | -0.003 (0.007)                  | 0.701   |
| Medium                                     | 159 | 26.43             | 26.43                   |   |                                 |         |
| High                                       | 159 | 26.07             | 26.05                   |   |                                 |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on natural logarithm of C4 complement versus log<sub>2</sub> (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 <sub>2</sub> (Initial Dioxin) |                                      |         |
|--|-----|------------------------|--|--------------------------------------|---------|
| Initial Dioxin                             | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>   | Adj. Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 158 | 26.58                  | 0.019  | -0.004 (0.008)                       | 0.638   |
| Medium                                     | 158 | 27.31                  |  |                                      |         |
| High                                       | 157 | 27.01                  |  |                                      |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of C4 complement versus log<sub>2</sub> (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 <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean vs. Comparisons (95% C.I.) <sup>c</sup> | p-Value <sup>d</sup> |
|------------------|-------|-------------------|-------------------------|---|----------------------|
| Comparison       | 1,194 | 25.91             | 25.90                   |   |                      |
| Background RH    | 376   | 25.26             | 25.41                   | -0.49 --  | 0.109                |
| Low RH           | 236   | 26.07             | 26.03                   | 0.13 --   | 0.733                |
| High RH          | 240   | 26.06             | 25.91                   | 0.01 --   | 0.986                |
| Low plus High RH | 476   | 26.06             | 25.97                   | 0.07 --   | 0.816                |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

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

<sup>d</sup> 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 13-55. Analysis of C4 Complement (mg/dl) (Continuous) (Continued)**

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |                        |   |                      |
|---|-------|------------------------|---|----------------------|
| Dioxin Category   | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Mean<br>vs. Comparisons<br>(95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| Comparison  | 1,193 | 27.24                  |   |                      |
| Background RH   | 374   | 26.93                  | -0.31 --  | 0.336                |
| Low RH  | 235   | 27.27                  | 0.03 --   | 0.942                |
| High RH   | 238   | 26.97                  | -0.27 --  | 0.494                |
| Low plus High RH  | 473   | 27.12                  | -0.12 --  | 0.680                |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> 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.

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                   | <b>Analysis Results for Log<sub>2</sub> (1987 Dioxin + 1)</b> |   |         |
|--|-----|-------------------|---|---|---------|
| 1987 Dioxin Category Summary Statistics                    |     |                   |   |   |         |
| 1987 Dioxin  | n   | Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 25.10             | 0.004   | 0.009 (0.005)                               | 0.070   |
| Medium   | 285 | 25.85             |   |   |         |
| High   | 284 | 26.19             |   |   |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of C4 complement versus log<sub>2</sub> (1987 dioxin + 1).

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |                        |   |   |         |
|--|-----|------------------------|---|---|---------|
| 1987 Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |   |         |
| 1987 Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope<br>(Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 26.73                  | 0.044   | 0.001 (0.005)                               | 0.849   |
| Medium   | 283 | 27.16                  |   |   |         |
| High   | 281 | 27.02                  |   |   |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of C4 complement versus log<sub>2</sub> (1987 dioxin + 1).

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

The unadjusted and adjusted analyses for Models 2 and 3 showed no significant relation between dioxin and C4 complement (Table 13-55(c–f):  $p > 0.10$  for each analysis). A marginally significant association between 1987 dioxin and C4 complement was revealed in the unadjusted Model 4 analysis (Table 13-55(g): slope=0.009,  $p=0.070$ ). After covariate adjustment, the adjusted analysis results became nonsignificant (Table 13-55(h):  $p=0.849$ ).



### 13.2.2.3.47 C4 Complement (Discrete)

Because of a sparse number of low C4 complement values among the participants, some analyses were not possible. Table 13-56 contains the results of these analyses.

**Table 13-56. Analysis of C4 Complement (Discrete)**

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |            |       |                   |                                  |                    |
|--|------------|-------|-------------------|----------------------------------|--------------------|
| Occupational Category  | Group      | n     | Number (%)<br>Low | Est. Relative Risk<br>(95% C.I.) | p-Value            |
| All  | Ranch Hand | 859   | 2 (0.2)           | 1.43 (0.20,10.20)                | 0.719              |
|  | Comparison | 1,231 | 2 (0.2)           |                                  |                    |
| Officer  | Ranch Hand | 340   | 2 (0.6)           | 2.89 (0.26,32.04)                | 0.386              |
|  | Comparison | 490   | 1 (0.2)           |                                  |                    |
| Enlisted Flyer   | Ranch Hand | 150   | 0 (0.0)           | --                               | 0.999 <sup>a</sup> |
|  | Comparison | 185   | 1 (0.5)           |                                  |                    |
| Enlisted Groundcrew  | Ranch Hand | 369   | 0 (0.0)           | --                               | --                 |
|  | Comparison | 556   | 0 (0.0)           |                                  |                    |

<sup>a</sup> P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a low C4 complement level.

--: Results not presented because of the sparse number of participants with a low C4 complement level.

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |                                      |         |
|--|--------------------------------------|---------|
| Occupational Category                                      | Adjusted Relative Risk<br>(95% C.I.) | p-Value |
| All  | 1.46 (0.20,10.59)                    | 0.707   |
| Officer  | 2.85 (0.26,31.68)                    | 0.394   |
| Enlisted Flyer   | --                                   | --      |
| Enlisted Groundcrew  | --                                   | --      |

--: Results not presented because of the sparse number of participants with a low C4 complement level.

Note: Results for analysis across all occupational categories are not adjusted for race, occupation, and degreasing chemical exposure because of the sparse number of participants with a low C4 complement level; results for individual occupational categories are not adjusted for race and degreasing chemical exposure because of the sparse number of participants with a low C4 complement level.

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                   |
|---|-----|-------------------|
| Initial Dioxin Category Summary Statistics                    |     |                   |
| Initial Dioxin  | n   | Number (%)<br>Low |
| Low   | 158 | 0 (0.0)           |
| Medium  | 159 | 0 (0.0)           |
| High  | 159 | 0 (0.0)           |

| Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
|---|---------|
| Estimated Relative Risk<br>(95% C.I.) <sup>b</sup>                  | p-Value |
| --  | --      |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

--: Results not presented because of the sparse number of Ranch Hands with a low C4 complement level.

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

**Table 13-56. Analysis of C4 Complement (Discrete) (Continued)**

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

| Analysis Results for Log <sub>2</sub> (Initial Dioxin) |                                      |         |
|--|--------------------------------------|---------|
| n  | Adjusted Relative Risk<br>(95% C.I.) | p-Value |
| --   | --                                   | --      |

--: Results not presented because of the sparse number of Ranch Hands with a low C4 complement level.

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

| Dioxin Category  | n     | Number (%)<br>Low | Est. Relative Risk<br>(95% C.I.) <sup>ab</sup> | p-Value            |
|------------------|-------|-------------------|--|--------------------|
| Comparison       | 1,194 | 2 (0.2)           |  |                    |
| Background RH    | 376   | 2 (0.5)           | 3.46 (0.47,25.38)                              | 0.222              |
| Low RH           | 236   | 0 (0.0)           | --   | 0.999 <sup>c</sup> |
| High RH          | 240   | 0 (0.0)           | --   | 0.999 <sup>c</sup> |
| Low plus High RH | 476   | 0 (0.0)           | --   | 0.913 <sup>c</sup> |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a low C4 complement level.

--: Results not presented because of the sparse number of Ranch Hands with a low C4 complement 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<br>(95% C.I.) <sup>a</sup> | p-Value |
|------------------|-------|---|---------|
| Comparison       | 1,193 |   |         |
| Background RH    | 374   | 2.99 (0.40,22.39)                                 | 0.286   |
| Low RH           | 235   | --  | --      |
| High RH          | 238   | --  | --      |
| Low plus High RH | 473   | --  | --      |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

--: Results not presented because of the sparse number of Ranch Hands with a low C4 complement 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.

Results are not adjusted for race, occupation, and degreasing chemical exposure because of the sparse number of participants with a low C4 complement level.

**Table 13-56. Analysis of C4 Complement (Discrete) (Continued)**

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                   |   |         |
|--|-----|-------------------|---|---------|
| 1987 Dioxin Category Summary Statistics                    |     |                   | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |         |
| 1987 Dioxin  | n   | Number (%)<br>Low | Estimated Relative Risk<br>(95% C.I.) <sup>a</sup>      | p-Value |
| Low  | 283 | 2 (0.7)           | 0.32 (0.12,0.90)  | 0.033   |
| Medium   | 285 | 0 (0.0)           |   |         |
| High   | 284 | 0 (0.0)           |   |         |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |  |   |         |
|--|-----|--|---|---------|
|  |     |  | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |         |
|  | n   |  | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup>       | p-Value |
|  | 847 |  | 0.26 (0.08,0.86)  | 0.024   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race, occupation, industrial chemical exposure, and degreasing chemical exposure because of the sparse number of Ranch Hands with a low C4 complement level.

Unadjusted and adjusted results for Models 1 through 3 revealed no significant associations between C4 complement in its dichotomous form and dioxin (Table 13-56(a–f):  $p > 0.22$  for each contrast). The unadjusted and adjusted Model 4 analyses revealed a significant relation between C4 complement and 1987 dioxin (Table 13-56(g,h): Est. RR=0.32,  $p=0.033$ ; Adj. RR=0.26,  $p=0.024$ , respectively).

#### 13.2.2.3.48 Haptoglobin (Continuous)

The unadjusted and adjusted Model 1 analyses of haptoglobin each revealed a significant overall group difference (Table 13-57(a,b): difference of means=8.7 mg/dl,  $p=0.002$ , for the unadjusted analysis; difference of means=8.0 mg/dl,  $p=0.003$ , for the adjusted analysis). The adjusted mean haptoglobin values for the Ranch Hands were 128.5 mg/dl versus 120.5 mg/dl for the Comparisons. After stratifying by occupation, both the unadjusted and adjusted analyses showed a significant difference in mean haptoglobin levels between Ranch Hands and Comparisons in the enlisted groundcrew stratum (Table 13-57(a,b): difference of means=10.2 mg/dl,  $p=0.016$ , for the unadjusted analysis; difference of adjusted means=9.9 mg/dl,  $p=0.016$ , for the adjusted analysis). The adjusted mean haptoglobin level among Ranch Hand enlisted groundcrew was 137.4 mg/dl versus 127.4 mg/dl among Comparison enlisted groundcrew.

**Table 13-57. Analysis of Haptoglobin (mg/dl) (Continuous)**

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

| Occupational Category | Group             | n     | Mean <sup>a</sup> | Difference of Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|-----------------------|-------------------|-------|-------------------|---|----------------------|
| <i>All</i>            | <i>Ranch Hand</i> | 859   | 135.2             | 8.7 --                                      | 0.002                |
|                       | <i>Comparison</i> | 1,231 | 126.5             |   |                      |
| Officer               | Ranch Hand        | 340   | 122.4             | 6.1 --                                      | 0.140                |
|                       | Comparison        | 490   | 116.3             |   |                      |
| Enlisted Flyer        | Ranch Hand        | 150   | 147.8             | 10.4 --                                     | 0.141                |
|                       | Comparison        | 185   | 137.4             |   |                      |
| Enlisted Groundcrew   | Ranch Hand        | 369   | 142.5             | 10.2 --                                     | 0.016                |
|                       | Comparison        | 556   | 132.3             |   |                      |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

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

| Occupational Category | Group             | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
|-----------------------|-------------------|-------|------------------------|--|----------------------|
| <i>All</i>            | <i>Ranch Hand</i> | 854   | 128.5                  | 8.0 --   | 0.003                |
|                       | <i>Comparison</i> | 1,229 | 120.5                  |  |                      |
| Officer               | Ranch Hand        | 340   | 112.2                  | 5.4 --   | 0.172                |
|                       | Comparison        | 489   | 106.8                  |  |                      |
| Enlisted Flyer        | Ranch Hand        | 148   | 137.3                  | 9.5 --   | 0.160                |
|                       | Comparison        | 184   | 127.8                  |  |                      |
| Enlisted Groundcrew   | Ranch Hand        | 366   | 137.4                  | 9.9 --   | 0.016                |
|                       | Comparison        | 556   | 127.4                  |  |                      |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root scale.

**(c) MODEL 2: RANCH HANDS -- INITIAL DIOXIN -- UNADJUSTED**

| Initial Dioxin Category Summary Statistics |     |                   |                         | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>b</sup> |                                 |         |
|--|-----|-------------------|-------------------------|---|---------------------------------|---------|
| Initial Dioxin                             | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>  | Slope (Std. Error) <sup>c</sup> | p-Value |
| Low  | 158 | 130.2             | 130.3                   | 0.002   | 0.084 (0.097)                   | 0.387   |
| Medium                                     | 159 | 144.4             | 144.5                   |   |                                 |         |
| High                                       | 159 | 140.0             | 139.9                   |   |                                 |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on square root of haptoglobin versus log<sub>2</sub> (initial dioxin).

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

**Table 13-57. Analysis of Haptoglobin (mg/dl) (Continuous) (Continued)**

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |     |                        |  |                                      |         |
|---|-----|------------------------|--|--------------------------------------|---------|
| Initial Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |                                      |         |
| Initial Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>   | Adj. Slope (Std. Error) <sup>b</sup> | p-Value |
| Low   | 158 | 118.8                  | 0.066  | -0.087 (0.111)                       | 0.433   |
| Medium  | 158 | 124.6                  |  |                                      |         |
| High  | 157 | 116.4                  |  |                                      |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of haptoglobin versus log<sub>2</sub> (initial dioxin).

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

| <b>(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED</b> |       |                   |                         |   |                      |
|---|-------|-------------------|-------------------------|---|----------------------|
| Dioxin Category   | n     | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | Difference of Adj. Mean vs. Comparisons (95% C.I.) <sup>c</sup> | p-Value <sup>d</sup> |
| Comparison  | 1,194 | 126.7             | 126.7                   |   |                      |
| Background RH   | 376   | 131.3             | 131.4                   | 4.7 --  | 0.210                |
| Low RH  | 236   | 134.6             | 134.5                   | 7.8 --  | 0.078                |
| High RH   | 240   | 141.8             | 141.7                   | 15.0 --   | 0.001                |
| Low plus High RH  | 476   | 138.2             | 138.1                   | 11.4 --   | 0.001                |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>d</sup> P-value is based on difference of means on square root 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.

| <b>(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED</b> |       |                        |   |                      |
|---|-------|------------------------|---|----------------------|
| Dioxin Category   | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Mean vs. Comparisons (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| Comparison  | 1,193 | 120.9                  |   |                      |
| Background RH   | 374   | 129.8                  | 8.9 --  | 0.014                |
| Low RH  | 235   | 127.5                  | 6.6 --  | 0.118                |
| High RH   | 238   | 128.0                  | 7.1 --  | 0.105                |
| Low plus High RH  | 473   | 127.7                  | 6.8 --  | 0.036                |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.

<sup>c</sup> P-value is based on difference of means on square root 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 13-57. Analysis of Haptoglobin (mg/dl) (Continuous) (Continued)**

| <b>(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED</b> |     |                   |   |  |         |
|--|-----|-------------------|---|--|---------|
| 1987 Dioxin Category Summary Statistics                    |     |                   | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin  | n   | Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 130.4             | 0.002   | 0.074 (0.065)                            | 0.254   |
| Medium   | 285 | 132.6             |   |  |         |
| High   | 284 | 142.5             |   |  |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of haptoglobin versus log<sub>2</sub> (1987 dioxin + 1).

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

| <b>(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED</b> |     |                        |   |  |         |
|--|-----|------------------------|---|--|---------|
| 1987 Dioxin Category Summary Statistics                  |     |                        | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |  |         |
| 1987 Dioxin  | n   | Adj. Mean <sup>a</sup> | R <sup>2</sup>  | Adjusted Slope (Std. Error) <sup>b</sup> | p-Value |
| Low  | 283 | 127.4                  | 0.055   | -0.116 (0.073)                           | 0.114   |
| Medium   | 283 | 125.1                  |   |  |         |
| High   | 281 | 124.4                  |   |  |         |

<sup>a</sup> Transformed from square root scale.

<sup>b</sup> Slope and standard error based on square root of haptoglobin versus log<sub>2</sub> (1987 dioxin + 1).

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

The unadjusted and adjusted Model 2 analyses showed no significant relation between initial dioxin and haptoglobin (Table 13-57(c,d):  $p > 0.38$  for each analysis). Three significant contrasts were found in the unadjusted Model 3 analysis of haptoglobin: Ranch Hands in the low dioxin category versus Comparisons (Table 13-57(e): difference of means=7.8 mg/dl,  $p=0.078$ ), Ranch Hands in the high dioxin category versus Comparisons (Table 13-57(e): difference of means=15.0 mg/dl,  $p=0.001$ ), and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-57(e): difference of means=11.4 mg/dl,  $p=0.001$ ).

After adjusting for covariates, two contrasts were found to be significant in the Model 3 analysis: Ranch Hands in the background dioxin category versus Comparisons and Ranch Hands in the low and high dioxin categories combined versus Comparisons (Table 13-57(f): difference of adjusted means=8.9 mg/dl,  $p=0.014$ ; difference of adjusted means=6.8 mg/dl,  $p=0.036$ , respectively). The adjusted mean haptoglobin levels for Ranch Hands in the background dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 129.8 mg/dl, 127.7 mg/dl, and 120.9 mg/dl respectively. No significant relation was determined between 1987 dioxin and haptoglobin in either the unadjusted or adjusted Model 4 analysis (Table 13-57(g,h):  $p > 0.11$  for each analysis).

#### 13.2.2.3.49 Haptoglobin (Discrete)

A significant overall group difference was revealed in both the unadjusted and adjusted Model 1 analyses of haptoglobin in its discrete form (Table 13-58(a,b): Est. RR=1.26,  $p=0.017$ ; Adj. RR=1.26,  $p=0.020$ , respectively). The percentage of Ranch Hands with high haptoglobin levels was 32.7 versus 27.9 for Comparisons. After stratifying by occupation, both the unadjusted and adjusted analyses revealed a marginally significant difference between Ranch Hands and Comparisons among the enlisted groundcrew

(Table 13-58(a,b): Est. RR=1.30, p=0.063; Adj. RR=1.31, p=0.061, respectively). The percentage of high haptoglobin levels among the Ranch Hand enlisted groundcrew was 37.4 versus 31.5 among the Comparison enlisted groundcrew.

**Table 13-58. Analysis of Haptoglobin (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   | 281 (32.7)      | 1.26 (1.04,1.52)              | 0.017   |
|   | Comparison | 1,231 | 343 (27.9)      |                               |         |
| Officer   | Ranch Hand | 340   | 84 (24.7)       | 1.19 (0.86,1.65)              | 0.300   |
|   | Comparison | 490   | 106 (21.6)      |                               |         |
| Enlisted Flyer  | Ranch Hand | 150   | 59 (39.3)       | 1.29 (0.82,2.01)              | 0.271   |
|   | Comparison | 185   | 62 (33.5)       |                               |         |
| Enlisted Groundcrew                                   | Ranch Hand | 369   | 138 (37.4)      | 1.30 (0.99,1.72)              | 0.063   |
|   | Comparison | 556   | 175 (31.5)      |                               |         |

| (b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED |                                   |         |
|---|-----------------------------------|---------|
| Occupational Category                               | Adjusted Relative Risk (95% C.I.) | p-Value |
| All   | 1.26 (1.04,1.52)                  | 0.020   |
| Officer   | 1.18 (0.85,1.64)                  | 0.316   |
| Enlisted Flyer                                      | 1.27 (0.81,2.01)                  | 0.295   |
| Enlisted Groundcrew                                 | 1.31 (0.99,1.73)                  | 0.061   |

| (c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED |     |                 |   |         |
|--|-----|-----------------|---|---------|
| Initial Dioxin Category Summary Statistics             |     |                 | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>a</sup> |         |
| Initial Dioxin   | n   | Number (%) High | Estimated Relative Risk (95% C.I.) <sup>b</sup>                     | p-Value |
| Low  | 158 | 49 (31.0)       | 1.05 (0.91,1.21)  | 0.506   |
| Medium   | 159 | 57 (35.8)       |   |         |
| High   | 159 | 58 (36.5)       |   |         |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> 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 <sub>2</sub> (Initial Dioxin) |  |         |
| n  | Adjusted Relative Risk (95% C.I.) <sup>a</sup> | p-Value |
| 473  | 0.98 (0.82,1.16)                               | 0.785   |

<sup>a</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>b</sup> Relative risk for a twofold increase in initial dioxin.

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

<sup>a</sup> Relative risk for a twofold increase in initial dioxin.

**Table 13-58. Analysis of Haptoglobin (Discrete) (Continued)**

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

| Dioxin Category  | n     | Number (%)<br>High | Est. Relative Risk<br>(95% C.I.) <sup>a,b</sup> | p-Value |
|------------------|-------|--------------------|---|---------|
| Comparison       | 1,194 | 337 (28.2)         |   |         |
| Background RH    | 376   | 115 (30.6)         | 1.13 (0.88,1.46)                                | 0.338   |
| Low RH           | 236   | 78 (33.1)          | 1.25 (0.93,1.69)                                | 0.140   |
| High RH          | 240   | 86 (35.8)          | 1.41 (1.05,1.89)                                | 0.023   |
| Low plus High RH | 476   | 164 (34.5)         | 1.33 (1.06,1.67)                                | 0.015   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

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

| Dioxin Category  | n     | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
|------------------|-------|---|---------|
| Comparison       | 1,193 |   |         |
| Background RH    | 374   | 1.32 (1.01,1.72)                                  | 0.042   |
| Low RH           | 235   | 1.25 (0.92,1.69)                                  | 0.160   |
| High RH          | 238   | 1.15 (0.84,1.56)                                  | 0.382   |
| Low plus High RH | 473   | 1.19 (0.95,1.51)                                  | 0.136   |

<sup>a</sup> Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.

Comparison: 1987 Dioxin  $\leq$  10 ppt.

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

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

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

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

| 1987 Dioxin Category Summary Statistics |     |                    | Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |         |
|---|-----|--------------------|---|---------|
| 1987 Dioxin                             | n   | Number (%)<br>High | Estimated Relative Risk<br>(95% C.I.) <sup>a</sup>      | p-Value |
| Low                                     | 283 | 86 (30.4)          | 1.03 (0.94,1.14)  | 0.509   |
| Medium                                  | 285 | 88 (30.9)          |   |         |
| High                                    | 284 | 105 (37.0)         |   |         |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.

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

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

| Analysis Results for Log <sub>2</sub> (1987 Dioxin + 1) |   |         |
|---|---|---------|
| n   | Adjusted Relative Risk<br>(95% C.I.) <sup>a</sup> | p-Value |
| 847   | 0.91 (0.82,1.02)                                  | 0.107   |

<sup>a</sup> Relative risk for a twofold increase in 1987 dioxin.



No significant relation between initial dioxin and haptoglobin in its discrete form was revealed in either the unadjusted or adjusted Model 2 analyses (Table 13-58(c,d):  $p > 0.50$  for each analysis). The unadjusted Model 3 analysis of haptoglobin revealed significant differences between Ranch Hands and Comparisons for Ranch Hands in the high dioxin category and Ranch Hands in the low and high dioxin categories combined (Table 13-58(e): Est. RR=1.41,  $p=0.023$ ; Est. RR=1.33,  $p=0.015$ , respectively). The adjusted Model 3 analysis showed a significant difference between Ranch Hands in the background dioxin category and Comparisons (Table 13-58(f): Adj. RR=1.32,  $p=0.042$ ). The percentages of high haptoglobin values for Ranch Hands in the background dioxin category, Ranch Hands in the high dioxin category, Ranch Hands in the low and high dioxin categories combined, and Comparisons were 30.6, 35.8, 34.5, and 28.2, respectively. The unadjusted and adjusted Model 4 analyses were nonsignificant (Table 13-58(g,h):  $p > 0.10$  for each analysis).

#### 13.2.2.3.50 Transferrin (Continuous)

The unadjusted and adjusted Model 1 analyses each revealed a significant overall group difference in the mean levels of transferrin (Table 13-59(a,b): difference of means=3.1 mg/dl,  $p=0.044$ , for the unadjusted analysis; difference of adjusted means=3.1 mg/dl,  $p=0.037$ , for the adjusted analysis). The adjusted mean level of transferrin was higher for the Ranch Hands than for the Comparisons (246.2 mg/dl vs. 243.1 mg/dl). Stratifying by occupation uncovered a marginally significant group difference within the enlisted groundcrew stratum in both the unadjusted and adjusted analyses (Table 13-59(a,b): difference of means=4.5 mg/dl,  $p=0.056$ , for the unadjusted analysis; difference of adjusted means=4.2 mg/dl,  $p=0.063$ , for the adjusted analysis). The adjusted mean level of transferrin among Ranch Hand enlisted groundcrew was 247.1 mg/dl versus 242.9 mg/dl among the Comparison enlisted groundcrew.

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

| <b>(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED</b> |                   |              |                         |   |                            |
|--|-------------------|--------------|-------------------------|---|----------------------------|
| <b>Occupational Category</b>                                 | <b>Group</b>      | <b>n</b>     | <b>Mean<sup>a</sup></b> | <b>Difference of Means (95% C.I.)<sup>b</sup></b> | <b>p-Value<sup>c</sup></b> |
| <i>All</i>   | <i>Ranch Hand</i> | <i>859</i>   | <i>252.7</i>            | <i>3.1 --</i>                                     | <i>0.044</i>               |
|  | <i>Comparison</i> | <i>1,231</i> | <i>249.6</i>            |   |                            |
| Officer  | Ranch Hand        | 340          | 250.0                   | 1.6 --  | 0.510                      |
|  | Comparison        | 490          | 248.4                   |   |                            |
| Enlisted Flyer   | Ranch Hand        | 150          | 254.5                   | 3.0 --  | 0.439                      |
|  | Comparison        | 185          | 251.5                   |   |                            |
| Enlisted Groundcrew  | Ranch Hand        | 369          | 254.5                   | 4.5 --  | 0.056                      |
|  | Comparison        | 556          | 250.0                   |   |                            |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

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

| <b>(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED</b> |            |       |                        |  |                      |
|--|------------|-------|------------------------|--|----------------------|
| Occupational Category                                      | Group      | n     | Adj. Mean <sup>a</sup> | Difference of Adj. Means (95% C.I.) <sup>b</sup> | p-Value <sup>c</sup> |
| All  | Ranch Hand | 854   | 246.2                  | 3.1 --   | 0.037                |
|  | Comparison | 1,229 | 243.1                  |  |                      |
| Officer  | Ranch Hand | 340   | 243.5                  | 1.9 --   | 0.412                |
|  | Comparison | 489   | 241.6                  |  |                      |
| Enlisted Flyer   | Ranch Hand | 148   | 247.9                  | 3.1 --   | 0.404                |
|  | Comparison | 184   | 244.8                  |  |                      |
| Enlisted Groundcrew  | Ranch Hand | 366   | 247.1                  | 4.2 --   | 0.063                |
|  | Comparison | 556   | 242.9                  |  |                      |

<sup>a</sup> Transformed from natural logarithm scale.

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

<sup>c</sup> P-value is based on difference of means on natural logarithm scale.

| <b>(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED</b> |     |                   |                         |   |                                 |         |
|---|-----|-------------------|-------------------------|---|---------------------------------|---------|
| Initial Dioxin Category Summary Statistics                    |     |                   |                         | Analysis Results for Log <sub>2</sub> (Initial Dioxin) <sup>b</sup> |                                 |         |
| Initial Dioxin  | n   | Mean <sup>a</sup> | Adj. Mean <sup>ab</sup> | R <sup>2</sup>  | Slope (Std. Error) <sup>c</sup> | p-Value |
| Low   | 158 | 251.5             | 251.5                   | 0.001   | 0.003 (0.005)                   | 0.594   |
| Medium  | 159 | 254.8             | 254.8                   |   |                                 |         |
| High  | 159 | 255.6             | 255.5                   |   |                                 |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Adjusted for percent body fat at the time of the blood measurement of dioxin.

<sup>c</sup> Slope and standard error based on natural logarithm of transferrin versus log<sub>2</sub> (initial dioxin).

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

| <b>(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED</b> |     |                        |  |  |                                      |         |
|---|-----|------------------------|--|--|--------------------------------------|---------|
| Initial Dioxin Category Summary Statistics                  |     |                        |  | Analysis Results for Log <sub>2</sub> (Initial Dioxin) |                                      |         |
| Initial Dioxin  | n   | Adj. Mean <sup>a</sup> |  | R <sup>2</sup>   | Adj. Slope (Std. Error) <sup>b</sup> | p-Value |
| Low   | 158 | 247.6                  |  | 0.014  | –0.001 (0.006)                       | 0.798   |
| Medium  | 158 | 249.2                  |  |  |                                      |         |
| High  | 157 | 249.2                  |  |  |                                      |         |

<sup>a</sup> Transformed from natural logarithm scale.

<sup>b</sup> Slope and standard error based on natural logarithm of transferrin versus log<sub>2</sub> (initial dioxin).

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