The date on which a participant was first diagnosed with diabetes was used to measure a time to diabetes onset by determining the number of years between the date of diagnosis and the end date of the last tour of duty in SEA. Time to diabetes onset for those participants who have not been diagnosed with diabetes was the number of years between the 1997 examination date and the end date of the last tour of duty in SEA. This method of determining time to diabetes onset also was used for participants with a 2-hour postprandial glucose level of 200 mg/dl or greater at the 1997 physical examination but not yet diagnosed with diabetes.

Participants with a pre-SEA history of diabetes were excluded from the analyses of the composite diabetes indicator, diabetic severity, and time to diabetes onset.

16.1.3.2.1 Physical Examination Data

The physical examination of endocrine function included manual palpation of the thyroid gland and testes. Thyroid abnormalities consisted of enlarged gland, tenderness, presence of nodules, or thyroidectomies. Testicular abnormalities consisted of atrophied or absent testes. Participants with a pre-SEA history of thyroid disease and participants who are currently taking thyroid medication were excluded from the analysis of the thyroid gland. For the analysis of testicular abnormalities, participants with pre-SEA orchiectomies or participants with a missing testicle because of an undescended testicle or a congenital absence were excluded.

16.1.3.2.2 Laboratory Examination Data

For the 1997 follow-up examination, 14 laboratory variables were analyzed statistically in the endocrine assessment for all participants. TSH (μIU/ml), thyroxine (μg/dl), LH (mIU/ml), FSH (mIU/ml), and total testosterone (ng/dl) were conducted using Ciba Corning ACS 180® equipment. Abbott IMX® equipment was used to measure α-1-C hemoglobin (percent) and estradiol (pg/ml). Measurements for fasting glucose (mg/dl) were taken using Dade RxL® equipment. Fasting urinary glucose analyses were conducted by dipstick methods using Bayer Atlas® equipment. Anti-thyroid antibodies were analyzed using passive hemagglutination assay. Free testosterone (pg/ml) was conducted by radioimmunoassay.

In addition, the analyses of 2-hour postprandial glucose (mg/dl), serum insulin (μIU/ml), and the presence of 2-hour postprandial urinary glucose were restricted to nondiabetics only. Measurements for 2-hour postprandial glucose (mg/dl) were taken using Dade RxL® equipment. Analyses for 2-hour postprandial urinary glucose were conducted by dipstick methods using Bayer Atlas® equipment. Abbott IMX® equipment was used to measure serum insulin. The 100-gram glucose load for the postprandial assays was standardized by the use of Glucola® and was not given to diabetics unless requested by the participant.

All laboratory variables were analyzed in both discrete and continuous forms except for anti-thyroid antibodies, fasting urinary glucose, and 2-hour postprandial urinary glucose. These variables were analyzed as discrete variables only and categorized as "present" or "absent."

TSH and serum insulin were categorized as "abnormally low," "normal," and "abnormally high." The results for 2-hour postprandial glucose were coded as "normal" and "impaired." All other laboratory results were dichotomized as "normal" or "abnormal" (abnormally high for all variables, except for thyroxine, total testosterone, and free testosterone, which were classified according to abnormally low values).

Participants with thyroidectomies, a pre-SEA history of thyroid disease, or who are taking thyroid medication were excluded from the analyses of TSH, thyroxine, and anti-thyroid antibodies. For total and free testosterone, participants with orchiectomies (pre-SEA or post-SEA), participants with a missing testicle because of an undescended testicle or a congenital absence, and participants currently taking testosterone medication were excluded. Participants with pre-SEA diabetes were excluded from the analysis of fasting glucose, fasting urinary glucose, and α-1-C hemoglobin. Participants who were diabetic (pre-SEA and post-SEA) or participants with a 2-hour postprandial glucose level greater than or equal to 200 mg/dl were excluded from the analyses of 2-hour postprandial glucose, 2-hour postprandial urinary glucose, and serum insulin.

As described above, a 100-gram glucose load for the postprandial assays was standardized by the use of Glucola®. Some participants were not given Glucola® by request. A subset of these participants was not classified as diabetic through a medical records review; their 2-hour postprandial glucose was less than 200 mg/dl without consuming the Glucola®. Consequently, these participants could not be classified as diabetic or nondiabetic for the composite diabetes indicator and were considered to have an unknown diabetic status. These participants were excluded from analyses of 2-hour postprandial glucose, 2-hour postprandial urinary glucose, and serum insulin.

16.1.3.3 Covariates

The endocrine assessment included the effects of age, race, and military occupation in the adjusted analyses of all variables. To adjust for the effects of stress on endocrinologic measures, personality type was used as an additional covariate for past thyroid disease, thyroid gland abnormalities, TSH, thyroxine, and anti-thyroid antibodies. Age, race, occupation, personality type, and body fat were included in the adjusted analyses of the testes-related variables (testicular examination, total testosterone, and free testosterone). A covariate characterizing family history of diabetes was included for the diabetes-related variables, along with age, race, military occupation, personality type, and body fat. These dependent variables included the composite diabetes indicator, diabetic severity, time to diabetes onset, fasting and 2-hour postprandial glucose, fasting and 2-hour postprandial urinary glucose, serum insulin, and α-1-C hemoglobin.

Age, race, and military occupation were determined from military records. Personality type was determined from the Jenkins Activity Survey administered during the 1997 follow-up examination and was derived from a discriminant-function equation based on questions that best discriminate men judged to be type A from those judged to be type B (47). Positive scores reflected the type A direction; negative scores reflected the type B direction. Personality type was dichotomized as type A or type B.

Body fat was calculated from a metric body mass index (48); the formula is

$$Body\ Fat\,(in\ percent) = \frac{Weight\,(kg)}{[Height\,(m)]^2} \bullet 1.264 - 13.305.$$

Each participant was asked in the 1997 questionnaire whether anyone in his immediate family ever had diabetes or sugar diabetes. A family history of diabetes covariate was constructed from this question and used in adjusted analyses of all diabetic-related dependent variables.

16.1.4 Statistical Methods

Table 16-1 summarizes the statistical analysis that was performed for the endocrine assessment. The first part of this table describes the dependent variables and identifies the covariates and the statistical methods. The second part of this table further describes the covariates. A covariate was used in its continuous form whenever possible for all adjusted analyses. If the covariate was inherently discrete (e.g., military occupation), or if a categorized form was needed to develop measures of association, the covariate was categorized as shown in Table 16-1. Table 16-2 provides a summary of the number of participants with missing dependent variable and covariate data. In addition, the number of participants excluded because of medical conditions is given.

Table 16-1. Statistical Analysis for the Endocrine Assessment

Dependent Variables

Variable (Units)	Data Source	Data Form	Cutpoints	Covariates[a]	Exclusions[b]	Statistical Analysis and Methods
Past Thyroid Disease	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Composite Diabetes Indicator	MR-V/ LAB	D	• Diabetic: Verified History or ≥200 mg/dl 2-hr. post-prandial glucose • Nondiabetic: Otherwise	(2)	(b)	U:LR A:LR L:LR
Diabetic Severity	MR-V	D	Requiring Insulin Oral Hypoglycemics Diet Only No Treatment No Diabetes	(2)	(b)	U:PR A:PR
Time to Diabetes Onset (years)	MR-V/ LAB/ MIL	C	--	(2)	(b)	U:ST A:ST
Thyroid Gland	PE	D	Abnormal Normal	(1)	(c)	U:LR A:LR
Testicular Examination	PE	D	Abnormal Normal	(3)	(d)	U:LR A:LR
TSH (μIU/ml)	LAB	D/C	Abnormal Low: <0.35 Normal: 0.35-5.5 Abnormal High: >5.5	(1)	(e)	U:PR,GLM A:PR,GLM L:PR,GLM
Thyroxine (T_4) (μg/dl)	LAB	D/C	Low: <4.8 Normal: ≥4.8	(1)	(e)	U:LR,GLM A:LR,GLM
Anti-Thyroid Antibodies	LAB	D	Present Absent	(1)	(e)	U:LR A:LR
Fasting Glucose (mg/dl)	LAB	D/C	High: >110 Normal: ≤110	(2)	(b)	U:LR,GLM A:LR,GLM L:LR,GLM
2-Hour Postprandial Glucose (mg/dl)	LAB	D/C	Impaired: 140-<200 Normal: <140	(2)	(f)	U:LR,GLM A:LR,GLM L:LR,GLM

Table 16-1. Statistical Analysis for the Endocrine Assessment (Continued)

Variable (Units)	Data Source	Data Form	Cutpoints	Covariates[a]	Exclusions[b]	Statistical Analysis and Methods
Fasting Urinary Glucose	LAB	D	Present Absent	(2)	(b)	U:LR A:LR
2-Hour Postprandial Urinary Glucose	LAB	D	Present Absent	(2)	(f)	U:LR A:LR
Serum Insulin (µIU/ml)	LAB	D/C	Abnormal Low: <18 Normal: 18-56 Abnormal High: >56	(2)	(f)	U:PR,GLM A:PR,GLM
α-1-C Hemoglobin (percent)	LAB	D/C	High: >7.7 Normal: ≤7.7	(2)	(b)	U:LR,GLM A:LR,GLM
Total Testosterone (ng/dl)	LAB	D/C	Low: <241 (Ages 45-49) <230 (Age ≥50) Normal: ≥241 (Ages 45-49) ≥230 (Age ≥50)	(3)	(g)	U:LR,GLM A:LR,GLM L:LR,GLM
Free Testosterone (pg/ml)	LAB	D/C	Low: <6 Normal: ≥6	(3)	(g)	U:LR,GLM A:LR,GLM
Estradiol (pg/ml)	LAB	D/C	High: >50 Normal: ≤50	(4)	None	U:LR,GLM A:LR,GLM
LH (mIU/ml)	LAB	D/C	High: >9.3 Normal: ≤9.3	(4)	None	U:LR,GLM A:LR,GLM
FSH (mIU/ml)	LAB	D/C	High: >15 Normal: ≤15	(4)	None	U:LR,GLM A:LR,GLM

[a]Covariates:
(1): age, race, military occupation, personality type.
(2): age, race, military occupation, personality type, body fat, family history of diabetes.
(3): age, race, military occupation, personality type, body fat.
(4): age, race, military occupation.

[b]Exclusions:
(a): participants with a pre-SEA history of thyroid disease.
(b): participants with a pre-SEA history of diabetes.
(c): participants with a pre-SEA history of thyroid disease, participants currently taking thyroid medication.
(d): participants with a pre-SEA orchiectomy, participants with a testicle absent (undescended or congenital absence).
(e): participants with a pre-SEA history of thyroid disease, participants with a thyroidectomy, participants currently taking thyroid medication.
(f): all diabetics (pre- and post-SEA), participants whose diabetic status was unknown at the 1997 physical examination.
(g): participants with an orchiectomy (pre-SEA or post-SEA), participants with a testicle absent (undescended or congenital absence), participants currently taking testosterone medication.

Table 16-1. Statistical Analysis for the Endocrine Assessment (Continued)

Covariates

Variable (Units)	Data Source	Data Form	Cutpoints
Age (years)	MIL	D/C	Born ≥1942 Born <1942
Race	MIL	D	Black Non-Black
Occupation	MIL	D	Officer Enlisted Flyer Enlisted Groundcrew
Personality Type	PE	D	A direction B direction
Body Fat (percent)	PE	D/C	Obese: >25% Lean or Normal: ≤25%
Family History of Diabetes	Q-SR	D	Yes No

Abbreviations

Data Source:
- LAB: 1997 laboratory results
- MIL: Air Force military records
- MR-V: Medical records (verified)
- PE: 1997 physical examination
- Q-SR: 1997 health questionnaire (self-reported)

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

Statistical Analysis:
- U: Unadjusted analysis
- A: Adjusted analysis
- L: Longitudinal analysis

Statistical Methods:
- GLM: General linear models analysis
- LR: Logistic regression analysis
- PR: Polytomous logistic regression analysis
- ST: Survival time analysis

Cutpoints for total testosterone were age-dependent. Consequently, normal and abnormal levels for total testosterone were constructed according to a participant's laboratory value and age at the physical examination. The age-specific cutpoints are listed in Table 16-1; the reference ages for these cutpoints are given in parentheses following the cutpoints.

The analysis of time to diabetes onset was based on a regression analysis of time to onset in which time to onset was modeled as a linear combination of exposure variables and covariates. Further details on the statistical procedures used for the analysis of time to onset are discussed in Chapter 7, Statistical Methods.

Table 16-2. Number of Participants Excluded or with Missing Data for the Endocrine Assessment

		Group		Dioxin (Ranch Hands Only)		Categorized Dioxin	
Variable	Variable Use	Ranch Hand	Comparison	Initial	1987	Ranch Hand	Comparison
Composite Diabetes Indicator	DEP	9	18	5	7	7	17
Diabetic Severity	DEP	9	18	5	7	7	17
Time to Diabetes Onset	DEP	9	18	5	7	7	17
Testicular Examination	DEP	1	0	0	1	1	0
2-hour Postprandial Glucose	DEP	1	2	1	1	1	2
2-hour Postprandial Urinary Glucose	DEP	3	5	2	3	3	5
Serum Insulin	DEP	1	2	1	1	1	2
Personality Type	COV	3	0	1	3	3	0
Family History of Diabetes	COV	7	12	4	7	7	12
Pre-SEA Thyroid Disease	EXC	7	5	4	7	7	5
Pre-SEA Diabetes	EXC	2	1	2	2	2	1
Taking Thyroid Medication	EXC	24	44	13	24	24	44
Diabetic or Diabetic Status Unknown	EXC	156	228	113	152	152	217
Pre-SEA Orchiectomy	EXC	2	2	1	2	2	2
Thyroidectomy	EXC	12	15	5	12	12	15
Pre- or Post-SEA Orchiectomy	EXC	8	5	4	8	8	5
Testicle Undescended or Congenitally Absent	EXC	6	13	3	6	6	13
Taking Testosterone Medication	EXC	6	7	3	5	5	7

Note: DEP = Dependent variable.
COV = Covariate.
EXC = Exclusion.
870 Ranch Hands and 1,251 Comparisons.
482 Ranch Hands for initial dioxin; 863 Ranch Hands for 1987 dioxin.
863 Ranch Hands and 1,213 Comparisons for categorized dioxin.

16.2 RESULTS

16.2.1 Dependent Variable-Covariate Associations

The associations between the dependent variables examined in the endocrine assessment and the covariates used in the adjusted analysis were investigated. The results are presented in Appendix F, Table F-8. These associations are pairwise between the dependent variable and the covariate and are not adjusted for any other covariates. Participants were excluded from each of the analyses as given in Table 16-1. Statistically significant associations are discussed below.

The covariate tests of association for past thyroid disease revealed a significant positive association with age (p=0.020).

A participant with a verified history of diabetes or a 2-hour postprandial glucose level of greater than or equal to 200 mg/dl was considered diabetic in the composite diabetes indicator variable. The covariate tests of association revealed age (p=0.001), race (p=0.011), personality type (p=0.001), body fat (p=0.001), and family history of diabetes (p=0.001) to be associated significantly with the composite diabetes indicator. The percentage of diabetic participants increased with age. A higher percentage of Black participants than non-Black participants were diabetic (25.6% versus 16.4%). The percentage of diabetic participants was higher for participants with type B personalities than participants with type A personalities (19.5% versus 13.0%). A higher percentage of obese participants were diabetic than lean and normal participants (28.6% versus 12.1%). A greater percentage of participants with a family history of diabetes were diabetic, relative to participants with no family history of diabetes (24.9% versus 14.1%).

Tests of covariate association revealed age (p=0.001), race (p=0.023), personality type (p=0.001), body fat (p=0.001), and family history of diabetes (p=0.001) to be significantly associated with diabetic severity. The percentage of nondiabetic participants was greater for younger participants, non-Blacks, those with a type A personality, lean participants, and participants with no family history of diabetes. The percentages of older participants who used no treatment, diet, oral hypoglycemics, and insulin to treat diabetes were 6.2, 2.5, 7.5, and 2.6, respectively. Percentages for younger participants were smaller than for older participants for all forms of treatment. The analysis of race showed that for Black participants, 7.2 percent used no treatment, 2.4 percent used diet only as a form of treatment, 11.2 percent used oral hypoglycemics, and 3.2 percent used insulin. For all forms of treatment, the percentages of non-Black participants were smaller than for Black participants. Covariate analyses revealed that 4.3 percent, 1.1 percent, 3.5 percent, and 2.1 percent of participants with type A personalities used no treatment, diet, oral hypoglycemics, and insulin, respectively, to treat their disorder. For participants with type B personalities, 6.3 percent, 2.1 percent, 6.8 percent, and 1.9 percent, respectively, used these methods in the treatment of diabetes. Of the obese participants, 9.9 percent used no treatment, 2.1 percent used diet as a form of treatment, 10.2 percent used oral hypoglycemics, and 2.1 percent used insulin. The percentages of lean or normal participants using these methods were less for each form of treatment. Of the participants with a family history of diabetes, 7.5 percent used no treatment, 2.2 percent used diet to treat their disorder, 9.1 percent used hypoglycemics, and 3.5 percent used insulin. The percentages of participants with no family history of diabetes using these methods were less for each form of treatment.

Time to diabetes onset was associated significantly with age (p<0.001), race (p=0.007), personality type (p<0.001), body fat (p<0.001), and family history of diabetes (p<0.001). Time to diabetes onset decreased significantly with increases in age and body fat. Black participants had a shorter time to diabetes onset than did non-Black participants. Participants with type A personalities had a significantly longer time to diabetes onset than did participants with type B personalities. Participants with a family history of diabetes had a significantly shorter time to diabetes onset than did participants with no family history of diabetes.

Abnormalities of the thyroid gland were significantly associated with occupation (p=0.019). Officers had the highest percentage of participants with abnormal thyroid glands (1.9%), followed by enlisted flyers (0.6%), then enlisted groundcrew (0.5%).

Tests of covariate association showed the percentage of abnormal testicular examinations to be significantly associated with age (p=0.001) and occupation (p=0.021). Older participants had a higher percentage of abnormal testicular examinations than did younger participants (6.2% versus 1.4%). Officers had the highest percentage of abnormal testicular examinations (5.2%), followed by enlisted flyers (5.1%), then enlisted groundcrew (2.8%).

TSH in its continuous form increased significantly with age (p<0.001). Race and occupation also were significant (p<0.001 and p=0.007). Non-Black participants had a higher mean TSH level than did Black participants (1.87 μIU/ml versus 1.38 μIU/ml). Officers had the highest mean TSH level (1.94 μIU/ml), followed by enlisted groundcrew (1.78 μIU/ml), then enlisted flyers (1.77 μIU/ml). No significant covariate associations were seen with TSH in its discrete form.

Thyroxine in its continuous form was significantly associated with occupation ($p<0.001$). Enlisted flyers had the highest mean thyroxine level (7.26 μg/dl), followed by enlisted groundcrew (7.20 μg/dl), then officers (6.81 μg/dl). Tests of covariate associations with thyroxine in its discrete form revealed no significant associations.

Fasting glucose in its continuous form increased with age ($p<0.001$) and body fat ($p<0.001$). Occupation ($p=0.039$), personality type ($p=0.001$), and family history of diabetes ($p<0.001$) also were associated significantly with fasting glucose. Enlisted flyers had the highest mean fasting glucose level (104.1 mg/dl), followed by enlisted groundcrew (101.8 mg/dl), then officers (100.4 mg/dl). Participants with type B personalities had a higher mean fasting glucose level than did participants with type A personalities (102.9 mg/dl versus 99.6 mg/dl). Participants with a family history of diabetes had a higher mean fasting glucose level (107.1 mg/dl) than did those participants with no family history of diabetes (99.8 mg/dl).

Fasting glucose in its discrete form increased with age ($p=0.001$) and body fat ($p=0.001$). Race ($p=0.040$), personality type ($p=0.001$), and family history of diabetes ($p=0.001$) also were significant in the tests of covariate association. Black participants had a greater percentage of high fasting glucose levels than did non-Black participants (24.2% versus 16.7%). A greater percentage of high fasting glucose values was seen for participants with personality type B (19.4%) versus personality type A (13.6%). Participants with a family history of diabetes had a higher prevalence of high fasting glucose levels (25.2% versus 14.4%).

Two-hour postprandial glucose was analyzed only for nondiabetics. Two-hour postprandial glucose in its continuous form increased with age ($p<0.001$) and body fat ($p<0.001$). Occupation ($p=0.014$), personality type ($p=0.035$), and family history of diabetes ($p=0.003$) also were significant. Enlisted flyers had the highest mean 2-hour postprandial glucose level (109.7 mg/dl), followed by enlisted groundcrew (104.8 mg/dl), then officers (103.5 mg/dl). Participants with type B personalities had a higher mean 2-hour postprandial glucose level than did participants with type A personalities (106.3 mg/dl versus 103.3 mg/dl). Participants with a family history of diabetes had a higher mean 2-hour postprandial glucose level (108.9 mg/dl) than those with no family history of diabetes (104.0 mg/dl).

Tests of covariate association for 2-hour postprandial glucose in its dichotomous form showed age ($p=0.001$), race ($p=0.007$), body fat ($p=0.001$), and family history of diabetes ($p=0.024$) to be significant. The percentage of participants with 2-hour postprandial glucose results classified as impaired increased with age and body fat. Non-Black participants had a higher percentage of impaired values than did Black participants (16.4% versus 5.4%). Participants with a family history of diabetes had a higher prevalence of impaired values than did participants with no family history of diabetes (19.5% versus 14.7%).

The presence of fasting urinary glucose was significantly associated with occupation ($p=0.029$), personality type ($p=0.004$), body fat ($p=0.001$), and family history of diabetes ($p=0.012$). The prevalence of participants with fasting urinary glucose present increased with body fat. Enlisted groundcrew had the highest percentage of positive fasting urinary glucose results (5.2%), followed by enlisted flyers (5.0%), then officers (2.8%). A greater prevalence of participants with fasting urinary glucose present was seen for participants with personality type B (5.2%) versus personality type A (2.6%). Participants with a family history of diabetes had a higher prevalence of positive fasting urinary glucose results than did participants with no family history of diabetes (6.1% versus 3.5%).

Two-hour postprandial urinary glucose was analyzed only for nondiabetics. The presence of 2-hour postprandial urinary glucose was significantly associated with occupation ($p=0.033$). Enlisted flyers had the highest prevalence of positive 2-hour postprandial urinary glucose results (26.7%), followed by enlisted groundcrew (24.9%), then officers (20.1%).

Serum insulin was analyzed only for nondiabetics. Serum insulin in its continuous form increased significantly with age ($p<0.001$) and body fat ($p<0.001$). Occupation ($p=0.001$), personality type ($p=0.006$), and family history of diabetes ($p=0.001$) also were significant. Enlisted flyers had the highest mean serum insulin level (52.55 μIU/ml), followed by enlisted groundcrew (50.58 μIU/ml), then officers (43.67 μIU/ml). Participants with type B personalities had a higher mean serum insulin level than participants with type A personalities (50.42 μIU/ml versus 44.72 μIU/ml). Participants with a family history of diabetes had a higher mean insulin level (54.32 μIU/ml) than those with no family history of diabetes (46.28 μIU/ml).

Serum insulin in its discrete form was significantly associated with age ($p=0.003$), occupation ($p=0.024$), personality type ($p=0.018$), body fat ($p=0.001$), and family history of diabetes ($p=0.001$). Younger participants had a higher percentage of abnormally low and a lower percentage of abnormally high serum insulin levels than did older participants. Officers had the highest percentage of abnormally low serum insulin levels (14.9%) and the lowest percentage of abnormally high serum insulin levels (37.4%). Participants with personality type A had a higher percentage of abnormally low serum insulin levels (14.9%) and a lower percentage of abnormally high serum insulin levels (38.4%) than did participants with personality type B. Obese participants had a lower percentage of abnormally low serum insulin levels (2.5%) than did lean or normal participants (16.4%). Lean or normal participants had a lower percentage of abnormally high serum insulin levels (32.0%) than obese participants (71.0%). Participants with no family history of diabetes had a higher prevalence of abnormally low serum insulin levels (14.2%) than did participants with a history of diabetes (8.5%). The prevalence of abnormally high serum insulin values was greater for participants with a family history of diabetes than for participants with no history of diabetes (49.6% versus 39.4%).

Age and body fat significantly increased with α-1-C hemoglobin in its continuous form ($p<0.001$ for each). Race, occupation, personality type, and family history of diabetes also were significant ($p<0.001$ for each). Black participants had a significantly higher mean α-1-C hemoglobin level than did non-Black participants (7.07 percent versus 6.45 percent). Enlisted flyers had the highest mean α-1-C hemoglobin level (6.61 percent), followed by enlisted groundcrew (6.58 percent), then officers (6.33 percent). Participants with personality type B had a higher mean α-1-C hemoglobin level than did participants with personality type A (6.57 percent versus 6.36 percent). Participants with a family history of diabetes had a higher mean α-1-C hemoglobin level than did participants with no family history of diabetes (6.73 percent versus 6.40 percent).

The discrete form of α-1-C hemoglobin paralleled the continuous analysis. Age ($p=0.001$), race ($p=0.001$), occupation ($p=0.002$), personality type ($p=0.001$), body fat ($p=0.001$), and family history of diabetes ($p=0.001$) were all significantly associated with α-1-C hemoglobin in the tests of covariate association. The covariate categories with the highest mean levels also had the greatest percentage of abnormal high α-1-C hemoglobin levels.

Total testosterone in its continuous form decreased with age and body fat ($p<0.001$ each). Occupation also was significant ($p=0.043$). Officers had the lowest mean total testosterone level (410.7 ng/dl), followed by enlisted groundcrew (429.7 ng/dl), then enlisted flyers (433.4 ng/dl).

Tests of covariate association for total testosterone in its dichotomous form showed body fat to be significant (p=0.001). Obese participants had a higher percentage of low testosterone levels than did lean or normal participants (15.3% versus 4.7%).

Free testosterone in its continuous form decreased with age and body fat (p<0.001 each). Occupation (p<0.001) and personality type (p=0.001) also were significant. Officers had the lowest mean free testosterone level (13.12 pg/ml), followed by enlisted flyers (13.99 pg/ml), then enlisted groundcrew (14.65 pg/ml). Participants with type B personalities had a lower mean free testosterone level than did participants with type A personalities (13.68 pg/ml versus 14.37 pg/ml). Free testosterone in its discrete form decreased significantly with age (p=0.001) and body fat (p=0.002).

Both the continuous and discrete forms of estradiol were significantly associated with race (p=0.008 and p=0.013, respectively). Black participants had a higher mean estradiol level as well as a higher percentage of high estradiol values than non-Blacks. The mean estradiol level was 44.26 pg/ml for Blacks and 40.15 pg/ml for non-Blacks. For Blacks, 37.5 percent had high estradiol levels, whereas 27.0 percent of non-Blacks had high estradiol levels.

LH in both its continuous and discrete forms increased significantly with age (p<0.001 and p=0.001, respectively).

FSH in its continuous form increased significantly with age (p<0.001). Occupation was also significantly associated with FSH (p=0.008). Officers had the highest mean FSH level (6.31 mIU/ml), followed by enlisted flyers (6.00 mIU/ml), then enlisted groundcrew (5.75 mIU/ml).

Similarly, FSH in its dichotomous form was significantly associated with age (p=0.001) and occupation (p=0.001). Older participants had a greater percentage of high FSH values (11.2%) than did younger participants (4.0%). Officers had the highest percentage of high FSH results (10.4%), followed by enlisted flyers (9.2%), then enlisted groundcrew (5.5%).

16.2.2 Exposure Analysis

The following section presents results of the statistical analysis of the dependent variables shown in Table 16-1. Four models were examined for each dependent variable. The analyses of these models are presented below. Further details on dioxin and the modeling strategy are found in Chapters 2 and 7, respectively. These analyses were performed both unadjusted and adjusted for relevant covariates. Model 1 examined the relation between the dependent variable and group (i.e., Ranch Hand or Comparison). In this model, exposure was defined as "yes" for Ranch Hands and "no" for Comparisons without regard to the magnitude of the exposure. As an attempt to quantify exposure, three contrasts of Ranch Hands and Comparisons were performed along with the overall Ranch Hand versus Comparison contrast. These three contrasts compared Ranch Hands and Comparisons within each occupational category (i.e., officers, enlisted flyers, and enlisted groundcrew). As described in previous reports and in Table 2-8, the average levels of exposure to dioxin were highest for enlisted groundcrew, followed by enlisted flyers, then officers.

Model 2 explored the relation between the dependent variable and an extrapolated initial dioxin measure for Ranch Hands who had a 1987 dioxin measurement greater than 10 ppt. If a participant did not have a 1987 dioxin level, the 1992 level was used to estimate the initial dioxin level. If a participant did not have a 1987 or a 1992 dioxin level, the 1997 level was used to estimate the initial dioxin level. A statistical adjustment for the percentage of body fat at the time of the participant's blood measurement of dioxin was included in this model to account for body-fat-related differences in elimination rate (49).

Model 3 divided the Ranch Hands examined in Model 2 into two categories based on their initial dioxin measures. These two categories are referred to as "low Ranch Hand" and "high Ranch Hand." Two additional categories, Ranch Hands with 1987 serum dioxin levels at or below 10 ppt and Comparisons with 1987 serum dioxin levels at or below 10 ppt, were formed and included in the model. Ranch Hands with 1987 serum dioxin levels at or below 10 ppt are referred to as the "background Ranch Hand" category. Dioxin levels in 1992 were used if the 1987 level was not available, and dioxin levels in 1997 were used if the 1987 and 1992 levels were not available. The four categories—Comparisons, background Ranch Hands, low Ranch Hands, and high Ranch Hands—were used in Model 3 analyses. The relation between the dependent variable in each of the three Ranch Hand categories and the dependent variable in the Comparison category was examined. A fourth contrast, exploring the relation of the dependent variable in the combined low and high Ranch Hand categories relative to Comparisons, also was conducted. This combination is referred to in the tables as the "low plus high Ranch Hand" category. As in Model 2, a statistical adjustment for the percentage of body fat at the time of the participant's blood measurement of dioxin was included in this model.

Model 4 examined the relation between the dependent variable and 1987 lipid-adjusted dioxin levels in all Ranch Hands with a dioxin measurement. If a participant did not have a 1987 dioxin measurement, the 1992 measurement was used to determine the dioxin level. If a participant did not have a 1987 or a 1992 dioxin measurement, the 1997 measurement was used to determine the dioxin level.

16.2.2.1 Medical Records Variables

16.2.2.1.1 Past Thyroid Disease

All unadjusted and adjusted analyses for Models 1 through 4 were nonsignificant (Table 16-3(a–h): p>0.17 for each analysis).

Table 16-3. Analysis of Past Thyroid Disease

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

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***863***	***65 (7.5)***	***0.89 (0.64,1.22)***	***0.456***
	Comparison	***1,246***	***105 (8.4)***		
Officer	Ranch Hand	338	29 (8.6)	0.91 (0.56,1.48)	0.704
	Comparison	492	46 (9.3)		
Enlisted Flyer	Ranch Hand	150	15 (10.0)	1.37 (0.64,2.94)	0.415
	Comparison	187	14 (7.5)		
Enlisted Groundcrew	Ranch Hand	375	21 (5.6)	0.69 (0.40,1.18)	0.171
	Comparison	567	45 (7.9)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***0.89 (0.64,1.22)***	***0.459***
Officer	0.91 (0.56,1.48)	0.701
Enlisted Flyer	1.37 (0.64,2.94)	0.419
Enlisted Groundcrew	0.70 (0.41,1.19)	0.189

Table 16-3. Analysis of Past Thyroid Disease (Continued)

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log₂ (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	160	12 (7.5)	1.13 (0.88,1.45)	0.360
Medium	160	9 (5.6)		
High	158	14 (8.9)		

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

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

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
477	1.20 (0.88,1.64)	0.245

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

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED				
Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,208	102 (8.4)		
Background RH	378	30 (7.9)	0.97 (0.64,1.49)	0.906
Low RH	237	15 (6.3)	0.73 (0.41,1.27)	0.263
High RH	241	20 (8.3)	0.94 (0.57,1.56)	0.825
Low plus High RH	478	35 (7.3)	0.83 (0.55,1.24)	0.362

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-3. Analysis of Past Thyroid Disease (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED			
Dioxin Category	**n**	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
Comparison	1,208		
Background RH	376	0.92 (0.60,1.42)	0.707
Low RH	237	0.70 (0.40,1.22)	0.209
High RH	240	1.07 (0.64,1.81)	0.792
Low plus High RH	477	0.87 (0.57,1.30)	0.490

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED				
1987 Dioxin Category Summary Statistics			**Analysis Results for Log_2 (1987 Dioxin + 1)**	
1987 Dioxin	**n**	**Number (%) Yes**	**Estimated Relative Risk (95% C.I.)[a]**	**p-Value**
Low	287	25 (8.7)	1.01 (0.85,1.20)	0.892
Medium	285	19 (6.7)		
High	284	21 (7.4)		

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

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
853	1.10 (0.89,1.36)	0.358

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

16.2.2.1.2 Composite Diabetes Indicator

The composite diabetes indicator variable was a dichotomous classification of whether a participant was considered diabetic or not. A participant with a verified history of diabetes or a postprandial glucose level of greater than or equal to 200 mg/dl was considered diabetic for these analyses.

The Model 1 unadjusted and adjusted analyses did not show a significant difference in the number of diabetic participants between Ranch Hands and Comparisons across all occupations or within each occupational stratum (Table 16-4(a,b): p>0.49 for each analysis).

Table 16-4. Analysis of Composite Diabetes Indicator

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

Occupational Category	Group	n	Number (%) Diabetic	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***859***	***145 (16.9)***	***0.99 (0.79,1.25)***	***0.960***
	Comparison	***1,232***	***209 (17.0)***		
Officer	Ranch Hand	337	52 (15.4)	1.08 (0.73,1.59)	0.709
	Comparison	490	71 (14.5)		
Enlisted Flyer	Ranch Hand	148	27 (18.2)	0.86 (0.50,1.48)	0.583
	Comparison	184	38 (20.7)		
Enlisted Groundcrew	Ranch Hand	374	66 (17.6)	0.98 (0.70,1.38)	0.915
	Comparison	558	100 (17.9)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.04 (0.81,1.33)***	***0.755***
Officer	1.08 (0.72,1.63)	0.711
Enlisted Flyer	0.82 (0.45,1.47)	0.498
Enlisted Groundcrew	1.11 (0.77,1.61)	0.572

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Diabetic	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	157	32 (20.4)	1.11 (0.94,1.32)	0.231
Medium	158	35 (22.2)		
High	160	39 (24.4)		

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

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

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

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
470	1.36 (1.09,1.69)	0.005

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

Table 16-4. Analysis of Composite Diabetes Indicator (Continued)

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

Dioxin Category	n	Number (%) Diabetic	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	199 (16.7)		
Background RH	379	37 (9.8)	0.67 (0.45,0.98)	0.041
Low RH	235	49 (20.9)	1.27 (0.88,1.84)	0.202
High RH	240	57 (23.8)	1.33 (0.94,1.90)	0.111
Low plus High RH	475	106 (22.3)	1.30 (0.99,1.72)	0.064

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,183		
Background RH	375	0.69 (0.46,1.02)	0.065
Low RH	232	1.22 (0.83,1.79)	0.311
High RH	238	1.47 (1.00,2.17)	0.048
Low plus High RH	470	1.34 (1.00,1.80)	0.049

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

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

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Diabetic	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	286	22 (7.7)	1.35 (1.20,1.52)	<0.001
Medium	284	54 (19.0)		
High	284	67 (23.6)		

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

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

Table 16-4. Analysis of Composite Diabetes Indicator (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
845	1.43 (1.21,1.68)	<0.001

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

The unadjusted Model 2 analysis did not reveal a significant relation between initial dioxin and the percentage of diabetic participants (Table 16-4(c): p=0.231). After adjusting for covariates, the results became significant (Table 16-4(d): Adj. RR=1.36, p=0.005). The percentages of diabetic participants in the low, medium, and high initial dioxin categories were 20.4, 22.2, and 24.4, respectively.

The unadjusted Model 3 analysis of the composite diabetes indicator revealed significant differences between Ranch Hands in the background dioxin category and Comparisons, as well as between Ranch Hands in the low plus high dioxin category and Comparisons (Table 16-4(e): Est. RR=0.67, p=0.041; Est. RR=1.30, p=0.064, respectively). After adjusting for covariates, three significant contrasts were revealed: Ranch Hands in the background dioxin category versus Comparisons (Table 16-4(f): Adj. RR=0.69, p=0.065), Ranch Hands in the high dioxin category versus Comparisons (Table 16-4(f): Adj. RR=1.47, p=0.048), and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 16-4(f): Adj. RR=1.34, p=0.049). The percentage of diabetic Comparisons was 16.7, versus 9.8 percent for Ranch Hands in the background dioxin category, 23.8 percent of Ranch Hands in the high dioxin category, and 22.3 percent for Ranch Hands in the low plus high dioxin category.

The unadjusted and adjusted Model 4 analyses each revealed a significant positive association between 1987 dioxin and the percentage of diabetic participants (Table 16-4(g,h): Est. RR=1.35, p<0.001; Adj. RR=1.43, p<0.001, respectively). The percentages of diabetic participants in the low, medium, and high 1987 dioxin categories were 7.7, 19.0, and 23.6, respectively.

16.2.2.1.3 Diabetic Severity

The unadjusted Model 1 analysis of diabetic severity revealed marginally significant or significant differences between the percentage of Ranch Hands and Comparisons taking oral hypoglycemics (Table 16-5(a): Est. RR=0.71, p=0.097) and requiring insulin (Table 16-5(a): Est. RR=2.04, p=0.026). The percentage of participants taking oral hypoglycemics was 4.4 for Ranch Hands versus 6.3 for Comparisons. The percentage of participants requiring insulin in the Ranch Hand group was 2.8 versus 1.4 in the Comparison group. Stratifying by occupation revealed a marginally significant difference between the percentage of Ranch Hand and Comparison officers requiring insulin (Table 16-5(a): Est. RR=2.53, p=0.054). For Ranch Hand officers, 3.6 percent required insulin versus 1.4 percent for Comparison officers. After adjusting for covariates, a significant difference in the percentage of Ranch Hands and Comparisons requiring insulin was observed (Table 16-5(b): Adj. RR=2.20, p=0.017). In addition, marginally significant differences were seen between the percentage of Ranch Hands and Comparisons requiring insulin in both the officer stratum and the enlisted groundcrew stratum (Table 16-5(b): Adj. RR=2.39, p=0.074; Adj. RR=2.52, p=0.084, respectively).

The unadjusted Model 2 analysis of diabetic severity did not reveal a significant relation between initial dioxin and the severity of diabetes (Table 16-5(c): p≥0.25 for each contrast). After adjusting for covariates, the percentage of Ranch Hands taking oral hypoglycemic and requiring insulin was associated significantly with initial dioxin (Table 16-5(d): Adj. RR=1.41, p=0.062 for oral hypoglycemics; Adj. RR=2.47, p=0.001 for requiring insulin). The percentages of Ranch Hands taking oral hypoglycemics in the low, medium, and high initial dioxin categories were 5.1, 6.3, and 8.8, respectively. The percentages of participants requiring insulin in the low, medium, and high initial dioxin categories were 2.5, 3.8, and 3.8, respectively.

The Model 3 unadjusted analysis revealed a significant difference between the percentage of Ranch Hands in the background dioxin category and Comparisons who took oral hypoglycemics to control diabetes (Table 16-5(e): Est. RR=0.27, p=0.006). For Ranch Hands in the background dioxin category, 1.3 percent used oral hypoglycemics versus 6.0 percent of Comparisons. Three Ranch Hand dioxin categories were significantly different from the Comparisons in the percentage of participants requiring insulin: Ranch Hands in the low dioxin category versus Comparisons (Table 16-5(e): Est. RR=2.43, p=0.042), Ranch Hands in the high dioxin category versus Comparisons (Table 16-5(e): Est. RR=2.40, p=0.046), and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 16-5(e): Est. RR=2.41, p=0.013). The percentages of requiring insulin Ranch Hands in the low dioxin category, high dioxin category, and low plus high dioxin category were 3.4, 3.3, and 3.4, respectively, versus 1.4 percent for Comparisons.

The adjusted Model 3 analysis revealed a marginally significant difference between the percentage of Ranch Hands in the high dioxin category and Comparisons who used diet only to control diabetes (Table 16-5(f): Adj. RR=2.32, p=0.089). For Ranch Hands in the high dioxin category, 2.9 percent used diet alone to treat their diabetes versus 1.4 percent of Comparisons. A significant difference between the percentage of Ranch Hands in the background dioxin category and Comparisons who took oral hypoglycemics was observed (Table 16-5(f): Adj. RR=0.28, p=0.008). Three Ranch Hand dioxin categories were significantly different from the Comparisons in the percentage of participants that required insulin: Ranch Hands in the low dioxin category (Table 16-5(f): Adj. RR=2.41, p=0.050), Ranch Hands in the high dioxin category (Table 16-5(f): Adj. RR=3.46, p=0.009), and Ranch Hands in the low plus high dioxin category (Table 16-5(f): Adj. RR=2.90, p=0.004).

The unadjusted Model 4 analysis of diabetic severity revealed a significant positive association between 1987 dioxin and the percentage of diabetics who used no treatment for diabetes (Table 16-5(g): Est. RR=1.28, p=0.010). A positive association between 1987 dioxin and the percentage of diabetics using oral hypoglycemics also was observed (Table 16-5(g): Est. RR=1.58, p<0.001). Adjusting for covariates revealed significant or marginally significant positive associations with 1987 dioxin for all four contrasts: no treatment (Table 16-5(h): Adj. RR=1.23, p=0.097), diet only (Table 16-5(h): Adj. RR=1.49, p=0.048), oral hypoglycemic (Table 16-5(h): Adj. RR=1.85, p<0.001), and requiring insulin (Table 16-5(h): Adj. RR=1.38, p=0.084).

Table 16-5. Analysis of Diabetic Severity

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

Occupational Category	Group	n	Number (%) Nondiabetic	No Treatment	Diet Only	Oral Hypo-glycemic	Requiring Insulin	Contrast vs. Nondiabetic	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*730 (85.0)*	*49 (5.7)*	*18 (2.1)*	*38 (4.4)*	*24 (2.8)*	*No Treatment*	*1.07 (0.73,1.57)*	*0.721*
	Comparison	*1,232*	*1,054 (85.6)*	*66 (5.4)*	*18 (1.5)*	*77 (6.3)*	*17 (1.4)*	*Diet Only*	*1.44 (0.75,2.79)*	*0.275*
								Oral Hypo-glycemic	*0.71 (0.48,1.06)*	*0.097*
								Requiring Insulin	*2.04 (1.09,3.82)*	*0.026*
Officer	Ranch Hand	337	289 (85.8)	16 (4.7)	8 (2.4)	12 (3.6)	12 (3.6)	No Treatment	0.94 (0.49,1.80)	0.859
	Comparison	490	426 (86.9)	25 (5.1)	6 (1.2)	26 (5.3)	7 (1.4)	Diet Only	1.97 (0.67,5.72)	0.215
								Oral Hypo-glycemic	0.68 (0.34,1.37)	0.281
								Requiring Insulin	2.53 (0.98,6.50)	0.054
Enlisted Flyer	Ranch Hand	148	125 (84.5)	9 (6.1)	2 (1.4)	9 (6.1)	3 (2.0)	No Treatment	0.78 (0.33,1.87)	0.579
	Comparison	184	152 (82.6)	14 (7.6)	2 (1.1)	12 (6.5)	4 (2.2)	Diet Only	1.22 (0.17,8.76)	0.846
								Oral Hypo-glycemic	0.91 (0.37,2.23)	0.840
								Requiring Insulin	0.91 (0.20,4.15)	0.905
Enlisted Groundcrew	Ranch Hand	374	316 (84.5)	24 (6.4)	8 (2.1)	17 (4.5)	9 (2.4)	No Treatment	1.34 (0.76,2.36)	0.314
	Comparison	558	476 (85.3)	27 (4.8)	10 (1.8)	39 (7.0)	6 (1.1)	Diet Only	1.21 (0.47,3.09)	0.697
								Oral Hypo-glycemic	0.66 (0.37,1.18)	0.160
								Requiring Insulin	2.26 (0.80,6.41)	0.125

Table 16-5. Analysis of Diabetic Severity (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS — ADJUSTED			
Occupational Category	**Contrast vs. Nondiabetic**	**Adj. Relative Risk (95% C.I.)**	**p-Value**
All	*No Treatment*	*1.10 (0.74,1.62)*	*0.642*
	Diet Only	*1.52 (0.78,2.96)*	*0.219*
	Oral Hypoglycemic	*0.73 (0.48,1.11)*	*0.137*
	Requiring Insulin	*2.20 (1.15,4.20)*	*0.017*
Officer	No Treatment	0.96 (0.50,1.86)	0.902
	Diet Only	2.04 (0.69,5.99)	0.195
	Oral Hypoglycemic	0.68 (0.33,1.39)	0.288
	Requiring Insulin	2.39 (0.92,6.20)	0.074
Enlisted Flyer	No Treatment	0.71 (0.29,1.72)	0.445
	Diet Only	1.09 (0.15,7.93)	0.931
	Oral Hypoglycemic	0.75 (0.29,1.91)	0.544
	Requiring Insulin	1.22 (0.24,6.24)	0.811
Enlisted Groundcrew	No Treatment	1.48 (0.83,2.66)	0.185
	Diet Only	1.32 (0.51,3.41)	0.572
	Oral Hypoglycemic	0.76 (0.41,1.41)	0.384
	Requiring Insulin	2.52 (0.88,7.23)	0.084

Table 16-5. Analysis of Diabetic Severity (Continued)

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

Initial Dioxin Category	n	Initial Dioxin Category Summary Statistics Number (%) Nondiabetic	No Treatment	Diet Only	Oral Hypoglycemic	Requiring Insulin	Analysis Results for Log_2 (Initial Dioxin)[a] Contrast vs. Nondiabetic	Est. Relative Risk (95% C.I.)[b]	p-Value
Low	157	131 (83.4)	11 (7.0)	3 (1.9)	8 (5.1)	4 (2.5)	No Treatment	1.14 (0.87,1.49)	0.332
Medium	158	128 (81.0)	9 (5.7)	5 (3.2)	10 (6.3)	6 (3.8)	Diet Only	1.12 (0.74,1.71)	0.584
High	160	124 (77.5)	12 (7.5)	4 (2.5)	14 (8.8)	6 (3.8)	Oral Hypoglycemic	1.13 (0.87,1.48)	0.358
							Requiring Insulin	1.23 (0.86,1.76)	0.250

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

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

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

n	Analysis Results for Log_2 (Initial Dioxin) Contrast vs. Nondiabetic	Adjusted Relative Risk (95% C.I.)[a]	p-Value
470	No Treatment	1.29 (0.93,1.78)	0.121
	Diet Only	1.25 (0.74,2.11)	0.411
	Oral Hypoglycemic	1.41 (0.98,2.01)	0.062
	Requiring Insulin	2.47 (1.43,4.25)	0.001

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

Table 16-5. Analysis of Diabetic Severity (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED						
		Number (%)				
Dioxin Category	n	Nondiabetic	No Treatment	Diet Only	Oral Hypoglycemic	Requiring Insulin
Comparison	1,195	1,026 (85.9)	63 (5.3)	17 (1.4)	72 (6.0)	17 (1.4)
Background RH	379	344 (90.8)	16 (4.2)	6 (1.6)	5 (1.3)	8 (2.1)
Low RH	235	195 (83.0)	13 (5.5)	5 (2.1)	14 (6.0)	8 (3.4)
High RH	240	188 (78.3)	19 (7.9)	7 (2.9)	18 (7.5)	8 (3.3)
Low plus High RH	475	383 (80.6)	32 (6.7)	12 (2.5)	32 (6.7)	16 (3.4)

	Contrast vs. Nondiabetic							
	No Treatment		Diet Only		Oral Hypoglycemic		Requiring Insulin	
Dioxin Category	Est. Relative Risk (95% C.I.)[ab]	p-Value	Est. Relative Risk (95% C.I.)[ab]	p-Value	Est. Relative Risk (95% C.I.)[ab]	p-Value	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison								
Background RH	0.91 (0.51,1.61)	0.749	1.23 (0.48,3.17)	0.668	0.27 (0.11,0.69)	0.006	1.55 (0.66,3.63)	0.318
Low RH	1.04 (0.55,1.94)	0.912	1.49 (0.54,4.11)	0.437	0.92 (0.49,1.72)	0.795	2.43 (1.03,5.72)	0.042
High RH	1.43 (0.83,2.47)	0.202	2.00 (0.81,4.92)	0.131	1.08 (0.61,1.91)	0.799	2.40 (1.02,5.65)	0.046
Low plus High RH	1.22 (0.77,1.92)	0.394	1.73 (0.81,3.70)	0.156	1.00 (0.63,1.58)	0.988	2.41 (1.20,4.83)	0.013

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-5. Analysis of Diabetic Severity (Continued)

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

		No Treatment vs. Nondiabetic		Diet Only vs. Nondiabetic	
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[a]	p-Value	Adj. Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,183				
Background RH	375	0.92 (0.51,1.65)	0.771	1.24 (0.47,3.30)	0.661
Low RH	232	0.95 (0.50,1.80)	0.878	1.55 (0.55,4.34)	0.408
High RH	238	1.58 (0.89,2.81)	0.122	2.32 (0.88,6.12)	0.089
Low plus High RH	470	1.23 (0.77,1.95)	0.385	1.90 (0.87,4.15)	0.108

		Oral Hypoglycemic vs. Nondiabetic		Requiring Insulin vs. Nondiabetic	
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[a]	p-Value	Adj. Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,183				
Background RH	375	0.28 (0.11,0.71)	0.008	1.42 (0.59,3.45)	0.435
Low RH	232	0.89 (0.46,1.71)	0.726	2.41 (1.00,5.82)	0.050
High RH	238	1.17 (0.63,2.18)	0.624	3.46 (1.36,8.81)	0.009
Low plus High RH	470	1.02 (0.63,1.65)	0.931	2.90 (1.40,5.99)	0.004

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-5. Analysis of Diabetic Severity (Continued)

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

Initial Dioxin Category	n	1987 Dioxin Category Summary Statistics Number (%) Nondiabetic	No Treatment	Diet Only	Oral Hypoglycemic	Requiring Insulin
Low	286	264 (92.3)	11 (3.8)	2 (0.7)	3 (1.1)	6 (2.1)
Medium	284	239 (84.2)	17 (6.0)	8 (2.8)	12 (4.2)	8 (2.8)
High	284	224 (78.9)	20 (7.0)	8 (2.8)	22 (7.7)	10 (3.5)

Analysis Results for Log_2 (1987 Dioxin +1)[a] Contrast vs. Nondiabetic	Est. Relative Risk (95% C.I.)[a]	p-Value
No Treatment	1.28 (1.06,1.55)	0.010
Diet Only	1.27 (0.94,1.72)	0.120
Oral Hypoglycemic	1.58 (1.28,1.94)	<0.001
Requiring Insulin	1.15 (0.87,1.50)	0.323

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

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

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

n	Analysis Results for Log_2 (1987 Dioxin + 1) Contrast vs. Nondiabetic	Adjusted Relative Risk (95% C.I.)[a]	p-Value
845	No Treatment	1.23 (0.96,1.58)	0.097
	Diet Only	1.49 (1.00,2.20)	0.048
	Oral Hypoglycemic	1.85 (1.37,2.49)	<0.001
	Requiring Insulin	1.38 (0.96,2.00)	0.084

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

16.2.2.1.4 Time to Diabetes Onset

The time to diabetes onset from time of duty in SEA did not differ significantly between Ranch Hands and Comparisons in the Model 1 unadjusted and adjusted analyses (Table 16-6(a,b): p≥0.39 for each analysis).

Table 16-6. Analysis of Time to Diabetes Onset (years)

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

Occupational Category	Group	n	Coefficient (Std. Error)[a]	p-Value[b]
All	***Ranch Hand***	***859***	***0.018 (0.035)***	***0.603***
	Comparison	***1,232***		
Officer	Ranch Hand	337	–0.008 (0.077)	0.916
	Comparison	490		
Enlisted Flyer	Ranch Hand	148	0.064 (0.075)	0.390
	Comparison	184		
Enlisted Groundcrew	Ranch Hand	374	0.015 (0.041)	0.715
	Comparison	558		

[a] Coefficient and standard error for group in a survival time analysis model, using a censored Weibull distribution. A negative coefficient implies that the time to diabetes onset is shorter for Ranch Hands than for Comparisons.
[b] P-value based on the group coefficient in a survival time analysis model, using a censored Weibull distribution.

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

Occupational Category	Group	n	Adj. Coefficient (Std. Error)[a]	p-Value[b]
All	***Ranch Hand***	***850***	***0.006 (0.035)***	***0.871***
	Comparison	***1,220***		
Officer	Ranch Hand	335	–0.001 (0.079)	0.993
	Comparison	488		
Enlisted Flyer	Ranch Hand	145	0.066 (0.077)	0.390
	Comparison	178		
Enlisted Groundcrew	Ranch Hand	370	–0.018 (0.043)	0.666
	Comparison	554		

[a] Coefficient and standard error for group in a survival time analysis model, using a censored Weibull distribution. A negative coefficient implies that the time to diabetes onset is shorter for Ranch Hands than for Comparisons.
[b] P-value based on the group coefficient in a survival time analysis model, using a censored Weibull distribution.

Table 16-6. Analysis of Time to Diabetes Onset (years) (Continued)

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

Initial Dioxin Category Summary Statistics		Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	**n**	**Slope (Std. Error)[b]**	**p-Value**
Low	157	–0.0214 (0.023)	0.356
Medium	158		
High	160		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Slope and standard error based on time to diabetes onset versus $\log_2$ (initial dioxin) in a survival time analysis model, using a censored Weibull distribution. A negative slope implies that the time to diabetes onset is shorter as initial dioxin increases.

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

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

Initial Dioxin Category Summary Statistics		Analysis Results for Log_2 (Initial Dioxin)	
Initial Dioxin	**n**	**Adjusted Slope (Std. Error)[a]**	**p-Value**
Low	156	–0.074 (0.030)	0.013
Medium	154		
High	160		

[a] Slope and standard error based on time to diabetes onset versus $\log_2$ (initial dioxin) in a survival time analysis model, using a censored Weibull distribution. A negative slope implies that the time to diabetes onset is shorter as initial dioxin increases.

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	Coefficient (Std. Error)[ab]	p-Value[c]
Comparison	1,195		
Background RH	379	0.143 (0.058)	0.013
Low RH	235	–0.058 (0.051)	0.254
High RH	240	–0.058 (0.048)	0.233
Low plus High RH	475	–0.058 (0.039)	0.134

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Coefficient and standard error for Ranch Hand versus Comparison contrast in a survival time analysis model, using a censored Weibull distribution. A negative coefficient implies that the time to diabetes onset is shorter for the Ranch Hand category than for Comparisons.
[c] P-value based on the Ranch Hand versus Comparison contrast in a survival time analysis model, using a censored Weibull distribution.

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 16-6. Analysis of Time to Diabetes Onset (years) (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED			
Dioxin Category	n	Adj. Coefficient (Std. Error)[a]	p-Value[b]
Comparison	1,183		
Background RH	375	0.134 (0.059)	0.024
Low RH	232	–0.065 (0.052)	0.214
High RH	238	–0.085 (0.051)	0.100
Low plus High RH	470	–0.075 (0.040)	0.061

[a] Coefficient and standard error for Ranch Hand versus Comparison contrast in a survival time analysis model, using a censored Weibull distribution. A negative coefficient implies that the time to diabetes onset is shorter for the Ranch Hand category than for Comparisons.
[b] P-value based on the Ranch Hand versus Comparison contrast in a survival time analysis model, using a censored Weibull distribution.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED			
1987 Dioxin Category Summary Statistics		Analysis Results for $\log_2$ (1987 Dioxin +1)	
1987 Dioxin	n	Slope (Std. Error)[a]	p-Value
Low	286	–0.098 (0.021)	<0.001
Medium	284		
High	284		

[a] Slope and standard error based on time to diabetes onset versus $\log_2$ (1987 dioxin + 1) in a survival time analysis model, using a censored Weibull distribution. A negative slope implies that the time to diabetes onset is shorter as 1987 dioxin increases.

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED			
1987 Dioxin Category Summary Statistics		Analysis Results for $\log_2$ (1987 Dioxin +1)	
1987 Dioxin	n	Adjusted Slope (Std. Error)[a]	p-Value
Low	282	–0.118 (0.027)	<0.001
Medium	283		
High	280		

[a] Slope and standard error based on time to diabetes onset versus $\log_2$ (1987 dioxin + 1) in a survival time analysis model, using a censored Weibull distribution. A negative slope implies that the time to diabetes onset is shorter as 1987 dioxin increases.

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

The Model 2 unadjusted analysis did not reveal a significant relation between initial dioxin and time to diabetes onset (Table 16-6(c): p=0.356). After adjusting for covariates, the results became significant (Table 16-6(d): adjusted slope=–0.074, p=0.013). The time to diabetes onset was shorter for Ranch Hands with higher initial dioxin levels.

The Model 3 unadjusted and adjusted analyses each revealed a significant difference in time to diabetes onset between Ranch Hands in the background dioxin category and Comparisons (Table 16-6(e,f): p=0.013, unadjusted; p=0.024, adjusted). The time to diabetes onset was significantly longer for Ranch Hands in the background dioxin category than for Comparisons. The adjusted Model 3 analysis also revealed two other marginally significant contrasts: Ranch Hands in the high dioxin category versus Comparisons (Table 16-6(f): p=0.100) and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 16-6(f): p=0.061). In each of these two contrasts, the time to diabetes onset from time of duty in SEA was shorter for the Ranch Hand category than for the Comparison category.

The unadjusted and adjusted Model 4 analyses each revealed a significant association between time to diabetes onset and 1987 dioxin (Table 16-6(g,h): slope=–0.098, p<0.001; adjusted slope=–0.118, p<0.001, respectively). In each analysis, the time to diabetes onset was shorter for Ranch Hands with higher 1987 dioxin levels.

16.2.2.2 Physical Examination Variables

16.2.2.2.1 Thyroid Gland

All unadjusted and adjusted analyses in Models 1 through 4 showed no significant associations with dioxin (Table 16-7(a–h): p>0.11 for each analysis).

Table 16-7. Analysis of Thyroid Gland

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

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***843***	***6 (0.7)***	***0.53 (0.21,1.36)***	***0.171***
	Comparison	***1,203***	***16 (1.3)***		
Officer	Ranch Hand	328	4 (1.2)	0.52 (0.16,1.63)	0.260
	Comparison	470	11 (2.3)		
Enlisted Flyer	Ranch Hand	144	1 (0.7)	1.27 (0.08,20.41)	0.868
	Comparison	182	1 (0.5)		
Enlisted Groundcrew	Ranch Hand	371	1 (0.3)	0.37 (0.04,3.32)	0.374
	Comparison	551	4 (0.7)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***0.54 (0.21,1.39)***	***0.183***
Officer	0.53 (0.17,1.67)	0.276
Enlisted Flyer	1.23 (0.08,19.88)	0.883
Enlisted Groundcrew	0.38 (0.04,3.39)	0.384

Note: Results are not adjusted for race because of the sparse number of participants with an abnormal thyroid gland.

Table 16-7. Analysis of Thyroid Gland (Continued)

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	157	1 (0.6)	0.95 (0.32,2.81)	0.923
Medium	158	0 (0.0)		
High	152	1 (0.7)		

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

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

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
466	1.01 (0.32,3.17)	0.981

[a] 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 an abnormal thyroid gland.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED				
Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,165	16 (1.4)		
Background RH	369	4 (1.1)	0.82 (0.27,2.47)	0.718
Low RH	233	1 (0.4)	0.31 (0.04,2.32)	0.253
High RH	234	1 (0.4)	0.30 (0.04,2.27)	0.242
Low plus High RH	467	2 (0.4)	0.30 (0.07,1.32)	0.112

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-7. Analysis of Thyroid Gland (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED			
Dioxin Category	**n**	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
Comparison	1,165		
Background RH	367	0.65 (0.21,2.01)	0.457
Low RH	233	0.29 (0.04,2.19)	0.229
High RH	233	0.56 (0.07,4.62)	0.590
Low plus High RH	466	0.40 (0.09,1.81)	0.234

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Results are not adjusted for race because of the sparse number of participants with an abnormal thyroid gland.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED				
1987 Dioxin Category Summary Statistics			**Analysis Results for Log_2 (1987 Dioxin + 1)**	
1987 Dioxin	**n**	**Number (%) Abnormal**	**Estimated Relative Risk (95% C.I.)[a]**	**p-Value**
Low	279	3 (1.1)	0.85 (0.47,1.51)	0.562
Medium	280	2 (0.7)		
High	277	1 (0.4)		

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

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
833	1.09 (0.50,2.36)	0.825

[a] 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 an abnormal thyroid gland.

16.2.2.2.2 Testicular Examination

The unadjusted and adjusted Model 1 and 2 analyses of testicular examination were nonsignificant (Table 16-8(a–d): p>0.10 for each analysis).

Table 16-8. Analysis of Testicular Examination

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

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	*861*	*39 (4.5)*	*1.20 (0.78,1.85)*	*0.409*
	Comparison	*1,237*	*47 (3.8)*		
Officer	Ranch Hand	336	16 (4.8)	0.86 (0.45,1.62)	0.635
	Comparison	490	27 (5.5)		
Enlisted Flyer	Ranch Hand	148	9 (6.1)	1.42 (0.54,3.79)	0.478
	Comparison	184	8 (4.3)		
Enlisted Groundcrew	Ranch Hand	377	14 (3.7)	1.77 (0.81,3.87)	0.152
	Comparison	563	12 (2.1)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.20 (0.77,1.87)*	*0.427*
Officer	0.84 (0.44,1.62)	0.611
Enlisted Flyer	1.31 (0.48,3.55)	0.595
Enlisted Groundcrew	1.96 (0.88,4.39)	0.101

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	158	10 (6.3)	0.93 (0.66,1.29)	0.653
Medium	162	8 (4.9)		
High	158	6 (3.8)		

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

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

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

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
477	1.08 (0.72,1.61)	0.714

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

Table 16-8. Analysis of Testicular Examination (Continued)

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

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,199	47 (3.9)		
Background RH	376	14 (3.7)	0.89 (0.49,1.65)	0.722
Low RH	237	15 (6.3)	1.68 (0.92,3.06)	0.091
High RH	241	9 (3.7)	1.00 (0.48,2.07)	0.994
Low plus High RH	478	24 (5.0)	1.29 (0.77,2.16)	0.333

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

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

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,199		
Background RH	374	0.84 (0.45,1.58)	0.594
Low RH	237	1.46 (0.78,2.71)	0.236
High RH	240	1.39 (0.63,3.03)	0.415
Low plus High RH	477	1.42 (0.82,2.45)	0.207

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

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

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	9 (3.2)	1.01 (0.81,1.26)	0.903
Medium	284	17 (6.0)		
High	286	12 (4.2)		

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

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

Table 16-8. Analysis of Testicular Examination (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
851	1.09 (0.82,1.44)	0.545

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

The unadjusted Model 3 analysis revealed a marginally significant difference in the percentage of abnormal testicular examination results between Ranch Hands in the low dioxin category and Comparisons (Table 16-8(e): Est. RR=1.68, p=0.091). The percentage of participants with abnormal testicular examination results for Ranch Hands in the low dioxin category was 6.3 versus 3.9 percent for the Comparisons. After covariate adjustment, the results were not significant (Table 16-8(f): p>0.20 for each contrast).

The unadjusted and adjusted Model 4 analyses of testicular examination were not significant (Table 16-8(g,h): p>0.54 for each analysis).

16.2.2.3 Laboratory Examination Variables

16.2.2.3.1 TSH (Continuous)

The unadjusted Model 1 analysis of TSH in its continuous form did not reveal any significant mean differences between Ranch Hands and Comparisons across all occupations or within each occupational stratum (Table 16-9(a): p≥0.13 for each contrast). The adjusted analysis showed no significant overall group difference between Ranch Hands and Comparisons (Table 16-9(b): p=0.105). Stratifying the adjusted analysis by occupation revealed a marginally significant difference between Ranch Hands and Comparisons in the enlisted groundcrew stratum (Table 16-9(b): difference of adjusted means=0.11 µIU/ml, p=0.088). The adjusted mean TSH level for Ranch Hand enlisted groundcrew was 1.71 µIU/ml versus 1.60 µIU/ml for Comparison enlisted groundcrew.

Table 16-9. Analysis of TSH (µIU/ml) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***841***	***1.88***	***0.08 --***	***0.130***
	Comparison	***1,199***	***1.81***		
Officer	Ranch Hand	326	2.01	0.12 --	0.170
	Comparison	468	1.89		
Enlisted Flyer	Ranch Hand	144	1.72	–0.10 --	0.428
	Comparison	182	1.82		
Enlisted Groundcrew	Ranch Hand	371	1.84	0.11 --	0.139
	Comparison	549	1.73		

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

Table 16-9. Analysis of TSH (µIU/ml) (Continuous)

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

Occupational Category	Group	n	Adjusted Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***838***	***1.64***	***0.07 --***	***0.105***
	Comparison	***1,199***	***1.57***		
Officer	Ranch Hand	325	1.69	0.10 --	0.178
	Comparison	468	1.59		
Enlisted Flyer	Ranch Hand	143	1.48	–0.09 --	0.370
	Comparison	182	1.58		
Enlisted Groundcrew	Ranch Hand	370	1.71	0.11 --	0.088
	Comparison	549	1.60		

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	**n**	**Mean[a]**	**Adj. Mean[ab]**	**R^2**	**Slope (Std. Error)[c]**	**p-Value**
Low	157	1.94	1.94	0.002	–0.015 (0.021)	0.475
Medium	158	1.85	1.85			
High	152	1.78	1.78			

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

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	**n**	**Adj. Mean[a]**	**R^2**	**Adj. Slope (Std. Error)[b]**	**p-Value**
Low	157	1.53	0.071	–0.019 (0.024)	0.433
Medium	157	1.45			
High	152	1.39			

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

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

Table 16-9. Analysis of TSH (µIU/ml) (Continuous)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED					
Dioxin Category	n	Mean[a]	Adj. Mean[ab]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[c]	p-Value[d]
Comparison	1,161	1.80	1.80		
Background RH	367	1.90	1.91	0.11 --	0.129
Low RH	233	1.90	1.89	0.09 --	0.273
High RH	234	1.82	1.81	0.01 --	0.942
Low plus High RH	467	1.86	1.85	0.05 --	0.446

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[d] P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED				
Dioxin Category	n	Adj. Mean[a]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[b]	p-Value[c]
Comparison	1,161	1.57		
Background RH	365	1.64	0.07 --	0.250
Low RH	233	1.64	0.07 --	0.292
High RH	233	1.62	0.05 --	0.454
Low plus High RH	466	1.63	0.06 --	0.237

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-9. Analysis of TSH (μIU/ml) (Continuous)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED					
1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin +1)		
1987 Dioxin	n	Mean[a]	R^2	Adjusted Slope (Std. Error)[b]	p-Value
Low	278	1.88	<0.001	–0.000 (0.015)	0.977
Medium	279	1.98			
High	277	1.77			

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

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED					
1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)		
1987 Dioxin	n	Adj. Mean[a]	R^2	Adjusted Slope (Std. Error)[b]	p-Value
Low	276	1.53	0.046	0.008 (0.017)	0.624
Medium	279	1.62			
High	276	1.48			

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

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

Unadjusted and adjusted analyses for Models 2, 3, and 4 showed no significant relations between TSH in its continuous form and dioxin (Table 16-9(c–h): p>0.12 for each analysis).

16.2.2.3.2 TSH (Discrete)

The unadjusted and adjusted Model 1 analyses of TSH in its discrete form did not reveal significant differences across all occupations (Table 16-10(a,b): p≥0.14 for each analysis). After stratifying by occupation, both the unadjusted and adjusted analyses revealed significant differences in the percentage of abnormal high TSH values between Ranch Hand and Comparison enlisted groundcrew (Table 16-10(a,b): Est. RR=2.06, p=0.044; Adj. RR=2.11, p=0.037, respectively). Of the Ranch Hand enlisted groundcrew, 5.1 percent had abnormally high TSH values versus 2.6 percent of the Comparison enlisted groundcrew.

Unadjusted and adjusted analyses in Models 2, 3, and 4 did not show significant associations between dioxin and TSH in its discrete form (Table 16-10(c–h): p>0.12 for each analysis).

Table 16-10. Analysis of TSH (Discrete)

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

Occupational Category	Group	n	Number (%) Abnormal Low	Number (%) Normal	Number (%) Abnormal High	Abnormal Low vs. Normal Est. Relative Risk (95% C.I.)	Abnormal Low vs. Normal p-Value	Abnormal High vs. Normal Est. Relative Risk (95% C.I.)	Abnormal High vs. Normal p-Value
All	***Ranch Hand***	***841***	***10 (1.2)***	***795 (94.5)***	***36 (4.3)***	***1.61 (0.65,3.98)***	***0.301***	***1.41 (0.88,2.25)***	***0.149***
	Comparison	***1,199***	***9 (0.8)***	***1,153 (96.2)***	***37 (3.1)***				
Officer	Ranch Hand	326	4 (1.2)	308 (94.5)	14 (4.3)	2.92 (0.53,16.01)	0.218	1.20 (0.58,2.47)	0.620
	Comparison	468	2 (0.4)	449 (95.9)	17 (3.6)				
Enlisted Flyer	Ranch Hand	144	3 (2.1)	138 (95.8)	3 (2.1)	1.89 (0.31,11.48)	0.488	0.63 (0.15,2.57)	0.519
	Comparison	182	2 (1.1)	174 (95.6)	6 (3.3)				
Enlisted Groundcrew	Ranch Hand	371	3 (0.8)	349 (94.1)	19 (5.1)	0.91 (0.22,3.84)	0.899	2.06 (1.02,4.16)	0.044
	Comparison	549	5 (0.9)	530 (96.5)	14 (2.6)				

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

Occupational Category	Abnormal Low vs. Normal Adj. Relative Risk (95% C.I.)	Abnormal Low vs. Normal p-Value	Abnormal High vs. Normal Adj. Relative Risk (95% C.I.)	Abnormal High vs. Normal p-Value
All	***1.57 (0.63,3.88)***	***0.332***	***1.42 (0.89,2.28)***	***0.140***
Officer	2.78 (0.50,15.33)	0.241	1.18 (0.57,2.44)	0.648
Enlisted Flyer	2.01 (0.33,12.28)	0.448	0.63 (0.15,2.55)	0.513
Enlisted Groundcrew	0.88 (0.21,3.71)	0.859	2.11 (1.04,4.28)	0.037

Table 16-10. Analysis of TSH (Discrete) (Continued)

(c) MODEL 2: RANCH HANDS — INITIAL DIOXIN — UNADJUSTED								
Initial Dioxin Category Summary Statistics					Analysis Results for Log_2 (Initial Dioxin)[a]			
		Number (%)			Abnormal Low vs. Normal		Abnormal High vs. Normal	
Initial Dioxin Category	n	Abnormal Low	Normal	Abnormal High	Est. Relative Risk (95% C.I.)[b]	p-Value	Est. Relative Risk (95% C.I.)[b]	p-Value
Low	157	1 (0.6)	150 (95.5)	6 (3.8)	1.40 (0.73,2.71)	0.311	1.27 (0.89,1.79)	0.183
Medium	158	0 (0.0)	154 (97.5)	4 (2.5)				
High	152	3 (2.0)	142 (93.4)	7 (4.6)				

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

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

(d) MODEL 2: RANCH HANDS — INITIAL DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (Initial Dioxin)			
	Abnormal Low vs. Normal		Abnormal High vs. Normal	
n	Adj. Relative Risk (95% C.I.)[a]	p-Value	Adj. Relative Risk (95% C.I.)[a]	p-Value
467	1.62 (0.82,3.20)	0.161	1.29 (0.90,1.85)	0.169

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

Note: Results are not adjusted for occupation and personality type because of the sparse number of Ranch Hands with an abnormally low TSH level.

Table 16-10. Analysis of TSH (Discrete) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY — UNADJUSTED								
		Number (%)			Abnormal Low vs. Normal		Abnormal High vs. Normal	
Dioxin Category	**n**	**Abnormal Low**	**Normal**	**Abnormal High**	**Est. Relative Risk (95% C.I.)[ab]**	**p-Value**	**Est. Relative Risk (95% C.I.)[ab]**	**p-Value**
Comparison	1,161	9 (0.8)	1,116 (96.1)	36 (3.1)				
Background RH	367	6 (1.6)	344 (93.7)	17 (4.6)	2.27 (0.80,6.50)	0.125	1.46 (0.80,2.64)	0.214
Low RH	233	1 (0.4)	225 (96.6)	7 (3.0)	0.54 (0.07,4.31)	0.564	0.97 (0.43,2.22)	0.951
High RH	234	3 (1.3)	221 (94.4)	10 (4.3)	1.60 (0.43,6.02)	0.485	1.47 (0.72,3.02)	0.294
Low plus High RH	467	4 (0.9)	446 (95.5)	17 (3.6)	0.93 (0.25,3.48)	0.919	1.20 (0.66,2.17)	0.553

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-10. Analysis of TSH (Discrete) (Continued)

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

		Abnormal Low vs. Normal		Abnormal High vs. Normal	
Dioxin Category	n	Adj. Relative Risk (95% C.I.)[a]	p-Value	Adj. Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,161				
Background RH	365	2.33 (0.79,6.87)	0.125	1.43 (0.78,2.62)	0.244
Low RH	233	0.52 (0.06,4.15)	0.536	0.98 (0.43,2.24)	0.963
High RH	233	1.51 (0.39,5.91)	0.550	1.58 (0.74,3.35)	0.236
Low plus High RH	466	0.89 (0.24,3.33)	0.858	1.24 (0.68,2.28)	0.481

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

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

	1987 Dioxin Category Summary Statistics				Analysis Results for Log_2 (1987 Dioxin + 1)			
		Number (%)			Abnormal Low vs. Normal		Abnormal High vs. Normal	
1987 Dioxin Category	n	Abnormal Low	Normal	Abnormal High	Est. Relative Risk (95% C.I.)[a]	p-Value	Est. Relative Risk (95% C.I.)[a]	p-Value
Low	278	4 (1.4)	260 (93.5)	14 (5.0)	0.97 (0.63,1.48)	0.881	0.98 (0.78,1.24)	0.894
Medium	279	3 (1.1)	266 (95.3)	10 (3.6)				
High	277	3 (1.1)	264 (95.3)	10 (3.6)				

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

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

Table 16-10. Analysis of TSH (Discrete) (Continued)

(h) MODEL 4: RANCH HANDS — 1987 DIOXIN — ADJUSTED				
	Analysis Results for Log_2 (1987 Dioxin + 1)			
	Abnormal Low vs. Normal		Abnormal High vs. Normal	
n	Adj. Relative Risk (95% C.I.)[a]	p-Value	Adj. Relative Risk (95% C.I.)[a]	p-Value
831	1.08 (0.64,1.83)	0.767	0.97 (0.74,1.27)	0.832

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

16.2.2.3.3 Thyroxine (Continuous)

The unadjusted and adjusted Models 1 and 2 analyses of thyroxine in its continuous form were not significant (Table 16-11(a,b): p>0.12 for each analysis).

Table 16-11. Analysis of Thyroxine (µg/dl) (Continuous)

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

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***841***	***7.07***	***0.03 --***	***0.601***
	Comparison	***1,199***	***7.04***		
Officer	Ranch Hand	326	6.76	−0.08 --	0.373
	Comparison	468	6.84		
Enlisted Flyer	Ranch Hand	144	7.28	0.03 --	0.818
	Comparison	182	7.24		
Enlisted Groundcrew	Ranch Hand	371	7.27	0.12 --	0.154
	Comparison	549	7.15		

[a] Transformed from square root scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[c] P-value is based on difference of means on square root scale.

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

Occupational Category	Group	n	Adjusted Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	***Ranch Hand***	***838***	***6.96***	***0.03 --***	***0.565***
	Comparison	***1,199***	***6.93***		
Officer	Ranch Hand	325	6.58	−0.08 --	0.370
	Comparison	468	6.66		
Enlisted Flyer	Ranch Hand	143	7.12	0.04 --	0.774
	Comparison	182	7.08		
Enlisted Groundcrew	Ranch Hand	370	7.19	0.13 --	0.129
	Comparison	549	7.06		

[a] Transformed from square root scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[c] P-value is based on difference of means on square root scale.

Table 16-11. Analysis of Thyroxine (μg/dl) (Continuous) (Continued)

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED						
Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	157	7.11	7.12	0.012	0.010 (0.008)	0.250
Medium	158	7.15	7.16			
High	152	7.28	7.26			

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

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

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED					
Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	157	6.99	0.045	–0.004 (0.010)	0.682
Medium	157	6.89			
High	152	6.89			

[a] Transformed from square root scale.
[b] Slope and standard error based on square root of thyroxine versus log_2 (initial dioxin).

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

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED					
Dioxin Category	n	Mean[a]	Adj. Mean[ab]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[c]	p-Value[d]
Comparison	1,161	7.04	7.04		
Background RH	367	6.95	6.95	–0.09 --	0.221
Low RH	233	7.13	7.13	0.09 --	0.344
High RH	234	7.23	7.23	0.19 --	0.053
Low plus High RH	467	7.18	7.18	0.14 --	0.059

[a] Transformed from square root scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[d] 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.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED				
Dioxin Category	**n**	**Adj. Mean[a]**	**Difference of Adj. Mean vs. Comparisons (95% C.I.)[b]**	**p-Value[c]**
Comparison	1,161	6.93		
Background RH	365	6.93	0.00 --	0.969
Low RH	233	7.02	0.09 --	0.344
High RH	233	6.98	0.05 --	0.646
Low plus High RH	466	7.00	0.07 --	0.357

[a] Transformed from square root scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[c] 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.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED					
1987 Dioxin Category Summary Statistics			**Analysis Results for Log_2 (1987 Dioxin +1)**		
1987 Dioxin	**n**	**Mean[a]**	**R^2**	**Slope (Std. Error)[b]**	**p-Value**
Low	278	6.95	0.008	0.015 (0.006)	0.009
Medium	279	7.03			
High	277	7.25			

[a] Transformed from square root scale.
[b] Slope and standard error based on square root of thyroxine versus $\log_2$ (1987 dioxin + I).

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED					
1987 Dioxin Category Summary Statistics			**Analysis Results for Log_2 (1987 Dioxin + 1)**		
1987 Dioxin	**n**	**Adj. Mean[a]**	**R^2**	**Adjusted Slope (Std. Error)[b]**	**p-Value**
Low	276	6.92	0.047	–0.001 (0.007)	0.862
Medium	279	6.91			
High	276	6.91			

[a] Transformed from square root scale.
[b] Slope and standard error based on square root of thyroxine versus $\log_2$ (1987 dioxin + 1).

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

The unadjusted Model 3 analysis of thyroxine in its continuous form revealed two marginally significant contrasts: Ranch Hands in the high dioxin category versus Comparisons and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 16-11(e): difference of means=0.19 µg/dl, p=0.053; difference of means=0.14 µg/dl, p=0.059, respectively). The adjusted analysis did not reveal any significant contrasts (Table 16-11(f): p>0.34 for each contrast).

The Model 4 unadjusted analysis revealed a significant positive association between thyroxine and 1987 dioxin (Table 16-11(g): adjusted slope=0.015, p=0.009). After covariate adjustment, the results became nonsignificant (Table 16-11(h): p=0.862)

16.2.2.3.4 Thyroxine (Discrete)

All unadjusted and adjusted analyses for Models 1 through 4 showed no significant relations between dioxin and thyroxine in its discrete form (Table 16-12(a–h): p>0.14 for each analysis).

Table 16-12. Analysis of Thyroxine (Discrete)

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

Occupational Category	Group	n	Number (%) Low	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***841***	***23 (2.7)***	***1.03 (0.60,1.77)***	***0.928***
	Comparison	***1,199***	***32 (2.7)***		
Officer	Ranch Hand	326	13 (4.0)	1.17 (0.56,2.47)	0.674
	Comparison	468	16 (3.4)		
Enlisted Flyer	Ranch Hand	144	3 (2.1)	1.27 (0.25,6.39)	0.772
	Comparison	182	3 (1.6)		
Enlisted Groundcrew	Ranch Hand	371	7 (1.9)	0.79 (0.31,2.01)	0.624
	Comparison	549	13 (2.4)		

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

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	***1.04 (0.61,1.80)***	***0.875***
Officer	1.21 (0.57,2.55)	0.622
Enlisted Flyer	1.24 (0.25,6.24)	0.796
Enlisted Groundcrew	0.80 (0.32,2.02)	0.636

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Low	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	157	3 (1.9)	1.22 (0.79,1.89)	0.375
Medium	158	1 (0.6)		
High	152	6 (3.9)		

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

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

Table 16-12. Analysis of Thyroxine (Discrete) (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
466	1.51 (0.87,2.62)	0.143

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

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with a low thyroxine level.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED				
Dioxin Category	n	Number (%) Low	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,161	31 (2.7)		
Background RH	367	13 (3.5)	1.40 (0.72,2.71)	0.325
Low RH	233	3 (1.3)	0.47 (0.14,1.55)	0.215
High RH	234	7 (3.0)	1.08 (0.47,2.49)	0.858
Low plus High RH	467	10 (2.1)	0.71 (0.33,1.54)	0.390

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED			
Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,161		
Background RH	365	1.23 (0.63,2.42)	0.545
Low RH	233	0.45 (0.14,1.49)	0.192
High RH	233	1.53 (0.62,3.73)	0.354
Low plus High RH	466	0.83 (0.38,1.82)	0.641

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-12. Analysis of Thyroxine (Discrete) (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED				
1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Low	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	278	8 (2.9)	0.97 (0.73,1.29)	0.825
Medium	279	8 (2.9)		
High	277	7 (2.5)		

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

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
831	1.14 (0.79,1.64)	0.487

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

16.2.2.3.5 Anti-Thyroid Antibodies

All unadjusted and adjusted analyses for Models 1 through 4 were nonsignificant (Table 16-13(a–h): p>0.43 for each analysis).

Table 16-13. Analysis of Anti-Thyroid Antibodies

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Number (%) Present	Est. Relative Risk (95% C.I.)	p-Value
All	***Ranch Hand***	***841***	***5 (0.6)***	***1.02 (0.32,3.22)***	***0.975***
	Comparison	***1,199***	***7 (0.6)***		
Officer	Ranch Hand	326	2 (0.6)	0.72 (0.13,3.93)	0.701
	Comparison	468	4 (0.9)		
Enlisted Flyer	Ranch Hand	144	2 (1.4)	2.55 (0.23,28.40)	0.447
	Comparison	182	1 (0.5)		
Enlisted Groundcrew	Ranch Hand	371	1 (0.3)	0.74 (0.07,8.18)	0.805
	Comparison	549	2 (0.4)		

Table 16-13. Analysis of Anti-Thyroid Antibodies (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.01 (0.32,3.21)*	*0.981*
Officer	0.73 (0.13,4.02)	0.717
Enlisted Flyer	2.62 (0.24,29.23)	0.434
Enlisted Groundcrew	0.73 (0.07,8.06)	0.796

Note: Results are not adjusted for race because of the sparse number of participants with anti-thyroid antibodies present.

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED				
Initial Dioxin Category Summary Statistics			Analysis Results for Log₂ (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Present	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	157	0 (0.0)	0.93 (0.30,2.89)	0.905
Medium	158	2 (1.3)		
High	152	0 (0.0)		

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

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

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
466	1.01 (0.31,3.23)	0.990

[a] 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 anti-thyroid antibodies present.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED				
Dioxin Category	n	Number (%) Present	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,161	7 (0.6)		
Background RH	367	3 (0.8)	1.20 (0.30,4.69)	0.798
Low RH	233	1 (0.4)	0.73 (0.09,5.96)	0.768
High RH	234	1 (0.4)	0.80 (0.10,6.56)	0.834
Low plus High RH	467	2 (0.4)	0.76 (0.16,3.70)	0.736

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 16-13. Analysis of Anti-Thyroid Antibodies (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED			
Dioxin Category	**n**	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
Comparison	1,161		
Background RH	365	1.07 (0.27,4.26)	0.921
Low RH	233	0.73 (0.09,5.99)	0.765
High RH	233	1.07 (0.12,9.66)	0.951
Low plus High RH	466	0.88 (0.17,4.46)	0.879

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

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Results are not adjusted for race because of the sparse number of participants with anti-thyroid antibodies present.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED				
1987 Dioxin Category Summary Statistics			**Analysis Results for Log_2 (1987 Dioxin + 1)**	
1987 Dioxin	**n**	**Number (%) Present**	**Estimated Relative Risk (95% C.I.)[a]**	**p-Value**
Low	278	2 (0.7)	0.82 (0.43,1.55)	0.535
Medium	279	2 (0.7)		
High	277	1 (0.4)		

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

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

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
831	0.86 (0.41,1.80)	0.689

[a] 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 anti-thyroid antibodies present.

16.2.2.3.6 Fasting Glucose (Continuous)

The unadjusted and adjusted Model 1 analyses did not reveal a significant difference in mean fasting glucose levels between all Ranch Hands and Comparisons or after stratifying by occupation (Table 16-14(a,b): p>0.38 for each analysis).

Fasting glucose in its continuous form was not significantly associated with initial dioxin in the unadjusted Model 2 analysis (Table 16-14(c): p=0.174). After adjusting for covariates, the results became significant (Table 16-14(d): adjusted slope=0.023, p=0.014). The adjusted mean fasting glucose levels in the low, medium, and high initial dioxin categories were 104.5 mg/dl, 109.2 mg/dl, and 109.5 mg/dl, respectively.

The unadjusted and adjusted Model 3 analyses of fasting glucose showed no significant mean differences between any of the Ranch Hand dioxin categories and Comparisons (Table 16-14(e,f): p>0.10 for each contrast).

Table 16-14. Analysis of Fasting Glucose (mg/dl) (Continuous)

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

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*868*	*101.4*	*–0.3 --*	*0.745*
	Comparison	*1,250*	*101.8*		
Officer	Ranch Hand	339	101.1	1.1 --	0.468
	Comparison	494	100.0		
Enlisted Flyer	Ranch Hand	151	103.2	–1.7 --	0.507
	Comparison	187	104.9		
Enlisted Groundcrew	Ranch Hand	378	101.0	–1.3 --	0.388
	Comparison	569	102.3		

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

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

Occupational Category	Group	n	Adjusted Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*859*	*103.7*	*0.0 --*	*0.970*
	Comparison	*1,238*	*103.8*		
Officer	Ranch Hand	337	101.9	0.9 --	0.550
	Comparison	492	101.0		
Enlisted Flyer	Ranch Hand	148	104.1	–1.6 --	0.516
	Comparison	181	105.7		
Enlisted Groundcrew	Ranch Hand	374	104.7	–0.3 --	0.819
	Comparison	565	105.1		

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

Table 16-14. Analysis of Fasting Glucose (mg/dl) (Continuous) (Continued)

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

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	**n**	**Mean[a]**	**Adj. Mean[ab]**	**R^2**	**Slope (Std. Error)[c]**	**p-Value**
Low	159	101.4	102.2	0.102	0.011 (0.008)	0.174
Medium	161	104.5	104.7			
High	160	104.9	103.9			

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

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

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

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	**n**	**Adj. Mean[a]**	**R^2**	**Adj. Slope (Std. Error)[b]**	**p-Value**
Low	158	104.5	0.160	0.023 (0.009)	0.014
Medium	157	109.2			
High	160	109.5			

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

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

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

Dioxin Category	n	Mean[a]	Adj. Mean[ab]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[c]	p-Value[d]
Comparison	1,212	101.7	101.6		
Background RH	381	98.4	100.3	–1.3 --	0.298
Low RH	238	101.4	100.8	–0.8 --	0.618
High RH	242	105.8	103.9	2.3 --	0.121
Low plus High RH	480	103.6	102.4	0.8 --	0.485

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[d] P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.