

**Table 6-55 (Continued)****Ranch Hands -  $\log_2$ (Initial Dioxin) - Adjusted**

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=458)	0.79(0.61,1.02)***	0.062***	RACE*DIOXIN(p=0.022) OCC(p=0.068)
d) D>5 ppt (n=616)	****	****	RACE*DIOXIN(p=0.003) OCC(p=0.002) F-AGE(p=0.088)

**Musculoskeletal Deformities (All Children)****Model 2: Children of Ranch Hands -  $\log_2$ (Current Dioxin) and Time**

Without adjustment for covariates (Table 6-56 [a]), there is a borderline significant variation in the association between musculoskeletal deformities and current dioxin level with time since duty in SEA (p=0.068) among children of Ranch Hands having more than 10 ppt current dioxin. Among children of Ranch Hands with early tours, the risk is significantly decreased (OR=0.68, 95% CI 0.48-0.96, p=0.030) and among children of Ranch Hands with late tours the risk is nonsignificant (OR=1.06, 95% CI 0.76-1.49, p=0.729).

Without adjustment for covariates (Table 6-56 [b]), there is no significant variation in the association between musculoskeletal deformities and current dioxin with time since duty in SEA tour among children of Ranch Hands having more than 5 ppt current dioxin (p=0.476). Furthermore, there is no significant association between musculoskeletal deformities and current dioxin among children of Ranch Hands with late (p=0.980) or early (p=0.342) tours.

After adjustment for covariates (Table 6-56 [c]), there is borderline significant variation in the association between musculoskeletal deformities and current dioxin (p=0.072) with time since duty in SEA among children of Ranch Hands having more than 5 ppt current dioxin. The risk is significantly decreased among children whose father had an early tour (OR=0.68, 95% CI 0.48-0.97, p=0.033) and the risk is not statistically significant among children whose father had a late tour (OR=1.08, 95% CI 0.75-1.53, p=0.688).

After adjustment for covariates (Table 6-56 [d]), the association between musculoskeletal deformities and current dioxin varies significantly with time since the father's duty in SEA and the father's age at conception ( $p=0.041$ ) among children of Ranch Hands having more than 5 ppt current dioxin. The basis for this variation in risk is displayed in Appendix Table D-2. The risk among children of younger fathers is higher than the risk among children of older fathers. The risk among children of older fathers with early tours is borderline significantly decreased ( $OR=0.74$ , 95% CI 0.53-1.04,  $p=0.080$ ) and among children of older fathers with late tours the risk is significantly decreased ( $OR=0.56$ , 95% CI 0.34-0.92,  $p=0.21$ ). All other within-stratum relative risks were not significant.

Table 6-56

Post-SEA Counts and Rates of  
Musculoskeletal Deformities

Variable: Musculoskeletal Deformities  
 Restrictions: All Children of Ranch Hands  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 2:  $\log_2(\text{Current Dioxin})$ , Time

Ranch Hands -  $\log_2(\text{Current Dioxin})$ , Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=509)	$\leq 18.6$	129.0 (8/62)	104.5 (14/134)	180.6 (13/72)	1.06(0.76,1.49)	0.729
	$>18.6$	175.0 (7/40)	157.4 (17/108)	64.5 (6/93)	0.68(0.48,0.96)	0.030
b) D>5 ppt (n=690)	$\leq 18.6$	155.6 (14/90)	126.4 (22/174)	145.5 (16/110)	1.00(0.80,1.26)	0.980
	$>18.6$	79.4 (5/63)	169.1 (23/136)	68.4 (8/117)	0.89(0.70,1.13)	0.342

Table 6-56 (Continued)

Ranch Hands - Log<sub>2</sub>(Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=459)			0.072	OCC(p=0.010) RACE(p=0.032)
	≤18.6	1.08(0.75,1.53)	0.688	
	>18.6	0.68(0.48,0.97)	0.033	
d) D>5 ppt (n=616)			0.872	OCC(p=0.001) F-AGE*DIOXIN*TIME (p=0.041)
	≤18.6	0.83(0.63,1.08)***	0.171	
	>18.6	0.81(0.62,1.05)***	0.107	

## Musculoskeletal Deformities (All Children)

## Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 6-57 [a]), there is no significant overall association between musculoskeletal deformities and categorized current dioxin ( $p=0.588$ ). Furthermore, there is no significant difference between the rates of musculoskeletal deformities among children of Ranch Hands in the High ( $p=0.246$ ), Low ( $p=0.747$ ) and Unknown ( $p=0.541$ ) categories and the rate among children of Comparisons in the Background category.

After adjustment for covariates (Table 6-57 [b]), the association between musculoskeletal deformities and categorized current dioxin varies significantly with the father's military occupation ( $p=0.001$ ). This variation in risk is displayed in Appendix Table D-2. There is a significant overall association between musculoskeletal deformity and categorized current dioxin among children whose fathers were officers ( $p=0.001$ ). The deformity rate among children of Ranch Hand officers in the Unknown current dioxin category is significantly lower than that of children of Comparisons in the Background current dioxin category ( $OR=0.30$ , 95% CI 0.12-0.74,  $p=0.009$ ). The rate in children of Ranch Hand officers in the Low current dioxin category is zero and hence no adjusted contrast with children of Comparisons in the Background category is possible. A contrast between children of Ranch Hand officers in the High category with children of Comparisons in the Background category was not carried out because there were no children of Ranch Hand officers in the High dioxin category. All other category contrasts with the Background category are not significant within each of the other occupations.

Table 6-57

Post-SEA Counts and Rates of  
Musculoskeletal Deformities

Variable: Musculoskeletal Deformities  
 Restrictions: All Children of Ranch Hands and Comparisons  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 3: Categorized Current Dioxin

## a) Unadjusted

Exposure Category	n	Abnormal Number	Category Rate	Est. Relative Risk (95% C.I.)	p-Value
Background	981	132	134.6	All Exp Categ	0.588
Unknown	282	34	120.6	Unk vs Bkgd	0.88(0.59,1.32)
Low	174	25	143.7	Low vs Bkgd	1.08(0.68,1.71)
High	227	24	105.7	High vs Bkgd	0.76(0.48,1.21)
Total	1664				

## b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	843	All Exp Categ	****	****	DIOXIN*OCC(p=0.001)
Unknown	246	Unk vs Bkgd			
Low	156	Low vs Bkgd			
High	203	High vs Bkgd			
Total	1448				

## **Musculoskeletal Deformities (Full Siblings)**

### **Model 1: Children of Ranch Hands - $\log_2$ (Initial Dioxin)**

Without adjustment for covariates (Table 6-58 [a] and [b]), there is no significant association between musculoskeletal deformities and initial dioxin among full sibling children of Ranch Hands having more than 10 ppt ( $p=0.136$ ) or more than 5 ppt ( $p=0.897$ ) current dioxin.

After adjustment for covariates (Table 6-58 [c]), the association between musculoskeletal deformities and initial dioxin varies significantly with the father's race ( $p=0.008$ ) among full sibling children of Ranch Hands having more than 10 ppt current dioxin. The basis for this variation in risk is displayed in Appendix Table D-2. The association between musculoskeletal deformities and initial dioxin is not significant in children of nonblack fathers. There is insufficient data to assess this association in children of Black fathers.

After adjustment for covariates (Table 6-58 [d]), the association between musculoskeletal deformities and initial dioxin varies significantly with the father's race ( $p=0.008$ ) among full siblings of Ranch Hands having more than 5 ppt current dioxin. The basis for this variation in risk is displayed in Appendix Table D-2. The association between musculoskeletal deformities and initial dioxin is not significant in children of nonblack fathers. There is insufficient data to assess this association in children of Black fathers.

Table 6-58

Post-SEA Counts and Rates of  
Musculoskeletal Deformities

Variable: Musculoskeletal Deformities  
 Restrictions: Full Siblings of Ranch Hands  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 1:  $\log_2$ (Initial Dioxin)

Ranch Hands -  $\log_2$ (Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Abnormal Number	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=420)	Low	78	10	128.2	0.136
	Medium	206	32	155.3	
	High	136	13	95.6	
b) D>5 ppt (n=557)	Low	114	10	87.7	0.897
	Medium	245	30	122.4	
	High	198	27	136.4	

Ranch Hands -  $\log_2$ (Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=390)	****	****	RACE*DIOXIN(p=0.008)
d) D>5 ppt (n=513)	****	****	RACE*DIOXIN(p=0.008) OCC(p=0.006) M-AGE(p=0.074) F-AGE(p=0.087)

## **Musculoskeletal Deformities (Full Siblings)**

### **Model 2: Children of Ranch Hands - $\log_2(\text{Current Dioxin})$ and Time**

Without adjustment for covariates (Table 6-59 [a]), there is no significant variation in the association between musculoskeletal deformities and current dioxin with time since duty in SEA among full sibling children of Ranch Hands having more than 10 ppt current dioxin ( $p=0.128$ ). The risk among children of Ranch Hands with early tours is borderline significantly decreased ( $OR=0.667$ , 95% 0.45-1.01,  $p=0.053$ ) and the risk among children of Ranch Hands with late tours is not significant ( $p=0.944$ ).

Without adjustment for covariates (Table 6-59 [b]), there is no significant variation in the association between musculoskeletal deformities and current dioxin with time since duty in SEA among full siblings of Ranch Hands having more than 5 ppt current dioxin ( $p=0.429$ ). Furthermore, there is no significant association between musculoskeletal deformities and current dioxin among children whose father had a late ( $p=0.524$ ) or early ( $p=0.627$ ) tour.

After adjustment for covariates (Table 6-59 [c]), there is borderline significant variation in the association between musculoskeletal deformities and current dioxin with time since duty in SEA among full siblings of Ranch Hands having more than 10 ppt current dioxin ( $p=0.096$ ). The risk among children of Ranch Hands with early tours is significantly decreased ( $OR=0.66$ , 95% CI 0.43-0.99,  $p=0.46$ ) and the risk among children of Ranch Hands with late tours is not significant ( $p=0.819$ ).

After adjustment for covariates (Table 6-59 [d]), there is no significant variation in the association between musculoskeletal deformities and current dioxin with time since duty in SEA among full sibling children of Ranch Hands having more than 5 ppt current dioxin ( $p=0.560$ ). Furthermore, there is no significant association between musculoskeletal deformities and current dioxin among whose father had late ( $p=0.605$ ) or early ( $p=0.189$ ) tours.

Table 6-59

Post-SEA Counts and Rates of  
Musculoskeletal Deformities

Variable: **Musculoskeletal Deformities**  
 Restrictions: **Full Siblings of Ranch Hands**  
**Children Conceived during or after the**  
**Father's Duty in SEA**  
 Model 2:  **$\log_2$ (Current Dioxin), Time**

**Ranch Hands -  $\log_2$ (Current Dioxin), Time - Unadjusted**

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=421)	≤18.6	170.2 (8/47)	95.7 (11/115)	203.1 (13/64)	1.01(0.71,1.44)	0.944
	>18.6	178.6 (5/28)	152.2 (14/92)	53.3 (4/75)	0.67(0.45,1.01)	0.053
b) D>5 ppt (n=557)	≤18.6	101.7 (6/59)	138.9 (20/144)	153.1 (15/98)	1.09(0.84,1.40)	0.524
	>18.6	56.6 (3/53)	160.4 (17/106)	61.9 (6/97)	0.93(0.71,1.23)	0.627

Table 6-59 (Continued)

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=391)			0.096	OCC(p=0.061)
	≤18.6	1.04(0.72,1.51)	0.819	
	>18.6	0.66(0.43,0.99)	0.046	
d) D>5 ppt (n=513)			0.560	OCC(p=0.017) M-AGE(p=0.064)
	≤18.6	0.92(0.68,1.25)	0.605	
	>18.6	0.82(0.60,1.10)	0.189	

## Musculoskeletal Deformities (Full Siblings)

## Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 6-60 [a]), there is no overall significant association between musculoskeletal deformities and categorized dioxin among full siblings ( $p=0.331$ ). There is no significant difference between the rates of musculoskeletal deformities among children of Ranch Hands in the High ( $p=0.215$ ), Low ( $p=0.993$ ) and Unknown ( $p=0.147$ ) dioxin categories and the rate among children of Comparisons in the Background category.

After adjustment for covariates (Table 6-60 [b]), the overall association between musculoskeletal deformity and categorized dioxin varies significantly with the father's military occupation in SEA ( $p=0.010$ ) among full siblings. This variation in risk is displayed in Appendix Table D-2. The rates of musculoskeletal deformity among children whose fathers were Ranch Hand officers are lower than the rates in the other strata. Among children of officers, there was an overall significant association between musculoskeletal deformity and categorized current dioxin ( $p=0.002$ ). The rate among children of Ranch Hand officers in the Unknown current dioxin category (49.0 per 1000) is significantly lower than that in children of Comparisons officers in the Background current dioxin category (153.5 per 1000) ( $p=0.010$ ); there were no Ranch Hand children whose fathers were in the High current dioxin category. All other contrasts with the Background category are not significant within each of the other occupations.

Table 6-60

Post-SEA Counts and Rates of  
Musculoskeletal Deformities

Variable: Musculoskeletal Deformities  
 Restrictions: Full Siblings of Ranch Hands and Comparisons  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 3: Categorized Current Dioxin

## a) Unadjusted

Exposure Category	n	Abnormal Number	Category Rate	Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	812	115	141.6	All Exp Categ		0.331
Unknown	221	23	104.1	Unk vs Bkgd	0.70(0.44,1.13)	0.147
Low	148	21	141.9	Low vs Bkgd	1.00(0.61,1.66)	0.993
High	195	21	107.7	High vs Bkgd	0.73(0.45,1.20)	0.215
Total		1376				

## b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	715	All Exp Categ	****	****	DIOXIN*OCC(p=0.010)
Unknown	199	Unk vs Bkgd			RACE(p=0.062)
Low	137	Low vs Bkgd			
High	180	High vs Bkgd			
Total		1231			

### **Anomalies of the Skin (All Children)**

#### **Model 1: Children of Ranch Hands - $\text{Log}_2(\text{Initial Dioxin})$**

Without adjustment for covariates (Table 6-61 [a] and [b]), there is no significant association between anomalies of the skin and initial dioxin among children of Ranch Hands having more than 10 ppt ( $p=0.428$ ) or more than 5 ppt ( $p=0.768$ ) current dioxin.

After adjustment for covariates (Table 6-61 [c]), there is no association between anomalies of the skin and initial dioxin among children of Ranch Hands having more than 10 ppt current dioxin ( $p=0.718$ ).

After adjustment for covariates (Table 6-61 [d]), the association between anomalies of the skin and initial dioxin varies significantly with the father's race ( $p=0.012$ ) among children of Ranch Hands having more than 5 ppt current dioxin. This variation in risk is displayed in Appendix Table D-2. The association between anomalies of the skin and initial dioxin is not significant among children of nonblack fathers. There is insufficient data to assess this association in children of Black fathers.

Table 6-61

## Post-SEA Counts and Rates of Anomalies of the Skin

Variable: Anomalies of the Skin  
 Restrictions: All Children of Ranch Hands  
 Children Conceived during or after the Father's Duty in SEA  
 Model 1:  $\log_2(\text{Initial Dioxin})$

Ranch Hands - $\log_2(\text{Initial Dioxin})$ - Unadjusted						
Exposure Restriction	Initial Dioxin	n	Abnormal Number	Est. Relative Risk (95% C.I.)	p-Value	
a) D>10 ppt (n=508)	Low	106	2	18.9	0.80(0.45,1.41)	0.428
	Medium	245	6	24.5		
	High	157	2	12.7		
b) D>5 ppt (n=690)	Low	155	2	12.9	0.94(0.62,1.42)	0.768
	Medium	308	8	26.0		
	High	227	2	8.8		

  

Ranch Hands - $\log_2(\text{Initial Dioxin})$ - Adjusted			
Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=458)	0.90(0.51,1.59)	0.718	None
d) D>5 ppt (n=616)	1.09(0.71,1.67)***	0.703***	RACE*DIOXIN(p=0.012)

## Anomalies of the Skin (All Children)

Model 2: Children of Ranch Hands -  $\log_2(\text{Current Dioxin})$  and Time

Without adjustment for covariates (Table 6-62 [a]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among children of Ranch Hands having more than 10 ppt current dioxin (p=0.338). Furthermore, the association between anomalies of the skin and current dioxin is not significant among children of Ranch Hands with late (p=0.303) or early (p=0.799) tours.

Without adjustment for covariates (Table 6-62 [b]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among children of Ranch Hands having more than 5 ppt current dioxin ( $p=0.202$ ). Furthermore, the association between anomalies of the skin and current dioxin is not significant among children of Ranch Hands with late ( $p=0.414$ ) and early ( $p=0.339$ ) tours.

After adjustment for covariates (Table 6-62 [c]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among children of Ranch Hands having more than 10 ppt current dioxin ( $p=0.483$ ). Furthermore, the association between anomalies of the skin and current dioxin is not significant among children whose father had a late ( $p=0.509$ ) or early ( $p=0.770$ ) tour.

After adjustment for covariates (Table 6-62 [d]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among children of Ranch Hands with more than 5 ppt current dioxin ( $p=0.412$ ). Furthermore, the association between anomalies of the skin and current dioxin is not significant among children whose father had a late ( $p=0.850$ ) or early ( $p=0.341$ ) tour.

Table 6-62

Post-SEA Counts and Rates of  
Anomalies of the Skin

Variable: Anomalies of the Skin  
 Restrictions: All Children of Ranch Hands  
                  Children Conceived during or after the  
                  Father's Duty in SEA  
 Model 2:  $\log_2$ (Current Dioxin), Time

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=509)	$\leq 18.6$	16.1 (1/62)	29.9 (4/134)	13.9 (1/72)	0.62(0.25,1.54)	0.303
	$>18.6$	0.0 (0/40)	27.8 (3/108)	10.8 (1/93)	1.11(0.50,2.44)	0.799
b) D>5 ppt (n=690)	$\leq 18.6$	22.2 (2/90)	28.7 (5/174)	9.1 (1/110)	0.78(0.43,1.41)	0.414
	$>18.6$	0.0 (0/63)	22.1 (3/136)	8.5 (1/117)	1.38(0.72,2.64)	0.339

Table 6-62 (Continued)

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=459)			0.483	None
	≤18.6	0.74(0.29,1.84)	0.509	
	>18.6	1.12(0.52,2.42)	0.770	
d) D>5 ppt (n=616)			0.412	OCC(p=0.070)
	≤18.6	0.94(0.50,1.77)	0.850	
	>18.6	1.37(0.72,2.61)	0.341	

## Anomalies of the Skin (All Children)

## Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 6-63 [a]), there is no significant overall association between anomalies of the skin and categorized current dioxin ( $p=0.318$ ). Furthermore, the rate of anomalies of the skin among children of Ranch Hands in the High ( $p=0.226$ ), Low ( $p=0.298$ ) and Unknown ( $p=0.702$ ) categories are not significantly different than that of children of Comparisons in the Background category.

After adjustment for covariates (Table 6-63 [b]), there is significant variation in association between anomalies of the skin and categorized current dioxin with the father's race ( $p=0.023$ ). This variation in risk is displayed in Appendix Table D-2. There is no significant overall association between anomalies of the skin and categorized current dioxin among children of non-black fathers ( $p=0.115$ ). Furthermore among children of nonblack fathers, there is no significant difference between the rates of the anomalies of the skin among the children of Ranch Hands in the High ( $p=0.285$ ), Low ( $p=0.197$ ) and Unknown ( $p=0.190$ ) categories and the rate among children of Comparisons in the Background category. There is insufficient data to assess the significance of this association among children of Black fathers.

If this variation in risk is ignored, there is no significant overall association between the anomalies of the skin and categorized dioxin ( $p=0.298$ ). Furthermore, there is no significant difference between the rates of skin anomalies among children of Ranch Hands in the High ( $p=0.289$ ), Low ( $p=0.208$ ) and Unknown ( $p=0.618$ ) categories and the rate among children of Comparisons in the Background category.

Table 6-63

Post-SEA Counts and Rates of  
Anomalies of the Skin

Variable: Anomalies of the Skin  
Restrictions: All Children of Ranch Hands and Comparisons  
Children Conceived during or after the  
Father's Duty in SEA  
Model 3: Categorized Current Dioxin

a) Unadjusted

Exposure Category	n	Abnormal Number	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	981	21	21.4	All Exp Categ	0.318
Unknown	282	5	17.7	Unk vs Bkgd	0.82(0.31,2.21) 0.702
Low	174	6	34.5	Low vs Bkgd	1.63(0.65,4.11) 0.298
High	227	2	8.8	High vs Bkgd	0.41(0.09,1.75) 0.226
Total		1664			

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	843	All Exp Categ		0.298***	RACE*DIOXIN
Unknown	246	Unk vs Bkgd	0.76(0.25,2.26)***	0.618***	(p=0.023)
Low	156	Low vs Bkgd	1.83(0.72,4.70)***	0.208***	
High	203	High vs Bkgd	0.46(0.11,1.95)***	0.289***	
Total		1448			

## Anomalies of the Skin (Full Siblings)

### Model 1: Children of Ranch Hands - $\log_2$ (Initial Dioxin)

Without adjustment for covariates (Table 6-64 [a]), there is a borderline significant negative association between anomalies of the skin and initial dioxin among full sibling children of Ranch Hands having more than 10 ppt (p=0.066) current dioxin.

Without adjustment for covariates (Table 6-64 [b]), there is no significant association between anomalies of the skin and initial dioxin among full sibling children of Ranch Hands having more than 5 ppt (p=0.366) current dioxin.

After adjustment for covariates (Table 6-64 [c] and [d]), there is no significant association between anomalies of the skin and initial dioxin among full sibling children of Ranch Hands with more than 10 ppt (0.171) or with more than 5 ppt (p=0.925) current dioxin.

Table 6-64

### Post-SEA Counts and Rates of Anomalies of the Skin

Variable: Anomalies of the Skin  
Restrictions: Full Siblings of Ranch Hands  
Children Conceived during or after the  
Father's Duty in SEA  
Model 1:  $\log_2$ (Initial Dioxin)

---

#### Ranch Hands - $\log_2$ (Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Abnormal Number	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=420)	Low	78	2	25.6	0.52(0.24,1.12) 0.066
	Medium	206	5	24.3	
	High	136	1	7.4	
b) D>5 ppt (n=557)	Low	114	1	8.8	0.80(0.48,1.32) 0.366
	Medium	245	7	28.6	
	High	198	1	5.1	

Table 6-64 (Continued)

Ranch Hands -  $\log_2$ (Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=390)	0.61(0.29,1.30)	0.171	None
d) D>5 ppt (n=513)	0.98(0.57,1.66)	0.925	OCC(p=0.102)

## Anomalies of the Skin (Full Siblings)

Model 2: Children of Ranch Hands -  $\log_2$ (Current Dioxin) and Time

Without adjustment for covariates (Table 6-65 [a]), there is no significant variation in association between anomalies of the skin and current dioxin with time since duty in SEA among full sibling children of Ranch Hands having more than 10 ppt current dioxin ( $p=0.974$ ). Furthermore, there is no significant association between anomalies of the skin and current dioxin among children of Ranch Hands with late ( $p=0.258$ ) or early ( $p=0.479$ ) tours.

Without adjustment for covariates (Table 6-65 [b]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among full sibling children of Ranch Hands with more than 5 ppt current dioxin ( $p=0.790$ ). Furthermore, there is no significant association between anomalies of the skin and current dioxin among children of Ranch Hands with late ( $p=0.571$ ) or early ( $p=0.961$ ) tours.

After adjustment for covariates (Table 6-65 [c]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among full sibling children of Ranch Hands with more than 10 ppt current dioxin ( $p=0.889$ ). Furthermore, there is no significant association between anomalies of the skin and current dioxin among children of Ranch Hands with late ( $p=0.453$ ) or early ( $p=0.491$ ) tours.

After adjustment for covariates (Table 6-65 [d]), there is no significant variation in the association between anomalies of the skin and current dioxin with time since duty in SEA among full sibling children of Ranch Hands with more than 5 ppt current dioxin ( $p=0.850$ ). Furthermore, there is no significant association between anomalies of the skin and current dioxin among children of Ranch Hands with late ( $p=0.804$ ) or early ( $p=0.957$ ) tours.

Table 6-65

Post-SEA Counts and Rates of  
Anomalies of the Skin

Variable: Anomalies of the Skin  
 Restrictions: Full Siblings of Ranch Hands  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 2:  $\log_2(\text{Current Dioxin})$ , Time

Ranch Hands -  $\log_2(\text{Current Dioxin})$ , Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Current Dioxin Low	Medium	High		
a) D>10 ppt (n=421)	$\leq 18.6$ (1/47)	21.3 (4/115)	34.8 (1/64)	15.6 (1/64)	0.59(0.23,1.48)	0.258
	$>18.6$ (0/28)	0.0 (2/92)	21.7 (0/75)	0.0 (0/75)	0.61(0.15,2.43)	0.479
b) D>5 ppt (n=557)	$\leq 18.6$ (1/59)	16.9 (5/144)	34.7 (1/98)	10.2 (1/98)	0.84(0.45,1.55)	0.571
	$>18.6$ (0/53)	0.0 (2/106)	18.9 (0/97)	0.0 (0/97)	0.98(0.38,2.51)	0.961

**Table 6-65 (Continued)****Ranch Hands -  $\log_2$ (Current Dioxin), Time - Adjusted**

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=391)			0.889	None
	≤18.6	0.70(0.27, 1.78)	0.453	
	>18.6	0.62(0.16, 2.40)	0.491	
d) D>5 ppt (n=513)			0.850	None
	≤18.6	1.09(0.55, 2.14)	0.804	
	>18.6	0.97(0.38, 2.48)	0.957	

**Anomalies of the Skin (Full Siblings)****Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin**

Without adjustment for covariates (Table 6-66 [a]), there is no significant overall association between anomalies of the skin and categorized current dioxin among full siblings ( $p=0.216$ ). Furthermore, the rates of anomalies of the skin among children of Ranch Hands in the High ( $p=0.211$ ), Low ( $p=0.238$ ) and Unknown ( $p=0.623$ ) categories are not significantly different from the rate among children of Comparisons in the Background category.

After adjustment for covariates (Table 6-66 [b]), there is no significant variation in overall association between anomalies of the skin and categorized current dioxin ( $p=0.180$ ) among full siblings. Furthermore, the rates of anomalies of the skin among children of Ranch Hands in the High ( $p=0.285$ ), Low ( $p=0.142$ ) and Unknown ( $p=0.498$ ) categories are not significantly different from the rate among children of Comparisons in the Background category.

Table 6-66

Post-SEA Counts and Rates of  
Anomalies of the Skin

Variable: Anomalies of the Skin  
 Restrictions: Full Siblings of Ranch Hands and Comparisons  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 3: Categorized Current Dioxin

## a) Unadjusted

Exposure Category	n	Abnormal Number	Category Rate	Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	812	15	18.5	All Exp Categ		0.216
Unknown	221	3	13.6	Unk vs Bkgd	0.73(0.21, 2.55)	0.623
Low	148	5	33.8	Low vs Bkgd	1.86(0.66, 5.20)	0.238
High	195	1	5.1	High vs Bkgd	0.27(0.04, 2.09)	0.211
Total	1376					

## b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	715	All Exp Categ		0.180	None
Unknown	199	Unk vs Bkgd	0.60(0.13, 2.68)	0.498	
Low	137	Low vs Bkgd	2.22(0.77, 6.41)	0.142	
High	180	High vs Bkgd	0.33(0.04, 2.53)	0.285	
Total	1231				

## Chromosomal Anomalies (All Children)

Model 1: Children of Ranch Hands -  $\log_2$ (Initial Dioxin)

There is insufficient data (Table 6-67) to assess the significance of the association between chromosomal anomalies and initial dioxin among children of Ranch Hands.

Table 6-67

Post-SEA Counts and Rates of  
Chromosomal Anomalies

Variable: Chromosomal Anomalies  
 Restrictions: All Children of Ranch Hands  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 1:  $\log_2$ (Initial Dioxin)

Ranch Hands -  $\log_2$ (Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Abnormal Number	Rate	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=508)	Low	106	0	0.0	No analyses, only 1 defect total	
	Medium	245	0	0.0		
	High	157	1	6.4		
b) D>5 ppt (n=690)	Low	155	1	6.5	No analyses, only 2 defects total	
	Medium	308	0	0.0		
	High	227	1	4.4		

Ranch Hands -  $\log_2$ (Initial Dioxin) - Adjusted

Exposure Assumptions	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=458)	No Adjusted Analyses, only 1 defect total		
d) D>5 ppt (n=616)	No Adjusted Analyses, only 2 defects total		

## Chromosomal Anomalies (All Children)

Model 2: Children of Ranch Hands -  $\log_2$ (Current Dioxin) and Time

There is insufficient data (Table 6-68) to assess the significance of variation in the association between chromosomal anomalies and current dioxin with time since duty in SEA among children of Ranch Hands.

Table 6-68

Post-SEA Counts and Rates of  
Chromosomal Anomalies

Variable: Chromosomal Anomalies  
 Restrictions: All Children of Ranch Hands  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 2:  $\log_2$ (Current Dioxin), Time

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=509)	$\leq 18.6$	0.0 (0/62)	0.0 (0/134)	0.0 (0/72)	No analyses, only 1 defect total	
	$>18.6$	0.0 (0/40)	0.0 (0/108)	10.8 (1/93)		
b) D>5 ppt (n=690)	$\leq 18.6$	11.1 (1/90)	0.0 (0/174)	0.0 (0/110)	No analyses, only 2 defects total	
	$>18.6$	0.0 (0/63)	0.0 (0/136)	8.5 (1/117)		

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=459)		No adjusted analyses, only 1 defect total		
d) D>5 ppt (n=616)		No adjusted analyses, only 2 defects total		

### Chromosomal Anomalies (All Children)

#### Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 6-69 [a]), there is no significant overall association between chromosomal anomalies and categorized current dioxin ( $p=0.292$ ). Furthermore, there is no significant difference between the rates of chromosomal anomalies among children of Ranch Hands in the High ( $p=0.751$ ), Low ( $p=0.560$ ) and Unknown ( $p=0.126$ ) categories and the rate among children of Comparisons in the Background category.

There is insufficient data (Table 6-69 [b]) to assess the association between chromosomal anomalies and categorized current dioxin with adjustment for covariates.

Table 6-69

#### Post-SEA Counts and Rates of Chromosomal Anomalies

Variable: Chromosomal Anomalies  
Restrictions: All Children of Ranch Hands and Comparisons  
Children Conceived during or after the Father's Duty in SEA  
Model 3: Categorized Current Dioxin

##### a) Unadjusted

Exposure Category	n	Abnormal Number	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	981	3	3.1	All Exp Categ	0.292
Unknown	282	3	10.6	Unk vs Bkgd	3.51(0.70,17.5)
Low	174	0	0.0	Low vs Bkgd	-- -- --
High	227	1	4.4	High vs Bkgd	1.44(0.15,14.0)
Total	1664				

**Table 6-69 (Continued)****b) Adjusted**

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	843		No adjusted analyses, only 7 defects total		
Unknown	246				
Low	156				
High	203				
<b>Total</b>	<b>1448</b>				

**Chromosomal Anomalies (Full Siblings)****Model 1: Children of Ranch Hands -  $\text{Log}_2(\text{Initial Dioxin})$** 

There is insufficient data (Table 6-70) to assess the significance of the association between chromosomal anomalies and initial dioxin among full siblings of Ranch Hands.

**Table 6-70****Post-SEA Counts and Rates of Chromosomal Anomalies**

Variable: Chromosomal Anomalies  
 Restrictions: Full Siblings of Ranch Hands  
 Children Conceived during or after the Father's Duty in SEA  
 Model 1:  $\text{Log}_2(\text{Initial Dioxin})$

**Ranch Hands -  $\text{Log}_2(\text{Initial Dioxin})$  - Unadjusted**

Exposure Restriction	Initial Dioxin	n	Abnormal Number	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=420)	Low	78	0	0.0	No analyses, only 1 defect total
	Medium	206	0	0.0	
	High	136	1	7.4	
b) D>5 ppt (n=557)	Low	114	1	8.8	No analyses, only 2 defects total
	Medium	245	0	0.0	
	High	198	1	5.1	

Table 6-70 (Continued)

Ranch Hands -  $\text{Log}_2$ (Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=390)	No Adjusted Analyses, only 1 defect total		
d) D>5 ppt (n=513)	No Adjusted Analyses, only 2 defects total		

## Chromosomal Anomalies (Full Siblings)

Model 2: Children of Ranch Hands -  $\text{Log}_2$ (Current Dioxin) and Time

There is insufficient data (Table 6-71) to assess the significance of variation in the association between chromosomal anomalies and current dioxin with time since duty in SEA among full sibling children of Ranch Hands.

Table 6-71

## Post-SEA Counts and Rates of Chromosomal Anomalies

Variable: Chromosomal Anomalies  
 Restrictions: Full Siblings of Ranch Hands  
 Children Conceived during or after the Father's Duty in SEA  
 Model 2:  $\log_2(\text{Current Dioxin})$ , Time

Ranch Hands -  $\log_2(\text{Current Dioxin})$ , Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Current Dioxin Low	Medium	High		
a) D>10 ppt (n=421)	≤18.6	0.0 (0/47)	0.0 (0/115)	0.0 (0/64)	No analyses, only 1 defect total	
	>18.6	0.0 (0/28)	0.0 (0/92)	13.3 (1/75)		
b) D>5 ppt (n=557)	≤18.6	16.9 (1/59)	0.0 (0/144)	0.0 (0/98)	No analyses, only 2 defects total	
	>18.6	0.0 (0/53)	0.0 (0/106)	10.3 (1/97)		

Ranch Hands -  $\log_2(\text{Current Dioxin})$ , Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=391)		No adjusted analyses, only 1 defect total		
d) D>5 ppt (n=513)		No adjusted analyses, only 2 defects total		

## Chromosomal Anomalies (Full Siblings)

### Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 6-72 [a]), there is no significant overall association between chromosomal anomalies and categorized current dioxin among full siblings ( $p=0.264$ ). Furthermore, the rates among children of Ranch Hands in the High ( $p=0.776$ ), Low ( $p=0.575$ ) and Unknown ( $p=0.110$ ) dioxin categories are not significantly different than that of children of Comparisons in the Background category.

There is insufficient data (Table 6-72 [b]) to assess the significance of the association between chromosomal anomalies and categorized dioxin among full sibling children with adjustment for covariates.

Table 6-72

#### Post-SEA Counts and Rates of Chromosomal Anomalies

Variable: Chromosomal Anomalies  
Restrictions: Full Siblings of Ranch Hands and Comparisons  
Children Conceived during or after the  
Father's Duty in SEA  
Model 3: Categorized Current Dioxin

##### a) Unadjusted

Exposure Category	n	Abnormal Number	Category	Est. Relative Risk (95% C.I.)	p-Value
		Rate	Contrast		
Background	812	3	3.7	All Exp Categ	0.264
Unknown	221	3	13.6	Unk vs Bkgd	3.71(0.74,18.5)
Low	148	0	0.0	Low vs Bkgd	-- -- --
High	195	1	5.1	High vs Bkgd	1.39(0.14,13.5)
Total	1376				

Table 6-72 (Continued)

## b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	715		No adjusted analyses, only 7 defects total		
Unknown	199				
Low	137				
High	180				
Total	1231				

## Other and Unspecified Anomalies (All Children)

Model 1: Children of Ranch Hands -  $\text{Log}_2(\text{Initial Dioxin})$ 

There is insufficient data (Table 6-73) to assess the significance of the association between other and unspecified anomalies and initial dioxin among children of Ranch Hands.

Table 6-73

## Post-SEA Counts and Rates of Other and Unspecified Anomalies

Variable: Other and Unspecified Anomalies  
 Restrictions: All Children of Ranch Hands  
 Children Conceived during or after the Father's Duty in SEA  
 Model 1:  $\text{Log}_2(\text{Initial Dioxin})$

Ranch Hands -  $\text{Log}_2(\text{Initial Dioxin})$  - Unadjusted

Exposure Restriction	Initial Dioxin	n	Abnormal Number	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=508)	Low	106	1	9.4	No analyses, only 3 defects total
	Medium	245	2	8.2	
	High	157	0	0.0	
b) D>5 ppt (n=690)	Low	155	1	6.5	No analyses, only 4 defects total
	Medium	308	3	9.7	
	High	227	0	0.0	

Table 6-73 (Continued)

Ranch Hands -  $\text{Log}_2$ (Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=458)		No adjusted analyses, only 3 defects total	
d) D>5 ppt (n=616)		No adjusted analysis, only 4 defects total	

## Other and Unspecified Anomalies (All Children)

Model 2: Children of Ranch Hands -  $\text{Log}_2$ (Current Dioxin) and Time

There is insufficient data (Table 6-74) to assess the significance of variation in the association between other and unspecified anomalies and current dioxin with time since duty in SEA among children of Ranch Hands.

Table 6-74

Post-SEA Counts and Rates of  
Other and Unspecified Anomalies

Variable: Other and Unspecified Anomalies  
 Restrictions: All Children of Ranch Hands  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 2:  $\log_2$ (Current Dioxin), Time

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Current Dioxin Low	Medium	High		
a) D>10 ppt (n=509)	$\leq 18.6$	0.0 (0/62)	7.5 (1/134)	0.0 (0/72)	No analyses, only 3 defects total	
	$>18.6$	25.0 (1/40)	9.3 (1/108)	0.0 (0/93)		
b) D>5 ppt (n=690)	$\leq 18.6$	0.0 (0/90)	5.7 (1/174)	0.0 (0/110)	No analyses, only 4 defects total	
	$>18.6$	15.9 (1/63)	14.7 (2/136)	0.0 (0/117)		

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks	
c) D>10 ppt (n=459)		No adjusted analyses, only 3 defects total			
d) D>5 ppt (n=616)		No adjusted analyses, only 4 defects total			

**Other and Unspecified Anomalies (All Children)**

**Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin**

There is insufficient data (Table 6-75) to assess the significance of the association between other and unspecified anomalies and categorized current dioxin.

**Table 6-75**

**Post-SEA Counts and Rates of  
Other and Unspecified Anomalies**

Variable: Other and Unspecified Anomalies

Restrictions: All Children of Ranch Hands and Comparisons

Children Conceived during or after the  
Father's Duty in SEA

Model 3: Categorized Current Dioxin

---

**a) Unadjusted**

Exposure Category	n	Abnormal Number	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	981	2	2.0	All Exp Categ	No analyses, only 5
Unknown	282	1	3.5	Unk vs Bkgd	defects total
Low	174	2	11.5	Low vs Bkgd	
High	227	0	0.0	High vs Bkgd	
Total	1664				

**b) Adjusted**

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	843		No adjusted analyses, only 5		defects total
Unknown	246				
Low	156				
High	203				
Total	1448				

## Other and Unspecified Anomalies (Full Siblings)

### Model 1: Children of Ranch Hands - $\log_2$ (Initial Dioxin)

There is insufficient data (Table 6-76) to assess the significance of the association between other and unspecified anomalies and initial dioxin among full sibling children of Ranch Hands.

Table 6-76

#### Post-SEA Counts and Rates of Other and Unspecified Anomalies

Variable: Other and Unspecified Anomalies  
Restrictions: Full Siblings of Ranch Hands  
Children Conceived during or after the Father's Duty in SEA  
Model 1:  $\log_2$ (Initial Dioxin)

#### Ranch Hands - $\log_2$ (Initial Dioxin) - Unadjusted

Exposure Restriction	Initial Dioxin	n	Abnormal Number	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=420)	Low	78	0	0.0	No analyses, only 1 defect total
	Medium	206	1	4.9	
	High	136	0	0.0	
b) D>5 ppt (n=557)	Low	114	1	8.8	No analyses, only 2 defects total
	Medium	245	1	4.1	
	High	198	0	0.0	

#### Ranch Hands - $\log_2$ (Initial Dioxin) - Adjusted

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=390)	No adjusted analyses, 1 defects total		
d) D>5 ppt (n=513)	No adjusted analysis, 2 defects total		

## Other and Unspecified Anomalies (Full Siblings)

### Model 2: Children of Ranch Hands - $\log_2$ (Current Dioxin) and Time

There is insufficient data (Table 6-77) to assess the significance of variation in the association between other and unspecified anomalies and current dioxin with time since duty in SEA among full sibling children of Ranch Hands.

Table 6-77

#### Post-SEA Counts and Rates of Other and Unspecified Anomalies

Variable: Other and Unspecified Anomalies  
Restrictions: Full Siblings of Ranch Hands  
Children Conceived during or after the Father's Duty in SEA  
Model 2:  $\log_2$ (Current Dioxin), Time

---

#### Ranch Hands - $\log_2$ (Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Anomaly Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=421)	$\leq 18.6$	0.0 (0/47)	0.0 (0/115)	0.0 (0/64)	No analyses, only 1 defect total	
	$>18.6$	0.0 (0/28)	10.9 (1/92)	0.0 (0/75)		
b) D>5 ppt (n=557)	$\leq 18.6$	0.0 (0/59)	0.0 (0/144)	0.0 (0/98)	No analyses, only 2 defects total	
	$>18.6$	18.9 (1/53)	9.4 (1/106)	0.0 (0/97)		

Table 6-77 (Continued)

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Adjusted

Exposure Restriction	Time Since SEA (years)	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=391)		No adjusted analyses, 1 defects total		
d) D>5 ppt (n=513)		No adjusted analyses, 2 defects total		

## Other and Unspecified Anomalies (Full Siblings)

## Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

There is insufficient data (Table 6-78) to assess the significance of the association between other and unspecified anomalies and categorized current dioxin among full sibling children.

Table 6-78

## Post-SEA Counts and Rates of Other and Unspecified Anomalies

Variable: Other and Unspecified Anomalies  
 Restrictions: Full Siblings of Ranch Hands and Comparisons  
 Children Conceived during or after the  
 Father's Duty in SEA  
 Model 3: Categorized Current Dioxin

## a) Unadjusted

Exposure Category	n	Abnormal Number	Category Rate	Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	812	2	2.5	All Exp Categ	No analyses, only 4	
Unknown	221	1	4.5	Unk vs Bkgd	defects total	
Low	148	1	6.8	Low vs Bkgd		
High	195	0	0.0	High vs Bkgd		
Total	1376					

Table 6-78 (Continued)

## b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	715		No adjusted analyses, only 4 defect total		
Unknown	199				
Low	137				
High	180				
Total	1231				

## 6.2 Conclusion

The statistical significance of the association between post-SEA birth defects and the father's dioxin level was assessed within each of the 13 birth defect categories in four separate series of analyses. Analyses were first conducted on all children and then with restriction to full sibling children. Within each of these two series, each analysis was carried out first without and then with adjustment for covariates. The results are summarized in Tables 6-79 through 6-81.

Throughout this section, nonsignificant results are indicated by NS, borderline significant results are indicated by NS\* and the presence of interactions with the p-value greater than or equal to 0.01 and less than 0.05 are indicated with a preceding double asterisk (\*\*). Four asterisks (\*\*\*\*) represent the presence of an interaction between a covariate and dioxin with a p-value less than 0.01. The p-value is replace by a double hyphen (--) when the analysis was not carried out due to sparse data.

Table 6-79

**P-Value Summary of Post-SEA Initial Dioxin (Model 1) Analyses  
of Birth Defects (Children of Ranch Hands)**

**a) All Children**

Variable	Unadjusted		Adjusted	
	D>10 ppt	D>5 ppt	D>10 ppt	D>5 ppt
Total Congenital Anomalies	NS	NS	NS	**NS
Nervous System Anomalies	NS	NS	--	--
Eye Anomalies	NS	NS	--	--
Ear, Face and Neck Anomalies	NS	NS	--	--
Circulatory System and Heart Anomalies	0.042	NS	--	--
Respiratory System Anomalies	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS
Genital Anomalies	NS	NS	NS	NS
Urinary System Anomalies	NS	NS	--	--
Musculoskeletal Deformities	NS	NS	**NS*	****
Anomalies of the Skin	NS	NS	NS	**NS
Chromosomal Anomalies	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--

**b) Full Siblings**

Variable	Unadjusted		Adjusted	
	D>10 ppt	D>5 ppt	D>10 ppt	D>5 ppt
Total Congenital Anomalies	NS	NS	NS	NS
Nervous System Anomalies	NS	NS	--	--
Eye Anomalies	NS	NS	--	--
Ear, Face and Neck Anomalies	NS	NS	--	--
Circulatory System and Heart Anomalies	NS*	NS	--	--
Respiratory System Anomalies	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS
Genital Anomalies	NS	NS	NS	NS
Urinary System Anomalies	NS	NS	--	--
Musculoskeletal Deformities	NS	NS	****	****
Anomalies of the Skin	NS*	NS	NS	NS
Chromosomal Anomalies	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--

Table 6-80

P-Value Summary of Current Dioxin and Time (Model 2) Analyses  
 Post-SEA Birth Defects (Children of Ranch Hands)

a) All Children

Variable	Unadjusted					
	D>10 ppt			D>5 ppt		
	Dioxin by Time	Time Since SEA (years) ≤18.6	>18.6	Dioxin by Time	Time Since SEA (years) ≤18.6	>18.6
Total Congenital Anomalies	NS	NS	NS	NS	NS	NS
Nervous System Anomalies	--	--	--	--	--	--
Eye Anomalies	NS	NS	NS	NS	NS	NS
Ear, Face and Neck Anomalies	NS	NS	NS	0.005	NS*	NS*
Circulatory System and Heart Anomalies	NS	NS	NS*	NS	NS	NS
Respiratory System Anomalies	--	--	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS	NS	NS
Genital Anomalies	NS	NS	NS	NS	NS	NS
Urinary System Anomalies	NS	NS	NS	NS	NS	NS
Musculoskeletal Deformities	NS*	NS	0.030	NS	NS	NS
Anomalies of the Skin	NS	NS	NS	NS	NS	NS
Chromosomal Anomalies	--	--	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--	--	--

Table 6-80 (Continued)

## b) Full Siblings

Variable	Unadjusted					
	D>10 ppt			D>5 ppt		
	Dioxin by Time	Time Since SEA (years) $\leq 18.6$	$>18.6$	Dioxin by Time	Time Since SEA (years) $\leq 18.6$	$>18.6$
Total Congenital Anomalies	NS	NS	NS	NS	NS	NS
Nervous System Anomalies	--	--	--	--	--	--
Eye Anomalies	--	--	--	--	--	--
Ear, Face and Neck Anomalies	NS	NS	NS	0.014	NS	NS*
Circulatory System and Heart Anomalies	--	--	--	--	--	--
Respiratory System Anomalies	--	--	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS	NS	NS
Genital Anomalies	NS	NS	NS	NS	NS	NS
Urinary System Anomalies	NS	NS	NS	NS	NS	NS
Musculoskeletal Deformities	NS	NS	0.053	NS	NS	NS
Anomalies of the Skin	NS	NS	NS	NS	NS	NS
Chromosomal Anomalies	--	--	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--	--	--

Table 6-80 (Continued)

## c) All Children

Variable	Adjusted					
	D>10 ppt			D>5 ppt		
	Dioxin by Time	Time Since SEA (years) ≤18.6	>18.6	Dioxin by Time	Time Since SEA (years) ≤18.6	>18.6
Total Congenital Anomalies	**NS	**NS	**NS	**NS	**NS	**NS
Nervous System Anomalies	--	--	--	--	--	--
Eye Anomalies	--	--	--	--	--	--
Ear, Face and Neck Anomalies	--	--	--	--	--	--
Circulatory System and Heart Anomalies	--	--	--	--	--	--
Respiratory System Anomalies	--	--	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS	NS	NS
Genital Anomalies	NS	NS	NS	NS	NS	NS
Urinary System Anomalies	--	--	--	--	--	--
Musculoskeletal Deformities	NS*	NS	0.033	**NS	**NS	**NS
Anomalies of the Skin	NS	NS	NS	NS	NS	NS
Chromosomal Anomalies	--	--	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--	--	--

Table 6-80 (Continued)

## d) Full Siblings

Variable	Adjusted					
	D>10 ppt			D>5 ppt		
	Dioxin by Time	Tour <18.6	>18.6	Dioxin by Time	Tour <18.6	>18.6
Total Congenital Anomalies	NS	NS	NS	NS	NS	NS
Nervous System Anomalies	--	--	--	--	--	--
Eye Anomalies	--	--	--	--	--	--
Ear, Face and Neck Anomalies	--	--	--	--	--	--
Circulatory System and Heart Anomalies	--	--	--	--	--	--
Respiratory System Anomalies	--	--	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS	NS	NS
Genital Anomalies	**NS	**NS	**NS	NS	NS	NS
Urinary System Anomalies	--	--	--	--	--	--
Musculoskeletal Deformities	NS*	NS	0.046	NS	NS	NS
Anomalies of the Skin	NS	NS	NS	NS	NS	NS
Chromosomal Anomalies	--	--	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--	--	--

Table 6-81

**P-Value Summary of Categorized Current Dioxin (Model 3) Analyses of Post-SEA Birth Defects (Children of Ranch Hands and Comparisons)**

a) All Children

Variable	All	Unknown	Unadjusted		
			Contrasts with Background		
			Low	High	
Total Congenital Anomalies	NS*	NS	0.013	NS	
Nervous System Anomalies	NS	--	NS	NS*	
Eye Anomalies	NS	NS	NS	NS	
Ear, Face and Neck Anomalies	NS	NS	NS	NS	
Circulatory System and Heart Anomalies	NS*	NS	0.016	NS	
Respiratory System Anomalies	NS	NS	NS	NS	
Digestive System Anomalies	NS	NS	NS	NS	
Genital Anomalies	0.005	NS	0.010	NS	
Urinary System Anomalies	NS	NS	0.037	NS	
Musculoskeletal Deformities	NS	NS	NS	NS	
Anomalies of the Skin	NS	NS	NS	NS	
Chromosomal Anomalies	NS	NS	NS	NS	
Other and Unspecified Anomalies	--	--	--	--	

Table 6-81 (Continued)

## b) Full Siblings

## Unadjusted

Variable	All	Contrasts with Background		
		Unknown	Low	High
Total Congenital Anomalies	NS*	NS	0.028	NS
Nervous System Anomalies	NS	--	NS	NS*
Eye Anomalies	NS	NS	NS	NS*
Ear, Face and Neck Anomalies	NS	NS	NS	NS
Circulatory System and Heart Anomalies	0.007	NS	0.028	NS
Respiratory System Anomalies	NS	NS	NS	NS
Digestive System Anomalies	NS	NS	NS	NS
Genital Anomalies	0.028	NS	0.050	NS
Urinary System Anomalies	NS	NS	NS*	NS
Musculoskeletal Deformities	NS	NS	NS	NS
Anomalies of the Skin	NS	NS	NS	NS
Chromosomal Anomalies	NS	NS	NS	NS
Other and Unspecified Anomalies	--	--	--	--

Table 6-81 (Continued)

## c) All Children

Variable	All	Adjusted		
		Contrasts with Background		
		Unknown	Low	High
Total Congenital Anomalies	****	****	****	****
Nervous System Anomalies	--	--	--	--
Eye Anomalies	--	--	--	--
Ear, Face and Neck Anomalies	NS	NS	NS	NS
Circulatory System and Heart Anomalies	NS	NS	NS	NS
Respiratory System Anomalies	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS
Genital Anomalies	0.007	NS	0.012	NS
Urinary System Anomalies	NS	NS	0.021	NS
Musculoskeletal Deformities	****	****	****	****
Anomalies of the Skin	**NS	**NS	**NS	**NS
Chromosomal Anomalies	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--

Table 6-81 (Continued)

## d) Full Siblings

Variable	All	Adjusted		
		Contrasts with Background		
		Unknown	Low	High
Total Congenital Anomalies	****	****	****	****
Nervous System Anomalies	--	--	--	--
Eye Anomalies	--	--	--	--
Ear, Face and Neck Anomalies	NS	NS	NS	NS
Circulatory System and Heart Anomalies	0.034	NS	NS	--
Respiratory System Anomalies	--	--	--	--
Digestive System Anomalies	NS	NS	NS	NS
Genital Anomalies	0.027	NS	NS*	NS
Urinary System Anomalies	NS	NS	0.055	NS
Musculoskeletal Deformities	****	****	****	****
Anomalies of the Skin	NS	NS	NS	NS
Chromosomal Anomalies	--	--	--	--
Other and Unspecified Anomalies	--	--	--	--

In the assessments of dioxin versus post-SEA birth defects, few significant associations were found. Those that were found did not appear consistently across analyses and most were not suggestive of a plausible dioxin effect. For example, a significant association was found between initial dioxin and circulatory system and heart anomalies, but the rate (6.4 per 1000) among children of Ranch Hands having the highest initial dioxin levels was less than that among children of Ranch Hands at the lowest dioxin levels (28.3 per 1000). In a Model 3 analysis restricted to full sibling children, a significant association was found between categorized dioxin and circulatory system and heart anomalies, but this was caused by a high rate (47.3 per 1000) among children of Ranch Hands in the Low category relative to children of Comparisons in the Background category (17.2 per 1000) and a low rate among children of Ranch Hands in the High category (0 per 1000). In a Model 2 analysis, a significant association was found between current dioxin and anomalies of the ear, face and neck, but this was caused by an increase in

anomalies with dioxin among children of Ranch Hands having early tours and a decrease in anomalies among children of Ranch Hands having late tours, a pattern that does not make biologic sense. A significant association was found in a Model 3 analysis of genital anomalies, but the pattern was not consistent with the expected dose-response. The rate among children of Ranch Hands in the Low dioxin category (51.7 per 1000) was greater than that among children of Ranch Hands in the High category (13.2 per 1000).

Several analyses of post-SEA total congenital anomalies and musculoskeletal deformities were complicated by significant interactions with covariates. Examination of these did not reveal meaningful patterns. For example, Model 3 analyses of total congenital anomalies (Table 6-3) found a significant interaction with the father's military occupation in SEA. Among children of officers, children of Ranch Hands in the Low dioxin category had a lower rate (45.5 per 1000) than children of Comparisons in the Background category (217.9 per 1000). Among children of flying enlisted and enlisted ground personnel, children of Ranch Hands in the Low dioxin category had higher rates (433.3 per 1000 and 317.3 per 1000) than children of Comparisons in the Background category (228.9 per 1000 and 212.7 per 1000) but the rates in children of enlisted ground personnel in the High category were not significantly elevated. A Model 3 analysis of musculoskeletal deformities (Table 6-57) also found a significant interaction with the father's military occupation in SEA. Children of Ranch Hand officers in the Low category had a low rate (0 per 1000) relative to children of Comparisons in the Background category (155.6 per 1000) and the rates in children of enlisted flyers and enlisted ground personnel were not significantly different from the rates in corresponding children of Comparisons in the Background category.

In summary, analyses of total congenital anomalies and musculoskeletal deformities found significant variation in relative risk, but taken together, no consistent pattern emerged. This suggests that these results are chance occurrences and that there is most likely no underlying association with dioxin. In conclusion, there is no evidence of an association between dioxin and birth defects among post-SEA children.

## 7. BIRTH DEFECT SEVERITY

### 7.1 Introduction

All live births were categorized according to severity following the CDC definition [14]. Major defects were defined as those that potentially can affect survival, require substantial medical care, result in marked physical or psychological handicaps, or interfere with a child's prospects for a productive and fulfilling life. Minor defects were defined as those that are not associated with one or more of the above mentioned sequelae.

Analyses were first carried out with each of Models 1, 2 and 3 to assess changes in the association between severity and dioxin with time of conception relative to the father's duty in SEA (pre-SEA, post-SEA) without adjustment for covariates. In these analyses, severity was reduced to two levels (not major, major), where "not major" is defined as none or minor. All analyses were carried out without and then with restriction to full sibling children. These analyses are shown in Tables 7-1 through 7-6.

The significance of the association between severity and dioxin was also assessed among post-SEA children with each of the three models. Each analysis was first carried out with severity having 3 levels (none, minor, major) and then with severity categorized with two levels (not major, major). The 3-category analyses were carried out without adjustment for covariates. The 2-category analyses were carried out without and then with adjustment for covariates. All analyses were carried out without and with restriction to full siblings. These analyses are shown in Tables 7-7 through 7-18.

In this section, rates were computed as the number of occurrences of a birth defect of a given severity per 1000 children.

### 7.2 Pre-post SEA Exposure Analyses - All Children

#### **Birth Defect Severity (2 Categories; All Children)**

##### **Model 1: Children of Ranch Hands - $\text{Log}_2(\text{Initial Dioxin})$**

Without adjustment for covariates (Table 7-1 [a] and [b]), there is no significant variation in the association between birth defect severity (not major, major) and initial dioxin with time of conception among children of Ranch Hands with more than 10 ppt ( $p=0.348$ ) or more than 5 ppt ( $p=0.646$ ) current dioxin.

Table 7-1

## Pre-Post SEA Counts and Rates of Birth Defect Severity (Not Major, Major)

Variable: Birth Defect Severity (Not Major, Major)  
 Restrictions: All Children of Ranch Hands  
 Model 1:  $\text{Log}_2(\text{Initial Dioxin})$

Ranch Hands -  $\text{Log}_2(\text{Initial Dioxin})$  - Unadjusted

## Time of Conception Relative to the Father's Duty in SEA

Exposure Restriction	Initial Dioxin	Pre-SEA			Post-SEA			p-Value
		n	Maj	Rate	n	Maj	Rate	
a) D>10 ppt (n=1208)	Low	249	8	32.1	106	6	56.6	0.348
	Medium	338	14	41.4	245	25	102.0	
	High	113	5	44.2	157	10	63.7	
b) D>5 ppt (n=1748)	Low	286	9	31.5	155	9	58.1	0.646
	Medium	616	19	30.8	308	26	84.4	
	High	156	10	64.1	227	15	66.1	

## Birth Defect Severity (2 Categories, All Children)

Model 2: Children of Ranch Hands -  $\text{Log}_2(\text{Current Dioxin})$  and Time

Without adjustment for covariates (Table 7-2 [a] and [b]), there is no significant variation in the association between birth defect severity (not major, major) and current dioxin with time since duty in SEA and time of conception among children of Ranch Hands with more than 10 ppt ( $p=0.506$ ) or more than 5 ppt ( $p=0.964$ ) current dioxin.

Table 7-2

## Pre-Post SEA Counts and Rates of Birth Defect Severity (Not Major, Major)

Variable: Birth Defect Severity (Not Major, Major)  
 Restrictions: All Children of Ranch Hands  
 Model 2:  $\log_2$ (Current Dioxin), Time

Ranch Hands -  $\log_2$ (Current Dioxin), Time - Unadjusted

Exposure Restriction	Time of Conception	Time Since SEA (years)	Severity Rate (No./n)			p-Value
			Current Dioxin	Low	Medium	
a) D>10 ppt (n=1210)	Pre-SEA	≤18.6	36.5	43.7	81.1	0.506
			(5/137)	(8/183)	(3/37)	
	Post-SEA	≤18.6	21.1	35.1	38.5	
			(2/95)	(6/171)	(3/78)	
b) D>5 ppt (n=1748)	Pre-SEA	≤18.6	48.4	111.9	41.7	0.964
			(3/62)	(15/134)	(3/72)	
	Post-SEA	≤18.6	75.0	101.9	75.3	
			(3/40)	(11/108)	(7/93)	

### Birth Defect Severity (2 Categories; All Children)

#### Model 3: Children of Ranch Hands and Comparisons - Categorized Current Dioxin

Without adjustment for covariates (Table 7-3), there is no significant variation in the overall association between birth defect severity (not major, major) and categorized current dioxin with time of conception ( $p=0.203$ ). However, the association between birth defect severity and time of conception among children of Ranch Hands in the Low ( $p=0.038$ ) category is significantly different from the association among children of Comparisons in the Background category. This finding is caused by a high rate of major severity (126.4 per 1000) among post-SEA children of Ranch Hands in the Low category relative to that of children of Comparisons in the Background category (57.1 per 1000). The association between birth defect severity and time of birth among children of Ranch Hands in the High ( $p=0.984$ ) and Unknown ( $p=0.529$ ) categories are not significantly different from the association among children of Comparisons in the Background category.

Table 7-3

#### Pre-Post SEA Counts and Rates of Birth Defect Severity (Not Major, Major)

Variable: Birth Defect Severity (Not Major, Major)  
Restrictions: All Children of Ranch Hands and Comparisons  
Model 3: Categorized Current Dioxin

Time of Conception Relative to the Father's Duty in SEA										
Exposure Category	n	Pre-SEA		Post-SEA			Odds Ratio	Category Contrast	p-Value	
		Maj	Rate	n	Maj	Rate				
Background	1459	60	41.1	981	56	57.1	1.41	All Exp Categ	0.203	
Unknown	582	20	34.4	282	17	60.3	1.80	Unk vs Bkgd	0.529	
Low	290	12	41.4	174	22	126.4	3.35	Low vs Bkgd	0.038	
High	168	7	41.7	227	13	57.3	1.40	High vs Bkgd	0.984	
Total	2499			1664						