

10. NEONATAL AND INFANT MORTALITY

10.1 Introduction

A childhood death is called a neonatal death if the child dies within 28 days of birth. The death is called an infant death if the child survives the 28th day but dies within 1 year of birth.

10.2 Pre-post SEA Exposure Analyses

The association between neonatal and infant mortality and dioxin was assessed with Models 1, 2 and 3 without and with restriction to full siblings. Pre-post SEA changes are assessed first, followed by post-SEA assessments of association with dioxin. All rates are expressed per 1000 children.

Neonatal Death (All Children)

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

Without adjustment for covariates (Table 10-1 [a] and [b]), there is no significant variation in the association between neonatal death and initial dioxin with time of conception among children of Ranch Hands having more than 10 ppt ($p=0.746$) or more than 5 ppt ($p=0.746$) current dioxin.

Table 10-1

Pre-post SEA Counts and Rates of Neonatal Deaths

Variable: Neonatal Death
 Restrictions: All Children of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 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	n	Pre-SEA		Post-SEA		p-Value	
			Deaths	Rate	n	Deaths		Rate
a) D>10 ppt (n=1208)	Low	249	2	8.0	106	0	0.0	0.746
	Medium	338	7	20.7	245	3	12.2	
	High	113	1	8.8	157	3	19.1	
b) D>5 ppt (n=1748)	Low	286	5	17.5	155	2	12.9	0.746
	Medium	616	8	13.0	308	2	6.5	
	High	156	2	12.8	227	4	17.6	

Neonatal Death (All Children)

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

Without adjustment for covariates (Table 10-2 [a] and [b]), there is no significant change in the association between neonatal death and current dioxin with time since duty in SEA and time of conception among children of Ranch Hands having more than 10 ppt current dioxin ($p=0.712$) or more than 5 ppt current dioxin ($p=0.780$).

Table 10-2

Pre-post SEA Counts and Rates of Neonatal Deaths

Variable: Neonatal Death
 Restrictions: All Children of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 2: $\text{Log}_2(\text{Current Dioxin})$, Time

Ranch Hands - $\text{Log}_2(\text{Current Dioxin})$, Time - Unadjusted						
Exposure Restriction	Time of Conception	Time Since SEA (years)	Neonatal Death Rate (No./n)			p-Value
			Low	Medium	High	
a) D>10 ppt (n=1210)	Pre-SEA	≤18.6	7.3 (1/137)	10.9 (2/183)	27.0 (1/37)	0.712
		>18.6	10.5 (1/95)	23.4 (4/171)	12.8 (1/78)	
	Post-SEA	≤18.6	0.0 (0/62)	7.5 (1/134)	0.0 (0/72)	
		>18.6	0.0 (0/40)	37.0 (4/108)	10.8 (1/93)	
b) D>5 ppt (n=1748)	Pre-SEA	≤18.6	19.1 (3/157)	3.2 (1/313)	45.5 (3/66)	0.780
		>18.6	13.3 (2/150)	18.5 (5/270)	9.8 (1/102)	
	Post-SEA	≤18.6	11.1 (1/90)	0.0 (0/174)	9.1 (1/110)	
		>18.6	15.9 (1/63)	7.4 (1/136)	34.2 (4/117)	

Neonatal Death (All Children)

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

Without adjustment for covariates (Table 10-3), there is no significant variation in the overall association between neonatal death and categorized dioxin with time of conception ($p=0.860$). Furthermore, the associations between neonatal death and time of conception among children of Ranch Hands in the High ($p=0.422$), Low ($p=0.939$) and Unknown ($p=0.731$) categories do not differ significantly from that among children of Comparisons in the Background category.

Table 10-3

Pre-post SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 Restrictions: All Children of Ranch Hands and Comparisons
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 3: Categorized Current Dioxin

Categorized Current Dioxin - Unadjusted									
Time of Conception Relative to the Father's Duty in SEA									
Exposure Category	n	Pre-SEA		Post-SEA		Odds Ratio	Category Contrast	p-Value	
		Deaths	Rate	n	Deaths	Rate			
Background	1459	13	8.9	981	4	4.1	0.46	All Exp Categ	0.860
Unknown	582	10	17.2	282	3	10.6	0.62	Unk vs Bkgd	0.731
Low	290	4	13.8	174	1	5.7	0.41	Low vs Bkgd	0.939
High	168	4	23.8	227	5	22.0	0.92	High vs Bkgd	0.422
Total	2499			1664					

Neonatal Death (Full Siblings)

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

Without adjustment for covariates (Table 10-4 [a] and [b]), there is no significant variation in the association between neonatal death and initial dioxin with time of conception among full sibling children of Ranch Hands having more than 10 ppt ($p=0.735$) or more than 5 ppt ($p=0.528$) current dioxin.

Table 10-4

Pre-post SEA Counts and Rates of Neonatal Deaths

Variable: Neonatal Death
 Restrictions: Full Siblings of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 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	n	Pre-SEA		Post-SEA			p-Value
			Deaths	Rate	n	Deaths	Rate	
a) D>10 ppt (n=1030)	Low	231	2	8.7	78	0	0.0	0.735
	Medium	276	3	10.9	206	3	14.6	
	High	103	1	9.7	136	2	14.7	
b) D>5 ppt (n=1489)	Low	252	5	19.8	114	2	17.5	0.528
	Medium	545	5	9.2	245	2	8.2	
	High	135	1	7.4	198	3	15.2	

Neonatal Death (Full Siblings)

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

Without adjustment for covariates (Table 10-5 [a] and [b]), there is no significant change in the association between neonatal death and current dioxin with time since duty in SEA and time of conception among full sibling children of Ranch Hands having more than 10 ppt current dioxin ($p=0.415$) or more than 5 ppt current dioxin ($p=0.402$).

Table 10-5

Pre-post SEA Counts and Rates of Neonatal Deaths

Variable: Neonatal Death
 Restrictions: Full Siblings of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 2: $\text{Log}_2(\text{Current Dioxin})$, Time

Exposure Restriction	Time of Conception	Time Since SEA (years)	Neonatal Death Rate (No./n) Current Dioxin			p-Value
			Low	Medium	High	
a) D>10 ppt (n=1032)	Pre-SEA	≤18.6	8.1 (1/124)	12.9 (2/155)	28.6 (1/35)	0.415
		>18.6	11.8 (1/85)	7.0 (1/143)	0.0 (0/69)	
	Post-SEA	≤18.6	0.0 (0/47)	8.7 (1/115)	0.0 (0/64)	
		>18.6	0.0 (0/28)	43.5 (4/92)	0.0 (0/75)	
b) D>5 ppt (n=1489)	Pre-SEA	≤18.6	23.8 (3/126)	3.6 (1/276)	50.0 (3/60)	0.402
		>18.6	13.8 (2/145)	8.4 (2/237)	0.0 (0/88)	
	Post-SEA	≤18.6	16.9 (1/59)	0.0 (0/144)	10.2 (1/98)	
		>18.6	18.9 (1/53)	9.4 (1/106)	30.9 (3/97)	

Neonatal Death (Full Siblings)

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

Without adjustment for covariates (Table 10-6), there is no significant variation in the overall association between neonatal death and categorized dioxin ($p=0.782$) with time of conception among full siblings. Furthermore, the association between neonatal death and time of conception among children of Ranch Hands in the High ($p=0.475$), Low ($p=0.426$) and Unknown ($p=0.457$) categories do not differ from that among children of Comparisons in the Background category.

Table 10-6

Pre-post SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 Restrictions: Full Siblings of Ranch Hands and Comparisons
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 3: Categorized Current Dioxin

Categorized Current Dioxin - Unadjusted

Exposure Category	n	Pre-SEA		Post-SEA		Odds Ratio	Category Contrast	p-Value
		Deaths	Rate	n	Deaths			
Background	1250	12	9.6	812	4	4.9	All Exp Categ	0.782
Unknown	514	7	13.6	221	3	13.6	Unk vs Bkgd	0.457
Low	244	1	4.1	148	1	6.8	Low vs Bkgd	0.426
High	148	3	20.3	195	4	20.5	High vs Bkgd	0.475
Total	2156			1376				

Infant Death (All Children)

Model 1: Children of Ranch Hands - Log₂(Initial Dioxin)

Without adjustment for covariates (Table 10-7 [a] and [b]), there is no significant variation in the association between infant death and initial dioxin with time of conception among children of Ranch Hands having more than 10 ppt ($p=0.424$) or more than 5 ppt ($p=0.437$).

Table 10-7

Pre-post SEA Counts and Rates of Infant Deaths

Variable: Infant Death
 Restrictions: All Children of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 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	n	Pre-SEA		Post-SEA		p-Value	
			Deaths	Rate	n	Deaths		Rate
a) D>10 ppt (n=1192)	Low	247	1	4.0	106	1	9.4	0.424
	Medium	331	2	6.0	242	1	4.1	
	High	112	2	17.9	154	1	6.5	
b) D>5 ppt (n=1725)	Low	281	2	7.1	153	1	6.5	0.437
	Medium	608	2	3.3	306	2	6.5	
	High	154	3	19.5	223	1	4.5	

Infant Death (All Children)

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

Without adjustment for covariates (Table 10-8 [a] and [b]), there is no significant change in the association between infant death and current dioxin and time since duty in SEA with time of conception among children of Ranch Hands having more than 10 ppt current dioxin ($p=0.576$) or more than 5 ppt current dioxin ($p=0.738$).

Table 10-8

Pre-post SEA Counts and Rates of Infant Deaths

Variable: Infant Death
 Restrictions: All Children of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 2: $\text{Log}_2(\text{Current Dioxin}), \text{Time}$

Ranch Hands - $\text{Log}_2(\text{Current Dioxin}), \text{Time}$ - Unadjusted						
Exposure Restriction	Time of Conception	Time Since SEA (years)	Infant Death Rate (No./n)			p-Value
			Low	Medium	High	
a) D>10 ppt (n=1194)	Pre-SEA	≤18.6	7.4 (1/136)	0.0 (0/181)	0.0 (0/36)	0.576
		>18.6	0.0 (0/94)	12.0 (2/167)	26.0 (2/77)	
	Post-SEA	≤18.6	0.0 (0/62)	0.0 (0/133)	0.0 (0/72)	
		>18.6	25.0 (1/40)	9.6 (1/104)	10.9 (1/92)	
b) D>5 ppt (n=1725)	Pre-SEA	≤18.6	6.5 (1/154)	3.2 (1/312)	0.0 (0/63)	0.738
		>18.6	6.8 (1/148)	3.8 (1/265)	29.7 (3/101)	
	Post-SEA	≤18.6	11.2 (1/89)	0.0 (0/174)	0.0 (0/109)	
		>18.6	0.0 (0/62)	14.8 (2/135)	8.8 (1/113)	

Infant Death (All Children)

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

Without adjustment for covariates (Table 10-9), there is no significant variation in the association between infant death and categorized dioxin with time of conception (p=0.696). Furthermore, the associations between infant death and time of conception among children of Ranch Hands in the High (p=0.664), Low (p=0.498) and Unknown (p=0.661) categories does not differ significantly from that among children of Comparisons in the Background category.

Table 10-9

Pre-post SEA Counts and Rates of Infant Death

Variable: Infant Death
 Restrictions: All Children of Ranch Hands and Comparisons
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 3: Categorized Current Dioxin

Categorized Current Dioxin - Unadjusted

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

Exposure Category	n	Pre-SEA		Post-SEA		Odds Ratio	Category Contrast	p-Value
		Deaths	Rate	n	Deaths			
Background	1446	3	2.1	977	1	1.0	All Exp Categ	0.696
Unknown	572	2	3.5	279	1	3.6	Unk vs Bkgd	0.661
Low	286	1	3.5	173	1	5.8	Low vs Bkgd	0.498
High	164	3	18.3	222	1	4.5	High vs Bkgd	0.664
Total	2468			1651				

Infant Death (Full Siblings)

Model 1: Children of Ranch Hands - Log₂(Initial dioxin)

There is insufficient data (Table 10-10) to assess the significance of variation in the association between infant death and initial dioxin with time of conception among full sibling children of Ranch Hands.

Table 10-10

Pre-post SEA Counts and Rates of Infant Deaths

Variable: Infant Death
 Restrictions: Full Siblings of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 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	n	Pre-SEA Deaths	Rate	n	Post-SEA Deaths	Rate	p-Value
a) D>10 ppt (n=1019)	Low	229	1	4.4	78	1	12.8	No analysis, only 5 deaths total
	Medium	273	2	7.3	203	0	0.0	
	High	102	1	9.8	134	0	0.0	
b) D>5 ppt (n=1471)	Low	247	2	8.1	112	1	8.9	No analysis, only 8 deaths total
	Medium	540	2	3.7	243	1	4.1	
	High	134	2	14.9	195	0	0.0	

Infant Death (Full Siblings)

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

There is insufficient data (Table 10-11) to assess the significance of variation in the association between infant death and current dioxin with time of conception among full sibling children of Ranch Hands.

Table 10-11

Pre-post SEA Counts and Rates of Infant Deaths

Variable: Infant Death
 Restrictions: Full Siblings of Ranch Hands
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 2: $\text{Log}_2(\text{Current Dioxin})$, Time

Ranch Hands - $\text{Log}_2(\text{Current Dioxin})$, Time - Unadjusted						
Exposure Restriction	Time of Conception	Time Since SEA (years)	Infant Death Rate (No./n)			p-Value
			Low	Medium	High	
a) D>10 ppt (n=1021)	Pre-SEA	≤18.6	8.1 (1/123)	0.0 (0/153)	0.0 (0/34)	No analysis, only 5 deaths total
		>18.6	0.0 (0/84)	14.1 (2/142)	14.5 (1/69)	
	Post-SEA	≤18.6	0.0 (0/47)	0.0 (0/114)	0.0 (0/64)	
		>18.6	35.7 (1/28)	0.0 (0/88)	0.0 (0/75)	
b) D>5 ppt (n=1471)	Pre-SEA	≤18.6	8.1 (1/123)	3.6 (1/275)	0.0 (0/57)	No analysis, only 8 deaths total
		>18.6	7.0 (1/143)	4.3 (1/235)	22.7 (2/88)	
	Post-SEA	≤18.6	17.2 (1/58)	0.0 (0/144)	0.0 (0/97)	
		>18.6	0.0 (0/52)	9.5 (1/105)	0.0 (0/94)	

Infant Death (Full Siblings)

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

There is insufficient data (Table 10-12) to assess the significance of variation in the association between infant death and categorized current dioxin among full sibling children.

Table 10-12

Pre-post SEA Counts and Rates of Infant Death

Variable: Infant Death
 Restrictions: Full Siblings of Ranch Hands and Comparisons
 Categories: Time of Conception Relative to the
 Father's Duty in SEA
 Model 3: Categorized Current Dioxin

Categorized Current Dioxin - Unadjusted

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

Exposure Category	n	Pre-SEA Deaths	Pre-SEA Rate	Post-SEA n	Post-SEA Deaths	Post-SEA Rate	Odds Ratio	Category Contrast	p-Value
Background	1238	1	0.8	808	1	1.2	1.53	All Exp Categ	No analysis, 8 deaths total
Unknown	507	2	3.9	218	1	4.6	1.16	Unk vs Bkgd	
Low	243	1	4.1	147	0	0.0	--	Low vs Bkgd	
High	145	2	13.8	191	0	0.0	--	High vs Bkgd	
Total	2133			1364					

10.3 Post-SEA Exposure Analyses

The association between neonatal and infant mortality and dioxin was assessed in post-SEA children with Models 1, 2 and 3. All analysis were carried out without and then with adjustment for covariates. Each analysis was first conducted without and then with restriction to full sibling children. The results are given in Tables 10-13 through 10-24.

Neonatal Death (All Children)

Model 1: Children of Ranch Hands - Log₂(Initial Dioxin)

Without adjustment for covariates (Table 10-13 [a] and [b]), there is no significant association between neonatal death and initial dioxin among full sibling children of Ranch Hands having more than 10 ppt (p=0.350) or more than 5 ppt (p=0.489) current dioxin.

There is insufficient data (Table 10-13 [c] and [d]) to assess the significance of the association between neonatal death and initial dioxin with adjustment for covariates.

Table 10-13

Post-SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 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	Neonatal Deaths Number	Rate	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=508)	Low	106	0	0.0	0.73(0.38,1.40)	0.350
	Medium	245	3	12.2		
	High	157	3	19.1		
b) D>5 ppt (n=690)	Low	155	2	12.9	0.84(0.52,1.36)	0.489
	Medium	308	2	6.5		
	High	227	4	17.6		

Ranch Hands - $\text{Log}_2(\text{Initial Dioxin})$ - Adjusted			
Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=458)	No adjusted analysis, only 6 deaths total		
d) D>5 ppt (n=616)	No adjusted analysis, only 8 deaths total		

Neonatal Death (All Children)

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

There is not sufficient data (Table 10-14) to assess the significance of variation in the association between neonatal death and current dioxin with time since duty in SEA without or with adjustment for covariates.

Table 10-14

Post-SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 Restrictions: All Children of Ranch Hands
 Children Conceived during or after the
 Father's Duty in SEA
 Model 2: $\text{Log}_2(\text{Current Dioxin}), \text{Time}$

Ranch Hands - $\text{Log}_2(\text{Current Dioxin}), \text{Time}$ - Unadjusted						
Exposure Restriction	Time Since SEA (years)	Current Dioxin Death Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=509)	≤18.6	0.0 (0/62)	7.5 (1/134)	0.0 (0/72)	No analysis, only 6 deaths total	
	>18.6	0.0 (0/40)	37.0 (4/108)	10.8 (1/93)		
b) D>5 ppt (n=690)	≤18.6	11.1 (1/90)	0.0 (0/174)	9.1 (1/110)	No analysis, only 8 deaths total	
	>18.6	15.9 (1/63)	7.4 (1/136)	34.2 (4/117)		
Ranch Hands - $\text{Log}_2(\text{Current Dioxin}), \text{Time}$ - 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 analysis, only 6 deaths total				
d) D>5 ppt (n=616)		No adjusted analysis, only 8 deaths total				

Neonatal Death (All Children)

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

Without adjustment for covariates (Table 10-15 [a]), there is a significant overall association between neonatal death and categorized current dioxin ($p=0.045$). The neonatal death rate among children of Ranch Hands in the High category is significantly greater than the rate in children of Comparisons in the Background category ($p=0.005$). The neonatal death rates in children of Ranch Hands in the Low ($p=0.757$) and Unknown ($p=0.191$) categories are not significantly different from the rate in children of Comparisons in the Background category.

There is insufficient data (Table 10-15 [b]) to assess the significance of the association between neonatal death and categorized current dioxin with adjustment for covariates.

Table 10-15

Post-SEA Counts and Rates of Neonatal death

Variable: Neonatal Death
 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	Neonatal Death Number	Death Rate	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	981	4	4.1	All Exp Categ		0.045
Unknown	282	3	10.6	Unk vs Bkgd	2.63(0.62,11.2)	0.191
Low	174	1	5.7	Low vs Bkgd	1.41(0.16,12.7)	0.757
High	227	5	22.0	High vs Bkgd	5.50(1.46,20.7)	0.005
Total	1664					

Table 10-15 (Continued)

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	843	All Exp Categ	No adjusted analysis, only 13		
Unknown	246	Unk vs Bkgd	deaths total		
Low	156	Low vs Bkgd			
High	203	High vs Bkgd			
Total	1448				

Neonatal Death (Full Siblings)

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

Without adjustment for covariates (Table 10-16 [a] and [b]), there is no significant association between neonatal death and initial dioxin among full sibling children of Ranch Hands having more than 10 ppt ($p=0.684$) or more than 5 ppt ($p=0.959$) current dioxin.

There is insufficient data (Table 10-16 [c] and [d]) to assess the significance of the association between neonatal death and initial dioxin with adjustment for covariates among full sibling children of Ranch Hands.

Table 10-16

Post-SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 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	Neonatal Death Number	Neonatal Death Rate	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=420)	Low	78	0	0.0	0.86(0.42,1.77)	0.684
	Medium	206	3	14.6		
	High	136	2	14.7		
b) D>5 ppt (n=557)	Low	114	2	17.5	0.99(0.58,1.67)	0.959
	Medium	245	2	8.2		
	High	198	3	15.2		

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

Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=390)	No adjusted analysis, only 5 deaths total		
d) D>5 ppt (n=513)	No adjusted analysis, only 7 deaths total		

Neonatal Death (Full Siblings)

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

There is insufficient data (Table 10-17) to assess the significance of variation in the association between neonatal deaths and current dioxin with time since duty in SEA without or with adjustment for covariates among full sibling children of Ranch Hands.

Table 10-17

Post-SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 Restrictions: Full Siblings of Ranch Hands
 Children Conceived during or after the
 Father's Duty in SEA
 Model 2: $\text{Log}_2(\text{Current Dioxin}), \text{Time}$

Ranch Hands - $\text{Log}_2(\text{Current Dioxin}), \text{Time}$ - Unadjusted						
Exposure Restriction	Time Since SEA (years)	Current Dioxin Death Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=421)	≤18.6	0.0 (0/47)	8.7 (1/115)	0.0 (0/64)	No analysis, only 5 deaths total	
	>18.6	0.0 (0/28)	43.5 (4/92)	0.0 (0/75)		
b) D>5 ppt (n=557)	≤18.6	16.9 (1/59)	0.0 (0/144)	10.2 (1/98)	No analysis, only 7 deaths total	
	>18.6	18.9 (1/53)	9.4 (1/106)	30.9 (3/97)		
Ranch Hands - $\text{Log}_2(\text{Current Dioxin}), \text{Time}$ - 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 analysis, only 5 deaths total				
d) D>5 ppt (n=513)		No adjusted analysis, only 7 deaths total				

Neonatal Death (Full Siblings)

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

Without adjustment for covariates (Table 10-18 [a]), there is no significant overall association between neonatal death and categorized current dioxin among full siblings ($p=0.161$). The neonatal death rate in children of Ranch Hands in the High category is significantly greater than the rate in the children of Comparisons in the Background category ($p=0.028$). The death rates in children of Ranch Hands in the Low ($p=0.776$) and Unknown ($p=0.165$) categories are not significantly different from the rate in children of Comparisons in the Background category.

There is insufficient data (Table 10-18 [b]) to assess the significance of the association between neonatal death and categorized current dioxin with adjustment for covariates among full sibling children.

Table 10-18

Post-SEA Counts and Rates of Neonatal Death

Variable: Neonatal Death
 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	Neonatal Number	Death Rate	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	812	4	4.9	All Exp Categ		0.161
Unknown	221	3	13.6	Unk vs Bkgd	2.78(0.62,12.5)	0.165
Low	148	1	6.8	Low vs Bkgd	1.37(0.15,12.4)	0.776
High	195	4	20.5	High vs Bkgd	4.23(1.05,17.1)	0.028
Total	1376					

Table 10-18 (Continued)

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	715	All Exp Categ	No adjusted analysis, only 12 deaths total		
Unknown	199	Unk vs Bkgd			
Low	137	Low vs Bkgd			
High	180	High vs Bkgd			
Total	1231				

Infant Death (All Children)

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

Without adjustment for covariates (Table 10-19 [a] and [b]), there is no significant association between infant death and initial dioxin among children of Ranch Hands having more than 10 ppt ($p=0.921$) or more than 5 ppt ($p=0.993$) current dioxin.

There is insufficient data (Table 10-19 [c] and [d]) to assess the significance of the association between infant death and initial dioxin with adjustment for covariates.

Table 10-19

Post-SEA Counts and Rates of Infant Death

Variable: Infant Death
 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	Infant Death Number	Rate	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=502)	Low	106	1	9.4	0.95(0.37,2.46)	0.921
	Medium	242	1	4.1		
	High	154	1	6.5		
b) D>5 ppt (n=682)	Low	153	1	6.5	1.00(0.50,2.02)	0.993
	Medium	306	2	6.5		
	High	223	1	4.5		

Ranch Hands - $\text{Log}_2(\text{Initial Dioxin})$ - Adjusted			
Exposure Restriction	Adj. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
c) D>10 ppt (n=452)	No adjusted analysis, only 3 death total		
d) D>5 ppt (n=609)	No adjusted analysis, only 4 deaths total		

Infant Death (All Children)

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

There is insufficient data (Table 10-20) to assess the significance of variation in the association between infant death and current dioxin with time since duty in SEA without or with adjustment for covariates.

Table 10-20

Post-SEA Counts and Rates of Infant Death

Variable: Infant Death
 Restrictions: All Children of Ranch Hands
 Children Conceived during or after the
 Father's Duty in SEA
 Model 2: Log₂(Current Dioxin), Time

Ranch Hands - Log₂(Current Dioxin), Time - Unadjusted

Exposure Restriction	Time Since SEA (years)	Current Dioxin Death Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=503)	≤18.6	0.0 (0/62)	0.0 (0/133)	0.0 (0/72)	No analysis, only 3 deaths total	
	>18.6	25.0 (1/40)	9.6 (1/104)	10.9 (1/92)		
b) D>5 ppt (n=682)	≤18.6	11.2 (1/89)	0.0 (0/174)	0.0 (0/109)	No analysis, only 4 deaths total	
	>18.6	0.0 (0/62)	14.8 (2/135)	8.8 (1/113)		

Ranch Hands - Log₂(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=452)	No adjusted analysis, only 3 deaths total			
d) D>5 ppt (n=609)	No adjusted analysis, only 4 deaths total			

Infant Death (All Children)

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

There is insufficient data (Table 10-21) to assess the significance of the association between infant death and categorized current dioxin without or with adjustment for covariates.

Table 10-21

Post-SEA Counts and Rates of Infant Death

Variable: Infant Death
 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	Infant Death Number	Rate	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	977	1	1.0	All Exp Categ	No analysis, only 4 deaths total	
Unknown	279	1	3.6	Unk vs Bkgd		
Low	173	1	5.8	Low vs Bkgd		
High	222	1	4.5	High vs Bkgd		
Total	1651					

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background	839	All Exp Categ	No adjusted analysis, only 4 deaths total		
Unknown	244	Unk vs Bkgd			
Low	155	Low vs Bkgd			
High	198	High vs Bkgd			
Total	1436				

Infant Death (Full Siblings)

Model 1: Children of Ranch Hands - Log₂(Initial Dioxin)

There is insufficient data (Table 10-22) to assess the significance of the association between infant death and initial dioxin without or with adjustment for covariates among full sibling children of Ranch Hands.

Table 10-22

Post-SEA Counts and Rates of Infant Death

Variable: Infant Death
 Restrictions: Full Siblings of Ranch Hands
 Children Conceived during or after the
 Father's Duty in SEA
 Model 1: Log₂(Initial Dioxin)

Ranch Hands - Log₂(Initial Dioxin) - Unadjusted						
Exposure Restriction	Initial Dioxin	n	Infant Death Number	Infant Death Rate	Est. Relative Risk (95% C.I.)	p-Value
a) D>10 ppt (n=415)	Low	78	1	12.8	No analysis, only 1 death total	
	Medium	203	0	0.0		
	High	134	0	0.0		
b) D>5 ppt (n=550)	Low	112	1	8.9	No analysis, only 2 deaths total	
	Medium	243	1	4.1		
	High	195	0	0.0		
Ranch Hands - Log₂(Initial Dioxin) - Adjusted						
Exposure Restriction	Adj. Relative Risk (95% C.I.)		p-Value		Covariate Remarks	
c) D>10 ppt (n=385)	No adjusted analysis, only 1 death total					
d) D>5 ppt (n=507)	No adjusted analysis, only 2 deaths total					

Infant death (Full Siblings)

Model 2: Children of Ranch Hands - Log₂(current dioxin) and time

There is insufficient data (Table 10-23) to assess the significance of variation in the association between infant deaths and current dioxin with time since duty in SEA without or with adjustment for covariates among full sibling children of Ranch Hands.

Table 10-23

Post-SEA Counts and Rates of Infant Death

Variable: Infant Death
 Restrictions: Full Siblings of Ranch Hands
 Children Conceived during or after the
 Father's Duty in SEA
 Model 2: Log₂(Current Dioxin), Time

Ranch Hands - Log ₂ (Current Dioxin), Time - Unadjusted						
Exposure Restriction	Time Since SEA (years)	Current Dioxin Death Rate (No./n)			Est. Relative Risk (95% C.I.)	p-Value
		Low	Medium	High		
a) D>10 ppt (n=416)	≤18.6	0.0 (0/47)	0.0 (0/114)	0.0 (0/64)	No analysis, only 1 death total	
	>18.6	35.7 (1/28)	0.0 (0/88)	0.0 (0/75)		
b) D>5 ppt (n=550)	≤18.6	17.2 (1/58)	0.0 (0/144)	0.0 (0/97)	No analysis, only 2 deaths total	
	>18.6	0.0 (0/52)	9.5 (1/105)	0.0 (0/94)		

Table 10-23 (Continued)

Ranch Hands - Log₂(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=386)	No adjusted analysis, only 1 death total			
d) D>5 ppt (n=507)	No adjusted analysis, only 2 deaths total			

Infant Death (Full Siblings)

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

There is insufficient data (Table 10-24) to assess the significance of the association between infant death and categorized current dioxin without or with adjustment for covariates among full sibling children.

Table 10-24

Post-SEA Counts and Rates of Infant Death

Variable: Infant Death
 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	Infant Number	Death Rate	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value
Background	808	1	1.2	All Exp Categ	No analysis, only 2 deaths total	
Unknown	218	1	4.6	Unk vs Bkgd		
Low	147	0	0.0	Low vs Bkgd		
High	191	0	0.0	High vs Bkgd		
Total	1364					

Table 10-24 (Continued)

b) Adjusted

Exposure Category	n	Category Contrast	Est. Relative Risk (95% C.I.)	p-Value	Covariate Remarks
Background Unknown	711	All Exp Categ	No adjusted analysis, only 2 deaths total		
Low	197	Unk vs Bkgd			
High	136	Low vs Bkgd			
	176	High vs Bkgd			
Total	1220				

10.4 Conclusion

Neonatal and infant death were examined for possible associations with dioxin using Models 1, 2 and 3. The first series of analyses were directed at changes in the association between risk of death and dioxin with time of conception relative to the father's duty in SEA. These pre-post SEA analyses are summarized in Tables 10-25 through 10-27.

Table 10-25

P-Value Summary of Initial Dioxin (Model 1) Pre-Post SEA Analyses of Neonatal and Infant Death

Outcome	Sibship Restriction	D>10 ppt	D>5 ppt
Neonatal Death	All Children	NS	NS
	Full Siblings	NS	NS
Infant Death	All Children	NS	NS
	Full Siblings	--	--

Table 10-26

P-Value Summary of Current Dioxin and Time (Model 2) Pre-Post SEA
Analyses of Neonatal and Infant Death

a) All Children			
Outcome	Unadjusted		
	D>10 ppt		D>5 ppt
Neonatal Death	NS		NS
Infant Death	NS		NS
b Full Siblings			
Outcome	Unadjusted		
	D>10 ppt		D>5 ppt
Neonatal Death	NS		NS
Infant Death	--		--

Table 10-27

P-Value Summary of Categorized Dioxin (Model 3) Pre-Post SEA
Analyses of Neonatal and Infant Death

a) All Children				
Outcome	All	Contrasts with Background		
		Unknown	Low	High
Neonatal Death	NS	NS	NS	NS
Infant Death	NS	NS	NS	NS
b) Full Siblings				
Outcome	All	Contrasts with Background		
		Unknown	Low	High
Neonatal Death	NS	NS	NS	NS
Infant Death	--	--	--	--

These data were generally too sparse to carry out all analyses. When the data were sufficient for analysis, no significant variation in the association between neonatal and infant mortality and dioxin was found.

Assessments of the association between neonatal and infant death and dioxin in post-SEA births were also carried out. The results are summarized in Tables 10-28 through 10-30.

Table 10-28

P-Value Summary of Initial Dioxin (Model 1) Post-SEA Analyses of Neonatal and Infant Death

a) Unadjusted			
Outcome	Sibship Restriction	D>10 ppt	D>5 ppt
Neonatal Death	All Children	NS	NS
	Full Siblings	NS	NS
Infant Death	All Children	NS	NS
	Full Siblings	--	--
b) Adjusted			
Outcome	Sibship Restriction	D>10 ppt	D>5 ppt
Neonatal Death	All Children	--	--
	Full Siblings	--	--
Infant Death	All Children	--	--
	Full Siblings	--	--

Table 10-29

P-Value Summary of Current Dioxin and Time (Model 2) Post-SEA Analyses of Neonatal and Infant Death

a) Unadjusted							
Outcome	Sibship Restriction	D>10 ppt			D>5 ppt		
		Dioxin by Time	Time Since SEA (years)		Dioxin by Time	Time Since SEA (years)	
			≤18.6	>18.6		≤18.6	>18.6
Neonatal	All Children	--	--	--	--	--	--
	Full Siblings	--	--	--	--	--	--
Infant	All Children	--	--	--	--	--	--
	Full Siblings	--	--	--	--	--	--

Table 10-29 (Continued)

b) Adjusted

Outcome	Sibship Restriction	Dioxin by Time	D>10 ppt Time Since SEA (years)		Dioxin by Time	D>5 ppt Time Since SEA (years)	
			≤18.6	>18.6		≤18.6	>18.6
Neonatal	All Children	--	--	--	--	--	--
	Full Siblings	--	--	--	--	--	--
Infant	All Children	--	--	--	--	--	--
	Full Siblings	--	--	--	--	--	--

Table 10-30

P-Value Summary of Categorized Current Dioxin (Model 3) Post-SEA
Analyses of Neonatal and Infant Death

a) Unadjusted					
Outcome	Sibship Restriction	All	Contrasts with Background		
			Unknown	Low	High
Neonatal Death	All Children	0.045	NS	NS	0.005
	Full Siblings	NS	NS	NS	0.028
Infant Death	All Children	--	--	--	--
	Full Siblings	--	--	--	--
b) Adjusted					
Outcome	Sibship Restriction	All	Contrasts with Background		
			Unknown	Low	High
Neonatal Death	All Children	--	--	--	--
	Full Siblings	--	--	--	--
Infant Death	All Children	--	--	--	--
	Full Siblings	--	--	--	--

Analyses of post-SEA infant death were either negative or could not be carried out due to insufficient data. Analyses of post-SEA neonatal death found significant associations in two Model 3 analyses. Both of these findings were caused by the rate of post-SEA neonatal death being higher in children of Ranch Hands in the High dioxin category than in children of Comparisons in the Background category. However, the corresponding pre-post

SEA data show that pre-SEA children of Ranch Hands in the High category also had a higher rate than pre-SEA children in the Background category. Therefore, these findings appear due to chance rather than to paternal dioxin exposure.

These analyses were generally negative and the two significant associations found in analyses of neonatal death most likely chance occurrences. We conclude that there is no association between dioxin and infant or neonatal mortality.