

APPENDIX G-1.

Discussion of Vibrotactile Threshold Methodology and Dependent Variable-Covariate Associations for the Neurology Assessment

This appendix contains a description of the methodology used to obtain vibrotactile threshold measurements of the right and left great toes of all participants. This appendix also contains Table G-1-1, which shows results of tests of association between each dependent variable and candidate covariates for the adjusted analysis. Pearson's chi-square test (continuity-adjusted for 2×2 tables) is used for significance testing of the associations between each discrete dependent variable and the candidate covariate. When a candidate covariate is continuous in nature (for example, age), the covariate is discretized prior to the analysis of the discrete dependent variable. Pearson's correlation coefficient is used for significance testing of the associations between the natural logarithm of each continuous dependent variable and a continuous candidate covariate. When a candidate covariate is discrete in nature, means transformed from the natural logarithm scale to the original scale are presented, and an analysis of variance is used to investigate the difference between the means on the natural logarithm scale.

VIBROTACTILE THRESHOLD METHODOLOGY

Vibrotactile threshold measurements were made on the right and left great toes of 2,228 AFHS participants. These observed values were gathered using the Vibratron II, a machine generating measurements in vibrational units (vu). Because vu are only produced by the Vibratron II, vu need to be converted to a standardized unit, such as microns of displacement, to allow comparisons between thresholds generated by this study and thresholds ascertained in other studies. The conversion from vu to microns of displacement is given by

$$\text{microns} = k(\text{vu})^n$$

where k and n are machine-specific. For the Vibratron II machine used in the AFHS, k and n were estimated to be 0.550 and 2.02217 respectively. These constants were evaluated by Dr. Richard Letz of the Division of Environmental and Occupational Health at Emory University School of Public Health, who calibrated the Vibratron II machine used in the AFHS before and after vibrotactile measurements were taken (39). These two calibrations resulted in two estimates of both k and n . Both calibrations were necessary to determine whether or not the machine's measurement standard had shifted over time. The estimates of k and n did not change substantially between the two calibrations, and errors in vibrotactile threshold measurements contributed by the Vibratron II are assumed to be constant across time. The numbers 0.550 and 2.02217 resulted from Dr. Letz's final calibration. The initial calibration estimated k and n to be 0.539 and 2.0856 respectively. The results of a study to determine the relationship between the measurements using the initial estimates of k and n and the final estimates of k and n is described subsequently.

As an additional analytical issue, vibrotactile measurements were gathered at SCRF using the method of limits procedure, which produced seven measurements for each great

toe. In order to obtain one measurement per toe, a trimmed mean was calculated for each set of seven measurements for each toe using the following algorithm:

- Drop the first observation.
- From the remaining six observations, delete the minimum and maximum observations.
- Average the other four measurements to produce one measurement per toe.

Investigation of the trimmed means and observations composing the trimmed means revealed that each of these distributions are highly skewed (positive skewness). To produce symmetric distributions, a log transformation was applied to the data. The vibrotactile measurements analyzed in the AFHS were computed by first transforming the seven vibrotactile measurements for each great toe before calculating the trimmed mean.

To assess the effect of the sequence of operations (transforming and averaging) used to produce a single vibrotactile measurement on the statistical analysis, the trimmed mean on the log(micron) scale and the log of the trimmed mean on the micron scale were computed for each participant's right and left great toes (RTLOG, RLOGT, LTLOG, and LLOGT respectively). Scatterplots of RTLOG versus RLOGT and LTLOG versus LLOGT were produced, and the Pearson correlation coefficients for RTLOG and RLOGT along with LTLOG and LLOGT were calculated. The respective correlation coefficients were 0.99330 and 0.99610, which imply a strong linear relationship between the two methods of transformation. Examination of the scatterplots also confirmed the linear relationship. As a result of the linear association, statistical conclusions would not be affected by the sequence of operations (transforming and averaging) used to produce a vibrotactile measurement for each great toe.

Also, to study the effect of the change in k and n obtained from the two calibrations on vibrotactile measurements, RTLOG and LTLOG were computed using values of k and n obtained from the initial and final calibrations (RTLOGI, LTLOGI, RTLOGF, and LTLOGF respectively). Scatterplots of RTLOGI versus RTLOGF and LTLOGI versus LTLOGF were examined along with the Pearson correlation coefficients associated with the two plots. The scatterplots and correlation coefficients indicated a strong linear relationship between vibrotactile measurements computed with values of k and n from the initial calibration and vibrotactile measurements based on values of k and n from the final calibration. RTLOGI and RTLOGF had a correlation coefficient of 0.99996, while LTLOGI and LTLOGF had a correlation coefficient of 0.99997. Therefore, choosing values for k and n from the initial or final calibration would not affect statistical conclusions.

The trimmed mean on the log(micron) scale is equivalent to a geometric trimmed mean on the micron scale. Statistical analysis on the log(micron) scale is consistent with two other studies that investigated vibrotactile thresholds. One study examined reliability and time efficiency for obtaining vibrotactile measurements, while the other study determined the magnitude of effect modifiers on vibrotactile thresholds (38).

Table G-1-1.
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Age			Race			
		Born ≥1942	Born <1942	p-Value	Black	Non-Black	p-Value	
Medical Records:								
Historical Neurological Disorders								
Inflammatory Diseases	Yes	(n=946) 0.4%	(n=1,272) 0.3%	0.950	(n=130) 0.0%	(n=2,088) 0.4%	0.999	
Hereditary and Degenerative Diseases	Yes	(n=951) 4.6%	(n=1,276) 5.9%	0.229	(n=130) 6.2%	(n=2,097) 5.3%	0.824	
Peripheral Disorders	Yes	(n=950) 12.2%	(n=1,272) 19.4%	<0.001	(n=130) 11.5%	(n=2,092) 16.6%	0.161	
Other Neurological Disorders	Yes	(n=946) 14.6%	(n=1,272) 24.1%	<0.001	(n=129) 33.3%	(n=2,089) 19.2%	<0.001	
Physical Examination:								
Cranial Nerve Function								
Smell	Abnormal	(n=951) 0.8%	(n=1,277) 1.8%	0.084	(n=130) 1.5%	(n=2,098) 1.4%	0.999	
Visual Fields	Abnormal	(n=949) 0.1%	(n=1,273) 0.2%	0.833	(n=130) 0.0%	(n=2,092) 0.2%	0.999	
Light Reaction	Abnormal	(n=950) 0.3%	(n=1,275) 0.4%	0.999	(n=130) 0.0%	(n=2,095) 0.4%	0.999	
Ocular Movement	Abnormal	(n=950) 0.4%	(n=1,275) 0.7%	0.555	(n=130) 0.0%	(n=2,095) 0.6%	0.758	
Facial Sensation	Abnormal	(n=951) 0.1%	(n=1,277) 0.2%	0.834	(n=130) 0.0%	(n=2,098) 0.2%	0.999	
Jaw Clench	Deviated	(n=951) 0.0%	(n=1,277) 0.1%	0.999	(n=130) 0.0%	(n=2,098) 0.0%	0.999	
Smile	Abnormal	(n=951) 0.5%	(n=1,277) 0.9%	0.387	(n=130) 0.0%	(n=2,098) 0.8%	0.609	
Palpebral Fissure	Abnormal	(n=951) 0.9%	(n=1,277) 0.9%	0.999	(n=130) 0.8%	(n=2,098) 1.0%	0.999	
Balance	Abnormal	(n=951) 0.0%	(n=1,275) 0.9%	0.010	(n=130) 0.0%	(n=2,096) 0.5%	0.854	
Gag Reflex	Abnormal	(n=951) 0.0%	(n=1,277) 0.1%	0.999	(n=130) 0.0%	(n=2,098) 0.0%	0.999	
Speech	Abnormal	(n=951) 0.1%	(n=1,277) 0.5%	0.170	(n=130) 0.8%	(n=2,098) 0.3%	0.960	
Palate and Uvula Movement	Deviated	(n=951) 0.0%	(n=1,277) 0.1%	0.999	(n=130) 0.0%	(n=2,098) 0.0%	0.999	
Neck Range of Motion	Abnormal	(n=950) 5.7%	(n=1,277) 20.4%	<0.001	(n=130) 6.2%	(n=2,097) 14.6%	0.011	
Cranial Nerve Index without Range of Motion	Abnormal	(n=950) 2.4%	(n=1,271) 5.1%	0.002	(n=130) 2.3%	(n=2,091) 4.1%	0.444	

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Occupation			p-Value		
		Officer	Enlisted Flyer	Enlisted Groundcrew			
Medical Records:							
Historical Neurological Disorders							
Inflammatory Disease	Abnormal	(n=864) 0.3%	(n=362) 0.6%	(n=992) 0.3%	0.791		
Hereditary and Degenerative Diseases	Abnormal	(n=867) 4.7%	(n=365) 6.6%	(n=995) 5.4%	0.416		
Peripheral Disorders	Abnormal	(n=865) 16.8%	(n=363) 17.6%	(n=994) 15.5%	0.583		
Other Neurological Disorders	Abnormal	(n=865) 8.3%	(n=364) 30.5%	(n=989) 26.4%	<0.001		
Physical Examination:							
Cranial Nerve Function							
Smell	Abnormal	(n=868) 1.5%	(n=365) 1.6%	(n=995) 1.2%	0.783		
Visual Fields	Abnormal	(n=867) 0.2%	(n=365) 0.0%	(n=990) 0.2%	0.667		
Light Reaction	Abnormal	(n=868) 0.3%	(n=365) 0.3%	(n=992) 0.4%	0.936		
Ocular Movement	Abnormal	(n=868) 0.8%	(n=365) 0.3%	(n=992) 0.5%	0.484		
Facial Sensation	Abnormal	(n=868) 0.0%	(n=365) 0.3%	(n=995) 0.3%	0.277		
Jaw Clench	Deviated	(n=868) 0.0%	(n=365) 0.0%	(n=995) 0.1%	0.538		
Smile	Abnormal	(n=868) 1.2%	(n=365) 0.3%	(n=995) 0.6%	0.199		
Palpebral Fissure	Abnormal	(n=868) 1.0%	(n=365) 0.8%	(n=995) 0.9%	0.925		
Balance	Abnormal	(n=866) 0.5%	(n=365) 0.8%	(n=995) 0.4%	0.610		
Gag Reflex	Abnormal	(n=868) 0.0%	(n=365) 0.0%	(n=995) 0.1%	0.538		
Speech	Abnormal	(n=868) 0.2%	(n=365) 0.3%	(n=995) 0.5%	0.592		
Palate and Uvula Movement	Deviated	(n=868) 0.0%	(n=365) 0.0%	(n=995) 0.1%	0.538		
Neck Range of Motion	Abnormal	(n=865) 16.8%	(n=365) 17.6%	(n=994) 10.4%	<0.001		
Cranial Nerve Index without Range of Motion	Abnormal	(n=865) 4.2%	(n=365) 3.8%	(n=991) 3.8%	0.928		

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Current Alcohol Use			p-Value		
		0-1 Drinks/Day	1-4 Drinks/Day	>4 Drinks/Day			
Medical Records:							
Historical Neurological Disorders							
Inflammatory Disease		--	--	--	--		
Hereditary and Degenerative Diseases		--	--	--	--		
Peripheral Disorders		--	--	--	--		
Other Neurological Disorders		--	--	--	--		
Physical Examination:							
Cranial Nerve Function							
Smell	Abnormal	(n=1,741) 1.5%	(n=400) 0.8%	(n=59) 1.7%	0.500		
Visual Fields	Abnormal	(n=1,737) 0.2%	(n=398) 0.0%	(n=59) 0.0%	0.590		
Light Reaction	Abnormal	(n=1,739) 0.4%	(n=399) 0.3%	(n=59) 0.0%	0.807		
Ocular Movement	Abnormal	(n=1,739) 0.5%	(n=399) 1.0%	(n=59) 0.0%	0.436		
Facial Sensation	Abnormal	(n=1,741) 0.2%	(n=400) 0.0%	(n=59) 0.0%	0.590		
Jaw Clench	Deviated	(n=1,741) 0.1%	(n=400) 0.0%	(n=59) 0.0%	0.876		
Smile	Abnormal	(n=1,741) 0.9%	(n=400) 0.5%	(n=59) 0.0%	0.598		
Palpebral Fissure	Abnormal	(n=1,741) 1.1%	(n=400) 0.5%	(n=59) 0.0%	0.409		
Balance	Abnormal	(n=1,739) 0.5%	(n=400) 0.8%	(n=59) 0.0%	0.652		
Gag Reflex	Abnormal	(n=1,741) 0.1%	(n=400) 0.0%	(n=59) 0.0%	0.876		
Speech	Abnormal	(n=1,741) 0.5%	(n=400) 0.0%	(n=59) 0.0%	0.347		
Palate and Uvula Movement	Deviated	(n=1,741) 0.1%	(n=400) 0.0%	(n=59) 0.0%	0.876		
Neck Range of Motion	Abnormal	(n=1,740) 13.3%	(n=400) 17.0%	(n=59) 13.6%	0.152		
Cranial Nerve Index without Range of Motion	Abnormal	(n=1,736) 4.3%	(n=398) 2.8%	(n=59) 1.7%	0.237		

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Lifetime Alcohol History			p-Value		
		0 Drink-years	0-40 Drink-years	>40 Drink-years			
Medical Records:							
Historical Neurological Disorders							
Inflammatory Disease	Yes	(n=132) 0.0%	(n=1,482) 0.4%	(n=562) 0.4%	0.761		
Hereditary and Degenerative Diseases	Yes	(n=134) 6.0%	(n=1,486) 4.5%	(n=564) 7.1%	0.060		
Peripheral Disorders	Yes	(n=134) 19.4%	(n=1,482) 15.4%	(n=563) 18.1%	0.201		
Other Neurological Disorders	Yes	(n=133) 21.1%	(n=1,481) 19.1%	(n=562) 20.6%	0.674		
Physical Examination:							
Cranial Nerve Function							
Smell	Abnormal	(n=134) 3.0%	(n=1,487) 1.2%	(n=564) 1.4%	0.238		
Visual Fields	Abnormal	(n=134) 0.7%	(n=1,483) 0.1%	(n=562) 0.2%	0.285		
Light Reaction	Abnormal	(n=134) 0.7%	(n=1,485) 0.3%	(n=563) 0.5%	0.512		
Ocular Movement	Abnormal	(n=134) 0.0%	(n=1,485) 0.7%	(n=563) 0.5%	0.609		
Facial Sensation	Abnormal	(n=134) 0.7%	(n=1,487) 0.1%	(n=564) 0.4%	0.115		
Jaw Clench	Deviated	(n=134) 0.0%	(n=1,487) 0.0%	(n=564) 0.2%	0.237		
Smile	Abnormal	(n=134) 1.5%	(n=1,487) 0.7%	(n=564) 0.7%	0.622		
Palpebral Fissure	Abnormal	(n=134) 2.2%	(n=1,487) 0.9%	(n=564) 0.9%	0.294		
Balance	Abnormal	(n=134) 0.7%	(n=1,485) 0.5%	(n=564) 0.4%	0.801		
Gag Reflex	Abnormal	(n=134) 0.0%	(n=1,487) 0.0%	(n=564) 0.2%	0.237		
Speech	Abnormal	(n=134) 0.0%	(n=1,487) 0.4%	(n=564) 0.4%	0.759		
Palate and Uvula Movement	Deviated	(n=134) 0.0%	(n=1,487) 0.0%	(n=564) 0.2%	0.237		
Neck Range of Motion	Abnormal	(n=134) 12.7%	(n=1,486) 12.9%	(n=564) 17.0%	0.047		
Cranial Nerve Index without Range of Motion	Abnormal	(n=134) 9.0%	(n=1,482) 3.6%	(n=562) 3.7%	0.010		

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Insecticide Exposure			Industrial Chemical Exposure			
		No	Yes	p-Value	No	Yes	p-Value	
Medical Records:								
Historical Neurological Disorders								
Inflammatory Diseases	Yes	(n=700) 0.6%	(n=1,518) 0.3%	0.457	(n=916) 0.2%	(n=1,302) 0.5%	0.563	
Hereditary and Degenerative Diseases	Yes	(n=702) 6.0%	(n=1,525) 5.0%	0.419	(n=919) 5.5%	(n=1,308) 5.2%	0.790	
Peripheral Disorders	Yes	(n=702) 12.5%	(n=1,520) 18.1%	0.001	(n=918) 15.3%	(n=1,304) 17.1%	0.270	
Other Neurological Disorders	Yes	(n=700) 18.7%	(n=1,518) 20.6%	0.325	(n=918) 16.7%	(n=1,300) 22.4%	0.001	
Physical Examination:								
Cranial Nerve Function								
Smell	Abnormal	(n=702) 1.0%	(n=1,526) 1.6%	0.377	(n=920) 1.6%	(n=1,308) 1.2%	0.532	
Visual Fields	Abnormal	(n=701) 0.1%	(n=1,521) 0.2%	0.999	(n=917) 0.2%	(n=1,305) 0.2%	0.999	
Light Reaction	Abnormal	(n=702) 0.1%	(n=1,523) 0.5%	0.435	(n=919) 0.3%	(n=1,306) 0.4%	0.999	
Ocular Movement	Abnormal	(n=702) 0.3%	(n=1,523) 0.7%	0.338	(n=919) 0.8%	(n=1,306) 0.5%	0.523	
Facial Sensation	Abnormal	(n=702) 0.1%	(n=1,526) 0.2%	0.999	(n=920) 0.2%	(n=1,308) 0.2%	0.999	
Jaw Clench	Deviated	(n=702) 0.1%	(n=1,526) 0.0%	0.691	(n=920) 0.1%	(n=1,308) 0.0%	0.860	
Smile	Abnormal	(n=702) 0.7%	(n=1,526) 0.8%	0.999	(n=920) 1.1%	(n=1,308) 0.5%	0.220	
Palpebral Fissure	Abnormal	(n=702) 1.0%	(n=1,526) 0.9%	0.999	(n=920) 1.2%	(n=1,308) 0.8%	0.415	
Balance	Abnormal	(n=702) 0.3%	(n=1,524) 0.6%	0.528	(n=918) 0.5%	(n=1,308) 0.5%	0.999	
Gag Reflex	Abnormal	(n=702) 0.1%	(n=1,526) 0.0%	0.691	(n=920) 0.1%	(n=1,308) 0.0%	0.860	
Speech	Abnormal	(n=702) 0.4%	(n=1,526) 0.3%	0.999	(n=920) 0.7%	(n=1,308) 0.2%	0.114	
Palate and Uvula Movement	Deviated	(n=702) 0.1%	(n=1,526) 0.0%	0.691	(n=920) 0.1%	(n=1,308) 0.0%	0.860	
Neck Range of Motion	Abnormal	(n=702) 13.2%	(n=1,525) 14.5%	0.473	(n=919) 15.9%	(n=1,308) 12.8%	0.049	
Cranial Nerve Index without Range of Motion	Abnormal	(n=702) 2.6%	(n=1,519) 4.6%	0.029	(n=916) 4.9%	(n=1,305) 3.3%	0.070	

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Decreasing Chemical Exposure			Diabetic Class			p-Value		
		No	Yes	p-Value	Normal	Impaired	Diabetic			
Medical Records:										
Historical Neurological Disorders										
Inflammatory Diseases	Yes	(n=821) 0.1%	(n=1,397) 0.5%	0.284	(n=1,640) 0.4%	(n=250) 0.4%	(n=325) 0.3%	0.982		
Hereditary and Degenerative Diseases	Yes	(n=823) 6.2%	(n=1,404) 4.8%	0.203	(n=1,647) 4.9%	(n=251) 7.2%	(n=326) 6.4%	0.202		
Peripheral Disorders	Yes	(n=823) 14.2%	(n=1,399) 17.6%	0.044	(n=1,644) 14.3%	(n=251) 17.9%	(n=324) 25.6%	<0.001		
Other Neurological Disorders	Yes	(n=819) 16.7%	(n=1,399) 21.9%	0.004	(n=1,640) 18.1%	(n=249) 24.1%	(n=326) 26.4%	0.001		
Physical Examination:										
Cranial Nerve Function										
Smell	Abnormal	(n=823) 1.5%	(n=1,405) 1.4%	0.985	(n=1,648) 1.2%	(n=251) 1.2%	(n=326) 2.5%	0.209		
Visual Fields	Abnormal	(n=821) 0.4%	(n=1,401) 0.1%	0.289	(n=1,645) 0.2%	(n=251) 0.0%	(n=323) 0.3%	0.686		
Light Reaction	Abnormal	(n=823) 0.4%	(n=1,402) 0.4%	0.999	(n=1,647) 0.3%	(n=251) 0.0%	(n=324) 0.9%	0.139		
Ocular Movement	Abnormal	(n=823) 0.6%	(n=1,405) 0.6%	0.999	(n=1,647) 0.5%	(n=251) 1.2%	(n=324) 0.6%	0.388		
Facial Sensation	Abnormal	(n=823) 0.1%	(n=1,405) 0.2%	0.999	(n=1,648) 0.1%	(n=251) 0.4%	(n=326) 0.3%	0.529		
Jaw Clench	Deviated	(n=823) 0.0%	(n=1,405) 0.1%	0.999	(n=1,648) 0.0%	(n=251) 0.4%	(n=326) 0.0%	0.020		
Smile	Abnormal	(n=823) 0.6%	(n=1,405) 0.9%	0.694	(n=1,648) 0.7%	(n=251) 0.4%	(n=326) 1.5%	0.203		
Palpebral Fissure	Abnormal	(n=823) 1.0%	(n=1,405) 0.9%	0.999	(n=1,648) 0.8%	(n=251) 0.8%	(n=326) 1.5%	0.490		
Balance	Abnormal	(n=822) 0.5%	(n=1,404) 0.5%	0.999	(n=1,647) 0.2%	(n=251) 0.4%	(n=325) 2.2%	<0.001		
Gag Reflex	Abnormal	(n=823) 0.0%	(n=1,405) 0.1%	0.999	(n=1,648) 0.0%	(n=251) 0.4%	(n=326) 0.0%	0.020		
Speech	Abnormal	(n=823) 0.5%	(n=1,405) 0.3%	0.689	(n=1,648) 0.3%	(n=251) 0.8%	(n=326) 0.3%	0.470		
Palate and Uvula Movement	Deviated	(n=823) 0.0%	(n=1,405) 0.1%	0.999	(n=1,648) 0.0%	(n=251) 0.4%	(n=326) 0.0%	0.020		
Neck Range of Motion	Abnormal	(n=823) 14.8%	(n=1,404) 13.7%	0.491	(n=1,647) 13.4%	(n=251) 15.1%	(n=326) 16.6%	0.287		
Cranial Nerve Index without Range of Motion	Abnormal	(n=820) 3.9%	(n=1,401) 4.0%	0.999	(n=1,645) 3.5%	(n=251) 2.8%	(n=322) 7.5%	0.002		

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Serum Insulin			
		No.	Abnormal	p-Value	
Medical Records:					
Historical Neurological Disorders					
Inflammatory Disease	--	--	--	--	
Hereditary and Degenerative Diseases	--	--	--	--	
Peripheral Disorders	--	--	--	--	
Other Neurological Disorders	--	--	--	--	
Physical Examination:					
Cranial Nerve Function					
Smell	Abnormal	(n=983) 1.5%	(n=1,243) 1.3%	0.768	
Visual Fields	Abnormal	(n=979) 0.3%	(n=1,241) 0.1%	0.458	
Light Reaction	Abnormal	(n=981) 0.4%	(n=1,242) 0.3%	0.999	
Ocular Movement	Abnormal	(n=981) 0.4%	(n=1,242) 0.7%	0.488	
Facial Sensation	Abnormal	(n=983) 0.0%	(n=1,243) 0.3%	0.202	
Jaw Clench	Deviated	(n=983) 0.0%	(n=1,243) 0.1%	0.999	
Smile	Abnormal	(n=983) 0.9%	(n=1,243) 0.6%	0.626	
Palpebral Fissure	Abnormal	(n=983) 1.2%	(n=1,243) 0.7%	0.326	
Balance	Abnormal	(n=983) 0.6%	(n=1,241) 0.4%	0.698	
Gag Reflex	Abnormal	(n=983) 0.0%	(n=1,243) 0.1%	0.999	
Speech	Abnormal	(n=983) 0.2%	(n=1,243) 0.5%	0.461	
Palate and Uvula Movement	Deviated	(n=983) 0.0%	(n=1,243) 0.1%	0.999	
Neck Range of Motion	Abnormal	(n=983) 13.3%	(n=1,242) 14.7%	0.376	
Cranial Nerve Index without Range of Motion	Abnormal	(n=979) 3.9%	(n=1,240) 4.0%	0.943	

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Age			Race			
		Born ≥1942	Born <1942	p-Value	Black	Non-Black	p-Value	
Physical Examination: Peripheral Nerve Function								
Pin Prick		(n=936)	(n=1,189)		(n=126)	(n=1,999)		
	Abnormal	4.0%	6.6%	0.009	3.2%	5.6%	0.336	
Light Touch		(n=936)	(n=1,189)		(n=126)	(n=1,999)		
	Abnormal	3.0%	5.5%	0.008	2.4%	4.5%	0.366	
Muscle Status		(n=950)	(n=1,276)		(n=130)	(n=2,096)		
	Abnormal	1.8%	3.8%	0.009	0.0%	3.1%	0.077	
Patellar Reflex		(n=948)	(n=1,274)		(n=129)	(n=2,093)		
	Abnormal	0.4%	3.2%	<0.001	1.6%	2.1%	0.942	
Achilles Reflex		(n=944)	(n=1,270)		(n=129)	(n=2,085)		
	Abnormal	4.4%	13.1%	<0.001	10.1%	9.4%	0.920	
Biceps Reflex		(n=951)	(n=1,277)		(n=130)	(n=2,098)		
	Abnormal	0.4%	1.3%	0.048	0.8%	1.0%	0.999	
Babinski Reflex		(n=951)	(n=1,275)		(n=130)	(n=2,096)		
	Abnormal	0.4%	0.5%	0.903	0.8%	0.5%	0.999	
Vibrotactile Threshold								
Measurement of Right Great Toe (microns) ^a		(n=2,223)			(n=129)	(n=2,094)		
		r=0.385		<0.001	$\bar{x}=14.74$	$\bar{x}=16.75$	0.221	
Vibrotactile Threshold Measurement of Left Great Toe (microns) ^a		(n=2,283)			(n=129)	(n=2,094)		
		r=0.420		<0.001	$\bar{x}=13.23$	$\bar{x}=16.96$	0.019	
Physical Examination: CNS Coordination Processes								
Tremor		(n=951)	(n=1,277)		(n=130)	(n=2,098)		
	Abnormal	2.4%	3.1%	0.440	1.5%	2.9%	0.539	
Coordination		(n=950)	(n=1,275)		(n=130)	(n=2,095)		
	Abnormal	0.8%	3.0%	0.001	1.5%	2.1%	0.905	
Romberg Sign		(n=951)	(n=1,275)		(n=130)	(n=2,096)		
	Abnormal	0.0%	0.9%	0.010	0.0%	0.5%	0.854	
Gait		(n=951)	(n=1,276)		(n=130)	(n=2,097)		
	Abnormal	2.3%	4.0%	0.037	2.3%	3.3%	0.699	
Central Nervous System Index		(n=950)	(n=1,276)		(n=130)	(n=2,096)		
	Abnormal	4.5%	7.0%	0.020	2.3%	6.2%	0.107	

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Note: Correlations (r) are based on total sample size and are not category specific.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Occupation			p-Value
		Officer	Enlisted Flyer	Enlisted Groundcrew	
Physical Examination: Peripheral Nerve Function					
Pin Prick	Abnormal	(n=821) 5.5%	(n=351) 7.1%	(n=953) 4.8%	0.270
Light Touch	Abnormal	(n=821) 4.4%	(n=351) 4.3%	(n=953) 4.4%	0.994
Muscle Status	Abnormal	(n=868) 2.6%	(n=363) 4.1%	(n=995) 2.7%	0.324
Patellar Reflex	Abnormal	(n=865) 2.2%	(n=363) 2.2%	(n=994) 1.8%	0.812
Achilles Reflex	Abnormal	(n=864) 10.5%	(n=361) 10.2%	(n=989) 8.2%	0.193
Biceps Reflex	Abnormal	(n=868) 1.3%	(n=365) 0.5%	(n=995) 0.8%	0.408
Babinski Reflex	Abnormal	(n=867) 0.3%	(n=364) 0.5%	(n=995) 0.6%	0.723
Vibrotactile Threshold Measurement of Right Great Toe (microns) ^a		(n=865) $\bar{x}=17.81$	(n=365) $\bar{x}=19.68$	(n=993) $\bar{x}=14.72$	<0.001
Vibrotactile Threshold Measurement of Left Great Toe (microns) ^a		(n=866) $\bar{x}=18.03$	(n=364) $\bar{x}=20.19$	(n=993) $\bar{x}=14.61$	<0.001
Physical Examination: CNS Coordination Processes					
Tremor	Abnormal	(n=868) 3.2%	(n=365) 2.2%	(n=995) 2.6%	0.547
Coordination	Abnormal	(n=867) 2.2%	(n=363) 1.9%	(n=995) 2.0%	0.943
Romberg Sign	Abnormal	(n=866) 0.5%	(n=365) 0.8%	(n=995) 0.4%	0.610
Gait	Abnormal	(n=867) 2.9%	(n=365) 4.1%	(n=995) 3.3%	0.542
Central Nervous System Index	Abnormal	(n=867) 5.7%	(n=364) 6.6%	(n=995) 5.9%	0.816

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Current Alcohol Use			p-Value
		0-1 Drinks/Day	1-4 Drinks/Day	> 4 Drinks/Day	
Physical Examination: Peripheral Nerve Function					
Pin Prick	Abnormal	(n=1,656) 5.4%	(n=389) 5.9%	(n=56) 5.4%	0.915
Light Touch	Abnormal	(n=1,656) 4.0%	(n=389) 5.9%	(n=56) 5.4%	0.232
Muscle Status	Abnormal	(n=1,739) 3.1%	(n=400) 2.0%	(n=59) 5.1%	0.310
Patellar Reflex	Abnormal	(n=1,736) 1.7%	(n=399) 3.0%	(n=59) 1.7%	0.248
Achilles Reflex	Abnormal	(n=1,727) 9.3%	(n=400) 8.8%	(n=59) 15.3%	0.274
Biceps Reflex	Abnormal	(n=1,741) 0.9%	(n=400) 1.3%	(n=59) 1.7%	0.647
Babinski Reflex	Abnormal	(n=1,739) 0.6%	(n=400) 0.2%	(n=59) 0.0%	0.608
Vibrotactile Threshold Measurement of Right Great Toe (microns) ^a			(n=2,196) r=0.040		0.062
Vibrotactile Threshold Measurement of Left Great Toe (microns) ^a			(n=2,196) r=0.051		0.017
Physical Examination: CNS Coordination Processes					
Tremor	Abnormal	(n=1,741) 2.5%	(n=400) 3.5%	(n=59) 5.1%	0.276
Coordination	Abnormal	(n=1,738) 2.0%	(n=400) 2.5%	(n=59) 0.0%	0.438
Romberg Sign	Abnormal	(n=1,739) 0.5%	(n=400) 0.8%	(n=59) 0.0%	0.652
Gait	Abnormal	(n=1,740) 3.2%	(n=400) 3.7%	(n=59) 3.4%	0.836
Central Nervous System Index	Abnormal	(n=1,739) 5.5%	(n=400) 7.0%	(n=59) 8.5%	0.362

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Note: Correlations (r) are based on total sample size and are not category specific.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Lifetime Alcohol History			p-Value
		0 Drink-years	0-40 Drink-years	>40 Drink-years	
Physical Examination: Peripheral Nerve Function					
Pin Prick	Abnormal	(n=128) 6.2%	(n=1,422) 5.0%	(n=538) 6.7%	0.315
Light Touch	Abnormal	(n=128) 3.9%	(n=1,422) 4.1%	(n=538) 5.2%	0.573
Muscle Status	Abnormal	(n=134) 0.7%	(n=1,485) 3.0%	(n=564) 3.4%	0.269
Patellar Reflex	Abnormal	(n=134) 3.0%	(n=1,482) 1.5%	(n=563) 3.0%	0.057
Achilles Reflex	Abnormal	(n=133) 11.3%	(n=1,475) 8.6%	(n=563) 10.8%	0.223
Biceps Reflex	Abnormal	(n=134) 0.7%	(n=1,487) 0.9%	(n=564) 1.2%	0.723
Babinski Reflex	Abnormal	(n=134) 0.0%	(n=1,485) 0.5%	(n=564) 0.5%	0.696
Vibrotactile Threshold Measurement of Right Great Toe (microns) ^a			(n=2,181) r=0.073		<0.001
Vibrotactile Threshold Measurement of Left Great Toe (microns) ^a			(n=2,181) r=0.089		<0.001
Physical Examination: CNS Coordination Processes					
Tremor	Abnormal	(n=134) 1.5%	(n=1,487) 2.2%	(n=564) 4.4%	0.015
Coordination	Abnormal	(n=134) 0.7%	(n=1,484) 2.1%	(n=564) 2.3%	0.517
Romberg Sign	Abnormal	(n=134) 0.7%	(n=1,485) 0.5%	(n=564) 0.4%	0.801
Gait	Abnormal	(n=134) 3.7%	(n=1,486) 2.8%	(n=564) 4.4%	0.183
Central Nervous System Index	Abnormal	(n=134) 4.5%	(n=1,485) 5.2%	(n=564) 8.2%	0.030

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Note: Correlations (r) are based on total sample size and are not category specific.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Insecticide Exposure			Industrial Chemical Exposure			
		No	Yes	p-Value	No	Yes	p-Value	
Physical Examination:								
Peripheral Nerve Function								
Pin Prick	Abnormal	(n=676) 5.0%	(n=1,449) 5.7%	0.622	(n=877) 5.1%	(n=1,248) 5.7%	0.645	
Light Touch	Abnormal	(n=676) 4.4%	(n=1,449) 4.3%	0.999	(n=877) 3.8%	(n=1,248) 4.8%	0.293	
Muscle Status	Abnormal	(n=701) 2.3%	(n=1,525) 3.2%	0.282	(n=920) 3.2%	(n=1,306) 2.8%	0.676	
Patellar Reflex	Abnormal	(n=701) 2.1%	(n=1,521) 2.0%	0.922	(n=919) 2.6%	(n=1,303) 1.6%	0.135	
Achilles Reflex	Abnormal	(n=699) 8.6%	(n=1,515) 9.8%	0.391	(n=918) 10.0%	(n=1,296) 9.0%	0.475	
Biceps Reflex	Abnormal	(n=702) 1.1%	(n=1,526) 0.9%	0.677	(n=920) 1.4%	(n=1,308) 0.6%	0.088	
Babinski Reflex	Abnormal	(n=701) 0.9%	(n=1,525) 0.3%	0.185	(n=920) 0.3%	(n=1,306) 0.6%	0.521	
Vibrotactile Threshold Measurement of Right Great Toe (microns) ^a		(n=701) $\bar{x}=16.25$	(n=1,522) $\bar{x}=16.81$	0.519	(n=917) $\bar{x}=17.63$	(n=1,306) $\bar{x}=15.96$	0.046	
Vibrotactile Threshold Measurement of Left Great Toe (microns) ^a		(n=700) $\bar{x}=15.77$	(n=1,523) $\bar{x}=17.18$	0.109	(n=917) $\bar{x}=17.18$	(n=1,306) $\bar{x}=16.41$	0.362	
Physical Examination: CNS Coordination Processes								
Tremor	Abnormal	(n=702) 3.3%	(n=1,526) 2.6%	0.411	(n=920) 3.4%	(n=1,308) 2.4%	0.200	
Coordination	Abnormal	(n=701) 2.0%	(n=1,524) 2.1%	0.999	(n=919) 2.5%	(n=1,306) 1.8%	0.290	
Romberg Sign	Abnormal	(n=702) 0.3%	(n=1,524) 0.6%	0.528	(n=918) 0.5%	(n=1,308) 0.5%	0.999	
Gait	Abnormal	(n=702) 3.7%	(n=1,525) 3.1%	0.524	(n=919) 3.4%	(n=1,308) 3.2%	0.928	
Central Nervous System Index	Abnormal	(n=702) 6.7%	(n=1,524) 5.6%	0.347	(n=919) 6.5%	(n=1,307) 5.5%	0.362	

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Decreasing Chemical Exposure			Diabetic Class			p-Value		
		No	Yes	p-Value	Normal	Impaired	Diabetic			
Physical Examination:										
Peripheral Nerve Function										
Pin Prick	Abnormal	(n=787) 4.7%	(n=1,338) 5.9%	0.280	(n=1,603) 4.3%	(n=234) 6.8%	(n=286) 10.8%	<0.001		
Light Touch	Abnormal	(n=787) 3.4%	(n=1,338) 4.9%	0.127	(n=1,603) 4.3%	(n=234) 6.8%	(n=286) 10.8%	0.001		
Muscle Status	Abnormal	(n=822) 3.0%	(n=1,404) 2.8%	0.897	(n=1,648) 2.6%	(n=250) 3.2%	(n=325) 4.0%	0.371		
Patellar Reflex	Abnormal	(n=821) 2.3%	(n=1,401) 1.9%	0.559	(n=1,643) 1.4%	(n=250) 0.8%	(n=326) 6.1%	<0.001		
Achilles Reflex	Abnormal	(n=820) 10.6%	(n=1,394) 8.8%	0.171	(n=1,636) 7.0%	(n=250) 10.4%	(n=325) 20.9%	<0.001		
Biceps Reflex	Abnormal	(n=823) 1.1%	(n=1,405) 0.9%	0.736	(n=1,648) 0.7%	(n=251) 0.8%	(n=326) 2.5%	0.009		
Babinski Reflex	Abnormal	(n=822) 0.6%	(n=1,404) 0.4%	0.784	(n=1,647) 0.4%	(n=250) 0.4%	(n=326) 0.6%	0.891		
Vibrotactile Threshold										
Measurement of Right Great Toe (microns) ^a		(n=820) $\bar{x}=17.34$	(n=1,403) $\bar{x}=16.23$	0.189	(n=1,646) $\bar{x}=15.51$	(n=251) $\bar{x}=17.26$	(n=323) $\bar{x}=22.84$	<0.001		
Vibrotactile Threshold										
Measurement of Left Great Toe (microns) ^a		(n=821) $\bar{x}=17.32$	(n=1,402) $\bar{x}=16.38$	0.278	(n=1,647) $\bar{x}=15.35$	(n=250) $\bar{x}=19.20$	(n=323) $\bar{x}=23.08$	<0.001		
Physical Examination: CNS Coordination Processes										
Tremor	Abnormal	(n=823) 2.7%	(n=1,405) 2.8%	0.915	(n=1,648) 2.7%	(n=251) 2.8%	(n=326) 3.1%	0.921		
Coordination	Abnormal	(n=821) 2.1%	(n=1,404) 2.1%	0.999	(n=1,648) 1.7%	(n=250) 2.4%	(n=324) 3.4%	0.127		
Romberg Sign	Abnormal	(n=822) 0.5%	(n=1,404) 0.5%	0.999	(n=1,647) 0.2%	(n=251) 0.4%	(n=325) 2.2%	<0.001		
Gait	Abnormal	(n=823) 3.2%	(n=1,404) 3.3%	0.906	(n=1,647) 2.8%	(n=251) 4.8%	(n=326) 4.3%	0.128		
Central Nervous System Index	Abnormal	(n=821) 5.7%	(n=1,405) 6.0%	0.826	(n=1,648) 5.2%	(n=251) 7.6%	(n=324) 8.0%	0.071		

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

Dependent Variable	Level	Serum Insulin		
		No.	Abnormal	p-Value
Physical Examination: Peripheral Nerve Function				
Pin Prick	Abnormal	(n=953) 5.9%	(n=1,170) 5.1%	0.510
Light Touch	Abnormal	(n=953) 4.9%	(n=1,170) 3.9%	0.311
Muscle Status	Abnormal	(n=983) 3.0%	(n=1,241) 2.9%	0.999
Patellar Reflex	Abnormal	(n=979) 2.3%	(n=1,241) 1.8%	0.421
Achilles Reflex	Abnormal	(n=976) 9.0%	(n=1,236) 9.8%	0.586
Biceps Reflex	Abnormal	(n=983) 0.9%	(n=1,243) 1.0%	0.999
Babinski Reflex	Abnormal	(n=982) 0.5%	(n=1,242) 0.5%	0.999
Vibrotactile Threshold Measurement of Right Great Toe (microns) ^a			(n=2,221) r=0.011	0.598
Vibrotactile Threshold Measurement of Left Great Toe (microns) ^a			(n=2,221) r=0.029	0.175
Physical Examination: CNS Coordination Processes				
Tremor	Abnormal	(n=986) 3.1%	(n=1,243) 2.6%	0.582
Coordination	Abnormal	(n=983) 1.6%	(n=1,240) 2.4%	0.249
Romberg Sign	Abnormal	(n=983) 0.6%	(n=1,241) 0.4%	0.698
Gait	Abnormal	(n=983) 3.5%	(n=1,242) 3.1%	0.765
Central Nervous System Index	Abnormal	(n=983) 6.2%	(n=1,241) 5.7%	0.697

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.

Note: Correlations (r) are based on total sample size and are not category specific.

Table G-1-1. (Continued)
Dependent Variable-Covariate Associations for the Neurology Assessment

	Composite Exposure to Heavy Metals			Worked With Vibrating Power Equipment or Tools		
	No.	Abnormal	p-Value	No.	Abnormal	p-Value
Physical Examination:						
Peripheral Nerve Function						
Vibrotactile Measurement of Right Great Toe (microns) ^a	(n=1,875)	(n=346)	0.572	(n=1,726)	(n=495)	0.663
	$\bar{x}=16.73$	$\bar{x}=16.10$		$\bar{x}=16.72$	$\bar{x}=16.30$	
Vibrotactile Measurement of Left Great Toe (microns) ^a	(n=1,875)	(n=346)	0.949	(n=1,726)	(n=495)	0.398
	$\bar{x}=16.73$	$\bar{x}=16.66$		$\bar{x}=16.91$	$\bar{x}=16.08$	

^a Means transformed from natural logarithm scale; correlations based on natural logarithm of dependent variable versus covariate.