PREVALANCE OF DIABETES AND CARDIOVASCULAR DISEASE IN RESIDENTS LIVING NEAR A CREOSOTE WOOD TREATMENT PLANT

James Dahlgren[1], Trevor Peckham[2], Jason Klein[2], James Sayre[3]

[1]UCLA School of Medicine, 2811 Wilshire Blvd. Suite 510, Santa Monica, CA 90403 USA. Telephone: 310-449-5525. E-mail: dahlgren@envirotoxicology.com
[2]James Dahlgren Medical, 2811 Wilshire Blvd. Suite 510, Santa Monica, CA 90403 USA
[3]UCLA School of Public Health, Dept of Biostatistics, Box 951772, Room 51-254 CHS, Los Angeles, CA 90095-1772

Abstract
Resident living near wood treatment plants are exposed to pesticides including creosote, pentachlorophenol and copper chromated arsenic. We studied a town with one of the largest creosote wood treating facilities in the US. A questionnaire was administered to 757 exposed and compared to 496 unexposed adults. When diabetes risk is adjusted for exposure, ethnicity, smoking history, sex, age, alcohol use, family income , education level and body mass index (BMI), the impact of exposure gives an odds ratio (OR) of 1.55 (95% CI 1.05-2.28). The results reveal an excess of diabetes in the in overweight (BMI 26-30) African Americans (OR=2.80, 95% CI 1.27-7.58) with a trend in the normal weight group. Cardiovascular disorders were in excess in the residents living near the wood treatment plant, with heart disease (OR=2.27, 95% CI 1.46-3.53), and high blood pressure, 1.42 (95% CI 1.06-1.89) significantly increased. While a significant excess in heart disease was shown in both exposed whites and blacks, an excess in high blood pressure was associated more profoundly in the exposed black population. Residents living closer to the plant seem to experience a more increased risk of adverse health effects.

Introduction
We performed a questionnaire study of a town with a large and still functioning creosote wood treatment plant. The plant has used creosote always for over 100 years, and has occasionally used pentachlorophenol and chromated copper arsenate (CCA) as a wood preservative. Elevated levels of polycyclic aromatic hydrocarbons (PAHs), dioxins, arsenic and chromium are present on the plant site and in the nearby residential neighborhood. Studies of arsenic and dioxins indicate increased risk for diabetes and cardiovascular disease[1,2,3,4]. This is the first study to examine the risk of diabetes and cardiovascular disease in a community near a wood treatment plant.

The US Environmental Protection Agency (EPA) Toxic Release Inventory (TRI) provided by the company indicates that millions of pounds of carcinogens have been released from the plant into the air, surface water and soil over its 100+ years of operation. The town's residents experience complain about irritative symptoms associated with the distinctive odor of creosote. Exposure assesements by environmental engineers confirm the presence of increased concentrations of polycyclic aromatic hydrocarbons (PAHs), arsenic, chromium, and dioxins in plant soil, and in residential and school attics throughout the town in addition to toxic concentrations of benzene which are indicated in exposure models[5,6]. These same chemicals are also reported at very high levels on the plant site by company consultants. The levels of these chemicals in the neighborhood sampling were elevated compared to normal background levels for these substances. The wood treatment plant is the only facility in Somerville emitting large volumes of known toxins.

We previously reported the results of an exposure assessment pilot study[6] conducted in the residential community surrounding the Tie Plant. Total chlorinated dioxins/furans were detected in all 10 indoor dust samples analyzed. Total chlorianted dioxins/furans ranged from 1,680 to 61,400 parts per trillion (ppt), with an average of 25,660 ppt. Copper, chromium, and arsenic at increased levels were detected in 11 of 13 groundwater samples. Fourteen households located within a two-mile radius of the wood treatment

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plant were randomly chosen for the indoor attic dust sampling. Samples collected in residential attic dust from 14 homes revealed the following means: Arsenic 8.91 mg/kg and Chromium 30.58 (mg/kg). Ventilation dust samples were collected from Somerville schools. Attic dust sampling found the level of B(a)P Equivalents in all 17 of the samples taken. The minimum was 0.98 mg/kg and the maximum was 707.48 mg/kg with a mean of 112.19 mg/kg and a median of 15.91mg/kg. We also previously reported the biomonitoring results which noted the mean 1-OHP level in urine for the exposed (n=14) is 3.099 µg/g and for controls (n=12) is 0.297 µg/g. The controls used for the PAH metabolite study are different than the controls used in this cancer prevalence study.

Materials and Methods

We approached all the residents in Somerville (exposed town) and Kerens (control town) Texas asking them to complete a detailed medical and residency questionnaire in exchange for $20. In Somerville 757 and in Kerens 496 adults completed the questionnaire. In both towns, there were some of the respondents who no longer lived in the town, but had lived in the town for a minimum of one year or worked in the town for 3 years.

The exposed community was divided into five areas based on the distance from the tie plant. Prevalence data was analyzed based on these five groups. Group 1 was within 1.5 miles from the plant. Groups 2 and 3 were within 3.5 miles from the plant. Group 4 was unknown distance but had a Somerville address. Group 5 lived over 3.5 miles from the plant. Most of the exposed subjects lived in group 1 (n=522). For a more detailed description of these goups and data collection methods, please refer to our companion paper discussing caner prevalence. Groups 1, 2 and 3 are reported here as "heavier exposure" while the groups 4 and 5 are categorized as a "lighter exposure."

Descriptive statistics, sample size, and percentage of sample reporting condition were calculated for the adults (age greater than or equal to 18 years) in the control and exposed groups. The chi-square test was used to test the null hypothesis that the proportion reporting diabetes or cardiovascular disease was equal to the proportion reporting the condition for the control group. The logistic model was used to calculate the adjusted (age, gender, ethnicity, BMI, alcohol use, smoking, family income) odds ratio between the two groups. For the purposes of this report, a normal weight range is considered BMI<24.9. The level of significance for all statistical tests of hypothesis is 0.05. All calculations were performed using STATA 10.

Results and Discussion

The unadjusted prevalence of diabetes reported by the study subjects was significantly increased in the residents of the entire exposed population (17.9% versus 9.9% in controls). Logistic regression with exposure, ethnicity, smoking history, sex, age, alcohol use, family income , education level and body mass index (BMI) revealed a significant excess of diabetes attributable to exposure (Table 1). BMI and age were also significant, but exposure remains the most important risk factor after adjustments.

Table 1 – Risk of diabetes in adults, adjusted and compared to various factors.

Varible	Odds Ratio	95% CI	P value
Exposure	1.55	1.05-2.28	0.027
BMI	1.07	1.04-1.09	<0.001
Age	1.04	1.03-1.05	<0.001
Smoking	1.16	0.79-1.70	0.439
Gender	1.03	0.71-1.49	0.873
Ethncity	1.16	0.94-1.44	0.161
Alcohol use	0.82	0.56-1.22	0.327
Family income	1.02	0.94-1.10	0.675
Education Level	1.00	0.94-1.06	0.937

When adjusted for BMI only, there was a significant increased rate of diabetes in the subjects in the exposed area, OR 1.96 (95% CI 1.37–2.81). In the heavily exposed populations (Groups 1, 2 and 3), there is a significant increase in diabetes in the overweight (BMI 25 -29.9) subjects. There is a trend of increased diabetes in the normal weight group of the heavy exposure group (p-value=0.059).There is no significant difference in diabetes prevalance in lighter exposed population or for participants in the obese range (BMI>30) (Table 2).

Table 2 – Rates of diabetes in higher and lower exposure groups compared to controls, by weight category.

	Weight Category								
	BMI >30 (Obese)			BMI 26-30 (overweight)			BMI <24.9 (Normal Weight)		
Exposure Groups	Odds Ratio	95% CI	n-value (controls=173)	Odds Ratio	95% CI	n-value (controls=160)	Odds Ratio	95% CI	n-value (controls=161)
1, 2 & 3 (n=554) Heavier Exposure	1.44	0.87-2.39	231	3.12*	1.61-6.07	156	2.54	0.96-6.74	167
4 & 5 (n=190) Lighter Exposure	1.51	0.78-2.94	77	1.67	0.66-4.21	58	2.11	0.57-7.78	53

*P Value < 0.05

Exposure was significantly associated with diabetes diagnosis when comparing the heavier exposed population to the controls and adjusting for age, sex and ethnicity (Table 3). In addition to residing in the heavily exposed areas near the wood treatment plant, ethnicity was also a substantial risk factor.

Table 3 – Risk of diabetes in heavily exposed adults, adjusted for age, sex, and ethnicity.

Varible	**Odds Ratio**	**95% CI**	**P value**
Heavy Exposure	1.57	1.07-2.31	0.020
Age	1.04	1.03-1.05	<0.001
Gender	1.08	0.76-1.56	0.658
Ethncity	1.32	1.05-1.65	0.016

The significant excess of diabetes occurred in the exposed African American subjects compared to the African American controls, again in overweight subjects. There is also a trend of increased diabetes in normal weight African Americans (p-value=0.055), with no significant difference in the obese subjects (Table 4).

The exposed group have a slightly older average age but the rate of diabetes remains significantly elevated for African Americans controlling for age, sex and BMI (OR = 2.34, 95% CI 1.38–3.95). When adjusting for the same variables, African Americans in the heavily exposed group showed a more increased prevalance of diabetes compared to controls (OR=2.49, 95% CI 1.45–4.29).

Our data also shows a significant excess of cardiovascular disease in the exposed subjects compared to controls. There is a more than doubling of the risk for being diagnosed with heart disease in the exposed adults, which remains significant when adjusted for BMI, age smoking, gender, ethnicity, alcohol use, education level and family income (Table 5). Significant increases occur in both exposed black and white adults.

Table 4 – Rates of diabetes by ethnicity and weight categories, adjusted for age and sex.

	Weight Category								
	BMI >30 (Obese)			BMI 26-30 (Overweight)			BMI <25 (Normal Weight)		
Groups	Odds Ratio	95% CI	n (exposed / control)	Odds Ratio	95% CI	n (exposed / control)	Odds Ratio	95% CI	n (exposed / control)
Exposed vs. Controls Afro-Americans	1.85	0.922-3.68	179 / 97	2.8*	1.11-7.03	103 / 83	7.86	0.96-64.65	103 / 77
Exposed vs. controls Non-Hispanic whites	0.46	0.17-1.25	83 / 60	2.11	0.68-6.53	75 / 68	0.47	0.11-1.90	94 / 78

* P value < 0.05

When comparing the exposed and control populations smoking is a signifcant risk factor for heart disease (Table 5). However when a multiple logistic regression is performed individually within each population and adjusted for the same factors (excluding exposure), heart disease was significantly associated with smoking in the controls (OR=3.4, 95% CI 1.28–9.30) but not in the exposed subjects (OR=1.29, 95% CI 0.81–2.06). This suggests that the risk of exposure is greater than the risk of cigarette consumption in the exposed population.

Table 5 – Logistic regression for heart disease in the exposed and control adults, adjusted for various factors.

Varible	**Odds Ratio**	**95% CI**	**P- value**
Exposure	2.27	1.46-3.53	<0.001
BMI	1.02	0.99-1.05	0.086
Age	1.06	1.05-1.07	<0.001
Smoking	1.57	1.04-2.37	0.034
Gender	1.07	0.73-1.59	0.721
Ethncity	1.00	0.77-1.29	0.993
Alcohol use	0.81	0.53-1.23	0.320
Family income	0.96	0.89-1.04	0.354
Education Level	0.99	0.93-1.05	0.745

Residence near the plant was associated with a higher rate of high blood pressure (HBP) when adjusting for BMI, age, smoking, gender, ethnicity, alcohol use, family income and education level (Table 6). Like diabetes, the excess occurs in the exposed black population when compared to control blacks and adjusted for numerous factors (Table 7). A significant increase in prevalance of hypertension is present in exposed African Americans in each weight category (Figure 1). As in earlier findings, the increase is more pronounced in the normal (OR=2.48, 95% CI 1.05-5.86) and overweight (OR=2.66, 95% CI 1.31-5.39) groups. However, in this case rates are significantly increased in the obese group as well (OR=1.87, 95% CI 1.01-3.45).

Smoking is also a signifcant risk factor for HBP when compairing exposed blacks and control blacks (Table 7). However when each population is studied individually and adjusted for the same factors (excluding exposure and ethnicity), HBP was only significantly associated with smoking in the controls (OR=2.13, 95% CI 1.10-4.89) but not in the exposed subjects (OR=1.30, 95% CI 0.76–2.22). This again implies that the risk of exposure from the wood treatment plant is a more important and severe risk factor than cigarette consumption in the exposed population.

There is a trend in myocardial infarction associated with the exposure in the higest exposure group compared to the controls and adjusted for BMI, age smoking, gender, ethnicity, alcohol use and family income (data not shown). Coronary bypass surgery, angina and chest pain are also significantly increased, (data not shown).

Table 6 – Logistic regression for high blood pressure in the exposed and control adults, adjusted for various factors.

Varible	**Odds Ratio**	**95% CI**	**P- value**
Exposure	1.42	1.06-1.89	0.018
BMI	1.07	1.05-1.09	< 0.001
Age	1.06	1.05-1.07	< 0.001
Smoking	1.23	0.91-1.67	0.176
Gender	1.10	0.83-1.47	0.513
Ethncity	1.26	1.06-1.50	0.009
Alcohol Use	0.88	0.64-1.21	0.431
Family Income	0.99	0.93-1.06	0.826
Education Level	1.09	1.03-1.15	0.002

Table 7 – Logistic regression for high blood pressure, odds ratios for exposed African American subjects versus control African Americans.

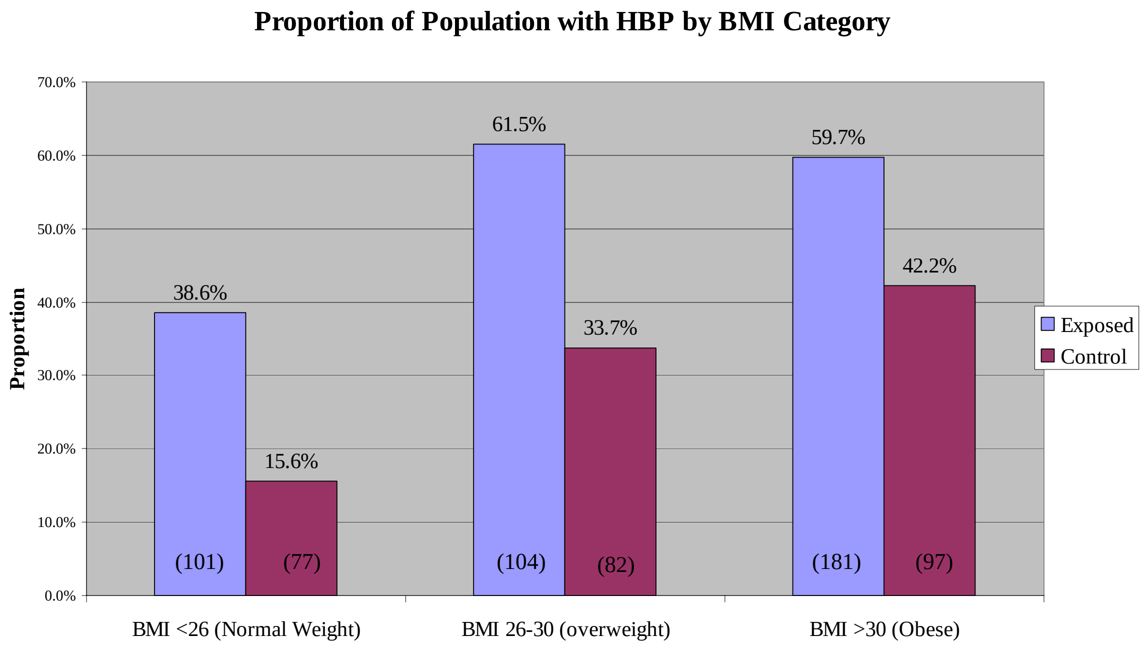
Variable	**Odds Ratio**	**95% CI**	**P-value**
Exposure	2.07	1.40-3.05	< 0.001
BMI	1.07	1.04-1.10	< 0.001
Age	1.06	1.05-1.07	< 0.001
Smoker	1.62	1.06-2.48	0.026
Gender	0.98	0.66-1.47	0.939
Alcohol Use	0.90	0.59-1.36	0.610
Family Income	0.96	0.89-1.05	0.408
Education Level	1.13	1.04-1.24	0.005

The significant increase in diabetes and hypertension in the exposed African Americans compared to black controls and the absence of this finding in the non-Hispanic whites, may be explained by the fact that the African Americans live closer to the plant, have a greater susceptibility, different diet or have poorer living conditions. There are more blacks in the exposed town with family incomes under $10,000 per year than blacks in the control town, however, the variation in proportions of low income residents was not significantly higher in the exposed area (52% vs 38%, p=0.055). We did not find a significant difference in disease prevalence by family income, although there were more African Americans with low family incomes. We have no data on diet.

Our data suggests that living near this wood treament plant is more of a risk in diabetes and various cardiovascular diseases than other common risk factors such as smoking cigarettes and obesity. Diabetes is also a risk factor for cardiovascular disease, however the significant increase in heart disease diagnosis in exposed whites, as well as exposed blacks, further implicates the role of emissions from the wood treatment plant in the adverse health effects experienced by all of the residents.

A companion paper reports on the cancer prevlance in this town. This diabetes and cardiovascular data is consistent with prior studies of community exposure to arsenic and dioxin increasing the occurrence of these conditions[7]. This data supports the need to reduce the emissions from wood treatment plants and reinforces our prior findings of significant health problems in another community next to a wood treatment plant[6,8].

Figure 1 – Increased rate of high blood pressure in African Americans in exposed area versus African American controls (n-value).



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