CANCER PREVALENCE IN RESIDENTS LIVING NEAR A WOOD TREATMENT PLANT

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Abstract
Residents living near a wood treatment plant in Somerville, Texas are exposed to a multitude of chemicals including, creosote, arsenic, chromium, pentachlorophenol, dioxins, benzene and polycyclic aromatic hydrocarbons. While creosote itself is classified as a Group II carcinogen, many wood treatment chemicals are classified as Group I carcinogens by IARC. We conducted a cross-sectional study in which we administered questionnaires to 757 adult residents exposed to the Tie Plant emissions and 496 unexposed adult control subjects. Prevalence of overall, total gastrointestinal (GI), colorectal, and stomach cancers are significantly increased when measured against the control population and US SEER data. Overall cancer prevalence in the most exposed population is 11.1% (n=353) for residents currently living and 14.2% (n=565) for ever having lived in these areas yielding age and gender adjusted odds ratios of 7.57 (95% CI 3.13-18.34) and 10.47 (95% CI 4.48-24.47), respectively, when compared to the control population. Our data also supports a dose response, in which the closer a subject lived to the plant, the higher their risk of being diagnosed with cancer.

Introduction
The wood treatment plant in Somerville, TX is one of the oldest and largest of its kind, treating 1.5 to 2.0 million railroad ties per year. The plant has always utilized coal tar creosote and intermittently used pentachlorophenol and copper chromated arsenic (CCA) to treat wood. They also used naphtha as a drying agent and added fuel oil extender to the creosote. Creosote is a complex mixture with over 200 constituents that is manufactured by distilling coal. Although creosote is classified by the International Agency on Research in Cancer (IARC) as a Group 2A carcinogen, it contains coal tar pitch and benzene which are classified as Group 1 carcinogens. Creosote also contains carcinogenic polycyclic aromatic hydrocarbons (PAHs). Other ingredients such as nitrogen containing polycyclic aromatic compounds (NPAC), heterocyclics and phenols are mutagenic (Heikklia 2001).

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 report irritative symptoms associated with the distinctive odor of creosote. Environmental engineers have studied the town's chemical concentrations in attic dust, air conditioning filters and air. Exposure models reveal high historic exposures to benzene, PAHs and dioxins. Measurements in residential and school attic dust reveal the presence of increased concentrations of polycyclic aromatic hydrocarbons (PAHs), arsenic, chromium, and dioxins. Air levels of PAHs and dioxin are elevated[1]. Fourteen households located within a two-mile radius of the wood treatment plant were randomly chosen for the dust sampling. Total Dioxins/Furans were detected in all 10 indoor dust samples analyzed. Filter and attic dust sampling found elevated levels of B(a)P Equivalents in all 17 of the samples. The minimum was 0.98 mg/kg and the maximum was 707.48 mg/kg with a mean of 112.19mg/kg and a median of 15.91mg/kg. The levels of these chemicals in the neighborhood sampling were elevated compared to normal background levels for these substances. These same chemicals are also found at high levels on the plant site by company sponsored consultants. The wood treatment plant is the only facility in Somerville emitting large volumes of known toxics.

We also found an elevated PAH metabolite (1-OHP) level in urine for a small group of group 1 exposed residents (n=14) of 3.099 µg/g compared to controls from Houston, Texas (n=12) of 0.297 µg/g. This data indicates that the residents are currently exposed to PAHs.

This paper reports prevalence of overall and GI cancer in the adult residents living near the creosote wood treatment plant compared with a control town and compared to US national rates.

Materials and Methods

In this population-based cross-sectional prevalence study, residents living near the wood treatment plant provided medical history data via a questionnaire that has been in use for many years on both exposed and unexposed populations. An attempt was made to include all the residents of the two towns. Some of the subjects in the exposed town are plaintiffs in a lawsuit against the plant. Only the adult cancer prevalence is reported here. Smoking and alcohol use as well as medical, family, occupational and residential histories were collected to identify confounders. Questionnaires were performed in both the exposed and control town were essentially identical. All questionnaires were proctored.

Kerens, Texas was selected as the control population due to its demographic similarity to Somerville, including population size, ethnicity, socioeconomic status, and education level. Participants were recruited from the study and control groups via similar methods, which included flyers, word of mouth, and help from community leaders. We provided a financial incentive of $20 to complete the questionnaire in both the exposed and control towns.

The residential, school and/or employment histories of each participant were reviewed to confirm that all participants qualified to be in the final dataset. The time requirement within the plume for the exposed cohort was set at a minimum of one year residing or three years working/attending school within the exposure plume. A required latency period of 10 years was applied to subjects included in the cancer analysis. This latency requirement was applied to both the exposed and control groups. To be considered as a cancer case, the participant was required to have lived in the exposure plume or control town, respectively, 10 years prior to having been diagnosed with cancer. Additional contact was made to those that marked yes for having been diagnosed with cancer, to verify diagnosis and latency periods. Only participants that confirmed their respective diagnoses, adequate latencies, and addresses were counted.

Because the aim of this study is to assess the health effects of the Tie Plant on nearby residents, we included subjects with significant years of exposure to the tie plant even if they had relocated to other towns. We reached out to everyone that that lived in the exposure plume and control town for at least one year and asked them to complete a questionnaire. We did not target any particular group or sub-sample.

Originally we selected participants based on having a Somerville or 77879 zip code addresses. We learned as we did our analysis that some subjects reported their correct address but lived relatively far from the plant (see Group 5 below). Similarly we found subjects without a Somerville address (Groups 2 and 3) but who were closer to the plant. The important issue was exposure, not the subjects' addresses per se. A 3.5 mile radius from the plant based on air modeling performed by Dr. Rosenfeld was estimated to be the most exposed and those living further away had less exposure. These results, along with the residential dust results are in preparation for publication. All participants from the Somerville area were placed into five groups based on their exposure, as judged by distance from the plant (see Figure 1). The following is the definition for each exposure group:

Group 1: The area of the city closest to the wood treatment plant. All of these subjects were within a 1.5 mile radius from the center of the plant. Group 1 also includes participants that worked or went to school for at least 3 years in the highest levels of air pollution in that area.

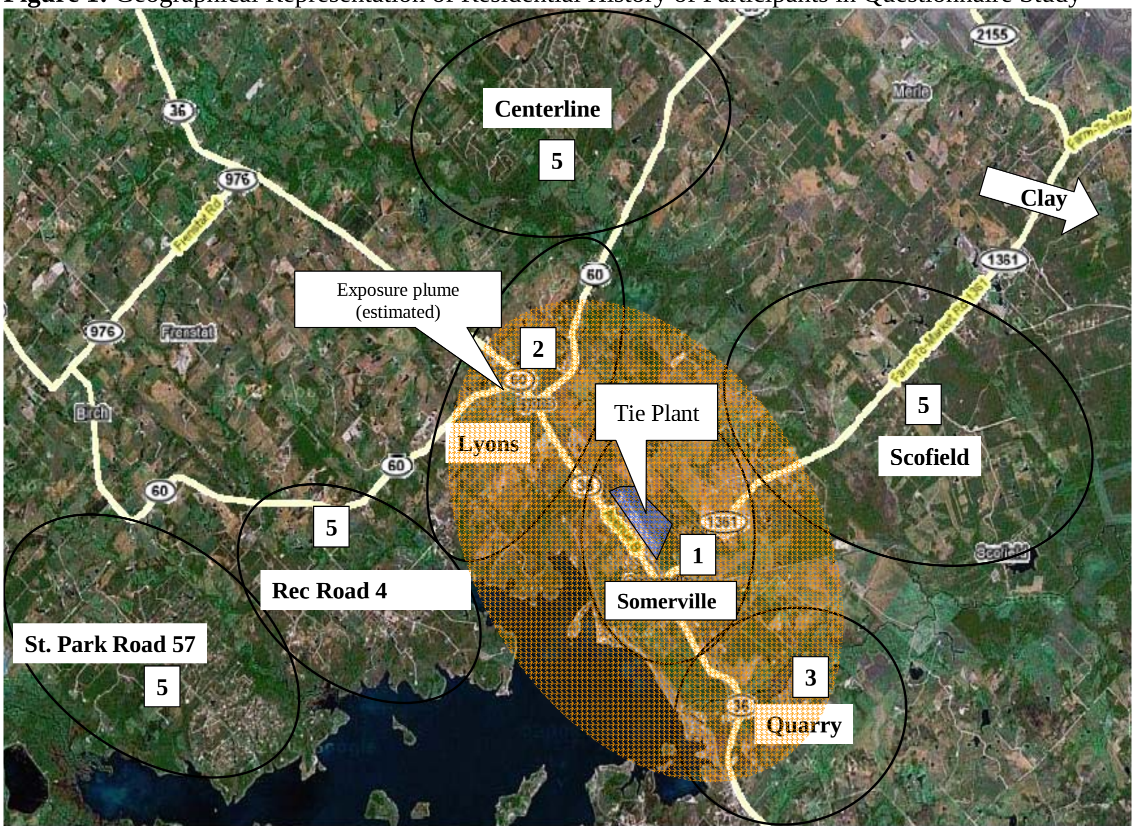
Group 2: Community northwest of Somerville, approximately 2.5 miles but still within the exposure plume.

Group 3: The community southwest of Somerville; approximately 1.5 – 3.5 miles south of the plant. Postal addresses from this community are in the neighboring town and county. Despite this cartographical disparity, this community has experienced significant exposures.

Group 4: This group of participants provided only a PO Box (mailing address) or entered Somerville as the city name but failed to provide a street address. Their location of residence could not be determined, and therefore were included in their own group for the purposes of statistical analysis.

Group 5: This group of participants were able to mapped but were found to reside/work more than 3.5 miles from the plant and thus exposed to the lowest amount of contamination from the plant.

Figure 1: Geographical Representation of Residential History of Participants in Questionnaire Study



The residents in each town were classified by number. The residents in Group 4 could not be mapped due to insufficient information provided in the address history section (i.e. only PO box address was provided)

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 percentage reporting the condition for the exposed group was equal to the percentage reporting the condition for the control group. The logistic model was used to calculate the adjusted odds ratio between the two groups. The odds ratio was adjusted for gender and age.

In addition, the cancer prevalence in the exposed group was compared to United States averages based on publically available US SEER data because in the control town there were either none or too few cases of various cancer types to perform statistics. For comparison of Somerville data with SEER data, a two-tailed z-test of the SEER proportion and confidence interval estimates were calculated when asymptotic normality could be assumed. Exact binomial test of the SEER proportion and confidence interval estimates in adults were calculated when the assumption of asymptotic normality could not be assumed i.e. small event counts. Prevalence odds ratios[2] (observed/expected) and 95% confidence intervals were calculated. The level of significance for all statistical tests of hypothesis is 0.05. All calculations were performed using either STATA 9.0 or 10.0.

Results and Discussion

We collected a total of 757 adult questionnaires from Somerville that qualified to be in the analysis after data cleaning. Of these, 565 adults lived in the communities closest to the wood treatment plant (Groups 1-3), 353 of which still lived in these areas. We collected 496 questionnaires from adult controls, 477of which were completed by adults that currently lived in the control town area.

Groups 1, 2 and 3 represent all residents within the air plume of emissions from the wood treatment plant. Cancer prevalence among these three groups is 11.0% (n=353) for residents currently living and 14.2% (n=565) for ever having lived in these areas, yielding age and gender adjusted odds ratios of 7.57 (95% CI 3.13-18.34) and 10.47 (95% CI 4.48-24.47), respectively.

Residents in the community of Somerville (Group 1) are most near the plant and have the heaviest exposure of all participants. Residents, both currently living and ever lived, in Group 1 had a statistically significant increased prevalence of overall, colorectal and gastrointestinal cancers (see Tables 1, 2). A similar increase is seen in overall, colorectal and stomach cancers when compared to US SEER data (see Tables 3, 4). Note that stomach cancer, a rare cancer, is greatly increased in the Somerville population.

Table 1: Group 1 (currently live) vs. Controls

Overall Cancer						
Adults	Total	Cancer	Proportion	p-value	Adjusted Odds Ratio	95% CI
Somerville	324	36	11.1%	<0.001	8.2	3.84-19.96
Kerens	477	6	1.2%			
Colorectal Cancer						
Adults	Total	Cancer	Proportion	p-value	Adjusted Odds Ratio	95% CI
Somerville	324	5	1.5%	0.0307	5.5	0.62-48.31
Kerens	477	1	0.2%			
GI Caner						
Adults	Total	Cancer	Proportion	p-value	Adjusted Odds Ratio	95% CI
Somerville	324	10	3.0%	<0.001	12.0	1.51- 95.73
Kerens	477	1	0.2%			

Table 2: Group 1 (ever lived) vs. Controls

Overall Cancer						
Adults	Total	Cancer	Proportion	p-value	Adjusted Odds Ratio	95% CI
Somerville	522	70	13.4%	<0.001	10.2	4.34-23.92
Kerens	496	6	1.2%			
Colorectal Cancer						
Adults	Total	Cancer	Proportion	p-value	Adjusted Odds Ratio	95% CI
Somerville	522	13	2.5%	<0.01	9.1	1.16-70.47
Kerens	496	1	0.2%			
GI Cancer						
Adults	Total	Cancer	Proportion	p-value	Adjusted Odds Ratio	95% CI
Somerville	522	21	4.0%	<0.001	15.3	2.03-115.00
Kerens	496	1	0.2%			

Table 3: Group 1 (currently live) vs. US SEER data

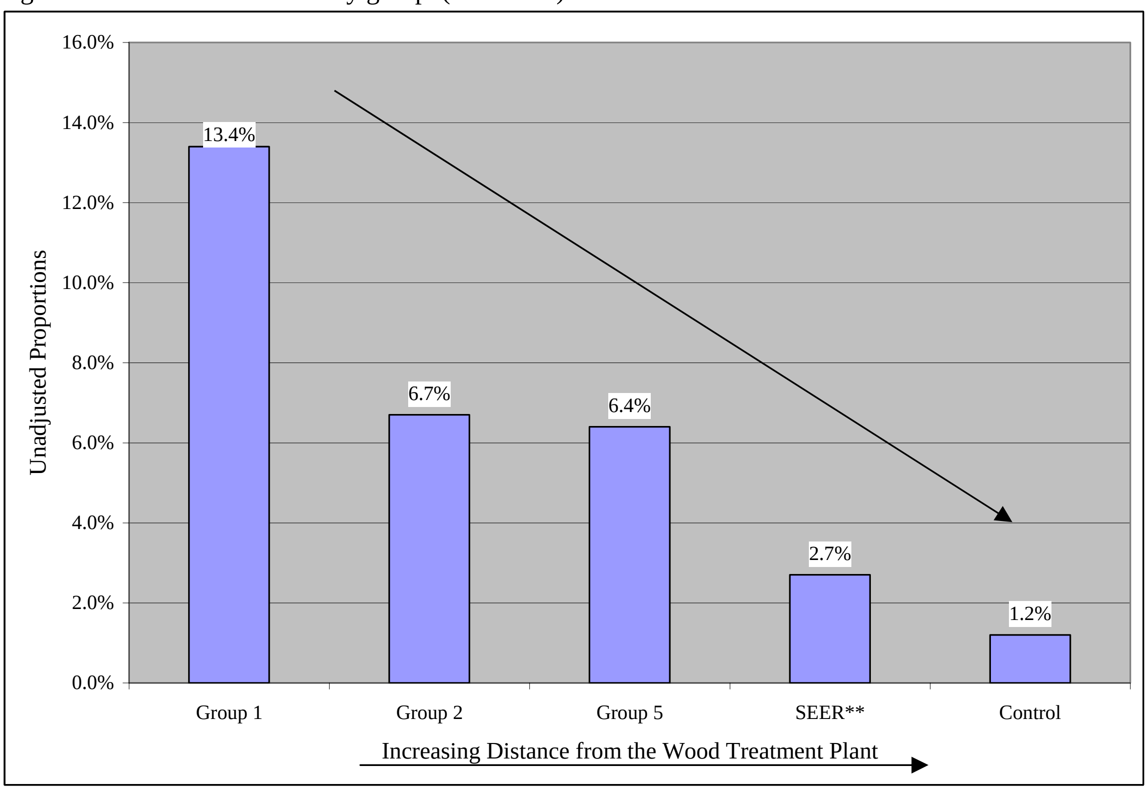
Cancer	Observed	Expected	p-value	Adjusted Odds Ratios	95% CI
Overall	36	8.317	<0.001	4.3	3.03-5.99
Colorectal	5	0.820	<0.01	6.1	1.98-14.23
Stomach	3	0.064	<0.001	46.9	9.66-136.99

Table 4: Group 1 (ever lived) vs. US SEER data

Cancer	Observed	Expected	p-value	Adjusted Odds Ratios	95% CI
Overall	70	13.399	<0.001	5.2	4.04-6.60
Colorectal	13	1.322	<0.001	9.8	5.24-16.82
Stomach	5	0.102	<0.001	49	15.92-114.40

Our data supports a dose response. The closer a subject lived to the plant, the higher their risk of being diagnosed with cancer (see Figure 2). For example, there is lower cancer prevalence among the 109 adult participants in the areas at the outer edge of the exposure plume (group 5). Of these 109 adults, only 7 marked that they had cancer, yielding a proportion of 6.4% which is still higher than the control. This percentage of cancer in a population is above national cancer prevalence rates as reported in the US SEER data. This is a substantially lower proportion compared to the residents in Group 1 which is expected because they would have had less exposure.

Figure 2: Rates of adult cancer by group* (ever lived)



*Group 3 is excluded due to its small sample size. Group 4 is excluded because participant proximity to the plant is not known

**All races/sexes, age-adjusted to the 2000 US Standard Population.

It is likely that some of the participants in Group 4 lived in these surrounding communities. If Group 4 adults are combined with the Group 5 adults it would total 190 participants with 11 cancers. This would yield a proportion of 5.8%, which is still above the national average but significantly lower than the exposed residents of groups 1, 2, and 3.

Likewise, it is likely that some of the participants in group area 4 were in the groups closer to the plant. If we did include these undefined participants in group 1 it would yield an age and sex adjusted odds ratio of 9.5 (95% CI 4.1 - 22.1) for total cancer in adults. The age and sex adjusted odds ratios for colorectal and GI cancers in adults would be 7.8 (95% CI 1.0 - 60.3) and 13.4 (95% CI 1.8 - 100.6), respectively. Although including them represents a conservative determination of the odds ratio because it includes non-cancer participants that live outside the exposure plume, it still yields a significant increase for cancer risk.

If we ignore the latency factor for the control town but keep it for the exposed town, the analysis yields an age and sex adjusted odds ratio of 3.2 (95% CI 1.9 – 5.4) for overall cancer prevalence in adults. If we then add all undefined participants (group 4) to the total for our exposed group and compared these two, analysis yields an age and sex adjusted odds ratio of 2.8 (95% CI 1.7 – 4.8) for overall cancer in adults. This additional analysis demonstrates a significant increase in cancer prevalence among the residents currently living in the town as well as among all the residents who ever lived in the town.

We included subjects with significant years of exposure to the Tie Plant even if they have relocated to other towns. We hypothesize that participants that relocated away from Somerville have been significantly exposed and that their inclusion in the study not only justified, but increases the scope of our analysis. Although we did not target any particular group or sub-sample of residents, there is the possibility of a bias due to the fact that those with cancer may have been more likely to contact our research team and provide their questionnaire information in contrast to health status of all previous Somerville residents. This bias is minimized by our using the same outreach efforts to contact previous residents of the control town, and by performing separate analyses of participants that currently resided in the area.

A study of the Texas death records by Dr. C. Aston revealed an elevated gastrointestinal (GI) cancer mortality rate of 126 per 100,000 between 2000 and 2004 in Somerville versus 26 per 100,000 in 12 comparable Texas towns[3]. This significant excess of GI cancer deaths in Somerville is independent support for our findings. This research is being prepared for publication. The researcher used Texas death records and discovered an excess of gastrointestinal cancer deaths of similar magnitude to our findings. Our prevalence study of living subjects, included cancer cases who did not currently live in Somerville, thus they would not have been counted in this mortality study, his data may under estimates the GI cancer death attributable to creosote wood treatment emissions.

In our previous study on the residential health effects from living near a creosote wood treatment plant, we found an increased cancer prevalence among the exposed subjects of 10.0%, compared to controls with a rate of 2.08% ($p < 0.05$)[4]. We concluded that residential exposure to wood preserving waste probably increased the cancer risk in that population. In the current study, the prevalence of overall and gastrointestinal cancers, especially colorectal and stomach is significantly higher than the controls and national rates. Additionally, an increase in residential proximity to the plant was associated with an increase in cancer prevalence. These findings add additional weight to our previous conclusion that living near a wood treatment plant significantly increases cancer risk.

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