SELF-REPORTED HEALTH EFFECTS ASSOCIATED WITH SOLID WASTE DISPOSAL IN ALASKA NATIVE VILLAGES

Running Title: Self-reported health effects and waste in AK villages

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Abstract

Solid waste management is deficient in many remote Alaska Native (AN) villages and there exists contamination concerns. A retrospective cohort study with cross-sectional components was used to evaluate the risk of experiencing self-reported health symptoms relative to: residence near a dumpsite, odor complaints, burning trash, dumpsite visits, and subsistence practices. In the summer of 2000, 1225 residents in four AN villages were interviewed about waste disposal practices and health symptoms experienced during the preceding 10 days. Residents living near dumpsites had greater incidences of vomiting (OR=1.74; 95% CI: 1.22, 2.49) and fever (OR=1.90; 95% CI: 1.25, 2.89). Burning waste near residences was associated with vomiting (OR=19.7; 95% CI: 2.93, 132.40). Odor complaints and dumpsite visits was correlated with increases in several symptoms with indications of dose-response. Traditional diets were protective against diarrhea (OR=0.54, 95% CI: 0.31, 0.96) and cough (OR=0.30, 95% CI: 0.12, 0.75). This is the first to attempt to characterize adverse health risks among ANs with respect to solid waste disposal but further research is needed.

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1. Introduction

An excess of self-reported health symptoms among residents potentially exposed to waste sites has frequently been found. Worldwide, links between exposures to hazardous waste and increases in symptoms such as fatigue, headaches, and respiratory complaints have been identified (Dunne et al. 1990; Fielder et al. 2000; Kasseva and Mbuligwe 2000; Miller and McGeehin 1997; Pukkala and Ponka 2001; Vrijheid 2000). However, these studies have never been performed in rural Alaska.

Alaska is the largest of the United States, encompassing over 15% of the country's landmass and has diverse cultures, severe temperatures, and sparse populations, all of which affect public health. In 2000, Alaska had 626,932 residents, 119,241 of whom were Alaska Native (AN) (US Census Bureau 2002). In this work, AN includes any people indigenous to the Western Hemisphere: Alaska Native, Native mixed, Aleut, Eskimo, Canadian Eskimo and Indian, and American Indian (Crondahl 1998). Many of these ANs are dispersed throughout federally recognized Tribal villages.

Solid waste management (SWM) is severely deficient in many of these remote villages, and is at a level comparable to what is generally found in developing countries (AVCP 1996; IHS 1998). Over 95% of AN villages use open dumpsites for solid waste disposal. An open dumpsite is a solid waste site that is not maintained, contains wastes that are not covered, and has no boundaries (AVCP 1996). The Alaska Department of Environmental Conservation, Division of Environmental Health Solid Waste Program reports that dumpsites include household waste as well as some commercial, construction and demolition waste. Some villages had local mining operations, served as military fueling stationers, or had logging or canning operations that have since dumped the

remainder of their supplies (paint, fuel, solvents, etc.). Medical waste may be frequently dumped. Dumpsites can also contain appliances, transformers, cars, and snowmobiles that will generally not have been drained of fluids nor had batteries removed. The used oil and other fluids and batteries can contribute substantial heavy metal contamination.

Open dumping can present an environmental and health threat through water and soil contamination, disease transmission, fire danger, and injury to site savagers (Zender 1999). In an attempt to reduce waste volume and visual blight, dump fires are set, or non-separated wastes are burned in metal containers (i.e. "burn boxes"), in about 75% of villages (Zender and Sebalo 2001). To avoid visiting the dump, residents in at least two-thirds of villages burn waste just outside their home, typically in 55-gallon drums (Zender and Sebalo 2001).

Over 45% of Alaska villages have no running water or are only partially plumbed, and the majority of these must haul their human wastes in "honeybuckets". The low rate of plumbing is due to a variety of reasons, but primary factors are the extreme logistic challenges in remote arctic and sub-arctic villages. Human wastes are often discarded at or near open dumps, increasing risks of exposure to pathogens when disposing of trash. (The Governor's Council on Rural Sanitation 1998; OTA 1994; Zender and Tchobanoglous 1996). Villagers hauling their solid wastes, parts salvagers, children, and household pets frequent dumpsites. Many ANs have subsistence diets so there are concerns about contaminants getting into food and water supplies (Duffy et al. 1998; Egeland et al. 1998). There is also a concern that limiting consumption of traditional foods and increasing consumption of less healthy foods pose a greater health threat to ANs than environmental

contamination (Verbrugge et al.1998) because cardiovascular disease and diabetes are increasing in indigenous people (Bell et al. 1997; Mahoney and Michalek 1998).

During 2000-2001, the Central Council of Tlingit and Haida Indian Tribes of Alaska (CCTHITA) carried out a statewide project that for the first time produced an in-depth portrait of SWM conditions and practices in Native villages. Besides developing a statewide SWM database, the SWM situation was evaluated through waste characterization, site assessment, soil, water, and vegetation sampling. All of the dumpsites at these villages were characterized as potentially highly hazardous to health and several contaminants including volatile and semi-volatile organic compounds, polyaromatic hydrocarbons, various metals, and high fecal indicators, were identified in soil and water samples (Zender and Sebalo 2001). This paper provides details on the health risk portion of the study.

As part of CCTHITA's SWM project, health effects associated with solid waste disposal in AN villages were examined. The study design was a retrospective cohort design with a cross-sectional component. The purpose of the study was to determine if exposure to dumpsites and solid waste disposal practices was associated with an increase in self-reported symptoms of poor health.

2. Methods

In the spring of 2000, CCTHITA distributed surveys about solid waste to 229 federally recognized Tribes in Alaska, inviting them to participate in a solid waste demonstration project. Of the 47 initial respondents, four worst-case villages were selected, based on their SWM practices, the quality of their dumpsite(s), probability of successful participation, and their geographic region. One village was chosen from each of

the Northwest, Yukon Interior, Southeast, and the Yukon-Kuskokwim Delta regions. Through the US Census 2000, the combined population for the four villages was determined to be 1891. Demographically, the average household size for the four villages was 4.4 persons and average household income was $30 107 per year (US Census 2000). The racial profile of the communities was 76.8% AN, 22.3% Caucasian, and 0.9% other. The study was approved by the respective Tribal Councils for the use of human subjects. Per agreement with Tribal Councils, the villages are not identified.

In June 2000, Tribal representatives were trained to accompany and assist investigators with administering surveys. Representatives also provided translation when necessary and evaluated standardized survey items for cultural sensitivity.

Following advertisement of the study, all residents of the four villages were asked to participate. Residents were considered eligible for the study if they were able to provide oral informed consent, had not left their village during the past 10 days nor admitted use of controlled substances not prescribed by a physician. Residents were approached by the interviewer and Tribal representative, asked to participate, had their eligibility determined, and, after completing the interviewer-administered questionnaire, were offered participatory incentives of hand sanitizer or fruit jam. The head of household usually completed the majority of the questionnaire, while other household members were questioned about their symptoms. Legal guardians acted as proxies for children under the age of 12. Surveys were examined for completeness at the end of each interview and rechecked every evening for missing data and participants were re-contacted as necessary to complete the forms.

Survey items included questions about general solid waste disposal practices as well as information about the previous 10 days. Predictor variables were based on general solid waste disposal practices and included distance of residence from dumpsite, odor complaints, burning waste near the home and frequency of burning, and subsistence practices. Number of visits to the dumpsite was measured simultaneously with the outcome variables. Outcome variables included self-reported incidence during the previous 10-day period of: skin irritation/rash, dizziness/feeling of faintness, fever greater than 37.7 ^{o}C, stomach upset, vomiting, diarrhea, earache, eye irritation, congestion, sore throat, cough, headache, and numbness, tingling, or weakness in limbs. Information was gathered about age, gender, race, income, level of environmental concern, including impact on subsistence practices, tobacco use and exposure, seasonal allergies, and diagnoses of diabetes or asthma.

2.1 Data analysis

Adjusted odds ratios and 95% confidence intervals were used to quantify the relationship between solid waste disposal practices and other environmental exposures and the incidence of health symptoms. Odds ratios were used for the exposure variables of distance, odor complaints, burning waste, and consumption of subsistence foods. Because visits to the dumpsite and outcome measurements both occurred in the same time frame, adjusted prevalence odds ratios (POR) were calculated to quantify the relationship between number of visits and symptoms experienced.

Resident distance from the dumpsite was categorized into those living within 0.8 km of the dumpsite versus those living further than 0.8 km from the site. Odor complaints about the dumpsite were categorized as none, moderately bothered, and highly bothered

during the preceding 10 day period. Burning near the home was defined as burning within 7.6 m. Frequency of burning was categorized by those who burned more than once a week versus others. Number of visits to the dumpsite during the previous 10 days was categorized as: none, moderate (one or two visits) and high (three or more visits). Subsistence practices were defined by eating subsistence foods more than half of the time versus other levels of consumption. Separate models were constructed for each symptom and each predictor variable. Multivariable models were used to estimate the odds ratios and prevalence odds ratios controlling for covariates. Covariates included in all the models were age (continuous), gender, race, (Native or non-Native), income less than $25 000 per year per household versus income equal to or greater than $25 000 annually, village of residence, level of environmental concern (none, moderate, high or moderate and high versus none), honeybucket use, and tobacco exposure. Honeybucket use was defined as positive for residents who had no water hookup. Exposure to tobacco was defined as having smoked at least 100 cigarettes in a lifetime and currently smoking, living in the same household as a smoker, or using chewing tobacco. In some models tobacco exposure was treated as one variable (exposure to tobacco versus no exposure) while in others cigarette smoking, passive smoking, and chewing tobacco were used as separate variables. Models used to predict dizziness/feeling of faintness and numbness and tingling or weakness in limbs also included self-reported diabetes as a covariate. Models predicting respiratory complaints (congestion, sore throat, and cough) included self-reported allergies and asthma as covariates.

To adjust for the lack of independence between members of the same household and differing covariates within clusters, logistic-binomial regression for random effects with distinguishable data was used (Egret 1999; Neuhaus 1992).

3. Results

Of the 1891 residents reported by the US Census, 648 residents (34.3%) could not be located or were not eligible for the study and 18 residents (1.4%) refused to participate. Two hundred ninety-five households representing 1,225 residents comprised the study population. This is 64.8% of the population of the four villages and indicates a response rate of 98.6%. Demographic characteristics of the study population are depicted in Table 1. Solid waste disposal habits are depicted in Table 2.

Exposure characteristics including residence distance from the dumpsite, dumpsite odor complaints, household burning, dumpsite visits and level of environmental concern are detailed in Table 2. One hundred seven households representing almost 48% of all households were located within 0.8 kilometers of a dumpsite, while 120 households representing approximately 30% of individuals lived at 1.6 km from the dumpsite. One hundred eighty-three households representing 66% of the people had been bothered by dumpsite odors during the proceeding 10 days. Seventy-nine households containing almost one-quarter of the study population burned their waste and most of those that burned did so within 7.6 m of their residence. Almost one-half of those that burned waste did so more than once week. Two hundred thirty-one of the households (78.3%) representing over 80% of the individuals took their own waste to the villages' dumpsites. One hundred sixty residents (13.1%) visited the dumpsite one or two times in the past 10 days and 93 residents (7.6%) visited the dumpsite at least three times. Two hundred three

households representing approximately 64% of residents had some level of general concern about the environment. Additionally, 202 households representing 64% of residents had concerns about the environment that had altered their subsistence activities. Prevalence and number of people experiencing symptoms within 10 days prior to the survey are displayed in Table 3. Prevalences ranged from 2.6% for vomiting to 21.1% for congestion. Eight of the 13 symptoms had prevalences over five percent and four symptoms had prevalences over 10%.

Residents living within 0.8 km of dumpsites were found to have higher prevalences of fever greater than 37.7 ^{o}C (odds ratio [OR]=1.90; 95% confidence interval [CI]: 1.25, 2.89) and vomiting (OR=1.74; 95% CI: 1.22, 2.49) than those living further away from the site (Table 4a). Models were adjusted for age, gender, race, income, village of residence, two levels of environmental concern, honeybucket use, and one level of tobacco exposure. Models examining risks associated with distances divided into more categories did not converge.

Complaints of being moderately and highly bothered by odors from the dumpsites were evaluated and adjusted for as predictors of symptoms using one model. Being moderately bothered by odors from dumpsites during the previous 10 days was significantly associated with eight symptoms: skin irritation/rash (OR=3.06; 95% CI: 1.21; 7.95), dizziness/feeling of faintness (OR=13.27; 95% CI: 1.21, 145.92), fever greater than 37.7 ^{o}C (OR=4.38; 95% CI: 1.26,15.22), earache (OR=11.65; 95% CI: 2.95,46.05), eye irritation (OR=8.41; 95% CI: 1.45, 48.66), congestion (OR=5.44; 95% CI: 2.02,14.67), headache (OR=2.88; 95% CI: 1.13, 7.32), and numbness, tingling, or weakness in limbs (OR=4.72; 95% CI: 1.05, 21.22). Complaints of being highly bothered by odors were

associated with eight symptoms, although not all of the same symptoms as those predicted by moderate odor complaints. Being highly bothered was associated with skin irritation/rash (OR=3.97; 95% CI: 1.43,11.06), dizziness/feeling of faintness (OR=10.61; 95% CI: 1.59,70.79), fever greater than 37.7 ^{o}C (OR=7.99; 95% CI: 2.35, 27.14), earache (OR=13.13; 95% CI: 3.24, 53.23), congestion (OR=2.83; 95% CI: 1.01, 7.94), sore throat (OR=2.91; 95% CI: 1.22, 6.95), cough (OR=2.49; 95% CI: 1.03, 6.06), and headache (OR=6.47; 95% CI: 2.29, 18.29). Odds ratios were adjusted for age, gender, race, village of residence, environmental concern, honeybucket use, and tobacco exposure. Multiple variables were used for level of environmental concern and tobacco exposure in models predicting earache and congestion. Other models were adjusted with dichotomous variables for environmental concern and tobacco exposure (Table 4b).

Respondents who burned waste near their homes experienced more vomiting within the past 10 days than residents who did not burn waste (OR=19.7; 95% CI: 2.93, 132.40) (Table 4c). Respondents who burned waste more than once a week had associations with symptoms of: dizziness/feeling of faintness (OR=2.54, 95% CI: 1.12, 5.74), vomiting (OR=1.76, 95% CI: 1.16, 2.65), and eye irritation (OR=5.83, 95% CI: 1.00, 33.87). In addition to the other covariates measured, the model predicting vomiting was adjusted with multiple levels of covariates for environmental concern and tobacco exposure while the remaining models were adjusted with dichotomous variables.

Frequency of visiting the dumpsites was evaluated and adjusted using one model. Visiting the dumpsite once or twice in the previous 10 day period was positively associated with an increased odds of experiencing six symptoms (Table 4d): fever greater than 37.7^{o}C (POR=3.04, 95% CI: 1.32, 6.99), stomach upset (POR=2.95, 95% CI: 1.36, 6.40), earache

(POR=13.13, 95% CI: 3.24, 53.23), eye irritation (POR=2.89, 95% CI: 1.03, 8.12), headache (POR=2.68, 95% CI: 1.42, 5.05), and numbness, tingling, or weakness in limbs (POR=3.15, 95% CI: 1.09, 9.06). Visiting the dumpsite three times or more in the previous 10 day period was positively associated with increased odds of experiencing 10 symptoms (Table 4d): skin irritation/rash (POR=2.60, 95% CI: 1.01, 6.66), dizziness/feeling of faintness (POR=15.62, 95% CI: 4.05, 60.27), stomach upset (POR=11.35, 95% CI: 3.95, 32.58), earache (POR=4.31, 95% CI: 1.73, 10.75), eye irritation (POR=14.45, 95% CI: 4.37, 47.59), congestion (POR=2.46, 95% CI: 1.01-5.98), sore throat (POR=2.36, 95% CI: 1.08, 5.15), cough (POR=3.43, 95% CI: 1.43, 8.25), headache (POR=12.60, 95% CI: 5.21, 30.45), and numbness, tingling, or weakness in limbs (POR=11.09, 95% CI: 3.42, 35.96). Prevalence odds ratios were adjusted for age, gender, race, village of residence, environmental concern, honeybucket use, and tobacco exposure. Multiple variables for level of environmental concern and tobacco exposure were used in models predicting fever greater than 37.7 ^{o}C, earache, eye irritation, and headache, while the remaining models were adjusted with dichotomous variables for environmental concern and tobacco exposure.

Eating subsistence foods more than half of the time was compared to those consuming subsistence foods half the time or less (Table 4e). Consuming subsistence foods more than half of the time was found to be protective against diarrhea (OR 0.54, 95% CI: 0.31, 0.96) and cough (OR 0.30, 95% CI: 0.12, 0.75). Models were adjusted with dichotomous variables for environmental concern and tobacco exposure, as well as the other measured covariates.

4. Discussion

We found several meaningful associations for all of the symptoms investigated. Even after adjusting for several potentially confounding factors, odds ratios were often elevated, frequently exceeding 3.0. Because of the small sizes of the villages we worked with, and the exceptional cooperation that we received, we were able to sample most of the population. Because of the unique SWM situation in rural AN communities, we had the opportunity to examine several exposure factors beside distance and odor complaints. Assumptions about the potential hazards of the dumpsites were not necessary because the concurrent environmental impact study, waste stream analysis, and environmental sampling detailed the actual condition of the dumpsites (Zender and Sebalo 2001). However, exposure was not directly tied to many of these findings.

Distance from the dumpsite is an objective predictor variable for symptoms of poor health and was associated with two symptoms. We may have been unable to detect more effects because most of the residents lived proximal to the dumpsite and there may be little difference in health effects at 0.8 km distant from the site. With 96% of residents living within 3.2 km of the dumpsites, all could be susceptible to potential effects of living near open dumpsites. Because of the number of participants, distance could not be further categorized. As many of the villagers do not have traditional employment outside the home, distance of employment site from the dumpsite was not examined and perhaps should be in future studies.

Odor complaints are a more subjective measurement than distance and were positively associated with an increase in experiencing 10 symptoms. Odor complaints can be construed to be a more sensitive variable because they are partially a function of wind direction as well as distance. However, people exposed to disagreeable odors may

associate the experience with any adverse health effects they later experience (Neutra et al. 1991; NRC 1991; White et al. 1999). The results were adjusted for level of environmental concern and therefore could be indicative of real risk. Odor complaints were not highly correlated with residence distance from dumpsites, which could be explained if the prevailing wind direction is away from homes and towards the dumpsites. Some people complaining of odors may have been bothered by these odors at their place of employment or some other location in the village rather than at their homes. For those models predicting skin irritation/rash, fever greater than 37.7 ^{o}C, earache, and headache, odds ratios for high odor complaints were greater than those of moderate complaints, suggesting a dose-response. However, in models predicting dizziness/feeling of faintness and congestion odds ratios were lower in the more highly exposed group. This would make sense for congestion as it is probable that the very congested would not be highly bothered by odors. Additionally, being moderately disturbed by odors was a predictor for numbness, tingling, or weakness in limbs while the model using high odor complaint was not significant (although it bordered on significance). These findings do not support a dose-response to odor complaints for dizziness/feeling of faintness and numbness, tingling, or weakness in limbs, and raises the question about some unidentified confounder not adjusted for in the analysis. It could be that not enough cases of these symptoms occurred in those bothered highly by odors to detect a significant result.

Residents who burned waste near their homes had experienced more vomiting compared than those who did not burn their waste during the preceding 10 days. Burning waste was also mildly associated with dizziness/feeling of faintness. For these two symptoms, associations were also found with an increased frequency of burning. These

results make sense: residents who burn near the home or who burn more frequently are often afflicted with the same two symptoms than those who do not. Frequency of burning was also predictive of eye irritation, but burning waste near their residence was not. This could indicate that a threshold frequency of burning needs to occur before meaningful effects can be found. Not until near the termination of fieldwork was it realized that some residents burn trash inside the home. Very little research has examined any health effects of home barrel or backyard burning. This may be the first study performed that compared health effects in residents who burn trash near their homes to those who do not. It has been suggested that home burning poses a greater hazard to residents than municipal burning (EPA 2003; Ostrowski 2003). Government agencies are concerned about the potential hazards associated with home barrel burning (EPA 2003; Lemieux et al. 2000; Ministry of Water 2002) and further studies focusing directly on the hazards of home barrel burning are needed.

Visiting the dumpsite during the previous 10 days appears to be the most robust predictor for many of the symptoms. However, it is not known if participants actually visited the dumpsite prior to experiencing symptoms. For those models predicting stomach upset, earache, eye irritation, headache, and numbness, tingling, or weakness in limbs odds ratios for visiting the dumpsites three or more times in a 10 day period were greater (often considerably so) than those visiting the sites one or two times. For the symptoms of skin irritation/rash and cough, odds ratios were also higher in the more highly exposed group, although the odds ratios were not statistically significant in the less exposed group. Higher odds ratios in the more highly exposed group suggest a dose-response when visiting the dumpsites for these seven symptoms. In models predicting symptoms of dizziness/feeling

of faintness, congestion and sore throat, only the more highly exposed group had a meaningful elevation of risk, perhaps indicating a threshold effect. In the model predicting fever greater than 37.7 ^{o}C, effects were only found in the less exposed group. These finding do not support a causative effect and raises the question about some unidentified confounder not adjusted for in the analysis. It could be that not enough cases of fever occurred in those bothered highly by odors to find a definitive result. However, results using dumpsite visits as a predictor of symptoms of poor health is relatively convincing. From a pragmatic point of view, people who actually visit the dumpsite are unquestionably exposed to the hazards of that dumpsite. Furthermore, these symptoms are associated with exposure to contaminants found at the dumpsites (Zender and Sebalo 2001).

No evidence was found in this study to support the notion that traditional foods increased symptoms of poor health; in fact, consumption of these foods was found to be protective against diarrhea and experiencing a cough. Consuming traditional foods was examined because of fears of environmental contamination of these foods (Hild 1998, Verbrugge et al. 1998). Several households voiced concerns about the safety of their traditional foods and 68% of households told investigators they had altered their subsistence habits based on these fears. Incidental reports were relayed about sightings of malformed fish and game. Although this study did not explore subsistence in depth it was interesting to note that only protective effects were detected with the increased consumption of traditional foods.

Estimates of demographic information in this study differ slightly from those found by the US Census 2000 performed just a couple of months prior. We found the AN population to be higher and the Caucasian population lower. These differences could be

because we sampled a greater proportion of the population. Additionally, populations in Native villages are different in the summer time as many people are away performing subsistence activities. The possibility exists that absent residents had fewer health problems than the ones who remained in their villages. Therefore, these results cannot be generalized to all members of the villages.

This study was plagued by the same problems that are inherent with all studies of self-reported health symptom. It is difficult to conclude whether these symptoms are a result of toxicological action of chemicals, a depressed immunity because of stress related to the waste sites, or an effect of reporting or recall bias (Vrijheid 2000). By asking residents about symptoms they have experienced in the past 10 days, it is hoped that recall bias was minimized. Adjusting for level of environmental concern could reduce positive effects related to stress.

Further studies are needed and those that could prove most useful to ANs would closely examine the effect of exposure and exposure concern on subsistence practices. As mentioned previously, the current mode of thought is that the fear of contamination can put consumers of traditional foods at greater risk of negative health impacts if those fears result in a decrease in consumption of traditional foods with concurrent increase in consumption of a westernized diet. The most alarming result of this study is that responding ANs are altering their subsistence practices at least in part due to a perception of local environmental pollution. Important follow-up would include elucidating how subsistence practices are being altered; i.e. change in location, decrease in consumption of traditional foods or a substitution in consumption. Simply knowing there has been a change in activities is not enough information to be useful to villages.

Risks to health from dumpsites are difficult to establish, although several studies have been performed. Exposure information is often poorly defined and effects of chronic exposure to low levels of environmental contaminants are not easy to quantify, either singly or jointly. Although there was more exposure information than is typical in these types of studies there was little information on how these exposures correlate with physiologic dose of toxins. By studying worst-case dumpsites the likelihood of finding existing effects would be increased. The most significant aspect of this study is that it is the first to attempt to characterize adverse health risks to ANs with respect to solid waste disposal.

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Table 1. Select demographic information for study participants on race, age distribution, gender, tobacco use, other background health conditions, household income, subsistence diet, honeybucket use, and household size, Summer 2000.

Characteristic	Individuals (n=1225)		Households (n=295)	
	Number	Percent	Number	Percent
Race				
Alaska Native	1052	85.9	-----	-----
African American	1	0.1	-----	-----
Asian	2	0.2	-----	-----
Caucasian	170	13.9	-----	-----
Age				
>6	159	13.0	-----	-----
6-17	394	32.2	-----	-----
18-34	237	19.3	-----	-----
35-59	349	28.5	-----	-----
60+	86	7.0	-----	-----
Gender				
Female	618	50.4	-----	-----
Male	607	49.6	-----	-----
Tobacco exposure				
Cigarette smoking	25	6.3	-----	-----
Cigarette smoking	265	40.0	-----	-----
Cigarette smoking	287	23.4	-----	-----
Passive smoking	472	38.5	-----	-----
Chewing tobacco	28	7.1	-----	-----
Chewing tobacco	121	18.0	-----	-----
Chewing tobacco	149	12.2	-----	-----
Other Conditions			-----	-----
Diabetes	11	0.9	-----	-----
Asthma	71	5.8	-----	-----
Allergies	65	5.3	-----	-----
Yearly household			-----	-----
<$25,000	287	23.4	96	32.5
$25,000+	938	76.6	199	67.5
Subsistence diet				
Less than half the	242	19.8	72	24.4
Half the time	377	30.8	90	30.5
More than half the	606	49.5	133	45.1
Honeybucket use				
Yes	386	31.5	71	24.1
No	839	68.5	224	75.9
Household size				
Mean			4.2	
Median			4	

Table 2. Exposure characteristics of the study population including distance from the dumpsite, odor complaints, burning waste, frequency of burning, visits to dumpsites, general concerns for the environment, and environmental concerns affecting subsistence activities, Summer 2000

Exposure Characteristics	Individuals (n=1225)		Households (n=295)	
	Number	Percent	Number	Percent
Distance from dumpsite				
Less 0.4 km	69	5.6	13	4.4
0.4 to less than 0.8 km	514	42.0	94	31.9
0.8 to less than 1.2 km	252	20.6	62	21.0
1.2 km to less than 1.6 km	26	2.1	6	2.0
1.6 km or more	364	29.7	120	40.7
Dumpsite odors				
Not bothered	416	34.0	112	38.0
Moderately bothered	422	34.4	96	32.5
Highly bothered	387	31.6	87	29.5
Burned waste near residence				
Burned < 7.6 m from residence	258	21.1	66	22.4
Burned >7.6 m from residence	57	4.7	13	4.4
Did not burn	910	74.3	216	73.2
Frequency of burning				
Once a month	33	2.7	6	2.0
Twice a month	70	5.7	14	4.7
Weekly	80	6.5	18	6.1
More than once a week	132	10.8	34	11.5
Dumpsite visits in past 10 days				
1 or 2 times	160	13.1	-----	-----
3 or more times	93	7.6	-----	-----
General environmental concerns				
No concerns	447	36.5	119	40.3
Moderately concerned	413	33.7	92	31.2
Highly concerned	365	29.8	84	28.5
Environmental concerns affecting subsistence				
No concerns	441	36.0	93	31.5
Moderately concerned	479	39.1	104	35.3
Highly concerned	305	24.9	98	33.2

Table 3. Prevalence of symptoms recalled by study participants during the previous 10 days, Summer 2000

Symptom	Frequency	Percent Affected
Skin irritation/rash	88	7.2
Dizziness/feeling of faintness	44	3.6
Fever > 37.7 ^{o}C	107	8.7
Stomach upset	117	9.6
Vomiting	32	2.6
Diarrhea	56	4.6
Earache	54	4.4
Eye irritation	72	5.9
Congestion	258	21.1
Sore throat	173	14.1
Cough	225	18.4
Headache	173	14.1
Numbness, tingling, or weakness in limbs	43	3.5

Table 4a. Adjusted* odds ratios for distance of residence within 0.8 km of dumpsites as a predictor of symptoms of poor health, Summer 2000

Symptom	Odds ratio	95% CI lower	95% CI upper	p-value
Skin irritation/rash	1.13	0.39	3.24	0.819
Dizziness/feeling of faintness†	0.78	0.14	4.42	0.781
Fever > 37.7 ^{o}C	1.90	1.25	2.89	0.003
Stomach upset	0.48	0.17	1.36	0.168
Vomiting	1.74	1.22	2.49	0.002
Earache	1.41	0.43	4.67	0.574
Eye irritation	0.46	0.13	1.58	0.218
Congestion‡	1.17	0.53	2.59	0.693
Sore throat‡	1.03	0.49	2.15	0.939
Cough‡	1.49	0.88	2.54	0.141
Headache	2.26	0.85	6.00	0.102
Numbness, tingling, or weakness in limbs†	2.68	0.57	12.65	0.212

* Adjusted for age, gender, race, village of residence, environmental concern, honeybucket use, and tobacco exposure.
†These models also adjusted for self-reported diabetes
‡These models also adjusted for self-reported allergies and asthma.
CI = Confidence interval

Table 4b. Adjusted* odds ratios for odor complaints as predictors of symptoms of poor health, Summer 2000

Symptom	Moderately bothered by odors				Highly bothered by odors			
	Odds ratio	95% CI lower	95% CI upper	p-value	Odds ratio	95% CI lower	95% CI upper	p-value
Skin irritation/rash	3.06	1.18	7.95	0.022	3.97	1.43	11.06	0.008
Dizziness/feeling of faintness†	13.27	1.21	145.92	0.035	10.61	1.59	70.79	0.015
Fever > 37.7 ^{o}C	4.38	1.26	15.22	0.020	7.99	2.35	27.14	< 0.001
Stomach upset	3.01	0.98	9.25	0.054	2.26	0.68	7.55	0.185
Vomiting	9.E+10	0.00	2.E+38	0.869	4.E+10	0.00	2.E+38	0.873
Diarrhea	9.E+09	0.00	2.E+38	0.850	0.29	0.05	1.78	0.182
Earache	11.65	2.95	46.05	< 0.001	13.13	3.24	53.23	< 0.001
Eye irritation	8.41	1.45	48.66	0.018	4.02	0.51	31.71	0.187
Congestion‡	5.44	2.02	14.67	< 0.001	2.83	1.01	7.94	0.048
Sore throat‡	2.10	0.94	4.70	0.070	2.91	1.22	6.95	0.016
Cough‡	0.98	0.43	2.22	0.959	2.49	1.03	6.06	0.044
Headache	2.88	1.13	7.32	0.026	6.47	2.29	18.29	< 0.001
Numbness, tingling, or weakness in limbs†	4.72	1.05	21.22	0.043	4.15	0.85	20.23	0.078

* Adjusted for age, gender, race, village of residence, environmental concern, honeybucket use, and tobacco exposure.
†These models also adjusted for self-reported diabetes
‡These models also adjusted for self-reported allergies and asthma
CI = Confidence interval

Table 4c. Adjusted* odds ratios for burning waste as a predictor of symptoms of poor health, Summer 2000

Symptom	Burns waste near residence				Frequency of burning			
	Odds ratio	95% CI lower	95% CI upper	p-value	Odds ratio	95% CI ratio	95% CI lower	p-value
Skin irritation/rash	0.90	0.27	3.02	0.870	1.01	0.70	1.44	0.971
Dizziness/feeling of faintness†	9.23	0.89	96.12	0.063	2.54	1.12	5.74	0.025
Fever > 37.7 °C	0.55	0.12	2.47	0.439	0.83	0.54	1.27	0.384
Stomach upset	1.10	0.27	4.40	0.898	0.89	0.58	1.37	0.598
Vomiting	19.70	2.93	132.40	0.002	1.76	1.16	2.65	0.008
Diarrhea	1.73	0.51	5.80	0.377	1.34	0.80	2.25	0.261
Earache	0.35	0.09	1.30	0.117	0.84	0.58	1.23	0.374
Eye irritation	1.76	0.45	6.85	0.417	5.83	1.00	33.87	0.050
Congestion‡	0.70	0.21	2.32	0.555	0.75	0.55	1.01	0.062
Sore throat‡	0.62	0.23	1.67	0.340	0.85	0.64	1.15	0.297
Cough‡	1.86	0.66	5.24	0.240	1.03	0.75	1.40	0.859
Headache	0.47	0.14	1.55	0.216	1.78	0.73	4.33	0.206
Numbness, tingling, or weakness in limbs†	0.84	0.19	3.73	0.814	0.94	0.62	1.43	0.784

* Adjusted for age, gender, race, village of residence, environmental concern, honeybucket use, and tobacco exposure.
†These models also adjusted for self-reported diabetes
‡These models also adjusted for self-reported allergies and asthma
CI = Confidence interval

Table 4d. Adjusted* prevalence odds ratios for dumpsite visits as predictors of symptoms of poor health, Summer 2000

Symptom	Visited dump one or two times				Visited dump more than twice			
	Odds ratio	95% CI lower	95% CI upper	p-value	Odds ratio	95% CI upper	95% CI lower	p-value
Skin irritation/rash	1.87	0.90	3.87	0.091	2.60	1.01	6.66	0.048
Dizziness/feeling of faintness**	2.19	0.47	10.22	0.319	15.62	4.05	60.27	< 0.001
Fever > 37.7 ^{o}C	3.04	1.32	6.99	0.009	1.05	0.22	5.11	0.948
Stomach upset	2.95	1.36	6.40	0.006	11.35	3.95	32.58	< 0.001
Vomiting	5.88	0.92	37.66	0.062	0.71	0.00	117.94	0.897
Diarrhea	3.20	0.81	12.73	0.098	0.61	0.07	5.52	0.663
Earache	4.31	1.73	10.75	0.002	9.41	3.06	28.94	< 0.001
Eye irritation	2.89	1.03	8.12	0.044	14.42	4.37	47.59	< 0.001
Congestion‡	1.19	0.64	2.21	0.583	2.46	1.01	5.98	0.048
Sore throat‡	1.29	0.69	2.42	0.418	2.36	1.08	5.15	0.031
Cough‡	1.74	0.94	3.21	0.077	3.43	1.43	8.25	0.006
Headache	2.68	1.42	5.05	0.002	12.60	5.21	30.45	< 0.001
Numbness, tingling, or weakness in limbs†	3.15	1.09	9.06	0.033	11.09	3.42	35.96	< 0.001

*Adjusted for age, gender, race, income, village of residence, two levels of environmental concern, honeybucket use, and one level of tobacco exposure.
†These models also adjusted for self-reported diabetes
‡These models also adjusted for self-reported allergies and asthma
CI = Confidence interval

Table 4e. Adjusted* odds ratios for consumption of subsistence foods as a predictor of symptoms of poor health, Summer 2000

Symptom	Consuming subsistence foods more than half of the time			
	Odds ratio	95% CI lower	upper	p-value
Skin irritation/rash	0.59	0.20	1.72	0.333
Fever > 37.7 ^{o}C	0.87	0.18	4.33	0.869
Stomach upset	2.14	0.51	8.86	0.296
Diarrhea	0.54	0.31	0.96	0.034
Earache	0.24	0.05	1.12	0.070
Eye irritation	2.52	0.49	12.96	0.270
Congestion‡	0.84	0.30	2.39	0.747
Sore throat‡	0.67	0.27	1.65	0.384
Cough‡	0.30	0.12	0.75	0.010
Headache	1.94	0.68	5.58	0.217
Numbness, tingling, or weakness in limbs†	1.80	0.35	9.20	0.483

*Adjusted for age, gender, race, income, village of residence, two levels of environmental concern, honeybucket use, and one level of tobacco exposure.
†These models also adjusted for self-reported diabetes
‡These models also adjusted for self-reported allergies and asthma
CI = Confidence interval