

Cancer Incidence Among Minnesota Taconite Workers

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BACKGROUND

Minnesota's Taconite Mining industry:

- Minnesota is largest producer of iron ore and taconite in the United States.
- Industry contributes \$1.8 billion to state's economy.

Health Concerns:

- Workers are exposed to respirable dusts containing silica and elongated mineral particles which may be a risk to human health.
- In 1997, the Minnesota Department of Health reported an excess of mesothelioma in the northeastern region of the state.
- Concerns remain over the possible link between excess mesothelioma and other occupational diseases and the taconite mining industry.

Purpose:

- In response to public concerns about the health of Minnesota taconite workers, we evaluated the cancer incidence in this population.

MATERIALS AND METHODS

Study population:

- All workers who had ever been employed in the taconite mining industry before 1983
- Born in 1920 or later
- Alive in 1988 when the Minnesota Cancer Surveillance System (MCSS) was created
- 41,200 workers included in the analysis

Cancer identification:

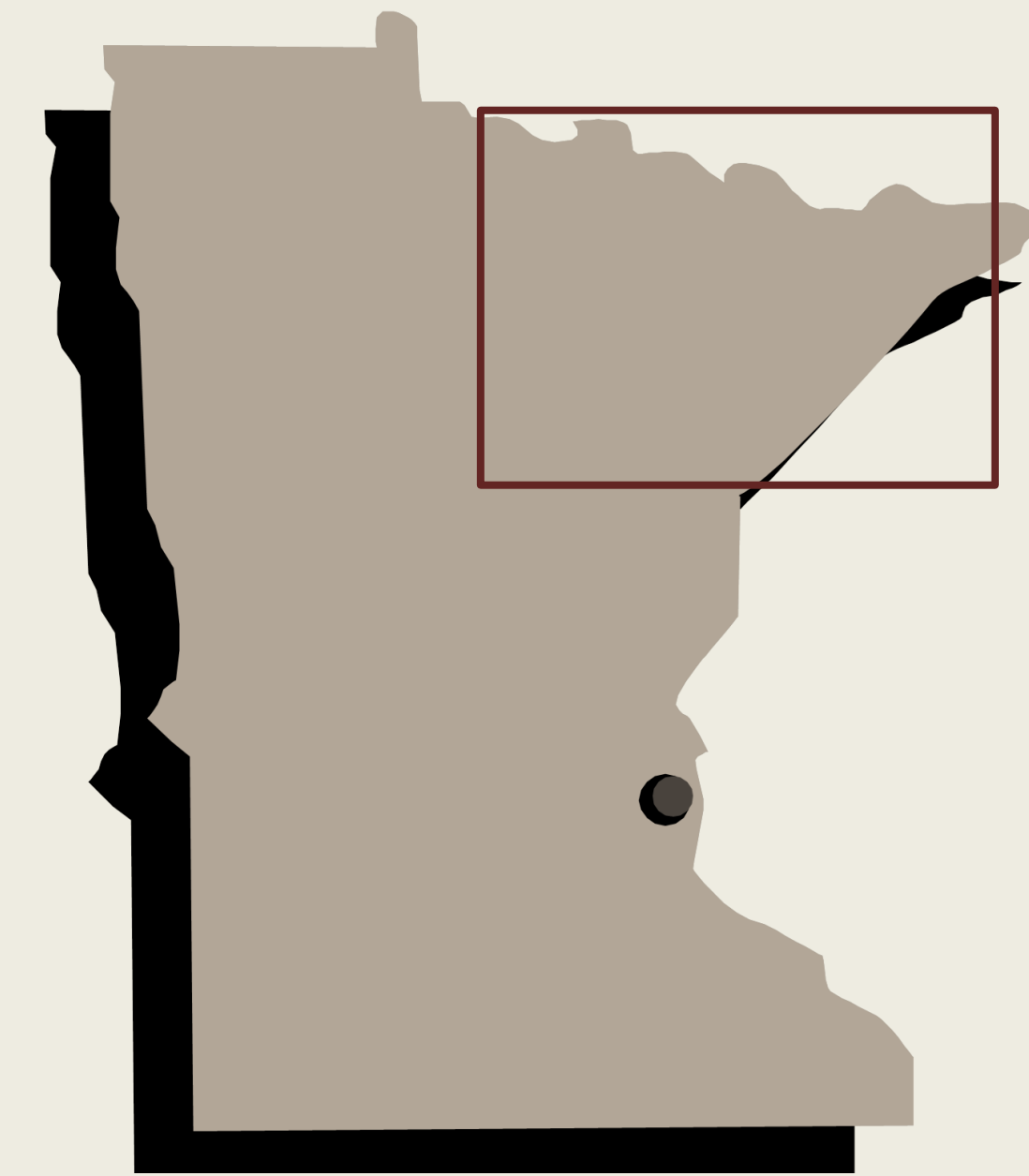
- Social security numbers, names, and dates of birth of cohort members linked to MCSS for cancer diagnosis
- Total of 6,121 cancers identified from 1988 through 2010

Standardized Incidence Ratio estimation:

- Person-years computed from 1988 until cancer diagnosis date or end of follow-up (December 31, 2010)
- Age and calendar period specific cancer rates in MN population applied to person-years of observation to estimate expected number of cancers
- Age and calendar period adjusted SIRs estimated: observed/expected cancers

Adjustment for out-of-state migration:

- Proportion of age-specific in-state deaths used to adjust person-time of the cohort residing in MN, and thus under MCSS surveillance



RESULTS

SIRs for Minnesota Taconite workers adjusted for out-of-state migration (Table 1)

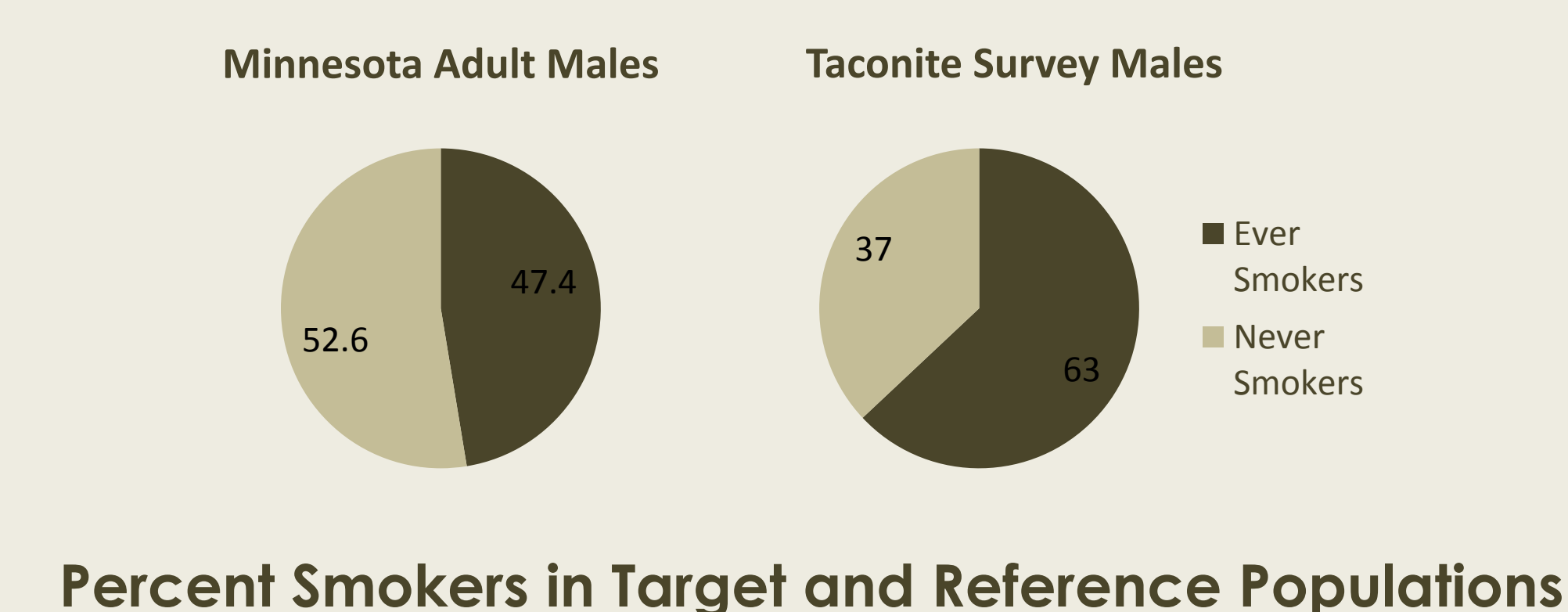
Cancer	Observed	Expected	SIR (95% CI) _{0.5}
Mesothelioma	51	21.1	2.4 (1.8, 3.2)
Lung	931	726.5	1.3 (1.2, 1.4)
Larynx	93	68.5	1.4 (1.1, 1.7)
Oral	165	159.9	1.0 (0.8, 1.0)
Bladder	359	336.7	1.1 (1.0, 1.2)
Esophagus	87	76.7	1.1 (0.9, 1.4)
Kidney	165	174.3	0.9 (0.8, 1.0)
Liver	50	48.6	1.0 (0.7, 1.3)
Pancreas	110	101.8	1.1 (0.9, 1.3)
Stomach	103	76.4	1.3 (1.1, 1.6)

Bias Factor for Smoking

Cancer incidence rate in cohort: $I_{exp} = I_0(Cx)(S_1) + I_0(1-S_1)$	S_1 = estimate of smoking prevalence in target population (questionnaire from subset of cohort)
Cancer incidence rate in Minnesota population: $I_{nonexp} = I_0(Cx)(S_0) + I_0(1-S_0)$	S_0 = estimate of smoking prevalence in reference population (MN Tobacco Survey)
Bias Factor: I_{exp}/I_{nonexp}	Cx = Cancer rate in smokers (vs non) I_0 = Cancer rate in non-smokers
Adjusted SIR = Observed SIR/Bias Factor	

Parameters used to estimate bias factor for smoking (Table 2 & Figure 1)

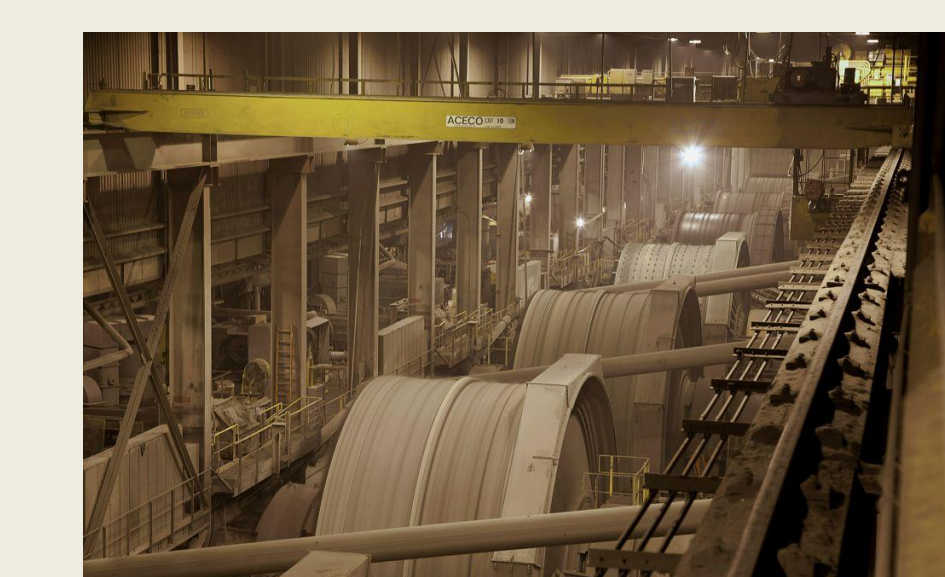
Cancer	Rate smokers vs non-smokers
Lung	10
Oral	27
Laryngeal	12
Bladder	3



SIRs for Minnesota Taconite workers adjusted with a bias factor for smoking (Table 3)

Cancer	Smoking Adjusted SIR (95% CI)
Lung	1.0 (0.9, 1.1)
Larynx	1.0 (0.8, 1.2)
Oral	0.8 (0.7, 0.9)
Bladder	1.0 (0.9, 1.1)

- The incidence of lung cancer and mesothelioma was higher than expected with SIRs of 1.3 (95% CI: 1.2-1.4) for lung cancer and 2.4 (95% CI: 1.8-3.2) for mesothelioma.
- Other elevated cancers include stomach, laryngeal, and bladder cancers.
- After adjusting with a bias factor for smoking, cancer incidence was as expected in Minnesota for smoking related cancers.



Open pit taconite mines. Taconite processing. Final product: steel pellets. (photos 1-3)

CONCLUSIONS

This preliminary analysis suggests taconite workers in Minnesota have an increased risk for certain cancers. The adjustment for smoking appears to reduce the risk for four smoking-related cancers in the population suggesting that lifestyle factors may play a significant role. The extent to which mining-related exposures contribute to disease burden is being explored.

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