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1 on the rest of the state (146 cases, rate ratio (RR)=2.1, 95%CI=1.8–2.5), while the rate in
2 females was less than expected (RR=0.72, 95%CI=0.38–1.2). The fact that the excess of
3 mesothelioma was only observed among males strongly suggests an occupational
4 etiology. In addition to the taconite industry, a plant producing asbestos ceiling tiles
5 (Conwed Corporation) was located in the northeastern Minnesota region. From 1958–
6 1965 amosite was used at Conwed, and from 1966–1974 chrysotile was used [Mandel
7 2008]. The MDH has initiated epidemiological studies of mesothelioma incidence
8 among workers at the Conwed Corporation and at the iron mines in northeastern
9 Minnesota. The records from a cohort of approximately 72,000 iron miners and from
10 5,700 Conwed workers have been linked with a mesothelioma data registry. Between
11 1988 and 2007, a total of 58 mesothelioma cases have been identified among the miners
12 and 25 cases have been identified among the Conwed workers. Because only 3 of the 58
13 mesothelioma cases identified in the miner cohort had also been employed at Conwed, it
14 is unlikely that the mesothelioma excess in miners could be explained by asbestos
15 exposures during employment at the Conwed ceiling tile facility [MDH 2007].
16

17 Brunner et al. [2008] have recently reported findings from an MDH study of
18 mesothelioma cases occurring among iron miners between 1988 and 1996. The job
19 histories of the cases were reviewed for evidence of exposure to commercial asbestos.
20 Mining jobs were identified from company personnel files. Non-mining employment
21 information was obtained from worker application files, worker compensation records,
22 and obituaries. Potential asbestos exposures for jobs held in the mining industry were
23 identified by conducting interviews of 350 workers representing 122 occupations and 7
24 different mining companies. To estimate the probability and intensity of potential
25 exposure to commercial asbestos in each of the jobs, an expert panel rated the potential
26 for asbestos exposure based on these interviews, available job descriptions from the
27 relevant time period, and their knowledge of the mining environment. Fifteen of 17 iron
28 miners known to have developed mesothelioma were judged to have sufficiently good
29 work histories for the study. Eleven of the cases were reported to have had probable
30 exposure, and 3 were reported to have possible exposure to commercial asbestos. The
31 asbestos exposures were from non-mining jobs (4 cases), mining jobs (4 cases), or both
32 (6 cases). The findings from this study suggest that the excess of mesothelioma observed
33 among taconite miners might be explained by exposure to commercial asbestos rather
34 than from the nonasbestiform amphibole EMPs generated during iron ore processing.
35 However, this being a case series, it was not possible to determine whether commercial
36 asbestos exposure was different in the cases than in the cohort as a whole or in a control
37 group. This study also did not include the 41 additional mesothelioma cases that have
38 been reported by the MDH since 1996 [MDH 2007].
39

40 In summary, the results from cohort mortality studies of taconite miners and millers in
41 Minnesota have not provided any evidence of an increased risk of respiratory cancer or
42 mesothelioma. This appears to be somewhat in conflict with reports from the MDH that
43 mesothelioma incidence is significantly elevated among males (but not females) in
44 northeastern Minnesota and that a large number of these cases were workers in the

1 Minnesota taconite industry. There is some evidence that these cases could, at least in
2 part, be related to exposures to commercial asbestos that occurred in or outside of the
3 taconite mining industry, but further research on this question is needed. The MDH is
4 currently working with researchers at the University of Minnesota, School of Public
5 Health on a mesothelioma case-control study, a respiratory morbidity study, and a
6 mortality study of the iron miners of northeastern Minnesota [MDH 2007].
7

8 *Summary of Epidemiological Studies of Cohorts Exposed to Nonasbestiform EMPs*

9 The results from studies of populations reportedly exposed to nonasbestiform EMPs do
10 not provide clear answers regarding the toxicity of these EMPs. There are a number of
11 features of these studies that limit their usefulness for answering these questions. First,
12 the populations in these studies were exposed to a complex mixture of particles.
13 Nonasbestiform EMPs generally represented only a small component of airborne
14 exposures, which included other minerals such as silica that are known to cause lung
15 diseases. Thus, although an excess of pneumoconiosis has been observed in the studies
16 of Homestake gold miners and New York talc workers, the extent to which these findings
17 are attributable to their exposures to nonasbestiform EMPs cannot be determined. A
18 potential limitation of the New York talc studies is that if the EMPs do include
19 asbestiform minerals as reported in the NIOSH [1980] study, it is difficult to determine
20 whether the observed health effects are from asbestiform or other EMPs.
21

22 Another major limitation of these studies is that they lack adequate information on past
23 exposure to EMPs. An excess of respiratory cancer was observed in the occupational
24 studies of New York talc workers and a small excess was observed in the most recent
25 study of Homestake gold miners. In both studies, the excess of respiratory cancer was
26 not found to increase with cumulative exposure to dust. Relationships between health
27 outcomes and exposure to an agent of interest can be attenuated when a nonspecific
28 exposure indicator is used as a surrogate for exposure to that agent [Blair et al. 2007;
29 Friesen et al. 2007]. Thus, when the exposure index used to assess the effect of EMPs is
30 based on a surrogate measure, such as respirable dust, rather than on specific
31 measurement of EMP concentrations, the lack of an exposure-response relationship
32 between the exposure index and the health outcome must be considered suspect,
33 particularly where the composition of a mixed exposure varies by work area.
34 Interpretation of findings from the New York talc studies has been further complicated by
35 the employment of the workers elsewhere, including employment at other talc mines in
36 the area. Lack of positive findings from exposure-response analyses in the New York
37 talc studies of RTV miners and millers could also have resulted from exposure
38 misclassification—possible under-ascertainment of exposure to talc and other mineral
39 particles caused by not considering exposures at neighboring talc mines.
40

41 The reliability of death certificate information is another major limitation, particularly for
42 the diagnosis of mesothelioma. Mesothelioma did not have a discrete ICD code until the
43 10th revision of the ICD, used for U.S. death certificate data only since 1999. This likely
44 explains the discordance between the apparent recent lack of excess mesothelioma deaths