

FILE NAME: Brakes (BRK)

DATE: 2011

DOC#: BRK218

DOCUMENT DESCRIPTION: Journal Article - Asbestos Fiber Concentrations
in the Lungs of Brake Repair Workers

RESEARCH ARTICLE

Asbestos fiber concentrations in the lungs of brake repair workers: commercial amphiboles levels are predictive of chrysotile levels

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Abstract

Objectives: To investigate the impact of extreme data points in Finkelstein's 2009 findings of no association between lung levels of commercial and non-commercial amphiboles (principally tremolite as a marker for chrysotile asbestos) in brake repair workers with mesothelioma.

Methods: We first identified potential outliers, high leverage points, and influential points among lung levels of commercial amphiboles and tremolite among 15 persons whose only known exposure to asbestos was through brake repair work. We used sensitivity analysis and quantile regression to account for extreme data points and model commercial amphibole levels as a predictor of tremolite levels. We also used quantile regression to evaluate whether case-reported duration of employment as a brake repair worker predicted lung levels of commercial amphiboles or tremolite.

Results: We found lung levels of commercial amphiboles are a statistically significant predictor of tremolite levels via sensitivity analysis ($r=0.82$, slope estimate P -value = 0.001, $R^2=0.68$) and quantile regression (slope estimate P -value < 0.0001). Our data provide no evidence that duration of employment as a brake repair worker was a predictor of lung levels of tremolite or commercial amphiboles.

Conclusions: Our findings suggest that elevated lung levels of tremolite in the lungs of brake repair workers with elevated levels of amphiboles arose from concurrent exposures to commercial amphibole and chrysotile asbestos in occupational settings other than brake repair work. These findings are supported by five new cases. The weight of the scientific evidence does not support a role for occupational exposure to brake dust and other friction products in the development of mesothelioma.

Keywords: Asbestos, amphiboles, tremolite, chrysotile, amosite, crocidolite, occupational diseases, lung cancer, mesothelioma, robust regression, sensitivity analysis

Introduction

Canadian chrysotile, which accounted for the vast majority of chrysotile used in the United States in the manufacture of asbestos products, is well-recognized to be contaminated with tremolite. It has been suggested that tremolite might be a reasonably good biomarker for exposure to Canadian chrysotile, as chrysotile tends to be degraded and removed from the lungs over time, whereas amphiboles like tremolite are more biopersistent

(Churg, 1988). Indeed, analyses of lung tissue samples from Canadian chrysotile miners and millers have shown predominance of tremolite fibers (Churg et al., 1993). Furthermore, mesothelioma occurrence among Canadian miners and millers correlates best with the degree of tremolite contamination in the various mines (McDonald et al., 1997).

In 2002, Roggli et al. reported the correlation between type of occupational asbestos exposure and asbestos fiber

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(Received 19 February 2011; revised 05 April 2011; accepted 08 April 2011)

lung burden levels for 1445 malignant mesothelioma cases. Butnor et al. (2003) reported results of lung fiber analysis for 10 malignant mesothelioma cases from Roggli et al. (2002) whose only known exposure to asbestos was occupational contact with friction products (e.g. brake dust as a brake repair worker). Commercial amphiboles (amosite or crocidolite asbestos) were found in eight cases with excessive commercial amphibole fibers found in five of the cases. The authors concluded that the presence of the elevated commercial amphiboles in the lungs of some of these cases suggested exposures other than occupational exposure to brake dust, which contains small amounts (0.1–1%) of mostly short (<1 µm in length) chrysotile asbestos fibers (Lynch, 1968; Hatch, 1970; Davis and Coniam, 1973; Williams and Muhlbaier, 1982; Wong, 2001).

Finkelstein (2008) reported a reanalysis of the data in Butnor et al. (2003) using an alternative computation for mean fiber concentration, which resulted in mean concentrations of non-commercial asbestos exposure (principally tremolite, with some actinolite and anthophyllite, measured as a marker of chrysotile exposure) that were higher than reported by Butnor et al. (2003). In a letter to the editor, Roggli et al. (2009) considered this finding consistent with those of Butnor et al. (2003). In response to the Roggli et al. (2009) letter, Finkelstein (2009) concluded from a regression analysis of the same 10 cases (Butnor et al., 2003) that levels of commercial amphiboles are not predictive of the levels of tremolite (as a marker of chrysotile exposure), thus implicating exposure to chrysotile fibers from friction products as a causative factor for these mesothelioma cases.

We questioned the validity of Finkelstein's 2009 conclusion due to the observation in his Figure 1 of at least two extreme data points that were not appropriately weighted in the regression analysis. The purpose of our

reanalysis reported here was to investigate the robustness of Finkelstein's 2009 findings with respect to the presence of these extreme points. Our reanalysis also extends the work of Finkelstein (2009) by including amphibole and tremolite fiber concentration levels for five new cases of malignant mesothelioma from the Roggli et al. case series whose only known asbestos exposure was occupational contact as a brake repair worker. We also examined whether case-reported duration of employment as a brake repair worker was a predictor of lung levels of commercial amphiboles or tremolite.

Methods

We abstracted from Butnor et al. (2003) data on the levels of commercial amphibole fiber and tremolite fiber found in the lungs of 10 mesothelioma cases used in the Finkelstein (2008, 2009) analyses. The 10 cases from Butnor et al. (2003) were selected on the basis of three criteria: (1) having mesothelioma, (2) only known asbestos exposure was occupational contact as a brake repair worker, and (3) lung tissue was available for analysis. In the process of preparing this manuscript, we identified and corrected three errors in Butnor et al. (2003) related to the lung fiber levels of two of the 10 cases. Specifically, for Case 2, the commercial amphiboles level changed from 4810 to 3940; for Case 3, commercial amphiboles changed from 380 to 970 and tremolite changed from 4630 to 4110. We also included lung levels of commercial amphibole and tremolite fibers for the five new mesothelioma cases from the Roggli et al. series who were observed since the publication of Butnor et al. (2003) and who met the same three inclusion criteria. We also included information on case-reported duration of employment as a brake repair worker for all 15 cases (Table 1).

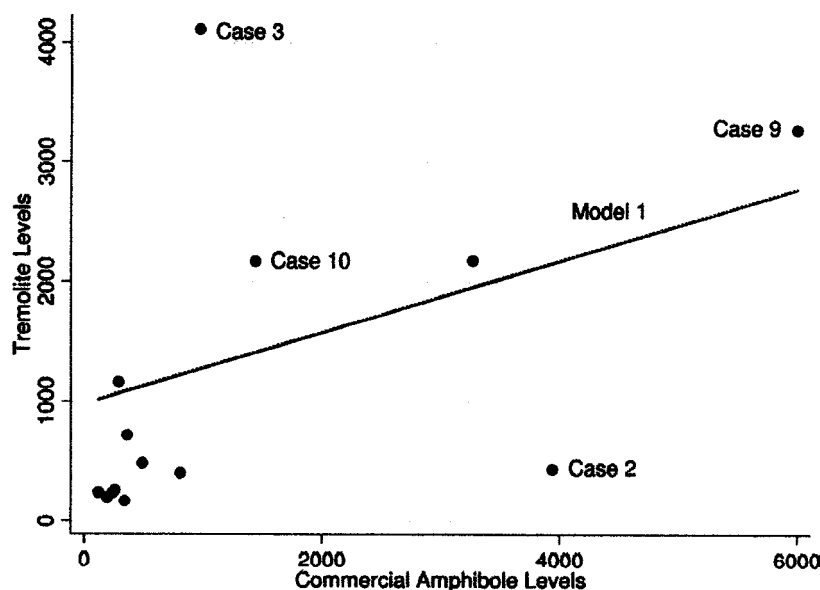


Figure 1. The relationship between the levels of commercial amphibole fibers and tremolite fibers in the lungs of brake repair workers: fitted simple linear regression model with 10 original data points (Model 1). From Butnor et al. (2003) and revised per Methods section.

Fiber analyses and ascertainment of the diagnosis of mesothelioma in the five new cases were as described previously by Butnor et al. (2003) and are summarized in Table 2 along with other relevant case information. All were males with ages ranging from 40 to 70 years (median: 58 years). Four were pleural mesotheliomas and one was peritoneal. Four out of five were smokers or ex-smokers. The length of employment as a brake repair worker ranged from 5 to 32 years (median: 20 years).

As in previous analyses (Roggli et al., 2002; Butnor et al., 2003; Finkelstein, 2009), we substituted a value of 1/2 the detection limit for fiber levels below the limit of detection. Cases with a less than (<) sign before the value are at the detection limit for that value. For example, as shown in Table 1, in Case 11 no asbestos fibers were

detected and the detection limit was 520. In Case 12, the asbestos body count is clearly elevated and a single crocidolite fiber was identified by SEM; the detection limit was 810 for that case. The detection limit varies from case to case because the amount of tissue available to analyze varied from case to case (i.e. the weight of the sample). For Case 15, one commercial amphibole fiber and one non-commercial amphibole fiber were identified. Chrysotile was not detected (Table 2).

We recognized that 15 cases represent a relatively small sample from which to infer whether tremolite levels are correlated with commercial amphibole levels or whether either level is correlated with duration of employment. Moreover, many data points for amphibole and tremolite levels were below the detection limit (non-detects). These

Table 1. Lung levels of commercial amphiboles and tremolite and reported duration of employment for 15 mesothelioma cases whose only known exposure to asbestos was occupational contact as a brake repair worker.

Case	Commercial amphiboles ^{a,d}	Tremolite ^{a,d}	Duration of employment (years)
1 ^a	3270	2180	37
2 ^a	3940	440	27
3 ^a	970	4110	24
4 ^a	<720 (used 360)	720	40
5 ^a	<580 (used 290)	1160	11
6 ^a	490	490	7
7 ^a	340	<340 (used 170)	15
8 ^a	120	240	40
9 ^a	6000	3280	17
10 ^a	1440	2170	24
11 ^b	<520 (used 260)	<520 (used 260)	5
12 ^b	810	<810 (used 405)	7
13 ^b	<480 (used 240)	<480 (used 240)	25
14 ^b	<390 (used 195)	<390 (used 195)	32
15 ^b	490	490	20

^aData abstracted from Butnor et al. (2003) and revised per Methods section.

^bNew cases from Roggli case series.

^cFibers per gram of wet lung tissue for fibers 5 µm or greater in length.

^dOne-half the detection limit value used in analysis and shown in parentheses.

Table 2. Demographic, pathologic, and occupational information, and results of lung tissue analysis for five new mesothelioma cases whose only known exposure to asbestos was occupational contact as a brake repair worker.

Case (from Table 1)	Age (years)/sex	Tumor type/site	Occupation	Smoking (pack-year)	Pleural plaque	AB/g ^a	Chrysotile ^b
11	69/M	BPl	Brake and clutch repair (IH)	1–1.5 ppd (XS—5 years)	ND	<7	<520
12	70/M	EPl	Auto mechanic	Pipe (XS—many years)	ND	90	<810
13	58/M	EPl	Auto mechanic	NS	ND	6.7	<480
14	58/M	EPl	Auto mechanic	1.5 ppd 45 years	ND	<29	<390
15	40/M	EPe	QC parts inspector	0.5 ppd 23 years	ND	2	<490
Median	58	—	—	—	—	<7	<490
Reference cases ^c	—	—	—	—	—	3 (<0.2–22)	<600 (<100–1000)

B, Biphasic; E, epithelial; IH, International Harvester; M, male; ND, not determined; NS, non-smoker; Pe, peritoneal; Pl, pleural; ppd, packs per day; QC, quality control; XS, ex-smoker.

AB, asbestos bodies; NAME, non-asbestos mineral fiber.

^aAB/g, asbestos bodies/g wet lung by light microscopy.

^bTotal coated (AB) and uncoated fibers ≥5 µm (length)/g wet lung as determined by scanning electron microscopy and energy dispersive X-ray analysis.

^cMedian values and range (in parentheses) for 20 cases with normal lungs at autopsy, normal range tissue asbestos body counts, and no evidence of asbestos-related disease (Butnor et al., 2003).

limitations notwithstanding, these 15 cases represent all eligible cases from the Butnor et al. (2003) and Roggli et al. case series. Obtaining additional cases and/or using or developing methods that lower fiber detection levels were not practical options for our analysis.

We first attempted to replicate the Finkelstein (2009) results by fitting a simple linear regression on the 10 data points from Butnor et al. (2003). Second, to assess whether commercial amphiboles are predictive of tremolite levels, we performed a simple linear regression and used regression diagnostics to locate any potential outliers, high leverage, or influential points using all 15 data points. An outlier is defined as any point with a large residual (difference between observed and fitted values) value, a high leverage point is an observation with an extreme value in one of the predictor variables, and an influential point is one that substantially changes the estimates of the coefficients when removed. A standardized residual is the residual divided by the estimate of its standard error. Any standardized residual value over 2.0 is typically considered to be large. A standard marker for high leverage is anything greater than $3(k+1)/n$, where k is the number of predictors in the model and n is the sample size. Criteria for a point to be considered a highly influential point is typically any value larger than $4/n$ (Chatterjee and Hadi, 2006). We then performed a sensitivity analysis by removing any points that were considered to be extreme (outliers, high leverage, or influential), refitting the regression model and comparing these results to the model based on all 15 points.

We also fit a quantile regression model to account for the undue influence of the extreme points without omitting them as in the sensitivity analysis. Unlike simple linear regression, which is based on a least squared deviation criterion, quantile regression minimizes the sum of absolute residuals using a linear absolute value function. Because this function is symmetric, minimizing the sum of absolute residuals ensures that the same number of observations occur above and below the median. Because the quantile regression model estimates the relationship between a predictor variable(s) and specific quantiles of the outcome variable (rather than the mean of the outcome variable as in simple linear regression), the parameter estimates are robust with respect to large outliers or influential points (Koenker and Hallock, 2001; Hao and Naiman, 2007; Cameron and Trivedi, 2009).

We also used simple linear regression and quantile regression to evaluate the relationship between duration of employment as a brake repair worker and lung levels of commercial amphiboles or tremolite. All statistical models were fit using the Stata Statistical Software Release 11 (StataCorp, 2009).

Results

While data are not shown here, we replicated exactly the simple linear regression results of Finkelstein (2009). Using

the revised data for Cases 2 and 3, we refit the simple linear regression model as shown in Model 1 and Figure 1:

$$\begin{aligned} \text{Tremolite level} = \\ 981.01 + 0.29 (\text{commercial amphiboles level}) \\ (\text{Model 1}) \end{aligned}$$

As found using the original data, commercial amphiboles level was not a statistically significant predictor of tremolite ($r = 0.43$, slope estimate P -value = 0.21) and the $R^2 = 0.19$ was low indicating a poor fit (only 19% of the variance explained by Model 1).

We refit the Finkelstein (2009) model using all 15 data points as shown in Model 2 and Figure 2:

$$\begin{aligned} \text{Tremolite level} = \\ 615.09 + 0.38 (\text{commercial amphiboles level}) \\ (\text{Model 2}) \end{aligned}$$

Unlike Model 1, commercial amphiboles level was a statistically significant predictor of tremolite ($r = 0.53$, slope estimate P -value = 0.04) but the $R^2 = 0.28$ was low indicating a poor fit (only 28% of the variance explained by Model 2). Model 2 remains an inferior model because it does not properly account for extreme values.

In Models 1 and 2, Case 2, Case 3, and possibly Cases 9 and 10 appear as extreme points that could affect the fitted line (Figures 1 and 2). We performed regression diagnostics to determine if these points were in fact causing undue influence to the fitted equation. Table 3 shows the computed residuals, standardized residuals, leverage, and influence statistics. For these data, the cutoff for high leverage is 0.40 and for a highly influential point it is 0.27. In Table 3, the highlighted values are those that exceed the typical cutoff values. Case 3 is an outlier and an influential point. Cases 2 and 10 also have the potential to be outliers as their residuals are much larger than the other residuals. Case 2 is also an influential point. Case 9 is a high leverage point.

We performed a sensitivity analysis by refitting the simple linear regression of tremolite versus commercial amphiboles with the three extreme points removed (Cases 2, 3, and 9). Case 10 was not removed because the cutoff was not exceeded for the standardized residual, leverage, and influence. The fitted line without these three points is shown in Model 3 and Figure 2:

$$\begin{aligned} \text{Tremolite level} = \\ 257.49 + 0.68 (\text{commercial amphiboles level}) \\ (\text{Model 3}) \end{aligned}$$

The constant term in Model 3 is about 1/3 that of Model 2 and the slope estimate for commercial amphiboles increased almost 2.5-fold. Commercial amphibole concentration is now a statistically significant predictor of tremolite ($r = 0.82$, slope estimate P -value = 0.001) and the $R^2 = 0.68$ (68% of the variation is explained by this Model 3).

The fitted quantile regression model is shown in Model 4 and Figure 2:

$$\begin{aligned} \text{Tremolite level} = \\ 177.96 + 0.52 (\text{commercial amphiboles level}) \\ (\text{Model 4}) \end{aligned}$$

As revealed by the slope estimates and the fitted lines in Figure 2, Model 4 falls between the model using all 15 points (Model 2) and the model with the three extreme points omitted (Model 3). In our quantile regression model that properly accounts for extreme values without

omitting them (Model 4), commercial amphibole concentration is a statistically significant predictor of tremolite concentration (slope estimate P -value < 0.0001). The correlation coefficient and R^2 are not shown for the quantile regression as no accepted method exists for calculating these statistics.

Figures 3 and 4 show the scatterplots of duration of employment and lung levels of tremolite and commercial amphiboles, respectively, as well as the fitted lines based on the simple linear regression and quantile regression. Each scatterplot reveals evidence of influential points. The fitted quantile regression models are given by:

$$\text{Tremolite level} = 359.23 + 6.54 (\text{duration of employment})$$

$$\text{Commercial amphiboles level} =$$

$$517.58 - 3.94 (\text{duration of employment})$$

Neither model revealed any evidence that duration of employment as a brake repair worker was a predictor of lung fiber level (slope estimate P -values = 0.90 for both models).

Discussion

Regression diagnostics, sensitivity analysis, and quantile regression are rigorous, well-accepted, and commonly used analytical procedures to ensure that the fit of a particular statistical model is not overly influenced by one or few observations (Koenker and Hallock, 2001; Chatterjee and Hadi, 2006; Hao and Naiman, 2007; Cameron and Trivedi, 2009). Our use of these rigorous procedures clearly showed that four extreme data points (Cases 2, 3, 9, and 10) led Finkelstein (2009) to conclude incorrectly

Table 3. Results of regression diagnostics: residuals, standardized residuals, leverage and influence.

Case	Residuals	Standardized residuals	Leverage	Influence
1 ^a	318.583	0.317	0.160	0.010
2 ^a	-1676.780	-1.745	0.234	0.465
3 ^a	3125.201	2.951	0.069	0.322
4 ^a	32.305	-0.031	0.087	0.0001
5 ^a	434.374	0.415	0.090	0.008
6 ^a	-311.853	-0.296	0.081	0.004
7 ^a	-574.682	-0.548	0.088	0.014
8 ^a	-420.832	-0.404	0.099	0.009
9 ^a	378.076	0.540	0.594	0.213
10 ^a	1006.066	0.949	0.067	0.032
11 ^b	-454.191	-0.434	0.091	0.009
12 ^b	-518.827	-0.491	0.072	0.009
13 ^b	-466.569	-0.446	0.092	0.010
14 ^b	-494.417	-0.473	0.095	0.012
15 ^b	-311.853	-0.296	0.081	0.004

^aData abstracted from Butnor et al. (2003) and revised per Methods section.

^bNew cases from Roggli et al. case series.

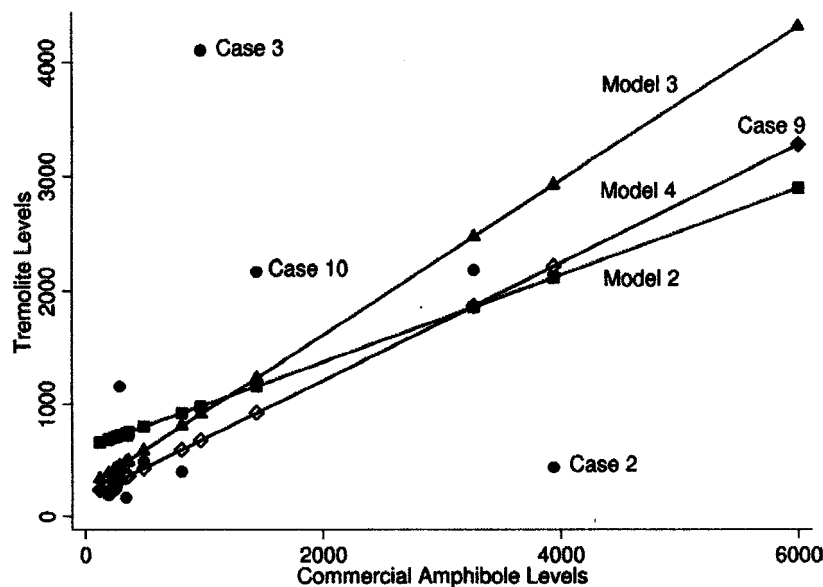


Figure 2. The relationship between the levels of commercial amphibole fibers and tremolite fibers in the lungs of brake repair workers: fitted simple linear regression model with all 15 data points (Model 2) and omitting three extreme points (Model 3). Also showing quantile regression model (Model 4). From Butnor et al. (2003) and revised per Methods section, and including five new cases from Roggli et al. case series.

that lung levels of commercial amphiboles are not predictive of the levels of tremolite as a marker of chrysotile asbestos. When we removed or properly accounted for these extreme observations using an appropriate regression model, we found that lung levels of commercial amphiboles are a statistically significant predictor of lung levels of tremolite.

We performed several confirmatory analyses to determine if our results were sensitive to the method of data substitution or data analysis. For example, since quantile regression is only one of several statistical approaches for handling data sets that deviate from the

usual assumptions of simple linear regression, such as extreme observations and absence of homoscedasticity, we fit two regression models as alternatives to Model 4. We also evaluated whether the results of Model 4 and the alternative models were sensitive to the method used (1/2 detectable level (DL)) for substituting values for non-detectable lung levels of asbestos. Finally, we refit Models 2–4 using the original 10 data points reported by Finkelstein (2009) and revised per the Methods section.

The first alternative regression model considered was robust regression. This model first removes points with an influence statistic greater than 1.0 (none in our

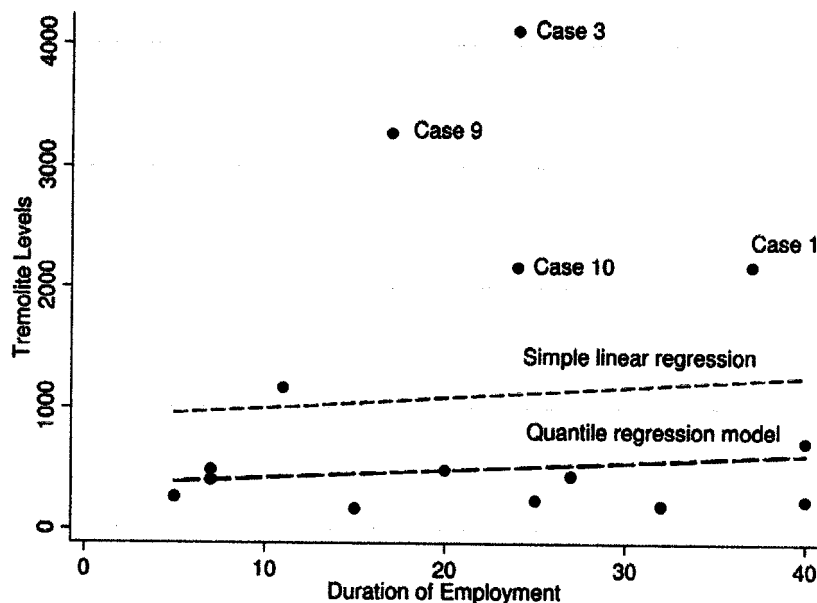


Figure 3. The relationship between duration of employment as a brake repair worker and the levels of tremolite fibers in the lungs of brake repair workers: fitted simple linear regression model with all 15 data points and quantile regression model.

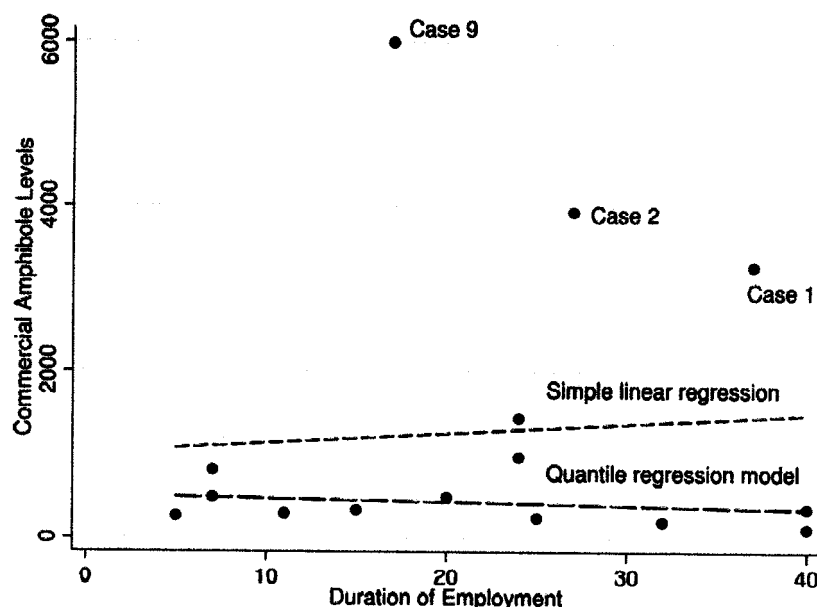


Figure 4. The relationship between duration of employment as a brake repair worker and the levels of commercial amphibole fibers in the lungs of brake repair workers: fitted simple linear regression model with all 15 data points and quantile regression model.

analysis), then performs a weighted least squares regression using weights that give small or zero weight to points with large residuals (Berk, 1990; Chatterjee and Hadi, 2006). In the second alternative regression model, an unweighted least squares criterion (simple linear regression) was used to fit logarithmic-transformed values of tremolite and commercial amphibole lung levels. Here, the logarithmic transformation gives less weight to the extreme values. Alternative methods considered for the substitution of non-detects were $DL/2^{1/2}$ and $2DL/3$ as proposed by Sanford et al. (1993) and discussed by Helsel (2006, 2010).

Although data are not shown here, both alternative regression models considered led to similar fitted models that corroborated the central result of Model 4, that is, lung levels of commercial amphiboles are a statistically significant predictor of lung levels of tremolite. Moreover, the choice of non-detect substitution method had negligible impact on the $DL/2$ -based results of Model 4 and the two alternative regression models. We also found similar results when Models 2–4 were refit using the 10 original data points revised per the Methods section.

Our finding that lung levels of commercial amphiboles predict lung levels of tremolite was supported by our related findings that case-reported duration of employment as a brake repair worker was not associated with lung levels of tremolite or commercial amphiboles. That is, one would expect lung levels of tremolite (chrysotile) to increase with increasing duration of employment only if there was an association between friction products and mesothelioma. Also, because automotive brakes in the United States include only the chrysotile form of asbestos, one would not expect lung levels of commercial amphiboles to increase with increasing duration of employment as a brake repair worker. This lack of correlation between exposure duration and lung levels of tremolite or commercial amphiboles is an important and heretofore unreported observation, although the raw data were available in the original Butnor et al.'s (2003) work. Thus, our findings suggest that elevated lung levels of tremolite (as a marker of chrysotile) in the lungs of some brake repair workers with elevated levels of amphiboles arose from concurrent exposures to commercial amphibole and chrysotile asbestos in occupational settings other than brake repair work.

Regarding the study by Butnor et al. (2003), some investigators have questioned the validity of using scanning electron microscopy (SEM) for the analysis of lung tissue samples. Reanalyzing lung tissue from Case 1 of Butnor et al. (2003), Dodson et al. (2008) claimed that transmission electron microscopy (TEM) is the superior instrument. As we have stated elsewhere, this is a moot point, because lung fiber burden studies of mesothelioma using TEM have come to similar conclusions as studies using SEM (Srebo et al., 1995; Roggli and Vollmer, 2008; Roggli et al., 2008). Moreover, studies from two laboratories employing TEM to analyze a smaller number of lung

tissue samples of brake mechanics with mesothelioma found similar results to those we reported. Dodson et al. (2005, 2008) reported two cases of mesothelioma (one in a brake mechanic and the other an auto machinist), both of which had elevated levels of commercial amphiboles (the auto machinist case was a reanalysis of Case 1 from Butnor et al., 2003). In fact, Hammar and Dodson have written elsewhere that "the question as to whether automotive mechanics ... have an increased risk of malignant mesothelioma remains unresolved and contentious" (Hammar et al., 2008). Furthermore, Gordon and Dikman reported eight cases of mesothelioma in brake mechanics. All eight had only chrysotile in their lung tissue samples, and the chrysotile in each instance was within their reported background population range (Gordon and Dikman, 2009). Because the findings in these two TEM studies are the same as what we have reported (either background levels of asbestos or elevated commercial amphiboles with or without elevated tremolite or chrysotile), there is no validity to the claim that TEM is superior to SEM for this purpose.

As noted in the study of Butnor et al. (2003) and summarized here, our reanalysis and extension of the work of Finkelstein (2009) has some underlying limitations. First, our reanalysis is based on a case series of 15 medico-legal cases that may not be representative of all individuals exposed to friction products occupationally. Also, historical information obtained by patient interview is subject to recall bias for events occurring decades previously. This may explain the absence of reported exposures to commercial amphiboles among the cases considered. Additionally, many data points for amphibole and tremolite levels associated with the 15 cases were below the detection limit (non-detects). As non-detects can complicate statistical analysis, they reflect the very low levels of asbestos in lung tissue, which in itself is indicative of a lack of a relationship between asbestos exposure and mesothelioma in brake repair workers.

Conclusions

Finkelstein's 2009 finding that lung levels of commercial amphiboles are not predictive of the levels of tremolite asbestos (chrysotile) is invalid because the regression analysis did not properly account for extreme data points. Our regression diagnostics, sensitivity analysis, quantile regression, and evaluation of reported duration of employment as a brake repair worker suggest that elevated lung levels of tremolite (chrysotile) in the lungs of brake repair workers with elevated levels of amphiboles arose from concurrent exposures to commercial amphibole and chrysotile asbestos in occupational settings other than brake repair work. These findings are supported by the five additionally reported cases in the current study. Despite suggestions to the contrary by Dodson et al. (2008) and Finkelstein (2008, 2009), the weight of the scientific evidence does not support a role

for occupational exposure to brake dust and other friction products in the development of mesothelioma.

Declaration of interest

Drs. Marsh and Youk performed this work (study and manuscript preparation) as a private consulting activity for Honeywell International, Inc. Dr. Marsh was on the Asbestos Panel of the Scientific Advisory Board of the US Environmental Protection Agency. He provided expert testimony for defendants in three asbestos litigation cases, including two involving friction products. Dr. Marsh also provided epidemiological and biostatistical consultation for defendants, including Honeywell, International, Inc., in cases involving friction products.

Dr. Youk was a statistical consultant and performed analyses in preparation for the trial of a defendant in an asbestos litigation case.

Dr. Roggli has served as an expert witness for both plaintiffs and defendants in asbestos litigation, including Honeywell in cases involving friction products.

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