Evidence that Reducing Knee Injuries in Underground Mining may have a Substantial Impact on Mine Company Finances

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ABSTRACT

The 2007 United States Mine Safety and Health Administration (MSHA) database reported 217 knee injuries in underground coal. From workers' compensation data, the National Institute for Occupational Safety and Health (NIOSH) determined that the average cost per knee injury in this industry was $13,121.29 yielding nearly three million dollars as an estimated financial burden of these injuries on the industry in 2007. (1) Recently, NIOSH has investigated various types of interventions that underground coal mining companies may implement as means of decreasing mine workers' risk for developing knee injuries. To encourage mining companies to implement this training program and interventions currently in development, NIOSH performed an analysis of workers' compensation data for one underground coal mine in Illinois and six in Pennsylvania. The data were for the 2004, 2005, and 2006 claim years of each mine and included medical and indemnity costs for injuries to each body part, the number of injuries per body part, and the annual audited payroll. The rating formulas for the respective states were utilized to determine workers' compensation premiums for 2008 which require injury data from 2004 to 2006. For each mine, the costs of workers' compensation premiums were determined with all the injuries reported. A second analysis was then performed whereby all knee injuries were excluded. By eliminating knee injuries, the annual workers' compensation premiums decreased by 1.1% to 16.2% depending on the mine's size and injury statistics. The savings that were observed ranged from $4,206, a 1.3% savings, to $1,454,767, a 6.4% savings. The cost of implementing the NIOSH recommended interventions is minimal; therefore, an overall savings for the mine would be expected. Moreover, NIOSH is continuing to develop other interventions to reduce the risk of knee injury as well such as a novel kneepad designed specifically for the low-seam mining environment.

INTRODUCTION

Musculoskeletal injuries in underground coal mining occur to a variety of body parts and include the neck, should, back, knee, wrist, etc. These injuries include strains and sprains, joint dislocations, fractures, etc. In 2007, for underground coal mining, 327 injuries to the back were reported while 217 were reported for the knee, 127 for the shoulder, and 66 for the neck. The total days lost was the greatest for back injuries with 22,390 total days lost. The knee resulted in the second largest days lost of these joints with 13,598 days lost. While many mining companies recognize the various benefits of investing in the reduction of back injuries, fewer resources have been invested in reducing knee injuries. However, knee injuries are a significant financial burden to the industry.

Injuries to the knee occur in both low- and high-seam mining environments. In low-seam mines, mine workers are restricted to kneeling, crawling, squatting, and duck walking postures which place substantial stress on the knee (2, 3) and often require the muscles of the leg to be active. (4) However, in high-seam environments, many injuries occur as a result of more diverse activities such as mine workers twisting their knee due to ground conditions. This may be due to the limited visibility associated with underground coal mining, poor ground conditions, or insufficient strength and flexibility of the leg muscles. From workers' compensation (WC) data, the National Institute for Occupational Safety and Health (NIOSH) determined that the average cost per knee injury in this industry was $13,121.29 (5) yielding nearly three million dollars as an estimated financial burden that these injuries imposed on self-insured mines and insurance providers in 2007. Self-insured mines pay for injuries directly and, thus, can easily determine the exact financial burden an injury has placed on the company. However, for those mines utilizing the WC system within their states, the actual financial burden an injury places on the

company is much more difficult to determine since these mines pay for their injuries indirectly via their WC premiums which are calculated using formulas and actuarial parameters.

Recently, NIOSH has investigated various types of interventions that underground coal mining companies may implement as means of decreasing mine workers' risk for developing knee injuries. These interventions include a training program that instructs mine workers how to identify symptoms of knee injuries and seek medical attention, redesign their work areas to reduce twisting on the knees, routinely move their knee joints through their full range of motion when kneeling or squatting for extended periods of time to increase joint nutrition, maintain good hygiene of clothing and kneepads to reduce injuries due to infected hair follicles, and implement at-home strengthening and stretching regimens for the leg muscles. (6) Other interventions are aimed at addressing the issue of poor visibility and include the use of a light-emitting diode (LED) cap lamp for improved illumination of the mining environment. (7-9)

The cost of implementing the NIOSH training program is minimal as mines are required to provide annual safety training whereby the NIOSH training program could easily be provided to the mine workers. Incorporating improved cap lamp technology is also a relatively minimal expense. It is important that mining companies utilize these interventions as they are likely to result in a decrease in knee injuries, as well as other injuries associated with poor lighting, in underground coal mining. Moreover, based on experimental data NIOSH collected during kneeling and crawling tasks, NIOSH is currently developing a novel kneepad design for low-seam mine workers that are restricted to their knees. This novel kneepad will better distribute the forces applied to the knee thereby decreasing the stress experienced at the knee and reducing injuries. As this device becomes available to the industry, implementation is encouraged.

Providing the mining industry with evidence that various interventions also have a financial benefit is helpful for encouraging mines to adopt these interventions as part of their safety and health programs. WC costs are directly associated with the number of injuries reported for a given entity and, to a lesser degree, the cost of these injuries. Even a modest reduction in injuries can have a large impact on premiums paid out by a company. Therefore, the goal of this study was to encourage mines to consider implementing various interventions that are likely to decrease knee injuries in underground coal by providing an estimate of the financial benefits in WC premiums that may be realized when these injuries are reduced.

METHODS

The WC methods utilized by two states were investigated: Pennsylvania and Illinois. Pennsylvania was selected because it has a unique formula for its WC calculations and is the only state to have a separate formula for underground mines. Illinois was selected as it is one of the states with the highest insurance rates.

Pennsylvania (PA)-Methods for Calculation of Workers' Compensation Premiums

Coal mines in PA are rated by the Coal Mine Compensation Rating Bureau of PA (CMCRB). Insurance providers offering coverage for coal mining in PA must be a member of the CMCRB. Several types of rating plans exist such as experience rating, manual rating, and merit rating. However, the majority of companies are evaluated with an experience rating plan. Therefore, only the experience rating plan will be discussed in this document. Any entity or company with a modified payroll of at least $300,000 during the three-year experience period qualifies for an experience rating.

Each year, the CMCRB sets a base loss cost rate (per $100 of payroll) which must be approved by the State Insurance Commissioner's Office. There are three components to the loss cost rate: federal black lung coverage, state black lung coverage, and traumatic coverage (10). Based on their three-year injury history, mines are either penalized or credited from this base loss cost rate. In order to determine whether a mine is penalized or credited from the base loss cost rate set by CMCRB, a modification factor, or MOD, is calculated for each mine. The MOD is defined as:

$$\text{MOD} = \left(\frac{\text{Adjustment Ratio}}{\text{Experience Rating Off - Balance Factor}} \right) \quad (1)$$

The Experience Rating Off-Balance Factor is obtained by using a table in Section VIII of the PA manual (11). This factor is what CMCRB uses to ensure that the experience rating plan is revenue neutral (i.e. premium volume overall stays the same when all ten classifications are pooled together). The Adjustment Ratio is calculated using four different parameters:

$$\text{Adjustment Ratio} = \text{Experience Ratio} \times (\text{BEC} + \text{REC}) + \text{NREC} \quad (2)$$

where,

Experience Ratio = calculated based on injury history and payroll (see Eq. 3)

BEC+REC = Basic plus Ratable Excess Component

NREC = Non-Ratable Excess Component

The experience ratio (see Eq. 3) consists of several parameters. The primary losses reported by a company are the first parameter. Primary losses, or basic losses reported (L_B in Eq. 3), are those losses associated with all injury claims, regardless of their value, up to the "primary limiting factor" which is $50,000. The secondary losses, or ratable excess losses (L_{EX} in Eq. 3), are all

losses beyond the primary losses associated with a claim, not to exceed $150,000. For example, for a $150,000 claim $50,000 would be primary losses and $100,000 would be secondary losses. The basic expected losses (EL_B in Eq. 3) are calculated based upon the mine's payroll. Specifically, the payroll for each year is multiplied by 0.01 (to put in terms of per $100 payroll) and then multiplied by the Basic Expected Losses Component (actuarial value obtained from the PA manual; use class 1001 for underground, bituminous coal) for that respective year. The values for each year are then summed together to yield the basic expected losses used in Eq. 3. The ratable excess losses (EL_{EX} in Eq. 3) are calculated similarly to the EL_B. The payroll for each year is multiplied by 0.01 (to put in terms of per $100 payroll) and then multiplied by the Ratable Excess Expected Losses Component (actuarial value obtained from the PA manual; use class 1001 for underground, bituminous coal) for that respective year. The values for each year are then summed together to yield the ratable excess expected losses (EL_{EX} in Eq. 3). The credibility factors (C_B and C_{EX}) are values obtained from the PA manual.

$$\text{Experience Ratio} = \frac{(L_B \times C_{\mathbf{B}}) + [EL_B \times (1 - C_B)] + (L_{EX} \times C_{EX}) + [EL_{EX} \times (1 - C_{EX})]}{EL_B + EL_{EX}} \quad (3)$$

L_B = Primary (Basic) Losses Reported

C_B = Basic Credibility

$EL_{\mathbf{B}}$ = Basic Expected Losses

L_{EX} = Secondary (Excess) Ratable Losses Reported

C_{EX} = Ratable Excess Creditability

EL_{EX} = Ratable Excess Expected Losses

Once the Experience Ratio is calculated, the Adjustment Ratio (Eq. 2) may be calculated. The Basic plus Ratable Excess Component (BEC+REC) and the Non-Ratable Excess Component are

actuarial values obtained by using a table in Section VIII of the PA manual (Note: these parameters are different from the Basic Expected Losses Component and the Ratable Excess Expected Losses Component described earlier). Companies are not individually penalized for injuries greater than $150,000 in value. Rather, these injuries are distributed across all experience rated mining companies using the Non-Ratable Excess Component as shown in Eq. 2. For this reason, the Non-Ratable Excess Component is not multiplied against the Experience Ratio.

Using the above-described three equations, any mine can calculate their MOD. This MOD is then used to determine whether or not the mine is penalized or credited with respect to the base loss cost rate. However, it should be noted that the MOD is only multiplied by the traumatic coverage (TC) portion of the loss cost rate and not the federal black lung (FBLC) and state black lung (SBLC) portions. It should also be noted that each insurance provider applies their own multiplier to the base loss cost rate to cover their administrative fees (e.g. taxes, overhead costs, costs associated with handling, settling, and defending claims). Thus, a company's WC premium per $100 of payroll would be determined as follows:

$$\text{WC Premium} = \text{admin fee multiplier} \times (\text{FBLC} + \text{CBLC} + \text{MOD} \times \text{TC}) \quad (4)$$

Pennsylvania –Expected Savings when Knee Injuries Avoided

WC data were obtained for six mines in PA for 2004, 2005, and 2006 allowing the WC premium for 2008 to be determined. These data included the audited payroll for each year, the number of injuries to each body part, and the losses (medical and indemnity) associated with each body part. In 2008, for bituminous, underground coal, the base loss cost rate was $0.93, $0.88, and $14.58 per $100 payroll, for federal black lung coverage, state black lung coverage,

and traumatic coverage, respectively (effective: April 1, 2008 – April 30, 2009; (10)). This yielded a base loss cost rate of $16.39 in 2008 for bituminous, underground coal. In PA, typical multipliers applied by insurance providers to cover administrative fees range from 1.17 to 1.60 (10). The remaining parameters were determined as follows:

- Primary (Basic) Losses Reported – For 2004, 2005, and 2006, WC data were provided for each mine. These data included the total number of injuries to each body part and the total incurred loss per body part. Incurred loss is the gross estimate of the loss by the claims adjuster based upon the medical evidence in hand and includes both medical and indemnity. Thus, this is an estimate that includes what has already been paid out for the claim as well as the reserves assigned to the claim based on the medical evidence. It is comprised of two parts, the amount paid to date and the outstanding case reserve. For each year, at each mine, the average incurred loss was then determined for all injured body parts. Average incurred losses up to $50,000, were included as Primary, or Basic, Losses. All incurred costs associated with these injuries were then summed across all three years to yield the Primary (Basic) Losses Reported when no knee interventions were implemented by the mine. It was then necessary to determine what the Primary (Basic) Losses Reported would have been if knee interventions had been incorporated. Since injury narratives were not available for each injury, there was no way of knowing which injuries would have been preventable through implementation of various interventions to reduce knee injuries. Thus, in order to determine the possible cost savings, it was assumed all knee injuries were prevented. Therefore, the Primary (Basic) Losses Reported by

each mine that were associated with knee injuries were removed from the analysis and a new value for the Primary (Basic) Losses Reported was obtained for the scenario when knee interventions were implemented.

- Secondary (Excess) Losses Reported – Those body parts where the average incurred cost exceeded $50,000 contributed to Secondary (Excess) Losses, as described above. The incurred costs of these injuries were summed to yield the Secondary (Excess) Losses Reported when no knee interventions were implemented by the mine. Again, all incurred costs associated with knee injuries that were considered Secondary (Excess) Losses were removed from the analysis and the remaining incurred costs were considered the Secondary (Excess) Losses Reported when knee interventions were implemented by the mine. The portion of injury costs that exceeded $150,000 are discarded from this part of the analysis. Rather, these injuries are factored into the analysis as an actuarial parameter, the Non-ratable Excess Component (See Eq. 2) so that the financial burden of these larger, unpredictable injuries are distributed across all carriers.

Illinois (IL) – Methods for Calculation of Workers' Compensation Premiums

The National Council on Compensation Insurance (NCCI) is the largest rating organization in the United States and is the licensed rating organization for 36 states. Illinois uses NCCI to perform their WC analyses. According to NCCI, typically a company that has been paying $5,000 average annual premium for the past few years or has paid $10,000 or more in a single recent year, qualifies to be experience rated. The experience period is usually three full policy years, ending one year prior to the effective date of the modification. The NCCI formula used for the rating (12) follows:

Primary Losses		Stabilizing Value		Ratable Excess	Total
Actual Primary Losses	+	(1-Weighting Value) x Expected Excess Losses + Ballast Value	+	Weighting Value x Actual Excess Losses	Total A
Expected Primary Losses	+	(1-Weighting Value) x Expected Excess Losses + Ballast Value	+	Weighting Value x Expected Excess Losses	Total B

(5)

(6)

The Actual Primary Losses (Eq 5) are losses associated with all injuries, regardless of their value, up to the primary limiting factor which is $5,000. The Expected Primary Losses (Eq 6) are then determined by multiplying the D-ratio by the Expected Losses (Eq 7; D-ratio is obtained using a table in the NCCI manual (12); this ratio determines the portion of a mine's total expected losses that are likely to be primary losses). The Expected Losses are determined by multiplying the Expected Loss Rate (ELR – obtained using a table in the NCCI manual; use classification 1016 for underground bituminous coal) by the payroll for the three years used in the rating. This value is then multiplied by 0.01 to put the number in terms of per $100 of payroll.

Expected Excess Losses are determined by subtracting the total expected primary losses from the total expected losses (Eq 8).

$$\text{Expected Primary Losses} = \text{D-ratio} \times \text{ELR X (3-year payroll)} \times 0.01 \quad (7)$$

$$\text{Expected Excess Losses} = \text{Expected Losses} - \text{Expected Primary Losses} \quad (8)$$

The weighting value is obtained using a table from the NCCI Experience Rating Plan Manual and is based on the Expected Losses (Note: different tables exist for different states).

The weighting value determines how much of the Actual Excess Losses and Expected Excess Losses are used in the experience rating. The weighting value increases as Expected Losses increase.

The ballast value is a stabilized element designed to limit the effect of any single loss on the experience rating modification. It is added to both the Actual Primary Losses and the Expected Primary Losses. This value also increases as Expected Losses increase. The MOD is then calculated as shown in Eq 9.

$$\text{MOD} = \frac{\text{Total A}}{\text{Total B}} \tag{9}$$

In 2008, the loss cost rates for IL were \$6.49, \$9.61, and \$17.64 per \$100 of payroll for federal black lung coverage, state black lung coverage, and traumatic coverage, respectively yielding total loss cost rate of \$33.74. In IL, the advisory rate set by the state was \$47.85. The advisory rate is greater than the base loss cost rate as it is the recommended rate that providers charge to cover not only the losses but also the administrative fees associated with processing claims. Thus, the multiplier used for administrative fees can be calculated to be 1.29 from the base loss cost rate and the advisory rate.

The insurance company only insured one IL mine from 2004 to 2006 and provided us with the WC data (total number of injuries to each body part and total incurred loss per body part) for this mine in the same format as they provided the data for the PA mines. The Actual Primary Losses used in IL is calculated in the same fashion as the Primary (Basic) Losses Reported is calculated in PA. The only difference is that, in IL, the primary limiting factor is set at only \$5,000. Moreover, the Actual Excess Losses is calculated in the same fashion as the Secondary (Excess) Losses Reported is calculated in PA. Again, the only difference is that, in

IL, the secondary limiting factor is set at $266,500. Once the Actual Primary Losses and the Actual Excess Losses were calculated based on the WC data provided by the insurance company, these data were plugged into the above equations along with the actuarial parameters that are obtained from the manual (e.g. Ballast Value, D-Ratio).

RESULTS

Table 1 shows the demographic information for the six mines in PA and the one mine in IL. The total number of injuries from 2004 to 2006 for the PA mines ranged from 41 to 317 and the number of knee injuries ranged from 1 to 62. The average payroll across all three years ranged from $1,420,588 to $19,607,475. As the insurance company collaborating in this study is the largest provider in PA, the mines used in this study are representative of typical underground coal mines in PA. Data for only one mine was available for the state of IL. This mine was considerably larger than those in PA. The total number of injuries reported was 1,073 with 82 injuries being to the knee. The average payroll from 2004 to 2006 for this mine was $37,920,004. For the PA mines, the percentage of their payout that was considered to be primary was 70.1%±33.2% for all injuries and 56.0%±28.9% when injuries to the knee were excluded. However, for the IL mine, only 17.1% of their payout was considered primary for all injuries and 15.3% was considered primary when knee injuries were excluded. This is a direct result of the difference in the primary limiting factor used in PA ($50,000) and IL ($5,000; Note: average cost of knee injuries for IL mine was greater than $5,000 for all three years).

Tables 2 and 3 depict the other input values utilized in the PA and IL WC formulas, respectively. The calculations utilized to determine the WC costs with and without the inclusion of knee injuries are shown in Tables 4 and 5 for PA and IL, respectively. The MODs reported for three of the PA mines were below one indicating that these mines would receive a credit from the base loss cost rate set by the insurance provider. This was true even when the injuries to the knee were included in the analysis. However, for the IL mine, the MOD was 1.443 when injuries to the knee were included and 1.306 when they were excluded. Thus, even when knee injuries were excluded, this mine would pay more than the base loss cost rate established by the

insurance provider and approved by the state. However, since the MODs decreased for seven mines in the analysis when knee injuries were excluded, all seven mines would have experienced a reduction in their WC premiums. For the PA mines, the savings ranged from $4,206 (1.3%) to $148,888 (3.3%) when knee injuries were excluded. For the IL mine, the savings when knee injuries were excluded was $1,454,767 which was 6.4% of their WC premium.

Table 1. Demographics pertaining to the six PA mines and one IL mine used in analysis.

	PA Mines						
	Mine 1	**Mine 2**	**Mine 3**	**Mine 4**	**Mine 5**	**Mine 6**	**IL Mine**
Total Injuries	61	182	92	317	74	41	1073
Knee Injuries	6	15	13	62	20	1	82
Loss cost rate (federal black lung)	$0.93	$0.93	$0.93	$0.93	$0.93	$0.93	$17.64
Loss cost rate (state black lung)	$0.88	$0.88	$0.88	$0.88	$0.88	$0.88	$9.61
Loss cost rate (traumatic)	$14.58	$14.58	$14.58	$14.58	$14.58	$14.58	$6.49
Multiplier (administrative fee)	1.385	1.385	1.385	1.385	1.385	1.385	1.29
2004 payroll (3rd year)	$4,062,315	$5,613,119	$3,195,976	$18,040,824	$3,676,553	$1,364,705	$36,480,066
2005 payroll (2nd year)	$5,127,208	$10,292,248	$5,837,434	$19,184,751	$3,462,335	$1,422,417	$38,430,600
2006 payroll (1st year)	$5,840,288	$11,474,350	$6,665,681	$21,596,850	$4,647,108	$1,474,642	$38,849,346

Table 2. Values obtained from PA manual that are used as inputs to the PA WC formula.

Input Values for WC Calculations in PA	
Basic plus ratable excess component	0.69981
Non-ratable excess component	0.30019
Experience rating off-balance factor	0.9778
Basic Expected Losses 1st year	4.2
Basic Ratable Excess Expected Losses 1st year	1.84
Basic Expected Losses 2nd year	4.08
Basic Ratable Excess Expected Losses 2nd year	3.66
Basic Expected Losses 3rd year	3.95
Basic Ratable Excess Expected Losses 3rd year	3.7

Table 3. Input values utilized for IL WC formula.

Input Values for WC Calculations in IL	
Expected Loss Rate (class 1016) - table in manual, based on Class Code	10.21
Discount Ratio (class 1016) - table in manual based on Class Code	0.15
Expected Losses	$11,614,897
Weighting Value - table in manual, based on Expected Losses	0.73
Expected Primary Losses	$1,742,235
Ballast Value - table in manual, based on Expected Losses	1,188,098
Expected Excess Losses	$9,872,663

Table 4. Calculations utilized to determine the savings in WC premiums associated with eliminating all knee injuries through implementation of interventions for the six PA mines.

Pennsylvania Mines when Knee Injuries Included						
	Mine 1	**Mine 2**	**Mine 3**	**Mine 4**	**Mine 5**	**Mine 6**
Primary (Basic) Losses Reported	$480,339	$1,592,433	$163,637	$2,539,089	$519,377	$133,102
Basic Credibility	0.87	0.9	0.87	0.93	0.85	0.76
Basic Expected Losses	$614,944	$1,123,565	$644,367	$2,402,418	$481,666	$173,875
Ratable Excess Losses Reported (Secondary Losses)	$33,858	$515,511	$0	$660,692	$134,376	$200,000
Ratable Excess Credibility	0.13	0.16	0.13	0.23	0.12	0.08
Ratable Excess Expected Losses	$445,423	$795,510	$454,550	$1,767,054	$348,261	$129,688
Exp ratio	0.84	1.20	0.57	.97	1.01	0.92
Adj Ratio	0.89	1.14	0.70	0.98	1.01	0.94
MOD	0.91	1.16	0.71	1.00	1.03	0.96
WC per $100 payroll	$15.04	$18.77	$12.19	$16.40	$16.80	$15.85
WC per $100 payroll & adm fee	$20.83	$26.00	$16.88	$22.72	$23.27	$21.95
WC Premium	$1,043,735	$2,372,829	$883,393	$4,454,262	$914,195	$311,835
WC Premium, $k	$1,044	$2,373	$883	$4,454	$914	$312
Pennsylvania Mines when Knee Injuries Excluded						
	Mine 1	**Mine 2**	**Mine 3**	**Mine 4**	**Mine 5**	**Mine 6**
Primary (Basic) Losses Reported	$351,435	$1,493,364	$147,432	$2,303,530	$269,485	$124,920
Basic Credibility	0.87	0.9	0.87	0.93	0.85	0.76
Basic Expected Losses	$614,944	$1,123,565	$644,367	$2,402,418	$481,666	$173,875
Ratable Excess Losses Reported (Secondary Losses)	$33,858	$515,511	$0	$660,692	$99,295	$200,000
Ratable Excess Credibility	0.13	0.16	0.13	0.23	0.12	0.08
Ratable Excess Expected Losses	$445,423	$795,510	$454,550	$1,767,054	$348,261	$129,688
Exp ratio	0.73	1.15	0.55	0.92	0.75	0.90
Adj Ratio	0.81	1.11	0.69	0.94	0.82	0.93
MOD	0.83	1.13	0.70	0.96	0.84	0.95
WC per $100 payroll	$13.94	$18.29	$12.05	$15.85	$14.08	$15.64
WC per $100 payroll & adm fee	$19.30	$25.33	$16.70	$21.96	$19.50	$21.66
WC Premium	$967,158	$2,311,547	$873,690	$4,305,374	$765,999	$307,629
WC Premium, $k	$967	$2,312	$874	$4,305	$766	$308
SAVINGS PER YEAR	$76,577	$61,282	$9,703	$148,888	$148,196	$4,206
% SAVINGS PER YEAR	7.3%	2.6%	1.1%	3.3%	16.2%	1.3%

Table 5. Calculations utilized to determine the savings in WC costs associated with eliminating all knee injuries through implementation of interventions for the one IL mine.

Illinois Mine when Knee Injuries Included	
Actual Primary Losses (limiting factor $5,000)	$3,920,770
Actual Excess Losses (limiting factor $266,500)	$19,054,263
Total A	$21,684,099
Total B	$12,802,995
MOD	1.694
WC per $100 payroll	$45.98
WC per $100 payroll & adm fee	$59.53
WC Premium	$22,575,266
WC Premium, $k	$22,575
Illinois Mine when Knee Injuries Excluded	
Actual Primary Losses (limiting factor $5,000)	$3,510,770
Actual Excess Losses (limiting factor $266,500)	$16,670,225
Total A	$19,533,751
Total B	$12,802,995
MOD	1.526
WC per $100 payroll	$43.01
WC per $100 payroll & adm fee	$55.70
WC Premium	$21,120,499
WC Premium, $k	$21,120
Savings Per Year	**$1,454,767**
% Savings Per Year	**6.4%**

DISCUSSION

In this study, a detailed analysis of WC premiums was performed for six underground, bituminous, coal mines in PA and one in IL for 2008. The analysis was initially performed with all injuries being included and then was performed a second time whereby knee injuries were excluded. For this study, it was assumed that implementing interventions pertaining to knee injuries would eliminate all knee injuries that occurred in 2004, 2005, and 2006. Hence, this warranted a second analysis for the WC premiums associated with 2008. For all seven mines, WC premiums decreased when knee injuries were excluded. The savings ranged from $4,206 to $1,454,767 and from 1.1% to 16.2% of the WC premiums. These savings resulted from eliminating knee injuries for three consecutive years (2004 – 2006). Therefore when implementing interventions to reduce knee injuries it will take five years to fully realize the financial benefits in WC premium reductions although some benefit will be seen after several years – i.e. in accordance with the example in this paper, eliminating the knee injuries in 2004 would not be included in the WC premium assessment until 2006. However, the costs associated with WC premiums are only part of the financial burden experienced by mining companies with respect to knee injuries. Many indirect costs would also be eliminated by implementing interventions to reduce knee injuries. Injuries have many other consequences that affect production such as: time needed to train new workers; loss of a skilled worker; reduction in worker morale; and reduced worker efficiency due to fatigue, pain, discomfort, or increased need for rest and break periods. Moreover, an injury to the knee could place the mine worker at risk for sustaining additional injuries associated with slips, trip, or falls. Thus, incorporating interventions to reduce knee injuries may not only improve worker quality of life but may also provide a significant financial benefit to a mine company.

There are several limitations to this study. First, the cost associated with each individual injury was not available. Instead, the total number of injuries per body part was provided along with the total incurred costs associated with that body part. Therefore, in order to determine if injuries to a specific body part were to be primary (basic) or secondary (excess), the average cost of the injury to that body part was utilized. Additionally, the administrative fee charged by the insurance provider was an approximation based upon administrative fees charged by a variety of insurance providers. While this would impact the WC premium calculated per $100 of payroll, it would have no impact on the percent savings in WC premium when knee injuries were excluded. However, this parameter was included so that the cost per $100 of payroll calculated in this study was representative of what a mine company would actually pay. Finally, this study assumed that all knee injuries would be prevented by implementing interventions to reduce knee injuries. It is unlikely that all knee injuries would be prevented, so the savings presented in this study are an upper bound. However, the investment required on the part of the mine to implement the interventions outlined in this study is minimal which suggests that eliminating even a few knee injuries would be financially beneficial to the mine.

CONCLUSION

Mine companies should consider implementing interventions to reduce knee injuries. For example, NIOSH recently published a training package entitled Keeping Knees Healthy in Restricted Work Spaces: Applications in Low-Seam Mining (6) that describes the common causes and symptoms of these injuries in low-seam mining, suggests changes to work station design and activities that may reduce a mine worker's exposure to risk factors for knee injuries, and provides basic stretching and strengthening exercises for the leg. NIOSH has also collected experimental data regarding the demands placed on the knee when in postures associated with low-seam mining (2-4, 13, 14). Using these data, NIOSH is working with a kneepad manufacturer to design, fabricate, and field test a novel kneepad that will reduce the forces and stresses on the knee when kneeling, squatting, and crawling. Mine worker input will be obtained throughout the design of the kneepad which will be evaluated experimentally to demonstrate a significant reduction in forces and stresses applied to the knee and will be field tested to ensure durability. In higher seams, uneven ground can result in mine workers twisting their knee. Thus, NIOSH researchers are currently investigating cap lamp technology in an effort to improve visibility in mines. Current investigations include light-emitting diode (LED) technology (7-9).

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