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Injuries Among Miners in Kentucky During 2010-2012 From Workers Compensation Data

Evelyn Thomas
University of Kentucky

Evelyn Thomas, Student

Wayne Sanderson, MS, CIH, Ph.D., Committee Chair

Dr. William Pfeifle, Director of Graduate Studies

UNIVERSITY OF KENTUCKY

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By
Evelyn Noelia Thomas, M.D.

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Wayne Sanderson, MS, CIH, Ph.D.,
Chair

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Steven Browning, Ph.D., MSPH

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Terry L. Bunn, Ph.D.

____

David Mannino, M.D.

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I. Abstract

Introduction: Coal miners in Kentucky have higher rates of injury morbidity and mortality than national rates. In order to understand better what is happening in this area, we not only analyzed the injuries and deaths, but also identified common characteristics between these nonfatal and fatal injuries.

The objectives of this study were to 1) Identify injuries among coal miners in Kentucky; 2) Determine if there are any other risk factors for injuries other than working in a mine; and 3) Determine the different health effects on coal mine workers.

Methods: Data from Kentucky Workers' Compensation First Reports of Injuries and Workers' Compensation Claims for the years 2010-2012 were analyzed using statistical and text narrative analysis techniques.

Results: Between 2010 and 2012, there were 2,814 workers' compensation claims of injuries from coal miners, including 19 deaths to coal mine workers. The study showed that as a state, Kentucky has more injuries than the national average. Also, this study showed that machinery, place, and equipment were the most common categories responsible for the events that caused the injury. Within these categories, scoop and bolter machines were responsible for the most injuries within their category (machinery) with an incidence rate of 4.87% and 4.01%, respectively. In Place, the element responsible for the majority of the injuries was rock, with an incidence of rate13.48%, followed by ground/ice/mud

(ground conditions) with an incidence of 3.09%. Cable (handling) was the most common element in the Equipment category followed by pinner with an incidence of 4.30% and 0.96%, respectively. Also, truck was the vehicle that was involved in the most injuries at 3.27%. Lifting--at1.95%--was the most common action involved in the injuries.

Conclusion: Strain, contusion, and amputation were identified as the most common type of injury that coal miners had in Kentucky. The results of the analyses of the variable “accident description” showed that rock was the most common element involved in the injuries/accidents.

The results of this research narrowed the scope of injuries and fatalities, identifying the need for additional research related to Place (or physical work environment), Equipment, and Machinery and their respective elements within each category. Also, a more precise narrative of the accident should be required in Workers’ Compensation claim reports.

II. Introduction

Mining work has been around since ancient times. The adverse health effects of working in mines have also been known for about as long, even though the physiopathology of the diseases was unknown. Since the early days of mining, there have been many advances in medicine, engineering, mechanics, and other related areas. That would lead us to think that the health problems and fatal incidents that miners experienced in the past would no longer be seen in these modern times. However, according to the Bureau of Labor Statistics, coal mine workers, are more likely to be killed or to incur a non-fatal injury or illness, and their injuries are more likely to be severe than workers in private industry as a whole (Bureau of Labor Statistic, 2012). That is not to say that there haven't been improvements. For example, fatal injuries among mine workers have been declining throughout the 20th century. From the years 1900 to 1945, more than 1,000 fatal injuries were registered in coal mining alone, according to the U.S. Department of Labor Mine Safety and Health Administration (MSHA) (Mine Safety and Health Administration, 2012). Since then, however, fatal injuries have shown a dramatic decrease overall. Likewise, nonfatal injuries among miners have shown the same decreasing trend overall; but some states like Kentucky (which is the state with the most mines in the United States) (U.S Energy Information Administration, 2012) still have a proportionally high number of injuries and fatalities. To explain why so many injuries and fatalities still occur in some mines, there are various studies that mention mine characteristics related to safety as possible explanations. These include 1) geological characteristics (Fotta, et al., 1997); 2) mining techniques (Pappas, et al., 2013); 3) mine size (National Research Council, 1982; Laney, et al., 2012; Grayson, 2011); 4) unionization (National Research Council, 1982; Morantz, 2011); 5) captive mines; 6) time into shift when injury occurred; 7) previous hours worked; 8) location within the mine where the incident occurred; 9) occupation; 10) work experience (Hull, et al., 1996); 11) frequency of task; 12) shift; and 13) mining region.

III. Literature Review

This literature review is a summary of important concepts in order to understand the work in coal mines and associated occupational injuries. The research cited is from published journal articles, national and international organizations reports, and governmental agencies.   The databases and sources used to identify the literature included PubMed Central, Google Scholar, and several other search engine databases

Basic Mining Concepts

To better understand the nature of the injuries, it's helpful to have at least a basic understanding of mining in general. In the mining industry, there are two main divisions: the coal mine industry, and the metal and nonmetal mine industries. Coal mining is further divided into 1) Bituminous coal underground mining; 2) Bituminous coal and lignite surface mining; and 3) Anthracite mining. Bituminous coal underground mining employs slightly more than half of all coal mining industry workers, but experiences a proportionately higher share of occupational injuries, illnesses, and fatalities (Bureau of Labor Statistic, 2012). In Kentucky almost all the mineable coal is bituminous (Kentucky Energy and Environmental Cabinet, 2013), with a very small percentage that is anthracite.

In order to access coal deposits in Kentucky, several different mining methods are used. The specific method used depends on the geography, hydrology, and the amount of soil and rock in each specific area. Historically, underground mines have represented approximately 64% of all the coal production in

Kentucky and the remaining 36% corresponds to bituminous surface mines (Kentucky Energy and Environmental Cabinet, 2012).

Even though national coal consumption in 2011 has decreased compared to 2010, coal production has increased since 2010. Also, even though the consumption in 2011 decreased, the US is still the country that consumes the highest coal per capita (BP, 2012).

Occupational Injury and Illness

To further understand the nature of the injuries in mining, it is important to understand what constitutes an occupational injury. The Mine Safety and Health Administration ("MSHA") defines an occupational injury as an injury to a mine worker which takes place at a mine and for which medical treatment is administered, or which results in death or loss of consciousness, restriction of work or motion, inability to execute all job duties on any day after an injury, lost workdays, temporary assignment to other duties, transfer to another job, or termination. The injury usually results from a recognizable single incident (Mine Safety and Health Administration, 2011).

Also, MSHA defines an occupational illness as an illness or disease of a mine worker which may have resulted from working at a mine or for which an award of compensation is made. Additionally, the disability must result from repeated exposure to the condition or substance which caused the disability (Mine Safety and Health Administration, 2011).

Workers Compensation Data

There are several studies that have used the data from workers' compensation, but those studies look at different outcomes. There is an older study that looks at the cost of injuries among industries in the USA (Leigh Paul J, et al., 2003). They ranked 260 industries on the basis of average cost per worker for fatal and all nonfatal injuries and illnesses. Taxicabs were in first place, followed by bituminous and lignite industries in second place. There is a more recent study that looks at cost by industry and musculoskeletal claims (Dunning K. et al., 2010). This study shows that industries with the highest cost per claim were the transport workers union (TWU), construction, and mining industries. Even though all these studies use data from workers' compensation claims, none of them have looked at the accident description in order to see what was happening when the injury occurred.

Injuries among States

According to MSHA the national injury rate (including deaths) per 200,000 hours worked for the period 2010-2012 ranged from 3.16 to 3.48, showing a decreased tendency (United States Department of Labor, 2013).

There are 26 states with coal mines (MSHA, 2010a).The incidence rate for injuries among states for the period 2010-2012 ranged from 10.31 to 0. The large rate range makes us wonder if there is a large variation within, in theory, the same type of job.

According to MSHA (MSHA, 2010a; MSHA, 2011a; MSHA, 2012a) Arkansas is the state with the highest incidence rate for the period 2010-2012 which is 10.31.

Illinois is in second place with an incidence rate of 5.41, followed by Tennessee with an incidence rate of 5.18. Kentucky is fifth with an incidence rate of 4.35 per 200.000 hours worked.

Age

Age is an important factor in the incidence and type of injuries, and this may be due to the existing relationship between age and experience. Young and new coal miners seem to have a higher risk of injuries than older miners. New workers in general suffer an elevated injury rate during their first year of work (Siskind, 1982).

In the general population of workers, age-related work injuries are higher in the group of workers younger than 34 years of age compared to workers older than 35 years of age. (Breslin et al., 2005). Another study (Laflamme et al., 1996) showed that the absolute risk reduction (ARR) of miners younger than 30 year old was higher than the oldest workers for injuries.

Those workers that are in the age categories of 16-24 and 24-39 have a significantly higher risk of injuries and fatalities than the rest of the workers (Groves et al, 2007).

An international review done by Salminem (Salminem, 2004) analyzed 64 international papers and the majority (56%) of the nonfatal studies concluded that younger workers (25 year old or younger) have a higher incidence of injuries than older workers. Unfortunately there isn’t much research that specifically studies the relationship between age and injuries in coal mines.

Equipment

Equipment is responsible for a high percentage of injuries and fatalities in miners (Moore et al., 2009). Less experienced workers seem to be more vulnerable to equipment-related accident/injuries and should, therefore, be the focus of prevention strategies and interventions for safety reasons (Kecojevic, et al., 2006).

Machinery

Coal mining, especially underground mines, has the highest incidence rate of severe machine-related accidents, followed by stone mining, and sand and gravel mining (Ruff et all, 2011). The authors of this study concluded that many of these injuries and fatalities happened during the process of maintenance and/or repair of the machines (25%), especially when the machines were reenergized without warning. This study also showed that the most common machinery involved in accidents were conveyors, roof bolting machines, haul trucks, and front-end loaders. Another study (Kecojevic et al., 2004) found that 41% of the fatalities related to loaders were due to being hit, struck by, or run over by the wheels of the loader. The second cause of fatalities-- that represented 34% related to loaders, involved rollovers from elevated surfaces.

Some of the factors in these injuries were (Ruff et al, 2011): 1) close proximity to mobile machinery; 2) visibility of the operator; 3) losing control of the machine; 4) mechanical problems such as brake failure; and 5) human error that resulted in a rollover or collision.

Actions

Loss of coordination or balance, extreme fatigue, slippery surfaces or spills on surfaces are some of the conditions that can lead to falls or slips and end in injuries.

There are some studies that have been done in coal miners about some of the actions that provoked the accident. One study looked at the influence of weather and temperature on injuries and concluded that handling material (e.g., lifting, pulling, pushing, and shoveling material) was the category with the greatest proportion of injuries for all temperatures combined, but slips and falls were the first most common type/cause of injury in coal mines, in colder temperatures (Bell J et al., 2000).

Another study (Muzaffar*,* et al., 2013) showed that slips and falls exceeded machinery-related fatal and non-fatal injuries among miners.

Vehicle

Different types of vehicles are used in mines to transport coal, workers, dirt, supplies, etc. In the literature there aren't many studies about injuries and/or accidents and/or fatalities caused by vehicles in mines. One study done in mines in the U.S. showed that of all the injuries, 20.7% were transport-related, and of those, the biggest percentages were in underground mines (Hunting K, et al., 1993).

Another study done in mines studied injuries and fatalities related to trucks (Kecojevic et al., 2004). The authors classified in nine categories the causes of truck-related injuries. These categories are: 1) failure of mechanical components; 2), lack of and/or failure to obey warning signals; 3) failure to maintain adequate berms; 4) failure to recognize adverse geological conditions; 5) inadequate hazard training; 6) inadequate maintenance procedures; 7) failure to respect the truck's working area; 8) failure to set the parking brake; and 9) operator's health condition.

Place

Generally, underground mines use observational techniques to determine roof stability which are not very efficient or accurate. Mine workers have "sounded" the rock - striking it and listening for the "drummy sounds" that signal loose rock.

According to Mine Safety and Health Administration (MSHA) statistics (2003-2012), falls (to the ground) were responsible for the largest portion (27%) of fatal incidents in the coal mining industry and about 33% of fatal incidents were in underground coal mining (CDC, 2012)

One study done in mines in Australia (Mitchell R, 1998) showed that 43% of injuries occurred in underground mines and most of them were due to wall or roof collapse. According to the CDC (CDC, 2000) roof and rib rock falls were responsible for a high number of mining injuries and fatalities.

Based on fatality data, it is well known that miners in Kentucky have higher rates of injury and death compared to the national rate. In order to better understand what is happening in this area, for this study we decided to not only analyze the morbidity and mortality rates, but also to identify the common characteristics between these injuries and fatal accidents using narrative text analysis.

The objectives of this study were to 1) Identify injuries among coal miners in Kentucky; 2) Determine if there are any other risk factors for injuries other than working in a mine; and 3) Determine the different health effects on coal mine workers.

IV. Methodology

Study population

This study used data from Kentucky Workers' Compensation First Reports of Injury and Workers' Compensation Claims for the years 2010-2012. The data were obtained from the Kentucky Injury Prevention and Research Center, and the Kentucky Office of Workers' Claims. The data did not contain personal identifiers. With the exception of those working in agriculture or businesses that have less than 10 employees, workers employed as domestic servants in a home with less than two full-time employees, any person employed by homeowners for residential maintenance and repair for no more than twenty consecutive workdays, or employees who are protected by federal laws --railroad and maritime workers- and members of certain religious groups, all workers, including part-time workers are required to carry workers' compensation insurance, (Commonwealth of Kentucky Department of Workers' Claims, 2011). In Kentucky, all workplace injuries that require one or more days off are reported.

The inclusion criteria for the current study were: 1) all mine workers in Kentucky that had an injury in calendar years 2010- 2012; 2) claimants of all ages including age unknown; and 3) workers that were injured in Kentucky, even though they may have lived in a different state. The industry code analyzed was the Standard Industrial Classification code (SIC). The injury description and the cause of injury were coded using the Nature of Injury and Cause of Injury codes from the Workers' Compensation Insurance Organization (WCIO).

Kentucky's Workers' Compensation data does not contain information on yearly levels of employment, therefore, it was obtained from the Kentucky Labor Market Statistics, Quarterly Census of Employment and Wages Program for the years 2010-2012*.*

This project was approved by the Institutional Board of the University of Kentucky.

Study design

This study is a descriptive epidemiologic study. The selection of mine workers' first reports of injury and claims was done according to the following criteria: Industry Code for coal mines (SIC codes 1221, 1222, 1231, and 1241).

After the first selection, all the cases were manually confirmed in order to be incorporated in the final dataset. The final dataset contained 2,814 coal mine workers.

Because of the similarities with some of the nature of injuries, similar codes were grouped. The rest of the codes for nature of injury weren't grouped, and maintained their respective codes.

The different codes for cause of injuries were grouped according to the 10 main descriptions of injury cause that the Office of Workers' Claims provides. Body parts were grouped according to the main body groups (Table 1).

After the new groups were formed, a manual review was done to ensure that all the elements were in the appropriate group.

To analyze the variable 'accident description', we performed a keyword text search. Because each accident description was analyzed individually, there was no loss of words due to misspelling, truncation, or fragmentation. After that, we derived general categories (Table 2) and grouped the keywords according to these categories: Vehicle, Equipment, Small Tools, Machinery, Place, Actions, Drugs, and Other.

Within ‘Place’, the keywords were related to everything structural or the building where the job is performed (e.g., stairs or a ventilation system within a mine shaft).

‘Vehicles’ included modes of transportation within and out of the mine.

‘Equipment’ included pressure washers, air guns, hydroseeders and other similar equipment. ‘Small tools’ included hammers, screwdrivers, utility knives, etc.

‘Machinery; referred to the machine responsible for the injury/fatality (accident related to the motion of the machine) such as dozers, scoops, and other large machines.

‘Action’ included the act that was responsible for the injury, such as a fall or repetitive motion.

‘Drugs’ included both illegal and prescription drugs. ‘Liquids’ included elements like oil or grease.

The category ‘Other’ contained all the key words that didn’t fit into the other categories.

Statistical analyses

The exploratory analysis included the use of descriptive statistics. Specifically, statistical means were determined for continuous variables, frequency tables, percentages, and CIs for categorical variables. The formula COUNTIF in Microsoft Excel was used to determine how many times the key word(s) appeared in the description of the accident. That count allowed us to see whether there was a pattern regarding how the injury occurred. This was very important because, to the author's knowledge, no study has been done previously in the US that (1) analyzes the narrative text of the accident description of coal miners in workers' compensation data, or (2) identifies a new or a previously unrecognized hazard for a specific injury in coal miners.

The injury rates were calculated according to the formula provided by MSHA. That is, all the rates were calculated per 200,000 hours worked. In order to calculate the injury rates, the denominator was obtained from MSHA (Mine Safety and Health Administration, 2010a; Mine Safety and Health Administration, 2011a; Mine Safety and Health Administration, 2012a).

The injury codes 'Black lung' and 'hearing loss' weren't included in the analyses since the accident descriptions contain materially different information from the rest of the injuries, and they weren't valuable for the purposes of this research. For example, in the majority of the injury narratives, the causative agent is included, such as "slip on ice." In contrast, the Black Lung narratives only included the Black Lung compensation program in which a person was enrolled or a diagnosis. For example, most of the Black Lung narratives contained simply "state Black Lung" (benefits program), or "coal workers' pneumoconiosis" (diagnosis); there were no specific causative agents for the injuries. Similarly, with hearing loss, there were no indications as to the agent(s) responsible for the hearing loss or the loud noise—for example, "exposure to an explosion", “following a trauma’, “consistent loud noise exposure to a continuous miner or drill”, or other such narratives that could provide insight, but rather the majority of the narratives were either “loud noise” or “exposure to noise” only.

The variables of interest were age, county where the injury occurred, gender, industry, occupation, death, nature of the injury, cause of injury, body part affected by the injury, and accident description.

The variables ‘disability’ and ‘impairment’ weren’t analyzed for this study because of the high percentage of missing values (89%) and the reporting of these values is not required by worker’s compensation claims.

The variable ‘occupation’ can provide important information, but because it is not a required field in the worker’s compensation claims, this variable had 69% (n=1954) missing values.

SAS 9.3 was used for the statistical analysis.

V. Results

Between 2010 and 2012, there were 2,814 first reports of injuries from coal miners, including 19 deaths to coal mine workers. The annual number of claims ranged from 788 to 1,056.

Of all first reports of injuries of Kentucky coal miners, 2,796 (99.36%) were made by males and 18 claims (0.64%) were made by females. The age of the mine workers ranged from 18 to 79 with a mean age of 39 years, and the highest frequency of claims was in the age group of workers between 25-34 years with a frequency of 732 (26.01%), followed by the age group of 35-44 years with a frequency of 701 (24.91%) (Figure 1).

Between 2010 and 2012, bituminous coal underground mining had 2,176 (77.33%) injuries, Bituminous coal and lignite surface mining had 520 injuries (18.48), Anthracite mining had 63 (2.24%) injuries, , and coal mining services had 55 (1.95%) injuries. Bituminous coal mining (surface and underground) was the industry with the highest frequency of injuries during the period studied (Figure 2).

The county with the highest number of mining injuries was Hopkins follow by Pike, Harlan, Union, Lawrence, and Webster (Table 3). The mining injury incidence in Kentucky during the period 2010 - 2012 was 4.59 per 200,000 hours worked. The results by year showed an increasing incidence rate tendency (Table 4).

Also, during the same period of time, strain or tear was the most common mining injury reported with a frequency of 985 and an incidence rate of 1.61 per 200,000 hours worked. Contusion was the second most common injury among coal miners in Kentucky with a frequency of 517 and an incidence rate of 0.84 per 200,000 hours worked. The third most common injury was amputation and laceration with a frequency of 326 and an incidence rate of 0.53 (Table 5).

The most frequent causes of injuries were: code VI)--strain or injury by--with a frequency of 943 (33.51%), follow by code VIII--struck or injury by--with a frequency of 813 (28.89%), and code IV--fall, slip or trip injury--with a frequency of 323 (11.48%) (Figure 3)

The body part most affected by injuries was upper extremities with a frequency of 790 (28.07%) (Figure 4). The number of fatalities among coal miners in Kentucky during the period 2010-2012 was 19 which represent a mortality rate of 4.03 per 10,000.

In the accident description for strains, machinery was involved in 230 (23.35%) incidents (table 6). In the accident description for contusions, the group place had a frequency of 220 (42.55%). For Amputation, the groups place and other had a frequency of 64 (19.69%), followed by Small tools with a frequency of 53 (16.31%).

Also, for strain the most common machinery involved in the injuries were scoop/loader/bucket/dozer, with an incidence rate of 9.0 % (table 7). Within Contusion, the most common element in Place involved in the injuries was rock with an incidence of 38.3 %. For amputation, the most common element within Place and Other were rock and metal/metal bands with an incidence of 25% and 8%, respectively.

The analysis of the accident description showed that the group place was within the first three most important factors for injuries in 16 of the 21 injuries that coal miners presented. Equipment was in the top three in 11 of the 21 types of injuries that coal miners had.

Within place, the element responsible for the most incidents was rock with an incidence of 34%, follow by ground with an incidence rate of 10.80%. Scoop was the most common machinery involved in the incidents with an incidence rate of 34%, follow by bolter/bolt with an incidence rate of 25.06%. Cable was the number one mine equipment responsible for the incident with an incidence rate 37.46%, follow by pinner with 8.36% of incidence rate (Table 8).

VI. Discussion

Since we used Workers' Compensation first reports of injury data, the injury rate from MSHA and ours slightly differ (4.59 versus 4.35). This may be due to the type of injury report that MSHA uses. Even though the difference between both rates, Kentucky still in the 5^{th} place for injuries among coal miners in the US (table 9).

This study showed that the most common hazards that today's miners in Kentucky, based on worker's compensation data, are exposed to are: 1) physical hazards, 2) mechanical hazards, 3) chemical hazards, and 4) ergonomic hazards. Within physical hazards, an unsafe ground condition was the most common.

Some of the most common mechanical hazards were scoop and bolters.

Within chemical hazard, the miners were exposed mostly to oil, grease, and fluid couplings.

The most common ergonomic hazard to which miners were exposed were frequent lifting and repetitive and/or cumulative movement.

Of all the injuries, the injuries in Bituminous coal underground mining represent the highest at 77.33 percent in comparison to anthracite and bituminous coal surface mining. This result supports Bureau of Labor Statistics Bituminous coal underground mining statistics on occupational injuries, illnesses, and fatalities (Bureau of Labor Statistic, 2012).

The etiology of the work-related musculoskeletal disorders (WRMSDs)–sprain, strain, hernia, tears--which was the most reported injury in workers' compensation claims, is assumed to be the direct consequence of physical factors related to the work environment or the way the work is performed, such as body posture, how much force was applied into the movement, movement repetitiveness, load handling, mechanical vibration or microclimate as well as psychosocial factors, such as quantitative and qualitative overload, and lack of control (Bugajska, et al., 2011)

The significance of these types of pathologies is not just the injury itself and the days of lost work, but also the fact that because of the type of injury, it may result in permanent damage to soft tissue structures, such as stretching of ligaments.

These musculoskeletal injuries can cause an individual to be more susceptible to dislocations or other types of joint injuries.

Contusion is the second most common injury in coal miners. The majorities of these lesions are not disabling, but depending on the severity may require the worker to be at rest for at least 24 hours. Re-injury is a recognized factor in prolonging disability.

Lacerations and amputations, and foreign bodies were the third and the seventh most common causes of injury, respectively. Eyes were one of the most affected organs by foreign bodies. The high level of injury by foreign bodies, coupled with the high levels of lacerations of varying levels of severity, make us wonder if personal protection equipment (PPE) is not available for the workers, or if it is available, whether or not it is being used or worn properly.

The analysis of the accident description showed that place and equipment were within the first three most important factors for injuries. This should be an area of focus for future studies in order to know why coal miners have so many injuries that involved place, like rocks, or different types of equipment, like cables, that was the most common element responsible for the incidents. The description of the accident report didn't have information about what type of cable the miners were handling when the injury occurred. There is a study that was done in Australia that identified cable handling while operating a continuous miner within one of six high-priority hazards in coal miners (Burgess-Limerick, et al. 2006). However, the descriptions of the injury the data from the Kentucky First Report of injury does not provide sufficient information to conclude the type(s) of cable the miners were handling.

Machinery, like scoop or roof bolting machines, was ranked between first and third in more than 30% of the injury types that coal miners presented, especially in the most frequent injuries like strain, contusion, amputation, and fracture. Our study showed that roof bolting machinery was ranked second within all machinery. Roof bolting also was ranked in second place in a study that observed the relationship between machinery and severe injuries in miners (Ruff, et al, 2011). Accidents between coal miners and machinery happen constantly, despite the use of safety measures like backup alarms.

The other cause of injuries through the use of machinery occurred during maintenance of the machinery itself. There are several studies that that show the relationship between injuries and the use of machinery in mines and identified that machine maintenance and repair, as well as the operation of equipment, were the two of the most dangerous coal mining activities (Ruff, et al., 2011). The reading of the accident narratives gave the impression that many of the injuries happened during the maintenance and repair process. Future research must focus on the identification of the factors surrounding the injuries and fatalities related to machinery in coal miners in Kentucky.

Overall, rocks were involved in the majority (13.68%) of the accidents causative of injuries. Flyrock is one of the most important causative elements of injuries as a result of rock blasting. The study done by Bajpayee, et al., (2004) Flyrocks and lack of blast area security accounted for 68.2% of the injuries in miners. Also, according to NIOSH (NIOSH, 2012), rock fall is one of the leading causes of injuries and fatalities in mines, in fact according to NIOSH, the falling of rocks injure between 400-500 coal miners per year.

Our study adds to the body of knowledge that rock (rock fall, flyrock, etc.) is one of the major causes of injuries and fatalities. It will be necessary to do more studies that look into details regarding the specific relationship between rocks and injuries in order to determine if the injuries were the product of flyingrocks, or rock that falls from the roof, for example, in order to take the appropriate measures to prevent more injuries.

According to MSHA (MSHA 2010b, MSHA 2011b, MSHA 2012b) the top 20 most frequent standards violations appear under the following categories: 1) Machinery and equipment; operation and maintenance, 2) Loading and haulage equipment; installations, 3) Travel ways at surface installations , 4) Loading and haulage equipment, inspection and maintenance 5) Surface installations; general, 6) Water, sediment, or slurry impoundments and impounding structures; general, 7) Protection from falls of roof, face and ribs, 8) Power wires and cables; and 9) insulation and protection, just to mention some. Even though these were violations in coal mines throughout the entire US and not specific to Kentucky, this information plus the results of this research may help to determine where a safety intervention strategy is needed.

According to the Kentucky Department for Energy Development and Independence, before inexperienced miners can be employed, they must pass a written exam as well as complete a minimum of 40 hours of training for underground miners and 24 hours for surface miners. In order to become an "experienced miner", an inexperienced miner must work at for least 45 days (surface miners and/or underground miners). For underground mines, 16 hours of retraining is required annually by miners to maintain a miner certification and continue working (Office of Mine Safety and Licensing [a]; Office of Mine Safety and Licensing [b]).

The high injury and fatality incidence observed in coal miners in Kentucky compared to the all states with coal mines showed that the actual required hours of training may be one of the reasons of why there are so many injuries and fatal accidents in this part of the country. Also, looking at the accident descriptions, it seems that the managers and workers may not be following some of the safety rules and may not be using the personal protective equipment (PPE).

This study has a major strength in that worker's compensation data contains all injuries that require only one day off or more from work (first report of injuries). Limitations of the study include the possible lack of specificity in the accident description and the inability to associate age with work experience that may affect the injury rate in the different age groups. The acceptance of the claims or first report may be affected by disparities by minorities, ethnicity, or gender. Another limitation of the study is the inability to calculate the severity of the injuries due to workers' compensation data report requirements.

Several mines in Kentucky are small, therefore, monetary reasons could be one of the reasons for the lack of investment in safety. But according to Kentucky

Coal Facts, 13th Edition, in 2011, Kentucky produced over 107 million tons of coal with an approximate value of $6.3 billion dollars (Kentucky Energy and Environment Cabinet, 2013); within Kentucky, coal represents the largest source of energy production and a major component of the economy. In 2011 and 2012, Kentucky ranked third nationally in coal production, after Wyoming and West Virginia. Not only a producer, but Kentucky is also a major consumer of coal, particularly in electricity generation, since it's cheap, reliable, and plentiful. Following Kentucky, Florida, Georgia, and South Carolina were the largest consumers of Kentucky coal during 2011 and 2012. Of the coal produced, underground mines provided over 60% (Kentucky energy and environment cabinet, 2013).

VII. Conclusion

This study contributes to identify the most prevalent injuries among coal mining in Kentucky like strain, contusion, and amputation. Also, the analyses of the accident description allow us to identify risk factors related to the fatalities and injuries in coal miners in Kentucky. The analyses of the narrative of the accident further showed that the principal element involved in the injuries in coal miners in Kentucky was rock, over all the other elements. Many of the pathologies that coal miners in Kentucky presented, like strain, are injuries that affect the health of the miners in different ways; since re-injury is a common problem with these types of injuries, the miners' quality of life is being affected by constant health issues, days off work, stress, and the workers may be more prone to accidents.

The lack of literature that explore the narrative of the accidents and the results of the data analyzed showed different areas of research for the future, these include injuries and fatalities related to Place (or physical work environment), Equipment and Machinery. Also, different types of interventions including adequate improvements in the work place and equipment and machinery design, maintenance, control, and training needs to be done to target these main categories and elements that contributed the most to the injuries and fatalities in coal miners in Kentucky.

A better description of the accident should be required in order to make better analyses and formulate conclusions that are more precise.

The analysis of the accident descriptions supports the need for constant improvement in engineering, educational and control measurements, and interventions in order to prevent more injuries and fatalities in this high-risk occupation.

VIII. References

Bajpayee T.S., Rehak T.R., Mowrey G.L., & Ingram D.K., (2004). Blasting injuries in surface mining with emphasis on flyrock and blast area security. *J Safety Res,* 35, 47– 57

Bell J. L, Gardner L., Landsittel I, & Douglas P. (2000). Slip and fall-related injuries in relation to environmental cold and work location in above-ground coal mining operations. *Am J In Med*, 38, 40-48.

BP (2012, June). *BP statistical review of world energy*. Available from: http://lgdata.s3-website-us-east-1.amazonaws.com/docs/697/584771/statistical_review_of_world_energy_full_report_2012.pdf

Breslin F. C, & Smith P. (2005). Age-related differences in work injuries: a multivariate, population-based study. *Am J In Med*, 48:50–56.

Bugajska J, Jedryka-Góral A, Gasik R, & Żołnierczyk-Zreda D. (2011). Acquired musculoskeletal dysfunction syndromes in workers in the light of epidemiological studies. *Med Pr* , 62 (2), 153 -161.

Bureau of Labor Statistic. (2012, April). *Coal Mining Injuries, Illnesses, and Fatalities.* Fact Sheet. Available from: http://www.bls.gov/iif/oshwc/osh/os/osar0012.pdf

Burgess-Limerick, R., & Steiner, L. (2006). Injuries associated with continuous miners, shuttle cars, load haul-dump and personnel transport in New South Wales underground coal mines. *Mining Technology: IMM Transactions*, 115(4), 160–168.

Center for Disease Control and Prevention (2000, June). Mining Publication: Technology News 481 - Update: Roof monitoring safety system for underground stone mines. Available from http://www.cdc.gov/niosh/mining/works/coversheet5.html

Center for Disease Control and Prevention (2012). Mining topic: ground monitoring. Available from http://www.cdc.gov/niosh/mining/topics/GroundMonitoring.html

Commonwealth of Kentucky Department of Workers' Claims. *Guidebook to workers' compensation*. Frankfort, Kentucky. Available from http://www.labor.ky.gov/workersclaims/Publications%202/2011%20DWC%20Guidebook.pdf

Dunning K. K., Davis K. G., Cook C., Kotowski S. E., Hamrick C., Jewell G., et al. (2010). Costs by industry and diagnosis among musculoskeletal claims in a state workers compensation system: 1999–2004. *Am J In Med*, 53,276–284.

Fotta, B.A., & Mallett, L.G. (1997, November). Effects of mining height on injury rates in U.S. underground non long wall bituminous coal mines. NIOSH Information Report 9447.NIOSH, Pittsburgh,PA. Circular.

Grayson, R.L. Safety vs. productivity and mines. *Mining Engineering*, 53(8), 40–44.

Groves W A, Kecojevic V J, & Komljenovic D. (2007). Analysis of fatalities and injuries involving mining equipment. *J Safety Res*, 38, 461-470.

Hull, P.B., Leigh, J., Driscoll, R.T., & Mandryk, J., (1996). Factors associated with occupational injury severity in the New South Wales underground coal mining industry. *Saf Sci,* 21, 191–204.

Hunting, K. L., & Weeks J. L. (1993). Transport injuries in small coal mines: an exploratory analysis. *Am J In Med,* 23, 391-406.

Kecojevic V, Komljenovic D, Groves W, & Radomsky M. (2007). An analysis of equipment related fatal accidents in U.S. mining operations: 1995-2005. *Saf Sci*, 45, 864–874.

Kecojevic V, & Radomsky M. (2004). The causes and control of loader- and truck-related fatalities in surface mining operations. *Inj Control Saf Promot*, 11(4), 239–251.

Kentucky Energy and Environment Cabinet (2013). *Kentucky coal facts*. Available from http://energy.ky.gov/Coal%20Facts%20Library/Kentucky%20Coal%20Facts%20-%2013th%20Edition%20 (2013).pdf

Laflamme L, & Blank Vera L. C. (1996). Age-related accident risks: longitudinal study of Swedish iron ore miners. *Am J In Med*, 30, 479-487.

Leigh JP, Waehrer G, Miller TR, & Keenan C. (2004). Costs of occupational injury and illness across industries. *Scand J Work Environ Health*, 30(3), 199-205.

Mine Safety and Health Administration. Coal Fatalities for 1900 through 2012. Available from: http://www.msha.gov/stats/centurystats/coalstats.asp

Mine Safety and Health Administration (2010a). *Injury experience in coal mining, 2010*. Available from: http://www.msha.gov/Stats/Part50/Yearly%20IR's/2010/Coal%20Mining%20 2010.pdf

Mine Safety and Health Administration (2010b). Most frequently cited standards for 2010. Underground – Coal. Available from http://www.msha.gov/stats/top20viols/top20viols.asp

Mine Safety and Health Administration (2011a). *Injury experience in coal mining, 2011*. Available from: http://www.msha.gov/Stats/Part50/Yearly%20IR's/2011/Coal%20Injury%20 Experience-2011.pdf

Mine Safety and Health Administration (2011b). Most frequently cited standards for 2011. Underground – Coal. Available from http://www.msha.gov/stats/top20viols/top20viols.asp.

Mine Safety and Health Administration (2011c). Most frequently cited standards for 2011.Surface – Coal. Available from http://www.msha.gov/stats/top20viols/top20viols.asp

Mine Safety and Health Administration (2012a). *Mine injury and worktime, quarterly 2012*. Available from: http://www.msha.gov/Stats/Part50/WQ/MasterFiles/MIWQ%20Master_20125.pdf

Mine Safety and Health Administration (2012b). Most frequently cited standards for 2012. Underground – Coal. Available from http://www.msha.gov/stats/top20viols/top20viols.asp.

Moore S. M., Porter W. L., & Dempsey P. G. (2009, December). Fall from equipment injuries in U.S. mining: Identification of specific research areas for future investigation. *J Safety Res*, 40 (6), 455–460.

Morantz, A. D. (2012, May 29). Coal mine safety: do unions make a difference? *Industrial and Labor Relations Review*, Forthcoming. Available from: http://ssrn.com/abstract=1846700

Mitchell R, Driscoll T, Hull B, Heale S Y, Mandryk J. (1999). Traumatic work-related fatalities involving mining in Australia, 1989-1992. *Safety Science Monitor*. *Trauma Epidemiology,* Special Edition (3): Article 2.

Muzaffar S, Cummings K, Hobbs G, Allison P, & Kreiss K. (2013, November). Factors associated with fatal mining injuries among contractors and operators. *J Occup Env Med*, 55 (11), 1337-1344.

National Research Council.(1982). Toward safer underground coal mines. National Academy Press, Washington, DC.

NIOSH (2012). Office of Mine Safety and Health Research. Mining topic: Rock fall. Available from http://www.cdc.gov/niosh/mining/topics/rockfalls.html

Office of Mine Safety and Licensing (a). *Laws governing the mining of coal. Kentucky revised statutes 351- 352*. Available from http://omsl.ky.gov/Documents/2014%20KRS%20351-352.pdf

Office of Mine Safety and Licensing (b). *Laws governing the mining of coal. Kentucky administrative regulation 805* (Chapter 7, pp. 28-30). Available from http://omsl.ky.gov/Documents/2014%20KAR%20805-825.pdf

Pappas, D.M., Mark, C., Dolinar, D.R., & Bhatt, S.K. (2013, September). Profile of ground fall accidents in underground coal mines. *Mining Engineering*, 65–71.

Quick B. L., Stephenson M. T, Witte K., Vaught C., Booth-Butterfield S., & Patel D. (2008). An examination of antecedents to coal miners' hearing protection behaviors: A test of the theory of planned behavior. *J Safety Res*, 39, 329–338.

Ruff T., Coleman P., & Martini L. (2011, March). Machine-related injuries in the US mining industry and priorities for safety research. *Int J Inj Contr Saf Promot,* 18(1), 11–20.

Salminen S. (2004). Have young workers more injuries than older ones? An international literature review. *J Safety Res*, 35(5), 513-521.

Staff, Information Technology Center Directorate of Program Evaluation and Information Resources (2010). Injury experience in coal mining. . Available from: http://www.msha.gov/Stats/Part50/Yearly%20IR's/2010/Coal%20Mining%202010.pdf.

Siskind, P. (1982). Another look at the link between work injuries and job experience. *Monthly Labor Review*, 105, 38.

United State Department of Labor (2013, June). Mine safety and health at a glance. Available from: http://www.msha.gov/MSHAINFO/FactSheets/MSHAFCT10.HTM#.UugARXko7mI

U.S. Energy Information Administration (2012, November). Annual coal report 2011. Available from http://www.eia.gov/coal/annual/pdf/table2.pdf

IX. Appendix 1: Figures & Tables

Table1: Grouped Codes for Nature of Injury, Cause of Injury, and Body Parts.

Nature of Injury
Code 31 include code 72
code 2 include code 40, 43, 46, 47
Code 59 include code 71
Cause of Injury
Code I : 1, 2,3,4,5,6,7,8,9, 11, 14, and 84
Code II: 10, 12, 13, 20
Code III: 15, 16, 17, 18 and 19
Code IV: 25, 26, 27, 28, 29, 30, 31, 32, and 33
Code V: 40, 41, 45, 46, 47, 18, and 50
Code VI: 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, and 97
Code VII: 65, 66, 67, 68, 69, and 70
Code VIII: 74, 75, 76, 77, 78, 79, 80, 81, 85, and 86
Code IX: 94 and 95.
Code X: 82, 87, 88, 89, 90, 91, 93, 96, 98, and 99
Body Parts
Head: codes 10,11,12,13,14,15,16,17,18,and 19.
Neck: codes 20,21,22,23,2,25, and 26.
Upper extremities: codes 30, 31, 32,33,34,35,36,37,38 and 39.
Trunk codes: 40,41,42,43,44,45,46,47,48,49,60,61,62,63.
Lower extremities: codes 50, 51, 51,53,54,55, 56, 57, and 58.
Multiple body parts: codes 64,65,66,90, 91 and 99.

Table 2: Categories of Accident Description

Vehicle	3 wheeler, 4 wheeler,blue ride, Brake car, buggy, buggy roof, bus, car, caterpillar, getman, golf cart, low trac, lo-lo, man buggy, man ride, mantrip, motor, pick up, ram, car ride, shuttle car, slope car, tractor, trailer, tram, truck, vehicle, wheeler.
Equipment	air gun, air hose, anchor pin, basket, bearing race, bolt, brake, drum, cable, cable reel, cable wire, canopy, canopy jack, car jack, chain, chain guard, chain saw, coal car, compressor, coupling, cover, equipment, feeder, feeder line, feeder spool, grinder, high wall miner, hoist cylinder, hood, hose, hydraulic hose, hydraulic jack, hydraulic oil, hydraulic tank, hydroseeder, idler, jamming, k-stopping panel, ladder, mast, metal bar, mine equipment, pallet, pin, pin board, pinner, pinner cable, pole, power cable, pressure washer, pump, pump line, rack, rail, jack, ratchet, ratchet jack, resistor box, rock dust, rock duster, rope, rope wheel, rotating steels, rubber hose, sandblaster, saw, saw horse, screw jack, shovel, stacker, steel plate, stinger, strap, tail, tail piece, tension pin, tire, tool box, torch, water pump, welder, wire, wire mesh.
Machinery	Auger, belt, belt framing, belt hanger, belt line, belt splice, bolt, bolt cable, bolter, bolting plate, bolting top, bolting boom, bucket, bulldozer, cable bolt, cat-head, chute, coal belt, continuous miner, conveyor belt, crusher, cutter drum, dozer, dozier, drill rig, duster, electric shovel, end loader, engine hoist, excavator, feeder, fork lift, grader, grinder hoist, loader, loader bucket, machine, motor grader, mower, outrigger, pulley, radiator, ram car, rib roll, rock crusher, rolled, roller, roof bolter, roof bolting, scattering belt, scissors lift, scoop, scoop pan, shoveling belt, skid, steer loader, splicing belt, super steer, supply, skid, tail roller, track loader, track press, trackhoe.
Place	vent tube, air lock curtain, air lock door, beam, block, boxes, brattice, brattice block, bump, cable, cage, cement, chair, coal, coal dust, concrete, corner section, crib, crib block, cross cut, curtain, dirt, discharge line, door, draw, draw slate, duct, electricity, elevator, foot shaft, gob, grating, gravel, ground, hole, ice, material, metal curtain, mine roof, mobile bridge, mud, pie pan, pillar, plug, power box, rail, rail runner, rib, rock, rock lodge, roof, rust, stairs, steel beam, steps, table, tie rail, timber, wall, water line.

Table 2: Categories of Accident Description (Cont.).

Action	trauma, bending, biting, body position, bolting, building brattices, carrying, cleaning, climbing, crawling, cross cut, cutting, dislodging, drilling, driving, drooping, dusting, fall, getting up, grabbing, hammering, hanging, holding, installing, jumping, knocking, lifting, loading, lost balance, lowering canopy, making splice, movement, moving, nailing, operating mining, over extension, plastering, pulling, pushing, putting, reaching, repeating, repetitive motion, repetitive trauma, replacing, repositioning, shoveling, slip, squatting, stacking, standing, stopping, straightening, stumbled, tightening, tripped, twisting, unlatching, walking, welding, working.
Small Tools	air gun, air valve, bar, belt knife, blade, chipping hammer, chisel, drill, hammer, hand tool, instrument, jack, jack pipe, knife, lug nut, nail, nail rod, pipe, plasma cutter, pry bar, ratchet, rib bolt, rod, scraper, slate bar, socket, screw driver, tire iron, tools, torque converter, valve, wrench.
Liquids	boiled, degreaser, fluid coupling, grease, oil, solution, water

Figure 1: Number of Injured Mining Workers in Kentucky, 2010-2012.

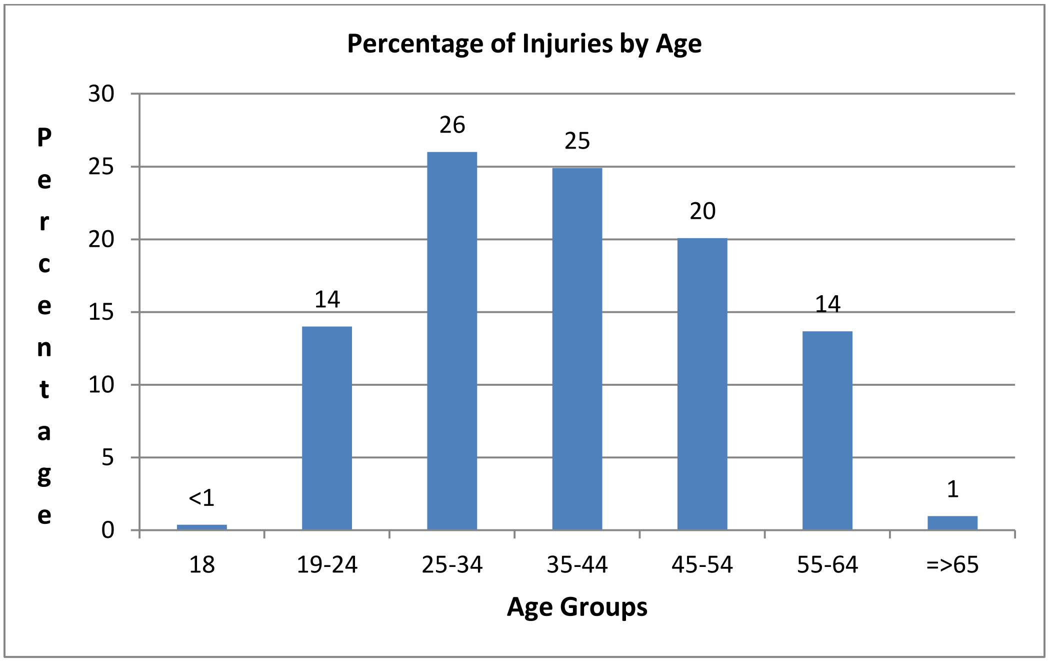

Figure 2: Injuries by Type of Coal Mining in Kentucky, 2010-2012.

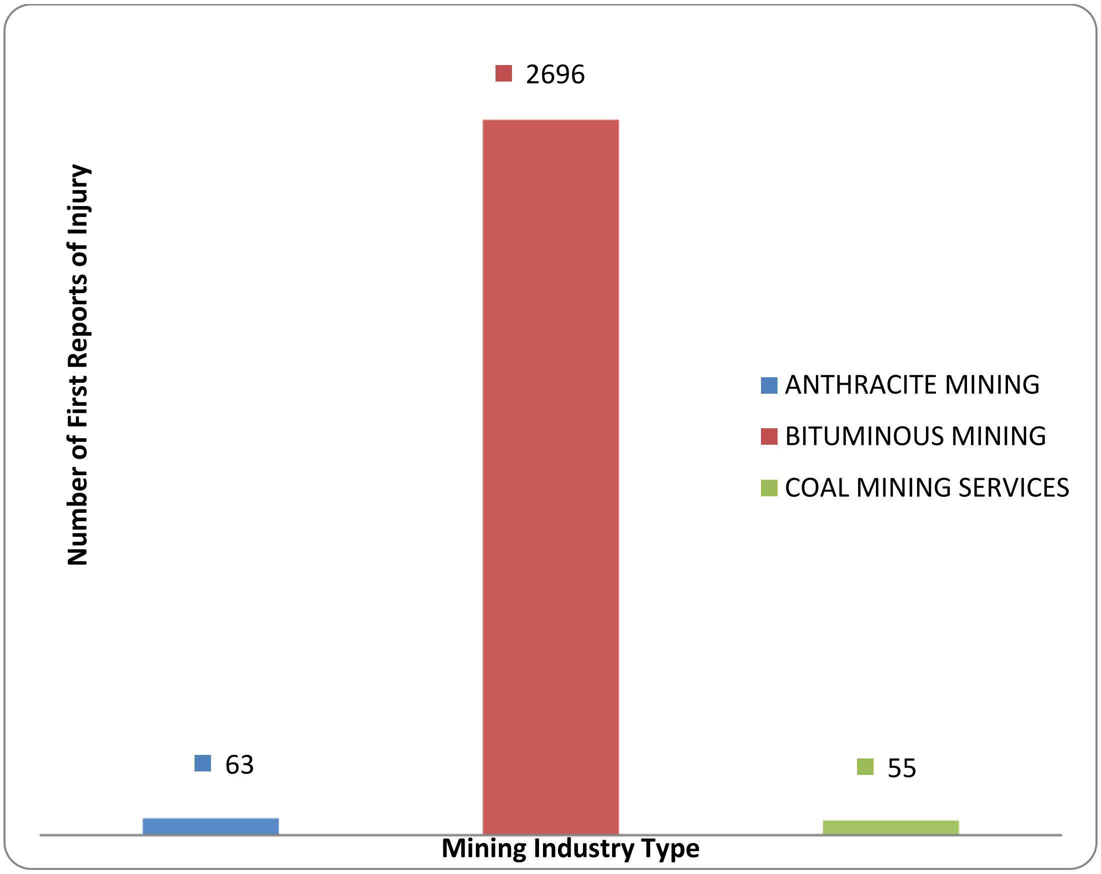

Table 3: Mining Injury Percent by Kentucky County, 2010-2012.

County Of Injury	N of workers injured	Percent
Hopkins	514	18.27
Pike	344	12.22
Harlan	286	10.16
Union	272	9.67
Lawrence	229	8.14
Webster	164	5.83
Out of state	127	4.51
Perry	122	4.34
Martin	103	3.66
Nelson	100	3.55
Whitley	94	3.34
Letcher	92	3.27
Knott	68	2.42
Floyd	66	2.35
Laurel	66	2.35
Bell	54	1.92
Leslie	19	0.68
Breathitt	11	0.39
Jessamine	11	0.39
Boyd	8	0.28
Fayette	8	0.28
Muhlenberg	7	0.25
Henderson	6	0.21
Johnson	5	0.18
Knox	5	0.18
Magoffin	5	0.18

Table 4: Coal Mining Injury Incidence in Kentucky by year.

Year	N	Rate per 200.000 hours	CI
2010	788	3.765	3.765 - 3.766
2011	1056	4.738	4.737-4.738
2012	970	5.382	5.381 - 5.383

Table 5: Mining Injuries by Nature of Injury, 2010-2012

Type of Injury	N of Injured	Rate per 200,000hr	CI
Strain or Tear	985	1.61	1.608 - 1.609
Contusion	517	0.84	0.844 - 0.8444
Amputation, Laceration	326	0.53	0.4345 - 0.4345
Fracture	226	0.37	0.368 - 0.369
Sprain or Tear	188	0.31	0.3069 - 0.3071
Foreign Body	92	0.15	0.1502 - 0.1503
Burn	48	0.08	0.0783 - 0.0784
Crushing	46	0.08	0.07507 - 0.07516
All other specific injuries NOC	46	0.08	0.07507 - 0.07516
Multiple Physical Injuries Only	30	0.05	0.04895 - 0.04903
All other cumulative injuries NOC	25	0.04	0.04079 - 0.04086
Dislocation	18	0.03	0.02936 - 0.02942
Hernia	13	0.02	0.0212 - 0.0213

Table 6: Mining Injuries in Kentucky by Injury Description Narrative, 2010-2012

Type of Injury	N	Rate
Strain or Tear		
Machinery	230	23.4
Equipment	198	20.1
Place*	169	17.2
Action	152	15.4
Vehicle	109	11.1
Others	60	6.1
Small Tools	36	3.7
Unknown**	31	3.2
Contusion		
Place*	220	42.6
Equipment	83	16.1
Machinery	66	12.8
Vehicle	56	10.8
Small Tools	44	8.5
Others	30	5.8
Action	14	2.7
Unknown**	4	0.8
Amputation, Laceration		
Place*	64	19.7
Others	64	19.7
Small Tools	53	16.3
Equipment	52	16.0
Machinery	52	16.0
Action	25	7.7
Vehicle	10	3.1
Unknown**	5	1.5
Fracture		
Place*	69	30.5
Machinery	49	21.7
Others	27	12.0
Vehicle	25	11.1
Equipment	22	9.7
Action	14	6.2
Small Tools	14	6.2
Unknown	5	2.2
Drugs	1	0.4

Table 6: Mining Injuries in Kentucky by Injury Description Narrative, 2010-2012 (Cont.).

Type of Injury	N	Rate
Sprain or Tear		
Place*	64	34.0
Machinery	56	29.8
Equipment	29	15.4
Vehicle	18	9.6
Small Tools	8	4.3
Others	7	3.7
Action	5	2.7
Unknown**	1	0.5
Foreign Body		
Others	26	28.3
Place*	25	27.2
Equipment	15	16.3
Machinery	12	13.0
Small Tools	10	10.9
Unknown**	3	3.3
Burn		
Equipment	11	22.9
Place*	11	22.9
liquids	10	20.8
Others	7	14.6
Action	7	14.6
Machinery	2	4.2
Crushing		
Machinery	14	32.6
Small Tools	10	23.3
Place*	9	20.9
Vehicle	4	9.3
Others	4	9.3
Equipment	1	2.3
Action	1	2.3
All other specific injuries NOC		
Place*	11	23.9
Small Tools	9	19.6
Action	8	17.4

Table 6: Mining Injuries in Kentucky by Injury Description Narrative, 2010-2012 (Cont.).

Type of Injury	N	Rate
Equipment	5	10.9
Vehicle	4	8.7
Others	4	8.7
Unknown**	3	6.5
Machinery	2	4.34
Multiple Physical Injuries Only		
Place*	10	33.3
Machinery	7	23.3
Vehicle	6	20.0
Others	3	10.0
Equipment	2	6.7
Action	1	3.3
Small Tools	1	3.3
All other cumulative injuries NOC		
Others	18	72.0
Action	4	16.0
Equipment	1	4.0
Place	1	4.0
Small Tools	1	4.0
Dislocation		
Equipment	4	22.2
Machinery	4	22.2
Place*	3	16.7
Action	3	16.7
Vehicle	2	11.1
Others	1	5.6
Unknown*	1	5.6
Hernia		
Action	11	84.6
Vehicle	1	7.7
Others	1	7.7

*Place: Falling rocks from the mine structure, for example……

**Unknown: No accident description information provided

Table 7: Elements in each category by injury.

Strain	N	%
Machinery		
Scoop/loader/bucket/dozer	89	9.0
Bolt/bolter/roof bolter	66	6.7
Belt/scattering belt	33	3.4
Roller	12	1.2
Continuous miner/cutter drum/cat-head	8	0.8
Equipment		
Cable/wire	86	8.7
Pin/pinner/pin board/pinner cable/anchor pin/tension pin	18	1.8
Shovel	17	1.7
Feeder/ feeder line/feeder spool/pump/pump line	10	1.0
Ladder	10	1.0
Hose	7	0.7
Rock duster	7	0.7
Welder	7	0.7
Rail jack/screw jack/ratchet jack/hydraulic jack/car jack	6	0.6
Place		
Rock	66	6.7
Ground/ice/mud	43	4.4
Rail/steel beam/beam	19	1.9
Curtain/ vent tube/brattice/brattice block	17	1.7
Water line	7	0.7
Stairs	6	0.6
Action		
Lifting	51	5.2
repetitive movement/work	21	2.1
Slip/fall/lost balance/jumped	13	1.3
pushing/pulling	11	1.1
loading/carrying/moving	9	0.9
Bending	7	0.7
Body Position/squatting/crawling/standing	7	0.7
Reaching/grabbing	6	0.6
Twisting	6	0.6
Vehicle		
Truck	50	5.1
four wheeler/mantrip/lo-trac/shutle car/buggy/golf cart	42	4.3
vehicle	9	0.9
Small Tools		
Pry bar/ratchet/wrench	12	1.2
Drill	9	0.9

Table 7: Elements in each category by injury.(Cont.)

Hammer	7	0.7
Others		
Metal plate/metal sheet/metal post/rod	10	1.0
Contusion	**N**	**%**
Place		
rock/gob/material	198	38.3
beam/timber	6	1.2
door	6	1.2
Equipment		
cable/cable reel	15	2.9
pinner/pin/pin board	14	2.7
steel plate/rotating steels	10	1.9
canopy/cover/canopy jack	9	1.7
chain fall/idler/chain	8	1.5
ladder	6	1.2
Machinery		
bulldozer/dozer/scoop/dozier	22	4.3
bolt/bolter/bolting/roof bolter	20	3.9
belt/shoveling belt	15	2.9
roller	5	1.0
Vehicle		
3-4 wheeler/golf cart/shuttle car	22	4.3
truck	19	3.7
man ride/mantrip/man buggy	5	1.0
Small Tools		
drill	14	2.7
hammer	11	2.1
pry bar/slate bar/ratchet	6	1.2
wrench	5	1.0
Action		
fall/tripped/slipped/climbing	9	1.7
Amputation		
Place		
rock	52	25.0
Equipment		
pin/pinner/pin board	13	7.7
cable/cable wire/power cable	10	5.9
chain/chain guard/chain saw	5	3.0

Table 7: Elements in each category by injury.(Cont.)

Amputation	N	%
Machinery		
Bolt/bolting/bolting plate/bolt cable/bolting top/roof bolter	19	11.2
bulldozer/scoop/dozer/excavator/loader bucket/track loader/skid steer loader	11	6.5
belt/belt hanger/belt framing/belt splice	10	5.9
continuous miner	6	3.6
Small Tools		
knife	20	6.2
hammer/screw driver/hand tool	11	3.4
pry bar/slate bar/tire iron/bar	9	2.8
Nail rod/blade/wrench	6	1.8
Others		
metal/metal band/metal hanger/plates	26	8
steel/steel plate/finisher steel	12	3.7
Action		
cutting	7	2.2
Fracture		
Place		
rock	40	25.7
water line/discharge line	6	3.8
Machinery		
roof bolter/bolter/bolt/cable bolt	21	19.0
belt/belt line/coal belt	9	8.1
chute/machine/hoist/mower/fork lift	5	4.5
Others		
material/steel/metal	9	14.7
objects	8	13.1
Vehicle		
truck/vehicle	9	16.6
car	7	12.9
Equipment		
chain/cable	5	10.1
Action		
slipped/fell	5	15.8
Small Tools		
pry bar/rod/ratchet	6	19.0
drill/hammer	6	19.0

Table 7: Elements in each category by injury.(Cont.)

Sprain	N	%
Place		
Ground/ mud/ice	35	29.1
Rock	16	13.3
Beam/cage/cribs	4	3.3
Stairs/steps	4	3.3
Machinery		
dozer/scoop/motor grader	30	28.5
Belt/splicing belt/conveyor belt	9	8.5
Bolt/bolter	9	8.5
Equipment		
Cable	13	23.8
Vehicle		
Mantrip/shuttle/golf cart	8	23.6
Truck	8	23.6
Small Tools		
Drill	5	33.2
Foreign Body		
Others		
Plaster	6	6.5
something	5	5.4
Place		
Coal dust	10	10.9
Rock	6	6.5
Mud/dirt	5	5.4
Equipment		
equipment/bolt/welder	5	5.4
pin	3	3.3
Wire	3	3.3
Machinery		
grinder	7	7.6
Burn		
Equipment		
torch	9	18.8
Place		
plug	8	16.7
Liquids		
grease/oil/fluid coupling/degreaser	6	12.5

Table 7: Elements in each category by injury.(Cont).

Action		
welding	5	10.4
Crushing		
Machinery		
continuous miner	6	14.0
Small Tools		
drill	5	11.6
hammer	5	11.6
Place		
rock	8	18.6
All other specific injuries NOC		
Place		
rock	7	15.2
Multiple injuries		
Machinery		
dozer/scoop/loader	5	16.7
All other cumulative injury NOC		
Others		
cumulative/accumulative injury	16	64
Hernia		
Action		
shoveling/loading/lifting	5	38.5

Figure 4: Kentucky Mining Injuries by Injured Body Part, 2010-2012

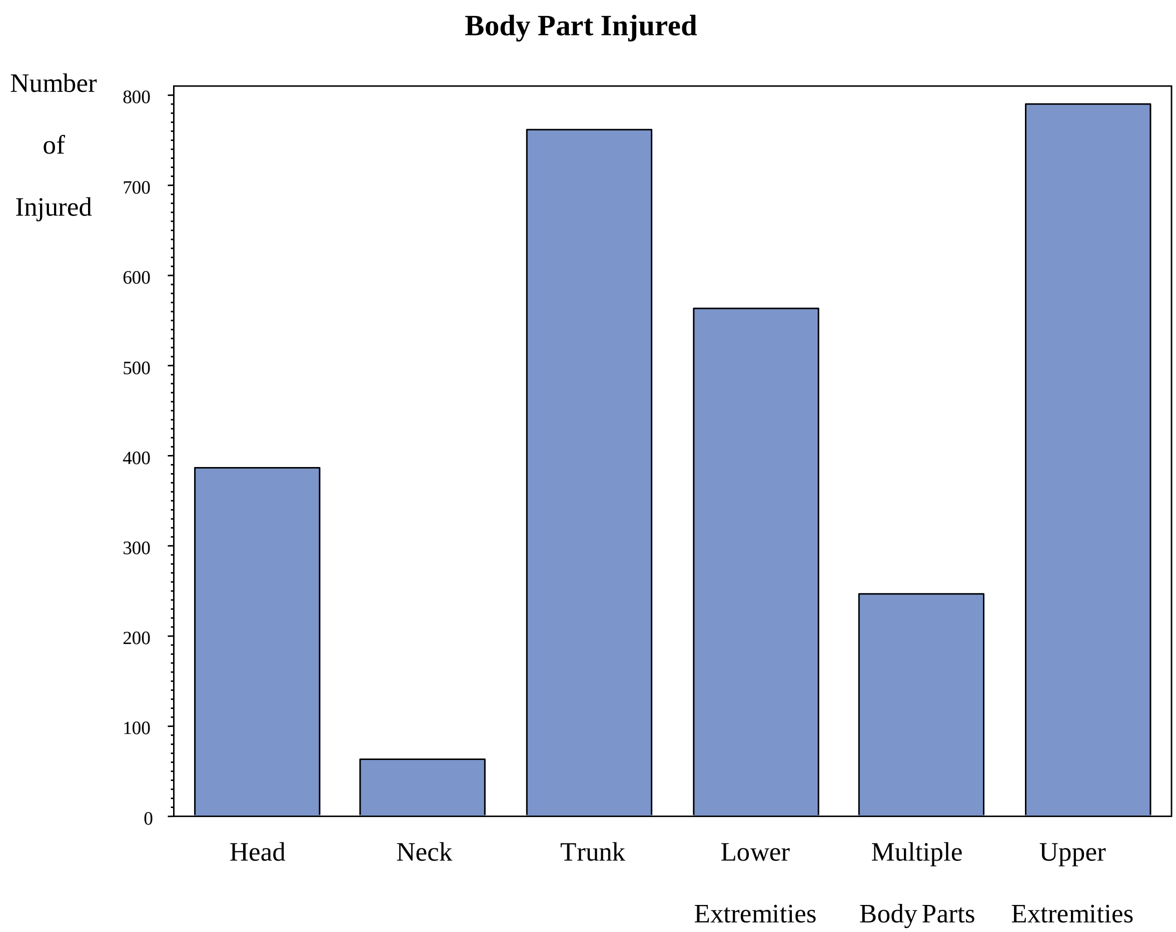

Table 8: Categories of Accident Description with Incidence Rates of Elements.

Category	N	%
Place		
Rock	385	13.68
Ground/ice/mud	87	3.09
Roof	24	0.85
Beam	22	0.78
Curtain	17	0.60
Water line	14	0.50
Steps	13	0.46
Rail	12	0.43
Door	11	0.39
Plug	8	0.28
Block	7	0.25
Rib roll	6	0.21
Timber	5	0.18
Machinery		
Scoop	137	4.87
Bolter/roof bolter/bolt	113	4.01
Belt	68	2.42
Continuous miner	21	0.75
Roller	19	0.67
Dozer	13	0.46
Machine	9	0.32
Loader	7	0.25
Fork lift	6	0.21
Bucket	5	0.18
Ram car	5	0.18
Equipment		
Cable	121	4.30
Pinner	27	0.96
Ladder	23	0.82
Shovel	21	0.75
Pin	18	0.64
Equipment	17	0.60
Chain	16	0.57
Hose	16	0.57
Canopy	10	0.36

Table 8: Categories of Accident Description with Incidence Rates of Elements. (Cont.)

Category	N	%
Steel plate	10	0.36
Torch	10	0.36
Pump	9	0.32
Ratchet	8	0.28
Pin board	6	0.21
Tool box	6	0.21
Wire	5	0.18
Vehicle		
Truck	92	3.27
Shuttle car	38	1.35
Mantrip	22	0.78
Car	13	0.46
Buggy	11	0.39
Vehicle	11	0.39
Golf cart	8	0.28
Trailer	8	0.28
4 wheeler	7	0.25
Action		
Lifting	55	1.95
Repetitive/cumulative movement	37	1.31
Slip	19	0.67
Bending	8	0.28
Loading	8	0.28
Shoveling	8	0.28
Moving	7	0.25
Tripped	7	0.25
Walking	7	0.25
Climbing	6	0.21
Pulling	6	0.21
Twist	6	0.21
Welding	6	0.21
Drilling	5	0.18
Fall	5	0.18
Pushing	5	0.18
Reaching	5	0.18

Table 8: Categories of Accident Description with Incidence Rates of Elements. (Cont.)

Category	N	%
Small Tools		
Drill	42	1.49
Hammer	38	1.35
Knife	20	0.71
Pry bar	16	0.57
Wrench	11	0.39
Pipe	6	0.21
Jack	5	0.18
Liquids		
Grease/oil/fluid coupling/degreaser	6	0.21

Table 9: Coal Mining Injury Rates by States, 2010-2012.

State	N	Rate per 200,000 hrs.	CI
Arkansas	22	10.31	10.3 - 10.32
Illinois	751	5.41	5.409 - 5.411
Tennessee	82	5.18	5.173 - 5.178
Alabama	802	4.71	4.708 - 4.71
Kentucky	2661	4.35	4.345 - 4.346
Oklahoma	30	4.20	4.196 - 4.203
Pennsylvania	1158	4.11	4.112 - 4.114
West Virginia	3255	3.99	3.993 - 3.994
Maryland	56	3.58	3.581 - 3.585
Virginia	609	3.46	3.464 - 3.466
Alaska	17	3.45	3.449 - 3.456
Utah	191	3.41	3.406 - 3.408
Ohio	350	3.23	3.227 - 3.229
Indiana	400	3.03	3.032 - 3.034
Colorado	203	2.81	2.81 - 2.812
New Mexico	81	1.93	1.933 - 1.935
Montana	65	1.68	1.684 - 1.685
Kansas	1	1.54	1.53 - 1.544
Texas	103	1.10	1.098 - 1.099
Wyoming	235	1.07	1.07 - 1.071
Arizona	12	0.81	0.808 - 0.810
North Dakota	25	0.73	0.726 - 0.727
Mississippi	5	0.65	0.653 - 0.656
Washington	1	0.64	6.386 - 6.442
Louisiana	4	0.47	0.471 - 0.473

X. Biographical Sketch

Evelyn Noelia Thomas is a physician from Argentina, where she trained and practiced as an M.D. prior to relocating to the U.S. She is currently completing a Master's Degree in Public Health with a focus in epidemiology. Her research focuses primarily in occupational injuries and diseases, and has published peer-reviewed research regarding burnout syndrome in healthcare professionals.

Contact Information:

3972 Westbrook Drive

Lexington, KY 40514

(859) 608-9160

eveoberlin@hotmail.com

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