A Study of the Correlation between Age and the Number of Work Accidents in Mining Enterprises between 2003–2017

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Abstract

Progressive changes in the demographic structure of developed countries observed for many years have caused increasing disproportions in the workforce age distribution. Every year, the number of older employees is reported to be increasing as opposed to the number of younger employees, which is decreasing. This affects the sphere of occupational health and safety. A work accident comprises a number of interrelated adverse technical, organizational, environmental, and human events [1,2]. However, it has been claimed that the main contributing factor responsible for work accidents is a human error (disruption). The causes of human errors may include: incapacity, nature of tasks being performed as well as physical and social environment. It is important to note that the first element is strongly related to both age and seniority. Based on available literature, the impact of age on work accidents is not clearly defined. Advanced age of employees favors the acquisition and consolidation of professional knowledge, but it can also be associated with greater automation of behaviors in work environment. This can lead to an error resulting in a dangerous situation or accident. The analysis of the age structure of individuals employed in mining enterprises indicates the dominance of employees aged 36–45 between 2003–2017. Bearing in mind the above, this study examined the relationship between age and the number of work accidents among individuals employed in mining enterprises. The study was carried out using the Pearson's correlation coefficient. The source of analysis included statistical data on the size of employment in individual age groups and the number of work accidents in mining enterprises. The period adopted for the analysis was between 2003–2017. The research showed a correlation between age and the number of work accidents in hard coal mines.

Keywords: work accidents, employee age, mining enterprises

Introduction

Progressive changes in the demographic structure of developed countries observed for many years have caused increasing disproportions in the workforce age distribution. Every year, the number of older employees is reported to be increasing as opposed to the number of younger employees, which is decreasing. In the case of analyzed data characterizing the employment structure of mining enterprises, this situation is also influenced by the restructuring processes that have been taking place for many years and, connected with them, temporary suspension of recruitment, among other consequences. Eventually, the employee age structure was extremely unfavorable between 2003–2017, when the group aged 36–45 predominated (Figure 1). Also, when considering the mean age at which workers employed underground currently reach the retirement age (43 years), the age of studied groups can be assessed as advanced, clearly approaching the retirement age threshold. This is an immensely unfavorable situation, as not only does it impact the efficiency of production, but also health and safety at work. Sociological research shows that employee age is related to their attitude, willingness to change work, retraining, training, and finally work productivity and quality [3]. As employees become older, the willingness and ability to retrain or train decreases. In addition, many specialists empha-size the relationship between age and the number of work accidents [4].

It is only recently that a change in the age structure of individuals employed in mining enterprises has been reported, which could have been influenced by the recruitment of new employees since 2008. This resulted in subsequent equalization of contribution of given age groups in the total employment structure.

With regard to the foregoing, this study presents a correlation analysis of age and the number of work accidents among employees of mining enterprises based on the statistical data from the years 2003–2017.

Employee age and accident rates.

Although specialists point to the relationship between employee age and work accidents, this impact is not explicit. Advanced age of employees means more experience and thus a lower risk of accidents through better knowledge of procedures, regulations, and occupational safety policy. On the other hand, it also means routine and lower perception of threats [5]. Numerous publications indicate that with age, physical and sensory fitness of these employees decline and susceptibility to specific types of work accidents increases, for example, falls from height, slips and trips [4,6,7]. Although young employees lack the experience, they show high physical fitness. Nevertheless, they are more
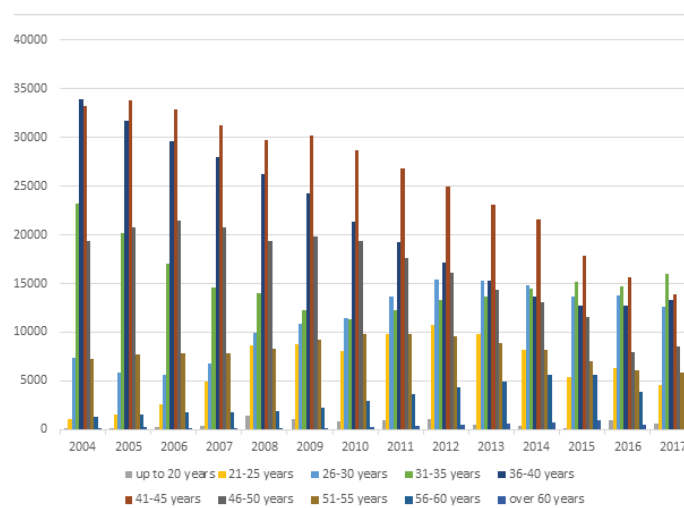
Fig. 1. Age structure of employees of mining enterprises between 2003–2017
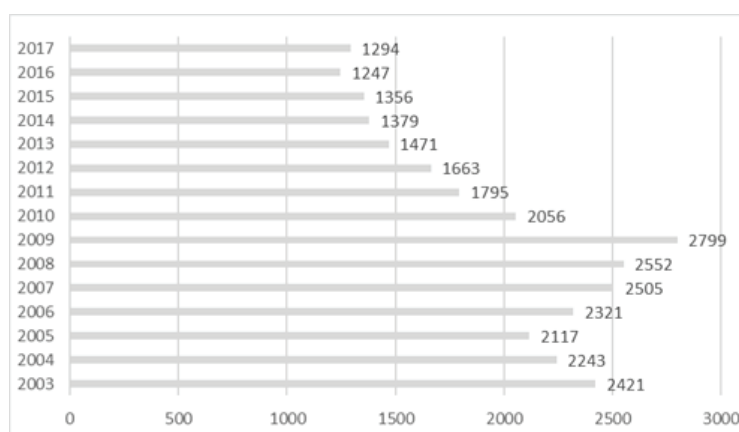Rys. 1. Struktura wieku pracowników przedsiębiorstw górniczych w latach 2003–2017

Fig. 2. Total number of work accidents in hard coal mines between 2003-2017 [9]
Rys. 2. Liczba wypadków ogółem w kopalniach węgla kamiennego w latach 2003–2017 [9]

often involved in work accidents due to insufficient knowledge of hazards, which results in poor decisions in crisis situations [8] It is worth noting that although statistical analyses show higher probability of work accidents among young employees, accidents involving older employees were found to have more serious and long-lasting consequences.

As shown in Figure 2, when analyzing the accidents reported in mining enterprises between 2003–2017, it is difficult to clearly determine a dominant trend. Only in 2009 could a downward trend be noticed, which turned into an upward trend again in 2017. Also, in 2009, there was an increase in the total number of accidents in mining enterprises, which coincides with a very large staff turnover in the previous year. According to the statistical data on mining industry, in 2008, almost 14,000 employees were dismissed, and more than 17,200 people were employed [10].

Study of the relationship between age and the number of work accidents in hard coal mines

The study of the relationship between age and the number of work accidents in hard coal mines was conducted using the Pearson's correlation coefficient. This coefficient is used to study linear relations of studied variables, in which an increase in the value of one characteristic causes proportional changes in the mean values of the other characteristic (increase or decrease). Poor or lack of relationship occurs at values below 0.2.

Correlation (interdependence of features) defines interrelations between selected variables. Here, values are accepted when in the range between -1 and 1. Positive correlation (correlation coefficient from 0 to 1) informs that an increase in the value of one characteristic is accompanied by an increase in the mean values of the other characteristic. Negative correlation (correlation coefficient from -1 to 0) informs that an increase in the value of one characteristic is accompanied by a decrease in the mean values of the other characteristic.

The calculated Pearson's correlation coefficient between the mean age and work accidents in mining enterprises between 2003–2017 shows (Figure 3, Tab. 1)

| YEAR	Total number of accidents (end of december)	up to 20 years	21-25 years	26-30 years	31-35 years	36-40 years	41-45 years	46-50 years	51-55 years	56-60 years	over 60 years
2003	2421	39	1318	9666	25894	35972	35403	19234	7512	1222	188
2004	2243	48	1115	7369	23250	33967	33267	19362	7245	1273	190
2005	2117	96	1514	5851	20191	31670	33830	20761	7734	1553	211
2006	2321	222	2557	5650	17041	29626	32927	21467	7871	1751	200
2007	2505	401	4936	6735	14553	27940	31228	20774	7828	1811	200
2008	2552	1407	8711	9890	13994	26288	29745	19320	8280	1903	175
2009	2799	1097	8730	10829	12254	24227	30203	19865	9230	2286	154
2010	2056	811	8081	11404	11297	21406	28647	19369	9801	2995	278
2011	1795	957	9838	13683	12221	19274	26840	17604	9792	3615	411
2012	1663	1051	10718	15411	13271	17210	24952	16157	9614	4317	555
2013	1471	488	9856	15333	13684	15353	23142	14328	8862	4980	667
2014	1379	325	8192	14856	14425	13640	21597	13043	8228	5583	786
2015	1356	113	5358	13615	15125	12687	17879	11531	7035	5577	1004
2016	1247	909	6334	13778	14709	12727	15665	8001	6054	3822	549
2017	1294	620	4610	12665	16006	13331	13862	8494	5872	4288	877
correlation coefficient		0,08	-0,25	-0,72	0,23	0,83	0,87	0,88	0,31	-0,86	-0,90
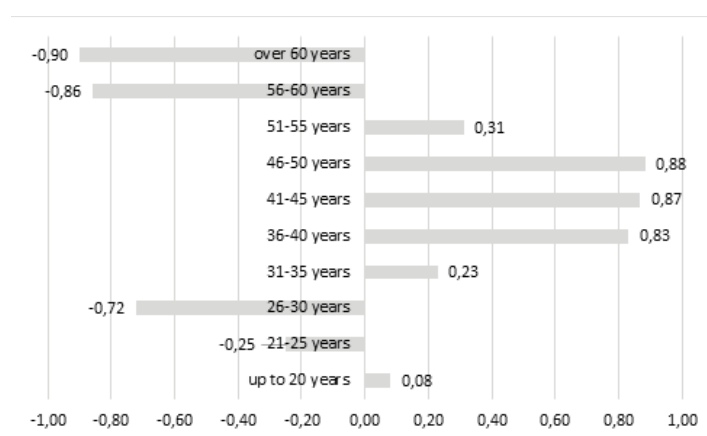
Fig. 3. Pearson's correlation coefficient between the mean age and work accident rates in mining enterprises between 2003–2017
Rys. 3. Współczynnik korelacji liniowej Pearsona między średnim wiekiem i wypadkowością pracowników w przedsiębiorstwach górniczych w latach 2003–2017

a strong positive correlation for employees aged 36–50. This means that the higher the number of employees in this age group, the higher the number of work accidents. At the same time, a strong negative correlation can be observed for the group of employees aged 26–30 as well as 56 and over 60. In this case, there is a decrease in the number of work accidents despite an increase in the number of employees in this age group.

Changes in the number of employees in age groups presented in Figure 4 show a reverse upward trend in relation to the number of work accidents especially after 2009. It can therefore be concluded that the growing number of employees in these age groups does not cause an increase in the number of work accidents.

Special attention should be paid to employees aged 26–30. In theory, it is a group of relatively young employees who may have not yet acquired a lot of professional experience [11,12,13], knowledge or skills that, according to many authors, allow for a correct and quick response when in danger. However, this study indicates an increase in the number of employees aged 26–30 and a simultaneous decrease in the number of work accidents in hard coal mines.

The groups of employees aged 36–50 (Figure 5) compared to the number of work accidents show the most positive correlation with the accident rate. A decline in the number of employees in the studied age groups is accompanied by a simultaneous decrease in the number of work accidents. Therefore, this group has a decisive influence on the overall accident rate in mining enterprises. In addition, these are very experienced employees familiar with safe work procedures. That is why, the least number of accidents should occur. However, this is only theory, as in practice, a reverse situation was reported. Many factors can be responsible for this situation, namely professional routine, age-related decline in functional capacity, and a low level of safety culture in mining enterprises.

Conclusions

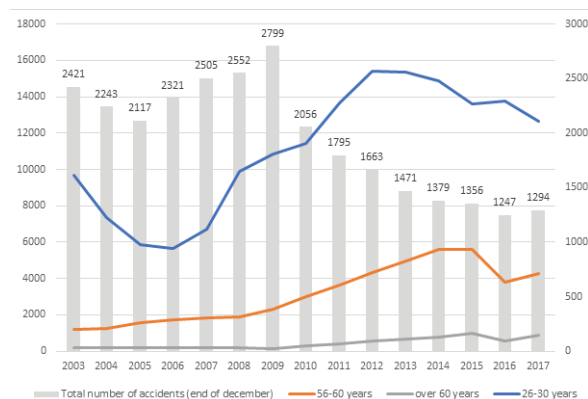This study showed a relationship between age and the number of work accidents in hard coal mines.

Fig. 4. Total number of work accidents versus changes in the number of employees in given age groups between 2003–2017.
Rys. 4. Liczba wypadków ogółem w kopalniach węgla kamiennego na tle zmian liczby pracowników w poszczególnych kategoriach wieku w latach 2003–2017
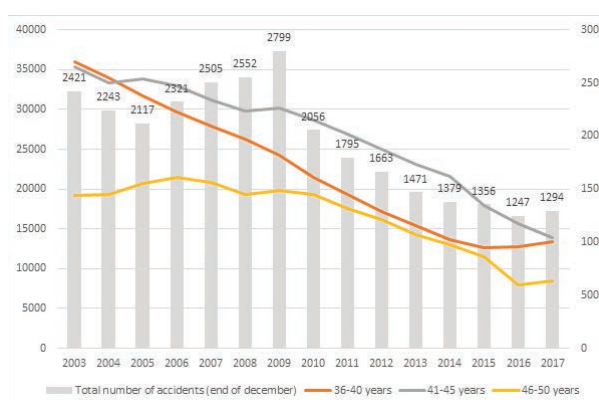

Fig. 5. Total number of work accidents in hard coal mines versus changes in the number of employees in given age groups between 2003–2017
Rys. 5. Liczba wypadków ogółem w kopalniach węgla kamiennego na tle zmian liczby pracowników w poszczególnych kategoriach wieku w latach 2003–2017

The correlation analysis showed that the strongest relationship between these values was reported in the following age groups: 36–50 and 26–30. For the first age group, it was found that the decrease in the number of employees coincided with the decrease in the number of work accidents. For the age group 26–30, a reverse situation was observed. Here, the increase in the number of employees failed to coincide with the increase in the number of work accidents. This reveals that the number of work accidents in hard coal mines is influenced by the group of employees aged 36–50, namely people who are already very experienced and know how to behave in dangerous situations. The analysis used statistical data on hard coal mines indicating that the higher the age of employees, the lower their physical fitness and ability to perceive threats, which in turn is one of the factors causing higher work accidents rates. This is an interesting observation that should be considered when planning preventive activities in the area of occupational health and safety as well as further research.

With regard to the foregoing, as part of the effective management of occupational safety and health in an enterprise, including OSH prevention, special attention should be paid to employees aged between 36 and 50. In order to decrease work accident rates, certain actions need to be implemented, for example, closer supervision of employees' activities and behaviors, counteracting professional routine, creating a system motivating employees to comply with health and safety regulations, and preparing tailor-made trainings. It will also be important to properly plan and implement an employment policy in hard coal mines to ensure equal participation of individual employee age groups in the total employment structure.

Acknowledgments

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Badanie korelacji między wiekiem a liczbą wypadków pracowników przedsiębiorstw górniczych w latach 2003–2017

Postępujące od wielu już lat w krajach rozwiniętych zmiany struktury demograficznej ludności powodują coraz większe dysproporcje w rozkładzie wiekowym siły roboczej. Z roku na rok wzrasta liczba pracowników starszych, a maleje młodszych. Nie pozostaje to bez wpływu na sferę bezpieczeństwa i higieny pracy. Na zdarzenie wypadkowe składa się szereg powiązanych ze sobą niekorzystnych zdarzeń technicznych, organizacyjnych, środowiskowych i ludzkich [1,2]. Uznaje się jednak, że zazwyczaj czynnikiem inicjującym wypadek przy pracy jest błąd (zakłócenie) człowieka. Pośród przyczyn popełniania błędów można wyróżnić przede wszystkim: niesprawność człowieka, cechy realizowanych zadań, warunki fizycznego środowiska oraz wpływ środowiska społecznego, przy czym pierwszy z wymienionych elementów jest bardzo powiązany z wiekiem czy stażem pracy pracownika. W literaturze przedmiotu wpływ wieku pracowników na występowanie wypadków przy pracy nie jest jednoznacznie zdefiniowany. Wyższy wiek pracownika sprzyja nabywaniu i utrwalaniu wiedzy zawodowej, ale może również wiązać się z większą automatyzacją zachowań w środowisku pracy, skąd tylko krok do błędu skutkującego zaistnieniem sytuacji niebezpiecznej czy wypadku. Poddana analizie struktura wiekowa pracowników przedsiębiorstw górniczych wskazuje na dominację w analizowanym okresie (lata 2003–2017) grup pracowników w wieku 36–45 lat. Mając na uwadze powyższe, w publikacji zaprezentowano analizy związków wieku i liczby wypadków przy pracy pracowników przedsiębiorstw górniczych. Badanie zależności między tymi wielkościami przeprowadzono wykorzystując współczynnik korelacji liniowej Pearsona. Jako źródło analizy przyjęto dane statystyczne dotyczące wielkości zatrudnienia w poszczególnych kategoriach wiekowych pracowników i liczby zaistniałych wypadków w przedsiębiorstwach górniczych. Przyjęty do analizy okres to lata 2003–2017. Przeprowadzone badania wykazały istnienie związku korelacyjnego między wiekiem pracowników a liczbą wypadków przy pracy w kopalniach węgla kamiennego.

Słowa kluczowe: wypadki przy pracy, wiek pracowników, przedsiębiorstwa górnicze