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ORIGINAL PAPER

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THE ANALYSIS OUTLINING THE OCCURRENCE AND CONSEQUENCES OF ACCIDENTS IN THE WORK ENVIRONMENT OF THE FIREFIGHTERS EMPLOYED BY THE STATE FIRE SERVICE IN POLAND IN 2008–2013

ANALIZA WYSTĘPOWANIA I SKUTKÓW WYPADKÓW W ŚRODOWISKU PRACY STRAŻAKÓW PAŃSTWOWEJ STRAŻY POŻARNEJ W POLSCE W LATACH 2008–2013

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Abstract

Background: Due to the specifics of their work and to being exposed to a wide range of hazards, firefighters working for the State Fire Service (SFS) face the risk of work-related accidents more often than members of other occupational groups. The aim of this paper is to analyze the occurrence and consequences of accidents in the work environment of the SFS officers in Poland between the years 2008–2013. **Material and Methods:** The material analyzed is based on aggregate data collected by the Headquarters of the State Fire Service. Figures regarding accidents in the period between 1 January 2008 and 31 December 2013 show that 8518 work-related accidents occurred in that period and 8635 people were injured. **Results:** The data shows that neither the number of accidents nor their frequency indicator underwent any significant fluctuations over the 6 years under consideration. The group that is most exposed to accidents on duty in the profession includes active firefighters serving in rescue and fire extinguishment divisions. According to the data, the greatest number of trauma incidents in the SFS between the years 2008–2013 occurred during sporting activities. The predominant cause of these was inappropriate behavior or the lack of proper care. The most frequent injuries sustained during the accidents were broken or fractured bones and sprained joints. **Conclusions:** Accidents on duty occur significantly more often when firefighters are at their stations, during sporting classes, exercises or maneuvers, than in the course of actual rescue operations. The firefighters of the State Fire Services are insufficiently prepared for their sporting activities. Med Pr 2016;67(1):1–9

Key words: firefighter, State Fire Service, occurrence of accidents, accident consequences, work environment, causes of accidents

Streszczenie

Wstęp: Funkcjonariusze Państwowej Straży Pożarnej (PSP) ze względu na specyfikę pracy i szeroki wachlarz zagrożeń częściej niż inne grupy zawodowe są narażeni na ryzyko wystąpienia wypadku przy pracy. Celem niniejszego opracowania jest analiza występowania i skutków wypadków w środowisku pracy funkcjonariuszy PSP w Polsce w latach 2008–2013. **Materiał i metody:** Analizie poddano materiał bazujący na danych zagregowanych, zebranych przez Komedę Główną Państwowej Straży Pożarnej. Zgodnie z tymi danymi w okresie od 1 stycznia 2008 r. do 31 grudnia 2013 r. miało miejsce 8518 wypadków przy pracy, w których rannych zostało 8635 osób. **Wyniki:** Zarówno liczba wypadków, jak i wskaźnik częstości wypadków przy pracy nie uległy zasadniczym zmianom w analizowanych 6 latach. Grupą najbardziej narażoną na wypadki w zawodzie strażaka są czynni strażacy, pracujący w jednostkach ratowniczo-gaśniczych. Najwięcej osób poszkodowanych w latach 2008–2013 w PSP miało wypadki w trakcie zajęć sportowych. Dominującą przyczyną zdarzeń było nieprawidłowe zachowanie lub nieostrożność. Najczęstszymi urazami w wyniku wypadków były liczne złamania, pęknięcia kości i zwichnięcia. **Wnioski:** Państwowa Straż Pożarna przygotowuje funkcjonariuszy pod względem przestrzegania zasad bezpieczeństwa i higieny pracy podczas udziału w akcjach ratowniczych. Wypadki strażaków podczas służby zdecydowanie częściej miały miejsce w trakcie pobytu w jednostce – w czasie zajęć sportowych – niż rzeczywistych działań ratowniczych. Med. Pr. 2016;67(1):1–9

Słowa kluczowe: strażak, Państwowa Straż Pożarna, występowanie wypadków, skutki wypadków, środowisko pracy, przyczyny wypadków

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INTRODUCTION

When the organizational structure of the State Fire Service (SFS) [1] was being formed in the late 1980s and early 1990s, a great deal of importance was attached to providing its workers with an all-around firefighting education and to improving the conditions of service, i.e., to raising the safety of operations [2]. Since that time both the technical equipment at the disposal of the stations and the personal protective equipment (PPE) of each firefighter as well as the forms and methods of hazard analysis, reconnaissance and extinguishment operations have undergone a fundamental change for the better, which resulted in improving safety on the job [3,4].

Due to the specifics of their work and the wide range of threats they face [5], firefighters are at more risk of work-related accidents [6] than other occupational groups. This is why they have been recognized as a special occupational group and have been entitled to take early retirement (at the age of at least 55 after 25 years of service) [7]. They have other privileges as well.

Aims

The aim of this paper is to analyze the occurrence and consequences of accidents in the work environment of the State Fire Service in Poland between the years 2008–2013.

MATERIAL AND METHODS

The material analyzed is based on aggregate data collected by the Headquarters of the State Fire Service (HSFS). Figures relating to accidents in the period between 1 January 2008 and 31 December 2013 show that 8518 work-related accidents occurred over that time and 8635 people were injured.

For the description of each case, a record was made of the data for the year when it occurred and the number of people involved. The circumstances of the hazards were determined, data regarding the causes of the accidents and the events that directly had led up to them as well as their consequences (the injuries occurring) were identified. All the data is collected in the Headquarters of the State Fire Service. A standard report is filled out and then sent in the form of a scanned copy to the Management Post of the Fire Service Headquarters (the National Centre for Rescue Coordination and Civil Protection – NCRCCP [8]). The records are kept at the SFS headquarters.

The documentation includes information regarding the number of individual and mass accidents on duty and at work, the number of trauma cases on duty or at work, which occurred in minor, major and fatal accidents at the State Fire Service, the events directly leading to accidents, the circumstances of hazards arising and the consequences of the accidents as well as the classification of trauma cases by the age and years of service of the victims.

The task set out in relation to the aim of this paper was carried out by performing an analysis of the available materials. Calculations were made using Microsoft Office Excel 2007. Statistical analysis was carried out using the Statistica 10 (prod. StatSoft, Tulsa, USA) software.

RESULT

Over 8500 accidents occurred during the 6-year period under the analysis. The total number of firefighters who were injured over that time was 8600. The number of accidents at work involving the State Fire Service firefighters is shown in the Figure 1. The data reveals the existence of 2 groups (between the years 2008–2010 and 2011–2013). In spite of the small sample being analyzed ($N = 6$), the mean from the years 2008–2010 (1306 ± 45) is significantly different from the one from the years 2011–2013 (1533 ± 49). The result of the Student's t-test shows that we can reject the null hypothesis, i.e., that the means of the 2 groups are equal, at the significance level of $\alpha = 0.005$. Although it is true that on the basis of this data we cannot speak of a statistically significant upward trend because the linear regression does not reach the usually accepted level of significance, i.e., $\alpha = 0.05$, which is caused by the small number of cases included in the sample, while the result is close to this borderline ($p = 0.074$).

Similarly to the number of accidents in the period under consideration, the rate of work-related accidents among firefighters (per 1000 employees) [9] underwent fluctuations with a tendency to rise which, however, is not statistically significant. The mean from the years 2008–2010 (43.7 ± 1.5) is significantly different from that from the years 2011–2013 (51.3 ± 1.5). The null hypothesis may be rejected here as well, already at the significance level $\alpha = 0.005$ (Figure 2).

In all the analyzed years, the highest percentage of trauma cases accounted for minor ones. Major and fatal accidents accounted for 1 per mille of the total number of those injured. In the period under consideration there were a total of 4 fatal and 19 severe accidents (Figure 3).

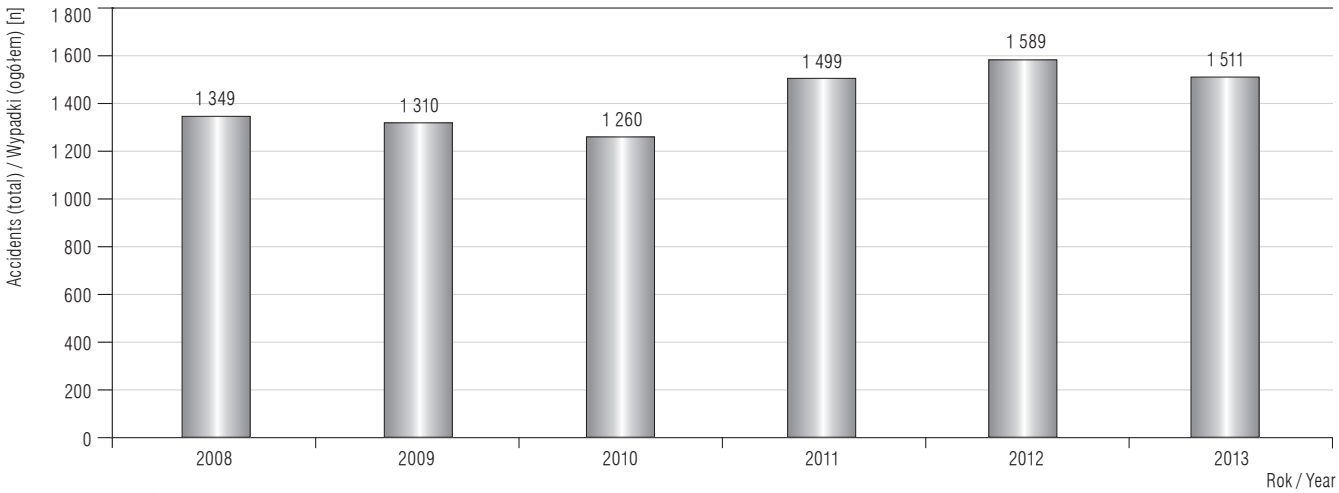

Fig. 1. Work-related accidents in the State Fire Service in Poland in 2008–2013
Ryc. 1. Wypadki przy pracy w Państwowej Straży Pożarnej w Polsce w latach 2008–2013

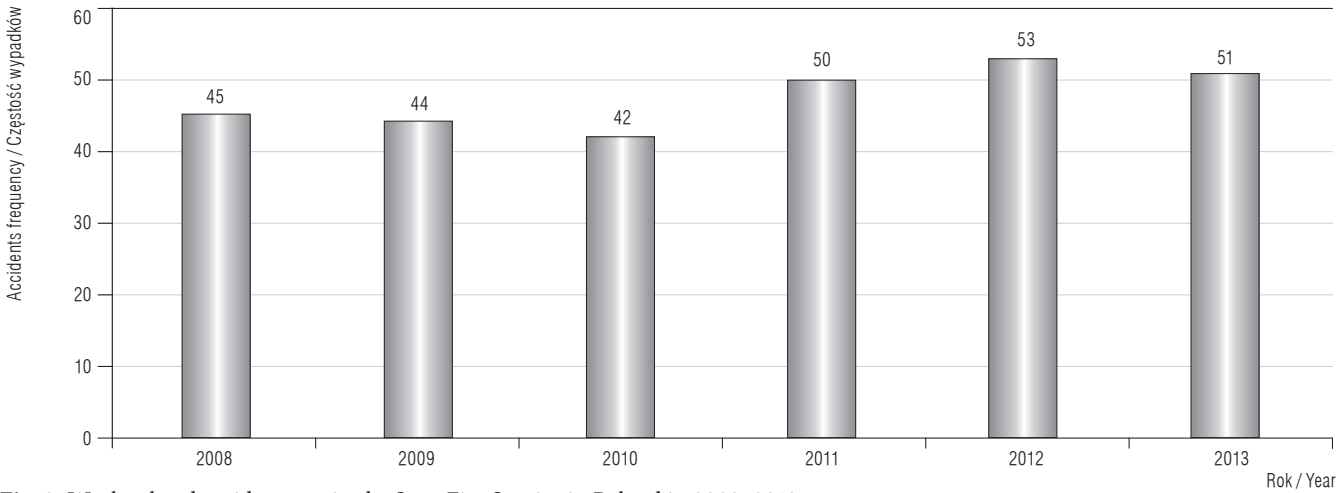

Fig. 2. Work-related accident rate in the State Fire Service in Poland in 2008–2013
Ryc. 2. Wskaźnik częstości wypadków przy pracy w Państwowej Straży Pożarnej w Polsce w latach 2008–2013

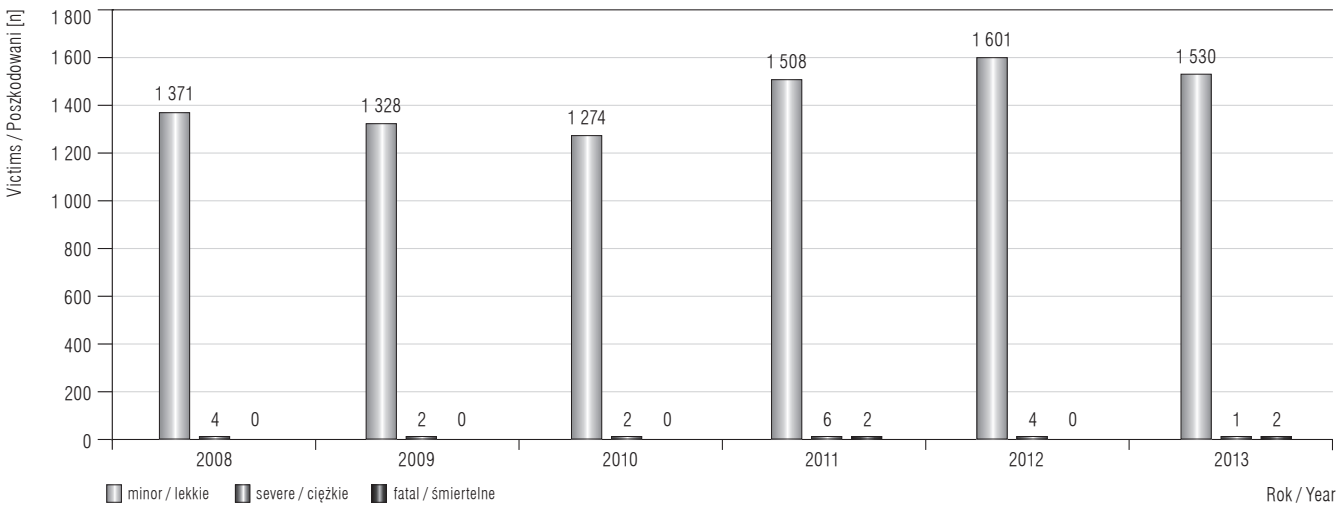

Fig. 3. Injuries sustained in accidents on duty or at work in the State Fire Service in Poland in 2008–2013
Ryc. 3. Poszkodowani w wypadkach podczas służby lub pracy w Państwowej Straży Pożarnej w latach 2008–2013

In 2013 the highest percentage of those injured was recorded for those between 26–35 years old. This group accounts for over 50% of the total number of those injured in 2013. The next group includes the 36–45 year-olds comprising 26% of all the casualties. The Figure 4 shows the age distribution in the group of those having fallen victim to accidents.

In 2013 there was an almost equal distribution of accidents involving people from different age groups, who were further divided into those who had had 4–7 and 8–15 years of service or work experience. The percentage share was about 30% (Figure 5).

The greatest number of injuries in the SFS between the years 2008–2013 took place during sporting activities, which accounts for about 41% of the cases for the entire period under consideration. The other most frequent places where accidents occurred were rescue operations, which accounted for nearly 20% of all the cases. In this group the largest number of accidents took place in 2008 (Figure 6). In circumstances when threats occur, it is interesting to note the tendencies in 2 subgroups, i.e., rescue operations and sporting activities. The rest of the circumstances do not display any regular changes. The upward trend in sports classes does not, however, reach statistical significance. Linear regression shows a statistically significant downward trend in the percent of accidents during rescue operations (at the significance level of $\alpha = 0.002$). This is, however, also connected with the concurrent fall in the number of interventions on the part of the fire services [10–14].

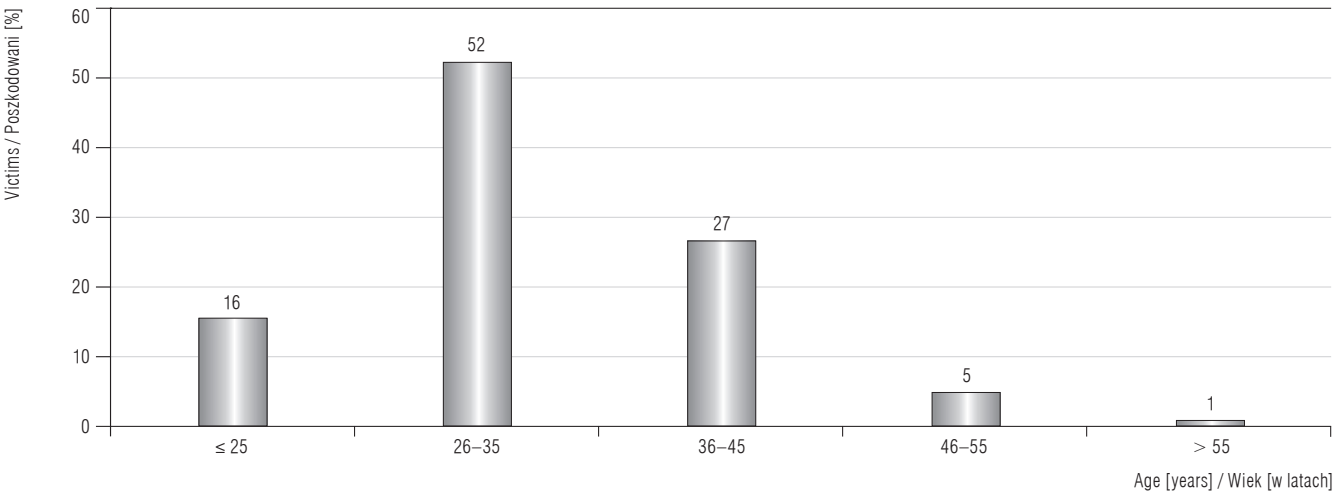

Fig. 4. Age of firefighters who sustained injuries at work in the State Fire Service in Poland in 2013
Ryc. 4. Wiek strażaków poszkodowanych w wypadkach w Państwowej Straży Pożarnej w Polsce w 2013 r.

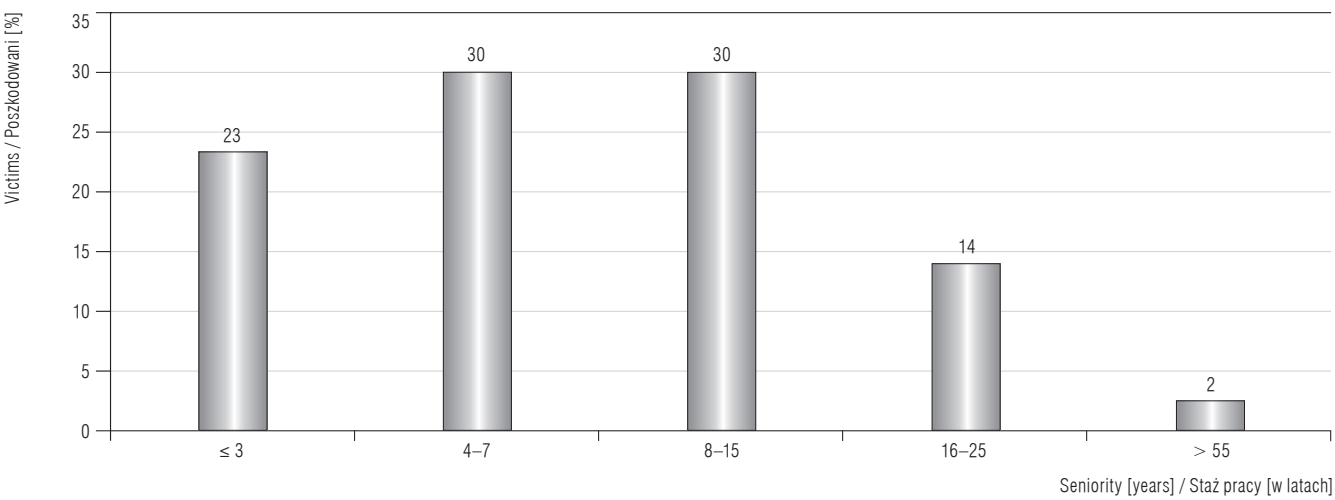

Fig. 5. Victims according to years of service in the State Fire Service in Poland in 2013
Ryc. 5. Poszkodowani według stażu pracy w Państwowej Straży Pożarnej w Polsce w 2013 r.

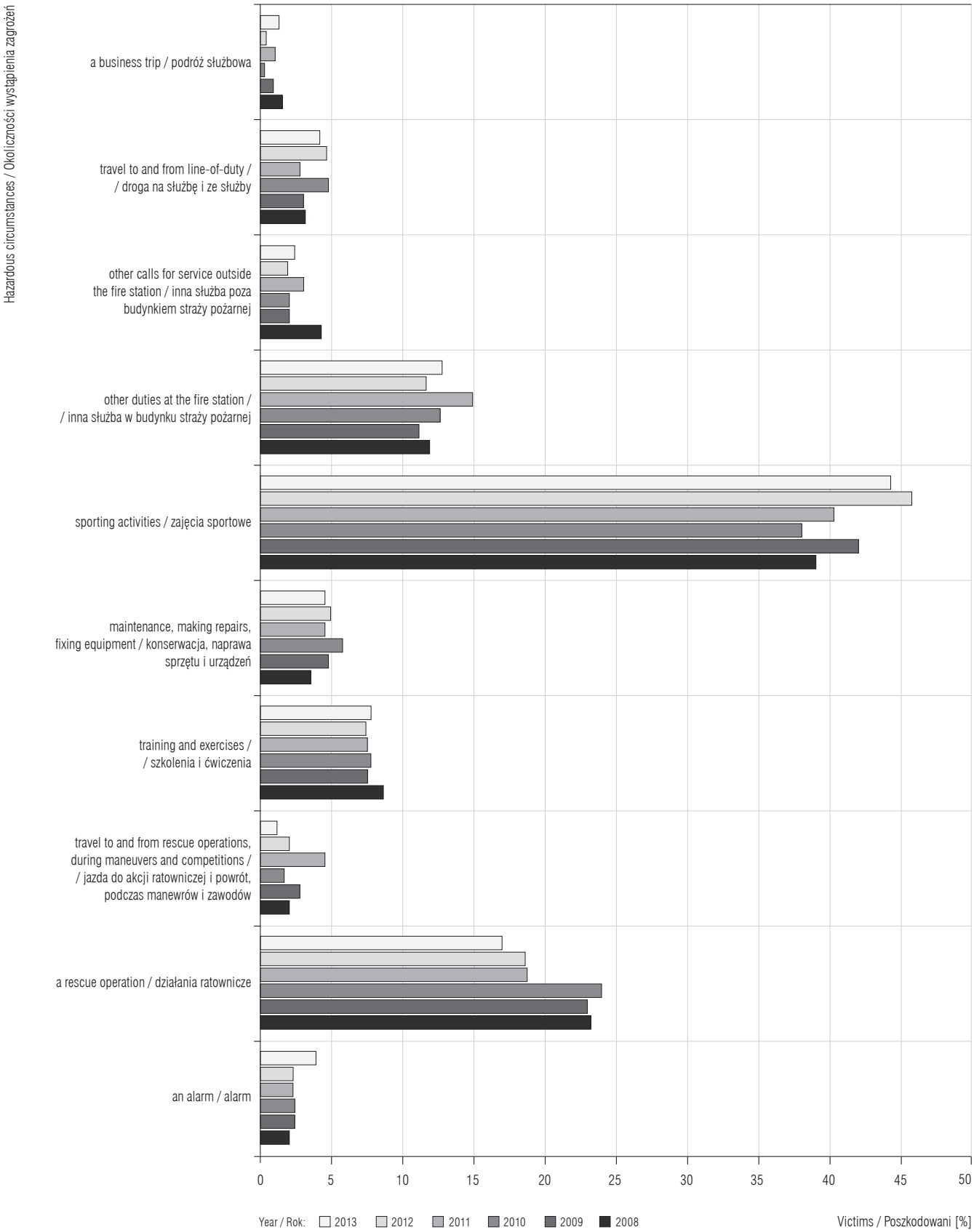

Fig. 6. Hazardous circumstances in the State Fire Service in Poland in 2008–2013
Ryc. 6. Okoliczności wystąpienia zagrożeń w Państwowej Straży Pożarnej w Polsce w latach 2008–2013

In the analyzed period, the major cause of incidents was inappropriate behavior or carelessness, which accounted for 56% of all the cases. The second most frequent cause included difficult, uneven, slippery passages, spaces or ground, which led to 1/5 of the accidents in the period under investigation (Table 1).

Some of the most frequent direct causes of accidents in the SFS, which occurred between the years 2008–2013, included: tripping, slipping, losing balance, falls – also from heights and into pits, accounting for nearly 48% of all the cases. Dynamic physical load is still another direct circumstance which affected the occurrence of accidents – accounting for 15% of all the cases (Table 2).

Throughout the period under consideration, injuries constituted the most frequent kind of consequence, including many broken or fractured bones and sprained joints, in terms of the largest category accounting for 57% of all the accident consequences. Bruises and wounds comprised nearly 13% and over 10% of the injuries, respectively (Table 3).

Table 1. Causes of accidents in the State Fire Service in Poland in 2008–2013
Tabela 1. Przyczyny wypadków w Państwowej Straży Pożarnej w Polsce w latach 2008–2013

Cause of accidents Przyczyna wypadków	Causes of accidents in subsequent years Przyczyny wypadków w kolejnych latach [%]						
	2008	2009	2010	2011	2012	2013	M
Defective construction materials, inappropriate craftsmanship, or the location of the material factor / Wady konstrukcyjne materiałowe, niewłaściwe wykonanie lub lokalizacja czynnika materialnego	0.5	0.5	0.6	0.5	0.5	1.1	0.6
Materials losing strength, breakdowns, failure of construction or material factor / / Utrata wytrzymałości, awaria, naruszenie konstrukcji lub czynnika materialnego	4.0	3.9	2.5	3.2	2.0	3.0	3.1
Inappropriate use of material factor / Niewłaściwa eksploatacja czynnika materialnego	0.4	0.5	1.0	0.6	1.1	0.7	0.7
Difficult, uneven, slippery passage, space or ground / Trudne, nierówne, śliskie przejście, przestrzenie, podłoże	23.2	21.2	23.4	22.3	20.4	18.5	21.4
Lack of, wrong use, wrong choice of, insufficiency or malfunctioning of protective resources / Brak, nieużycie, niewłaściwy dobór lub niesprawność środków ochronnych	1.2	0.9	1.0	2.1	0.9	0.7	1.1
Inappropriate organisation of work / Niewłaściwa organizacja pracy	0.5	0.2	0.2	0.1	0.4	0.3	0.3
Not observing safety rules and regulations, inappropriate work performance / / Nieprzestrzeganie przepisów i zasad bhp, niewłaściwe wykonywanie pracy	0.6	0.7	0.3	0.5	0.8	0.7	0.6
Inappropriate mental or physical condition / Niewłaściwy stan psychofizyczny	0.7	0.8	0.4	0.7	0.3	0.0	0.5
Inappropriate behavior, carelessness / Nieprawidłowe zachowanie się, nieostrożność	53.4	56.0	56.3	55.5	57.5	58.3	56.2
Lack of, or inappropriate safety training, or inappropriate vocational preparation / / Brak szkolenia lub niewłaściwe przeszkolenie w zakresie bhp, albo niedostateczne przygotowanie zawodowe	2.1	0.0	0.0	0.1	0.1	0.1	0.4
Sudden medical cases or other causes / Nagłe przypadki medyczne i inne przyczyny	13.5	15.3	14.4	14.5	16.1	16.7	15.1

M – mean / średnia.

Table 2. Events directly leading to accidents in the State Fire Service in Poland in 2008–2013
Tabela 2. Wydarzenia będące bezpośrednią przyczyną wypadków w Państwowej Straży Pożarnej w Polsce w latach 2008–2013

Event Wydarzenie	Events in subsequent years Wydarzenia w kolejnych latach [%]						
	2008	2009	2010	2011	2012	2013	M
Being hit, or pressed down by a falling, spilling or flowing out material factor / / Uderzenie, przygniecenie przez spadający, wysypujący, wylewający się czynnik materialny	2.6	3.7	4.0	3.1	4.9	3.4	3.6

Table 2. Events directly leading to accidents in the State Fire Service in Poland in 2008–2013 – cont.
Tabela 2. Wydarzenia będące bezpośrednią przyczyną wypadków w Państwowej Straży Pożarnej w Polsce w latach 2008–2013 – cd.

Event Wydarzenie	Events in subsequent years Wydarzenia w kolejnych latach [%]						
	2008	2009	2010	2011	2012	2013	M
Coming into contact or being hit by an unmoving material factor / Zetknięcie się z nieruchomymi czynnikami materialnymi lub uderzenie o nie	10.3	9.8	10.6	11.2	7.6	7.7	9.5
Coming into contact, being hit, caught, or pressed down by a moving material factor / / Zetknięcie się, uderzenie, pochwycenie, przygniecenie przez czynniki materialne będące w ruchu	9.6	10.1	9.2	9.0	9.8	9.6	9.6
Tripping, slipping, losing balance, falls, including ones from heights and into pits / / Potknięcie się, poślizgnięcie, utrata równowagi, upadek, w tym z wysokości do zagłębień	47.4	47.9	46.0	46.6	48.3	49.1	47.6
Traffic accident / Wypadek komunikacyjny	1.7	2.0	2.3	2.7	2.7	2.8	2.4
Extreme temperatures, severe atmospheric conditions / Skrajne temperatury, uciążliwe warunki atmosferyczne	1.3	1.2	1.6	1.1	1.5	1.1	1.3
Electric shock / Porażenie prądem elektrycznym	0.1	0.2	0.2	0.1	0.3	0.0	0.1
Explosion / Wybuch	0.1	0.4	0.1	0.2	0.3	0.0	0.2
Coming into contact with chemical, or infectious substances, radiation, or others / / Zetknięcie się z substancjami chemicznymi, zakaźnymi, promieniowaniem i innymi	1.5	1.5	0.6	1.3	1.3	0.8	1.2
Dynamic physical load / Fizyczne obciążenie dynamiczne	15.0	14.7	14.0	16.5	17.3	16.4	15.7
Other events (contact with animals, forces of nature, others) / Inne wydarzenia (kontakt ze zwierzętami, działanie sił przyrody, inne)	10.4	8.6	11.3	8.2	6.2	9.1	8.9

M – mean / średnia.

Table 3. Accident consequences in the State Fire Service in Poland in 2008–2013
Tabela 3. Następstwa wypadków w Państwowej Straży Pożarnej w Polsce w latach 2008–2013

Accident consequence Następstwo wypadków	Accident consequences in subsequent years Następstwa wypadków w kolejnych latach [%]						
	2008	2009	2010	2011	2012	2013	M
Loss of extremities or a part of them / Utrata kończyn lub ich części	0.1	0.0	0.0	0.1	0.3	0.1	0.1
Broken or fractured bones, sprains / Złamania, pęknięcia kości, zwichnięcia	55.9	61.7	57.8	57.3	59.8	52.5	57.4
Bruises / Stłuczenie	15.0	11.8	12.7	12.4	12.1	13.7	12.9
Wounds / Rany	9.8	10.2	11.2	12.2	8.5	9.5	10.2
Burns / Oparzenia	1.5	3.0	3.1	1.8	1.9	1.6	2.1
Frostbite / Odmrożenia	0.1	0.2	0.2	0.0	0.1	0.0	0.1
Internal injuries / Obrażenia wewnętrzne	2.4	1.5	1.8	1.9	1.8	1.2	1.8
Poisoning / Zatrucia	0.4	0.4	0.3	0.3	0.3	0.2	0.3
Damaging eye-sight / Uszkodzenie wzroku	1.5	0.6	0.3	0.7	1.4	0.4	0.8
Electric shock / Porażenie prądem elektrycznym	0.1	0.0	0.2	0.1	0.3	0.0	0.1
Paresis, strokes, heart attacks / Niedowłady, udary, zawały serca	0.1	0.1	0.2	0.1	0.2	0.1	0.1
Other consequences / Inne następstwa	13.0	10.6	12.2	13.1	13.5	20.7	14.0

M – mean / średnia.

DISCUSSION

The data shows that both the number and frequency of work-related accidents underwent changes in the period under consideration. Both the rate of accidents (per 1000 cases) [9] and the number of accidents in that period show an upward trend, which is, however, not really statistically significant.

In all the years of the period under the analysis, the highest percentage of those hurt sustained minor injuries. Severe and fatal accidents accounted for 1 per mille of the total number of those injured. The comparison of this data with similar figures for the USA in the years 2004–2009, where 100 firefighters' deaths and over 80 000 injuries were recorded each year [15], shows that the ratio of fatalities among firefighters to the number of accidents in Poland is higher.

The young age of 26–35 years old and a relatively short period of work experience were 2 factors which put the firefighters in the group that most often sustained casualties. It indicates that preventive training should comprise dedicated activities (particularly informative ones) specifically addressed to this group of firefighters.

The largest number of injuries were suffered during sporting activities and not, as might have been expected, during rescue operations. These accounted for 41% of all the accidents that happened. Taking into account the occupational hazard connected with firefighting, such a result is very surprising. It indicates that the way sporting activities are run should be investigated from the point of view of the professionalism of the trainers. The syllabus of such exercises should be changed and the participants should be made aware of the threats they are facing. Discipline should also be improved. Moreover, needs should be analyzed from the point of view of taking safety precautions and specialized training should be organized, so that firefighters from the SFS are better prepared for sporting activities.

In the context of these results, which clearly indicate that the greatest number of accidents are due to inappropriate behavior and (or) carelessness (over 56% of all the cases), it must be underlined that there is a special need to undertake preventive action in order to address this category of causes. Two lines of action should be taken. On the one hand there should be training of a general character (independent of the occupational group) emphasizing the kinds of behavior which will limit exposure to accidents (observing procedures, reacting to the inappropriate behavior of colleagues, etc.). On the other hand there should be classes directly addressed to firefighters. In the latter case, special emphasis should be placed on identifying the factors that are hazards to their safety at work (by pointing out the kinds of behavior that pose the greatest threat of accidents).

The lack of precautions, failure to use protective measures, making the wrong choices or having faulty equipment, poor management, non-observance of safety regulations, improper performance at work, lack of safety training or inadequate vocational training constitute only a fraction of the causes of firefighters' accidents at work in the period under consideration. It is, therefore, plausible to state that such factors as observing safety precautions, rules and regulations and the principles of using personal protective equipment (PPE) are at a very high level. Unlike in Poland, the main reasons for work-related accidents in the USA between the years 2004–2009 are: inadequate equipment (e.g., the lack of resources, not using them or making the wrong choices, faulty equipment), inadequate preparation for / anticipation of adverse events during operations, incomplete adoption of incident command procedures and sub-optimal personnel readiness [15].

Situations which directly led to accidents in the SFS over the years 2008–2013 include:

- tripping,
- slipping,
- losing balance,
- falls, including ones from heights and into pits,
- all of these accounting for nearly 48% of all cases.

Dynamic physical load is another direct circumstance leading to accidents in the period under consideration, accounting for a total of over 15% of all the cases. This data confirms the direct causes of accidents. A significant group of accident causes also includes such situations as coming into contact with or hitting unmoving material objects, coming into contact, being hit, caught, or pressed down by a moving material object or other events (such as encountering animals, forces of nature, and others).

It must be pointed out that throughout the analyzed period, injuries are the dominant group of consequences including manifold broken or fractured bones and twisted joints, accounting for over 57% of the trauma cases. Nearly 13% of the accident consequences are bruises, and over 10% – wounds. Such casualties are not severe; nevertheless they should be mentioned as a part of the information campaign directed at effective accident prevention, particularly emphasizing the risk

of injuries to both the upper and lower extremities (which are most prone to post-accident injury). In this context it is important to raise people's awareness of how important it is to use preventive measures protecting the extremities. When analyzing the causes and circumstances of accidents in the SFS, it seems that firefighters should improve their physical fitness and stamina in connection with sporting activities. Taking into account the consequences of the accidents, perhaps extra warm-ups should be practised before sports classes to prepare the organism for a more intense effort.

CONCLUSIONS

1. Accidents among firefighters occur significantly more often in the course of their activities at the fire station, i.e., during sporting activities, exercises and maneuvers than in real rescue operations.
2. Firefighters from the State Fire Service in Poland are inadequately prepared for the implementation of sporting activities.
3. More frequent, dedicated sporting activities, preceded by appropriate warm-ups, should solve the problem of the physical fitness of firefighters.
4. Using safety precautions protecting the extremities could reduce the number of injuries.
5. Implementing preventive action aimed at emphasizing which factors increase the number of accidents should be mandatory.
6. In order to eliminate inappropriate approach, systematic training should be organized. A system of penalties for not observing regulations should be implemented. It is important to analyze the causes of each accident and to record individual files concerning each firefighter's work for monitoring purposes.

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