

Risk rates of workplace accidents in Brazil: effect of the Accidental Prevention Factor (APF)?

Amanda da Rosa Wernke (<https://orcid.org/0000-0002-0616-5899>)¹
Manuella Caroline Luchtenberg Teixeira (<https://orcid.org/0000-0002-1710-790X>)¹
Beatriz de Oliveira Kock (<https://orcid.org/0000-0002-1833-5234>)¹
Olga Luiza Oliveira Sousa (<https://orcid.org/0000-0001-6651-343X>)¹
Ana Carolina Macedo Carvalho de Melo (<https://orcid.org/0000-0002-0325-9080>)¹
Thiago Mamoru Sakae (<https://orcid.org/0000-0002-0603-3685>)¹
Flávio Ricardo Liberali Magajewski (<https://orcid.org/0000-0003-2092-9610>)¹

Abstract *Historically, the conflict of interests between employers and workers obliged the State to assume the role of regulating this relationship, instituting laws and overseeing the application of health and safety standards at work. The Accident Prevention Factor (FAP) is one of these guidelines. This article aims to analyze the correlations between the FAP and the risk rate for occupational accidents in Brazil in the period between 2006 and 2016. Ecological study, which analyzed the occupational accidents, registered in the Brazilian Social Security database in the period between 2006 and 2016. The analysis included the calculation of accident risk rates according to the Brazilian regions, divisions of the CNAE, reason/situation, ICD-10 chapters, sex and age. The comparison between results from the two periods was performed using the average risk rates from the two periods using Student *t* test, Spearman correlation and beta value. Basically, all rate series analyzed had a strong downward trend in the FAP period, contrary to what occurred in the immediately previous period.*

Key words *Occupational health, Occupational accidents, Risk factors*

¹Curso de Medicina,
Universidade do Sul de
Santa Catarina (UNISUL).
Av. José Acacio Moreira 787,
Dehon, Campus Tubarão.
88704-900 Tubarão SC
Brasil.
magajewski@hotmail.com

Introduction

Historically, the concept of labor was associated with something burdensome and laden with suffering. The word labor comes from the Latin word *labor*, which means toil and trouble. In medieval times, working was considered punishment, and so, the noble and the feudal lords refused to perform this activity by imposing it on their servants and slaves¹.

However, this perspective has been altered throughout time, and it was strongly influenced by technological advancements that were incorporated to productive processes. Modern work can be conceptualized as “all physical or intellectual energy employed by men with productive purposes”¹; thus implying a physical or mental effort with the purpose of achieving a set goal.

In the capitalist mode of production, the centrality of labor relations and their potential for conflict gradually demanded the constitution of a broad regulatory framework in order to guarantee the dignity of workers, without harming their productivity potential^{1,2}. Since its founding, in 1919, the International Labor Organization has sought to build consensus amongst countries regarding the promotion and harmonization of labor rights through the establishment and application of international standards of occupational health and safety. An example of this leading role can be observed in the content of the Convention 155 of 1981, which emphasized the protection of workers' health in the workplace, and related initiatives to prevent the occurrence of work-related accidents and make employers responsible for following norms, safety, and hygiene standards in the workplace, both individually and collectively².

According to the article 19 of Brazilian Law N° 8,213/1991, work-related accidents can be characterized as the ones that occur through the performance of work at the service of a company or through the exercise of work, provided that it results in bodily injury or functional disturbance that causes death, loss, or reduction in the ability to work, whether temporary or permanent³.

On article 20 of the Brazilian Law N° 8,213/1991, the legislator has determined the equivalence of certain morbidities to work accidents³, specifically citing the occupational disease, understood as the one produced or triggered by the exercise of work characteristic of a given activity; and the work-related disease, understood as the one acquired or triggered by special conditions in which the work is performed and that are directly related to it. In addition, §2

explicitly states: “In exceptional cases, verified that a disease, not included in the list provided by the items I and II of this article, has resulted from the special conditions under which the work is performed and is directly related to it, the Social Security must consider it a work accident”^{3,4}. In other words, a disease can be classified as a work accident whenever the causal link between a disabling morbidity and the conditions under which the work was performed is proven.

In addition to the damage caused to workers, work accidents generate costs for both the State and the employer. In more serious cases, the National Institute of Social Security (INSS) is responsible for the payment of benefits, such as work-related or occupational disease assistance, accident assistance, professional and personal habilitation and rehabilitation, disability retirement, and death pension^{4,5}. The employer, in turn, suffers from legal, economic, social, and social security repercussions. They can no longer count with the temporarily unavailable workforce, in addition to bearing costs in case of less serious accidents, since they are directly responsible for paying the wages of workers on leave for health reasons until the fifteenth day^{4,6}.

Since 2010, companies have been charged or rewarded according to the occurrence of occupational accidents at levels above or below the average of the economic activity to which they operate, considering that their frequency, severity, and cost affect the calculation of the Accident Prevention Factor - FAP for that company, pursuant to article 10 of Law N° 10,666/2003⁶.

The FAP was created after years of debate between the Ministry of Labor and Social Security, which sought to make flexible rates for the payment of the Work Accident Insurance - SAT, which correspond to 1, 2, or 3% of the payroll according to the level of risk of the company, multiplying them according to the magnitude of damages and the economic impact of work accidents that occurred in each company, as a strategy to encourage companies to improve working conditions^{7,8}. Simply put, companies are sorted into three large groups or terciles, which encompass companies with the same economic activity code according to a calculation index that takes into account the variables of frequency, severity and cost of accidents at work. The group of companies with the lowest levels of morbidity and severity are able to obtain a reduction in SAT payments of up to 50%^{8,9}.

On the other hand, if, as a result of the higher degree of accidentality, a company's social secu-

rity morbidity indicators fall into the group with the worst performance among other companies in its field of economic activity, it may be double charged for the rates related to payroll that refer to Environmental Work Risks (RAT), the new name of the SAT^{8,9}.

Therefore, the FAP stands as an economically inducing mechanism for companies to improve measures that increase safety at work, bringing their performance closer to their social responsibility, the latter defined as the “obligation of an organization to maximize its positive impact in the long term, and minimize its negative impact on society”¹⁰. Corporate social responsibility is related to the perspective of continuous improvement of work processes and community relations, focusing on the well-being of workers^{10,11}.

Bringing to the center of the discussions the evolution of the occupational accident rates and the possible effect that the measures implemented by the government may have in their reduction, can be a contribution to the revision of the logic of labor relations. The perspective that these measures – including the FAP – may induce companies to opt for more effective action selection strategies in the field of occupational health and safety (OHS), may have, as a direct effect, the reduction of occupational accident rates in general.

Research efforts focused on the analysis of reality can produce knowledge that guides the actions of public and private decision-makers. The study of the temporal trend of occupational accidents is, therefore, of importance for the academic environment. As it is a relatively new and understudied topic, its relationship with employers’ decisions within the scope of OHS have not yet been sufficiently clarified.

Thus, this research sought to compare the evolution of the risk of work accidents in Brazil in the period before (2006-2009) and after the establishment of the FAP (2010-2016), according to the variables available in the Social Security databases.

Methods

This is an observational study of the ecological type, which used secondary data of Brazilian workers with social security relationship, who have suffered any kind of occupational accident registered in the Social Security databases (Social Security Statistical Yearbooks - AEPS and Statistical Yearbooks of Work Accidents - AEAT) in the 2006-2016 timeframe.

The development of this work was done in three stages. The first consisted in collecting the data of interest, using the Historical Database of Work Accidents, available on the Social Security website, carried out with the support of Infologo, a tool of data extraction and tabulation¹². Work accidents registered in Brazil, between 2006 and 2016 were selected by major Brazilian regions, class of Economic Activity Code (CNAE), reason/situation, ICD 10 chapters, sex, and age. The average number of formal jobs for each year was also collected, according to major Brazilian regions, CNAE class, reason/situation, ICD10 chapters, sex, and age, in order to calculate risk rates for each variable.

In the second stage, the data were tabulated, and the risk rates were calculated according to the equation: *Risk rate = (number of work accidents [year, major region, CNAE, reason/situation, ICD10, sex, age] / average number of jobs [year, major region, CNAE, reason/situation, ICD10, gender, age]) x 1000*. The information was organized in tables using Microsoft Office Excel, and later analyzed using the IBM Software - SPSS version 19.0.

For the statistical analysis, the rates of the two periods were used, which were compared using χ^2 square test and Student’s t test. The time-event relationship was established by Spearman’s correlation and Pearson’s simple linear regression (Beta value). The significance level adopted was $p < 0.05$.

Results

This study aimed to analyze the possible relationship of the effects of the implementation of the FAP on the evolution of work accident records in the Social Security database, considering the entire formalized Brazilian workforce bound by the Consolidation of Labor Laws (CLT). For the period between 2006 and 2009 (prior to the implementation of the FAP) the average annual population of workers studied was 30,471,666 employment contracts, with an annual average of 665,275 records of work accidents: an average accident rate of 21.74 accidents/1,000 workers.

The period under the influence of the Accident Prevention Factor – 2010-2016 – had an average of 41,311,474 workers per year, with an average of 683,338 records of work accidents per year, totaling an average accident rate of 16.61 work accidents /1,000 workers for the period (p -value<0.0001).

Evolution of the work accidents rate by large region of occurrence

It is possible to observe that in the period prior to the implementation of the FAP there was an upward trend in the accident rates in the formalized Brazilian workforce, confirmed by Spearman and Beta values, which were positive for all major regions of occurrence (Table 1), despite the lack of significance (except the results for the northeast region). On the other hand, as of 2010, during the FAP period, there was a significant downward trend in the annual rates of risk of work accidents (p -value <0.001), with Spearman and Beta values being strongly negative for all regions and for the country as a whole. Considering the period under the influence of the FAP (2010-2016), there was an average reduction of 1,125 accidents per year for each group of 1,000 workers in Brazil, that is, an average reduction of 40.63% compared to the average for the period prior to the implementation of the FAP.

Evolution of work accidents rate by division of CNAE

Considering the CNAE divisions (Table 2) with the highest number of registered accidents, it is possible to notice that in the period of 2006-2009, all activities showed an upward trend in the accident rate of the formalized Brazilian workforce, corroborated by the positive Spearman value, except for the primary sector, which showed a strong downward trend in the rate of work accidents. Among the aggregates of economic activities studied, only health activities and the primary sector showed statistical significance. After the implementation of the FAP, the downward trend in the accident rate was noticeable in all sectors, with a negative Spearman index, except in health activities. During this period, the results showed statistical significance for most sectors, excluding health activities and trade except vehicles.

Table 1. Work accidents rate (x1,000 workers) according to the year of registration and large region of occurrence. Brazil, 2006-2016.

Year	North	Northeast	Center-West	Southeast	South	Brazil
2006	15.95	11.12	15.88	17.91	14.2	19.27
2007	18.76	13.44	18.35	21.85	17.73	22.5
2008	18.23	14.34	19.2	23.87	18.38	23.55
2009	18.04	14.61	17.51	22.13	16.96	21.64
Mean	17.75	13.38	17.74	21.44	16.82	21.74
MAV%	0.05	0.11	0.04	0.08	0.07	0.04
Spearman	0.200	1.00	0.400	0.800	0.400	0.400
Beta	0.627	0.753	0.477	0.386	0.440	0.409
p-value	0.400	0.074	0.477	0.247	0.373	0.422
2010	15.51	13.03	15.89	19.65	14.47	19.29
2011	15.09	12.24	15.21	18.07	13.54	18.23
2012	13.8	10.84	14.37	16.6	12.81	17.03
2013	13.45	10.24	14.05	16.83	12.69	16.93
2014	12.73	9.69	13.25	16.25	11.91	16.24
2015	11.62	8.37	11.87	14.37	10.81	14.41
2016	10.71	7.92	11.4	13.81	10.63	14.11
Mean	13.27	10.33	13.72	16.51	12.41	16.61
MAV%	-0.06	-0.08	-0.06	-0.06	-0.06	-0.06
Spearman	-1.00	-1.00	-1.00	-0.964	-1.00	-1.00
beta	-1.231	-1.139	-1.290	-1.038	-1.523	-1.125
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

MAV%=Mean annual variation - percentual; Spearman=Spearman's Correlation Coefficient; beta=Mean annual variation by linear regression; p-value (ANOVA).

Source: Elaborated by the authors, adapted from Infologo of the Social Security¹².

Table 2. Work accidents rate (x1,000 workers) according to year and CNAE divisions. Brazil, 2006-2016.

Year	Health Activ.	Retail	Food Manuf.	Land Transp.	Primary Sector	Trade Exc. Vehicles	Building Constr.	Infrastr. Work
2006	1.4	1.59	1.67	0.78	1.05	0.55	0.44	0.48
2007	1.52	1.89	1.94	0.9	0.85	0.67	0.5	0.57
2008	1.57	2.01	1.99	0.98	0.78	0.71	0.65	0.7
2009	1.63	1.89	1.79	0.93	0.75	0.64	0.65	0.68
Mean	1.53	1.85	1.85	0.9	0.86	0.64	0.56	0.61
MAV%	0.05	0.06	0.03	0.06	-0.1	0.06	0.15	0.13
Spearman	1.00	0.632	0.4	0.8	-1	0.4	0.949	0.8
p-value	<0.001	0.371	0.607	0.204	<0.001	0.599	0.512	0.196
2010	1.54	1.54	1.54	1.71	0.97	0	0.67	0.59
2011	1.52	1.64	1.32	0.76	0.58	0.56	0.66	0.55
2012	1.52	1.5	1.18	0.72	0.53	0.54	0.66	0.57
2013	1.58	1.52	1.13	0.71	0.47	0.53	0.63	0.53
2014	1.51	1.17	0.94	0.51	0.45	0.44	0.45	0.48
2015	1.62	1.17	0.98	0.54	0.4	0.47	0.44	0.4
2016	1.69	1.2	0.93	0.52	0.37	0.45	0.35	0.31
Mean	1.57	1.39	1.15	0.78	0.54	0.43	0.55	0.49
MAV%	0.01	-0.05	-0.08	-0.17	-0.15	-0.04	-0.07	-0.07
Spearman	0.52	-0.81	-0.96	-0.89	-1.00	-0.14	-0.99	-0.96
p-value	0.23	0.03	<0.001	<0.001	<0.001	0.76	<0.001	<0.001

MAV%=Mean annual variation - percentual; Spearman=Spearman's Correlation Coefficient; beta=Mean annual variation by linear regression; p-value (ANOVA); Activ.=Activities; Manuf.=Manufacturing; Land Transp.=Land Transportation; Exc.=Except; Constr.=Construction; Infrastr.=Infrastructure.

Source: Elaborated by the authors, adapted from Infologo of the Social Security¹².

Evolution of the work accidents rate by reason - situation

Considering the accidents according to reason - situation (Table 3), it is noted that before the implementation of the FAP there was already a downward trend in the rates of typical work accidents with WAR, commuting with WAR and disease with WAR, confirmed by the negative Spearman and Beta indices, and an increasing trend in accidents without WAR, by positive Spearman value. Among these, only typical accidents with WAR and disease with WAR were significant. In the period under the influence of the FAP, there was a downward trend in the accident rates of typical accidents with WAR, occupational disease with WAR and accidents without WAR, all with statistical significance. In the opposite direction, commuting accidents with WAR showed an increasing trend, with positive Spearman and Beta values, but without statistical significance for the period.

Evolution of the work accidents rate by ICD10 chapters

Regarding the accidents according to the main ICD10 chapters (Table 4), considering the accident rates, in the period of 2006 and 2009, there was an upward trend for most of the analyzed chapters, noticeable by the positive Spearman values, except for the chapters XIX and XX that showed negative Spearman values. In this period, only accidents classified in chapters XX and XXI were statistically significant. In the period under the influence of the FAP, there was a trend towards a reduction in accidents in chapters XIX, XIII and "other". All rate series were statistically significant between 2010 and 2016.

Evolution of work accidents rate by sex and age range

Observing the accident rates of the formalized Brazilian workforce according to sex, in the

Table 3. Work accidents rate (x1,000 workers) according to year and reason-situation. Brazil, 2006-2016.

Year	Typical WAR	Commuting WAR	WAR Disease	No WAR	Total
2006	15.33	2.81	1.14	0	19.27
2007	14.23	2.7	0.76	4.81	22.5
2008	13.76	2.76	0.63	6.38	23.55
2009	12.52	2.66	0.58	5.87	21.64
Mean	13.96	2.73	0.78	4.27	21.74
MAV%	-0.06	-0.02	-0.19	0.12	0.04
Spearman	-1	-0.8	-1	0.8	0.4
Beta	-1.095	-14.914	-4.702	0.376	0.409
p-value	0.013	0.237	0.077	0.151	0.422
2010	11.34	2.59	0.47	4.88	19.29
2011	10.78	2.55	0.43	4.47	18.23
2012	10.16	2.46	0.4	4	17.03
2013	10.13	2.62	0.4	3.78	16.93
2014	9.82	2.65	0.4	3.38	16.24
2015	8.93	2.47	0.36	2.65	14.41
2016	8.63	2.64	0.3	2.54	14.11
Mean	9.97	2.57	0.39	3.67	16.61
MAV%	-0.05	-0.01	-0.05	-0.11	-0.06
Spearman	-1.00	0.36	-0.96	-1.00	-1.00
Beta	-2.215	4.907	-37.85	-2.438	-1.129
p-value	<0.001	0.703	0.002	<0.001	<0.001

MAV%=Mean annual variation - percentual; Spearman=Spearman's Correlation Coefficient; beta=Mean annual variation by linear regression; p-value (ANOVA); WAR=Work Accident Report.

Source: Elaborated by the authors, adapted from Infologo of the Social Security¹².

period of 2006-2009, there was no trend towards and increased risk in both sexes, with positive Spearman and Beta indices, without statistical significance. However, in the period after the implementation of the FAP, there was a strong downward trend in rates, with negative Spearman and Beta values, and statistical significance for both sexes (Table 5).

When we consider the accident rates by age range of formalized Brazilian workers, it is possible to observe an upward trend in the period from 2006 to 2009, except for the age range up to 19 years old. During this period, only the ranges of extremes were significant – up to 19 years old and from 60 to 69 years old. For the period after the implementation of the FAP, there was a strong downward trend in accident rates, with negative Spearman and Beta values for all age groups, except those over 70 years, the only age group without statistical significance (Table 5).

Discussion

The Decree 6,042/2007 has instituted the application, monitoring and evaluation of the Accident Prevention Factor (FAP) and of the Epidemiological Technical Nexus (NTEP), through the inclusion of the article 202-A in the Social Security Regulations. As it is well known, the FAP was one of the measures created to encourage the improvement of working conditions, and the data source used for the generation of the FAP are temporary – the universe of data used to calculate the frequency, severity and cost indices refer to data individualized by company, recalculated biannually and this dynamic encourages the investment in health and safety in the workplace¹⁰⁻¹³.

As observable in the results presented, there was a significant reduction in the accidents rate during the FAP period, which may indicate some positive effect resulting from its implementation.

Table 4. Work accidents rate (x1,000 workers) according to year and ICD10 chapter. Brazil, 2006-2016.

Year	Chap.XIX	Chap.XIII	Chap.XX	Chap.V	Chap.XXI	Other
2006	15.37	2.01	0.6	0.17	0.22	0.9
2007	15.8	4.22	0.58	0.38	0.24	1.28
2008	16.29	4.46	0.55	0.55	0.27	1.43
2009	15.12	3.82	0.54	0.52	0.31	1.33
Mean	15.65	3.63	0.57	0.41	0.26	1.24
MAV%	0	0.34	-0.03	0.54	0.12	0.16
Spearman	-0.2	0.4	-1	0.8	1	0.8
p-value	0.802	0.607	<0.001	0.203	<0.001	0.196
2010	13.79	3.15	0.51	0.43	0.33	1.08
2011	13.08	2.85	0.5	0.41	0.39	1
2012	12.19	2.54	0.51	0.41	0.45	0.92
2013	12.06	2.49	0.54	0.45	0.49	0.9
2014	11.56	2.31	0.54	0.44	0.56	0.85
2015	10.23	1.9	0.54	0.45	0.59	0.71
2016	10.05	1.77	0.55	0.46	0.63	0.65
Mean	11.85	2.43	0.53	0.44	0.49	0.87
VMA%	-0.06	-0.09	0.01	0.01	0.12	-0.08
Spearman	-1.00	-1.00	0.898	0.818	1.00	-1.00
p-value	<0.001	<0.001	0.006	0.024	<0.001	<0.001

MAV%=Mean annual variation - percentual; Spearman=Spearman's Correlation Coefficient; beta=Mean annual variation by linear regression; p-value (ANOVA); Chap.XIX=Injuries, poisonings, and other consequences of external causes; Chap. XIII=Musculoskeletal and connective system diseases; Chap.XX=External causes of morbidity and mortality; Chap.V=Mental and behavioral disorders; Chap.XXI=Factors influencing the health status and the contact with health services.

Source: Elaborated by the authors, adapted from Infologo of the Social Security¹².

Despite the impossibility of asserting causality due to the chosen methodology, the decreasing trend of risk rates observed in the results of this research occurred especially after the FAP came into effect. It is also undeniable that the bonus/burden mechanism incorporated into the methodology for calculating the rates of payment of Environmental Work Risks (RAT) can induce companies to consider more effective investments in the health and safety of work environments in order to reduce costs with social charges^{11,13}.

It should be noted that there was growth in the workforce both in the first and second periods analyzed. However, in the second period this trend continued only until 2014, when there was a reduction in the number of formal employment relationships. The economic recession and the subsequent tendency of reduction in the employed workforce might have effects on the profile of workers and also on the risk of accidents, since the profile of the unemployed is not the same as those who kept their jobs in the recession. The selection bias produced by this disparity stems from the fact that the main group that suffers from unemployment is the youth work-

force. This has already been reiterated by Da Cruz Vilas¹³, who verified that those most affected by unemployment in Portugal were young people, especially the less educated. Young workers are usually at increased risk for occupational accidents because they get concentrated in higher risk activities, they are likely on a probationary period or with an experimental relationship, and they have less cognitive and psychological experience, according to the European Agency for Health and Safety at Work¹⁴. Thus, the observed drop in the accident rate may have been influenced by this particularity of the labor market. However, to counter this statement, the data observed in this study showed that the age range which presented the highest risk rates for occupational accidents in Brazil was the workers between 50 and 59 years old. For this reason, the possible explanations for the significant reduction in accident rates in the aforementioned period remain open, and the effects of the implementation of the FAP methodology cannot be discarded.

In the opposite sense, one could also consider the possible effect of another macro-process that is quite evident in recent labor relations: the

Table 5. Work accidents rate (x1,000 workers) according to year, sex, and age range. Brazil, 2006-2016.

Year	Male	Female	Up to 19 y.o	20 to 29 y.o	30 to 39 y.o	40 to 49 y.o	50 to 59 y.o	60 to 69 y.o	70 y.o or more
2006	24.36	12.57	23.29	21.32	19.34	19.23	18.5	12.81	6.08
2007	27.45	16.45	23.17	23.55	22.38	23.75	25.61	18.58	6.75
2008	28.19	17.04	22.29	23.54	23.1	25.03	27.49	19.03	7.18
2009	26.69	16.28	20.05	21.98	21.93	23.93	26.51	19.08	6.65
Mean	26.67	15.59	22.2	22.6	21.69	22.99	24.53	17.38	6.67
MAV%	0.03	0.1	-0.05	0.01	0.05	0.08	0.14	0.16	0.03
Spearman	0.400	0.400	-1.00	0.200	0.400	0.800	0.800	1.00	0.400
Beta	0.468	0.471	-0.784	0.259	0.528	0.389	0.258	0.345	1.740
p-value	0.398	0.257	0.088	0.774	0.331	0.226	0.182	0.185	0.390
2010	23.97	14.72	19.11	20.05	19.57	21.41	23.07	16.47	7.07
2011	22.57	14.07	16.08	18.9	18.61	20.28	21.92	15.56	7.34
2012	21.05	13.19	14.14	17.58	17.53	19.01	20.09	14.55	5.73
2013	20.46	13.25	13.87	16.9	17.33	18.71	19.89	14.49	7.28
2014	19.34	12.64	12.83	16.08	16.47	17.63	18.36	13.75	6.88
2015	17.23	11.51	10.84	14.44	14.88	15.58	16.29	12.32	6.61
2016	16.79	11.36	10.77	14.35	14.6	15.4	15.92	12.17	6.51
Mean	20.2	12.96	13.95	16.9	17	18.29	29.36	14.19	6.77
MAV%	-0.06	-0.05	-0.11	-0.06	-0.05	-0.06	-0.07	-0.06	0.00
Spearman	-1.00	-0.964	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-0.500
Beta	-0.812	-1.706	-0.705	-0.997	-1.164	-0.944	-0.794	-1.339	-1.069
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.550

MAV%=Mean annual variation - percentual; Spearman=Spearman's Correlation Coefficient; beta=Mean annual variation by linear regression; p-value (ANOVA); y.o=years old.

Source: Elaborated by the authors, adapted from Infologo of the Social Security¹².

flexibilization of work, evidenced by the trend towards outsourcing work, with an increase in the subcontracting of labor, which has been associated with an increased risk of occupational accidents due to increased turnover, lack of experience and familiarity with the equipment and task requirements of the outsourced workforce^{15,16}, in addition to the reduction of control by public bodies and a tendency of companies to disclaim responsibility regarding health and safety at work¹⁷.

Another characteristic of recessive periods that can lead to a reduction in occupational accidents is what could be called exposure bias, which arises from the increase of idleness in companies, which at the same time are obliged to maintain an employed technical core, but one that spends less time exposed to the risks of its activities¹⁸. This circumstance tends to reduce the risk of accidents in the population that remained employed during this period.

Yet another important point to be noted is the increase in commuting accidents after the implementation of the FAP (Table 3). It is noteworthy

that commuting work accidents are those that occur between home and the workplace, therefore they are not directly influenced by factors controlled by the occupational health and safety management. This same trend has already been observed by Almeida et al.¹⁹, in the period between 1998 and 2008, who believe that this may be associated with the increase in urban violence, the increase in the number of vehicles per 100,000 inhabitants or even the higher prevalence of motorcycles as a means of transportation. The relative independence of commuting accident rates and the upward trend observed during the FAP period may be an indication that the WAR registration system continued to function with its usual characteristics, which enhances the idea that were the adopted measures of expansion of actions to control occupational risk factors which explained, at least partially, the reduction of the risk of typical accidents and occupational diseases. It is noteworthy that the aforementioned authors, using the same methodology, reached the same results as this study regarding the evolution of other types of accidents: there was a significant downward

trend in the incidence rates of work accidents in general, the same occurring for typical work accidents, with an increase in the absolute number of records. The authors pointed out as contributing factors for the decline in the incidence of occupational accidents and mortality from this cause the improvement of working conditions, the greater growth of the services sector compared to the industrial sector, underreporting of accidents at work, and outsourcing of services^{19,20}.

It is also important to highlight that the period prior to the implementation of the FAP included the year 2006, which did not make use of the NTEP methodology. As previously mentioned, this methodology, implemented in April 2007, has incorporated a filter statistically associating the risks of economic activities with pathologies responsible for work disability, adding the logic of the collective nexus of absence from work. In this sense, after its implementation, there was an increase in the number of accidents at work in the order of 45.99% between 2006 and 2008, simply at the expense of records that did not issue a WAR (86%), according to an analysis by Silva-Junior et al.²⁰. These facts may explain the decrease in the trend of registrations with WAR and the increase in accident rates for the period, observed in Table 3.

The NTEP, in general terms, is the recognition of the limitations of the social security technical nexus (NTP), which supported in isolation the classification logic of Social Security until 2006, and the inclusion, as accidental events, of disabilities that occurred as a result of statistical significance between different types of illnesses and a certain economic activity, and which were referred for the granting of social security benefits (not related to work) by companies²¹. It is known that the WAR alone is not a reliable source of notification, since the registration of work accidents, although mandatory, is subjected to the interest of the employer, which tends to underreport. In this sense, a validation study of nexus cases carried out by the NTEP epidemiological filter pointed to its institutionalization as an advance in the establishment of the work-disease nexus in the social security sphere, indicating that it expanded and diversified previously underreported diagnoses, despite highlighting the need for medical expertise for confirmation, in addition to the suggestion of on-site visits to the workplaces of workers on leave²⁰. This was clearly demonstrated with the Social Security

data referring to chapters V (Mental Disorders) and XIII (Diseases of the Musculoskeletal System) of the ICD-10 one year after the incorporation of the epidemiological filter methodology to the records of leave of absence from work, which showed a growth of 1,578% and 517%, respectively, in the records²¹.

For these reasons, considering the results achieved and presented in this study, the finding that almost all of the variables related to occupational accidents studied – large region of occurrence, CNAE division, reason-situation, ICD-10 chapters, gender and age range – undeniably had a strong downward trend in occupational accident rates concurrent with the establishment and implementation of the FAP. This was confirmed by the strong statistical significance in most series of rates analyzed ($p\text{-value}<0.05$), which, amongst other potential explanations, may indicate the virtuous effect of the implementation of the FAP in reducing accidents as a result of the companies' interest in making more effective investments in the control of risk factors in the work environments carried out by companies.

Despite this, several other factors and hypotheses can be considered as competing explanations to the one presented in this study. Therefore, further studies on this topic are needed to better control the different biases that may have affected the achieved results and to clarify in a more consistent way the causal relationships that explain the behavior supported by this research: the tendency to reduce the risk of accidents in the formalized population of Brazilian workers in the period from 2010 to 2016.

Conclusions

This study has observed an undefined trend in the evolution of most series of work accidents rates studied before the FAP methodology came into effect (2006-2009). Conversely, almost all rate series analyzed during the FAP period (2010-2016) showed a strong reduction, with statistically significant differences between the two periods.

Considering the methodological limitations of this exploratory study, it is not possible to affirm the causality of the findings presented, however, the FAP incorporates a logic of inducing more effective investments in occupational health and safety, which may have contributed to the results obtained.

Collaborations

AR Wernke worked with methodology, research, data analysis and interpretation, bibliographic references, design and final text revision. MCL Teixeira worked with translation, bibliographic references, and final text revision. BO Kock worked with translation, bibliographic references,

and final text revision. OLO Sousa worked with bibliographic references, and final text revision. ACMC Melo worked with bibliographic references, and final text revision. TM Sakae worked with methodology, statistical analysis, data interpretation, and final text revision. FRL Magajewski worked with orientation, methodology, data analysis and interpretation, and final text revision.

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Article submitted 13/04/2020

Approved 21/07/2021

Final version submitted 23/07/2021

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva