Temporal trend of workplace accidents incidence in Brazil, according to federative units, and by sector of economic activity

Tendência temporal da incidência de acidentes do trabalho no Brasil, segundo unidades federativas e por setor econômico

Tendencia temporal de la incidencia de accidentes laborales en Brasil, según unidades federativas y por sector económico

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Abstract *The objective of this study was to assess the temporal trend of workplace accidents (WA) incidence in Brazil, across its federative units (FU) and by economic activity sector, from 2009 to 2019. An ecological study of time series was conducted using data from the Statistical Yearbook of Occupational Accidents (AEAT InfoLogo) and the Statistical Yearbook of Social Security (AEPS InfoLogo). The annual percent change (APC) of WA incidence rates and the 95% confidence intervals were estimated through Prais-Winsten linear regression. The average WA rate per 1,000 work contracts decreased from 21.64 to 13.72, with an APC of -4.45%. The reduction was observed across all age groups, both genders, and in 26 FU. Incidence rates of WA requiring medical assistance or resulting in disability also showed a declining trend. There was also variation in the indicator among different categories of the National Classification of Economic Activities, with some categories exhibiting a more pronounced declining trend than others. The decrease in WA rates and the declining trend in FU may be the result of public policies and strategies adopted in recent years to address workplace accidents.*
Key words *Workplace accidents, Social security, Occupational health, Surveillance of the workers health, Time series studies*

Resumo *O objetivo do estudo foi avaliar a tendência temporal da incidência de acidentes do trabalho (AT) no Brasil, entre suas unidades federativas (UF) e por setor de atividade econômica, de 2009 a 2019. Realizou-se um estudo ecológico de séries temporais, com dados do Anuário Estatístico de Acidentes do Trabalho (AEAT InfoLogo) e do Anuário Estatístico da Previdência Social (AEPS InfoLogo). A variação percentual anual (VPA) das taxas de incidência de AT e os intervalos de confiança 95% foram estimados através de regressão linear de Prais-Winsten. A taxa média de AT por 1.000 vínculos de trabalho diminuiu de 21,64 para 13,72, com VPA de -4,45%. A redução foi observada em todas as faixas etárias, ambos os sexos e em 26 UF. As taxas de AT que necessitaram de assistência médica ou que implicaram incapacidade também apresentaram tendência decrescente. Houve também variação no indicador entre as diferentes classes da Classificação Nacional de Atividades Econômicas, com algumas categorias apresentando tendência decrescente mais expressiva do que outras. A queda nas taxas de AT e a tendência decrescente nas UF podem ser efeito de políticas públicas e estratégias adotadas nos últimos anos para enfrentamento dos AT.*
Palavras-chave *Acidentes do trabalho, Previdência social, Saúde do trabalhador, Vigilância em saúde do trabalhador, Estudos de séries temporais*

Resumen *El estudio tuvo como objetivo evaluar la tendencia temporal de la incidencia de accidentes laborales (AL) en Brasil, entre sus unidades federativas (UF) y por sector de actividad económica, de 2009 a 2019. Se realizó un estudio de series temporales ecológicas, con datos del Anuario Estadístico de Accidentes Laborales (AEAT InfoLogo) y del Anuario estadístico de la Seguridad Social (AEPS InfoLogo). El cambio porcentual anual (CPA) de las tasas de incidencia de AL y los intervalos de confianza del 95 % se estimaron mediante la regresión lineal de Prais-Winsten. La tasa media de AL por cada 1.000 contratos de trabajo disminuyó de 21,64 a 13,72, con un CPA del -4,45%. La reducción se observó en todos los grupos de edad, ambos sexos y en las 26 UFs. Las tasas de AL que requirieron asistencia médica o resultaron en discapacidad también mostraron una tendencia a la baja. También hubo variación en el indicador entre las distintas clases de la Clasificación Nacional de Actividades Económicas, mostrando algunas categorías una tendencia decreciente más significativa que otras. La caída de las tasas de AL y la tendencia a la baja de las UFs pueden ser el efecto de políticas públicas y estrategias adoptadas en los últimos años para enfrentar los AL.*
Palabras clave *Accidentes laborales, Seguridad social, Salud ocupacional, Vigilancia de la salud ocupacional, Estudios de series temporales*

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Introduction

Workplace accidents (WA) are unexpected events that occur during work activities resulting in bodily injuries or functional disturbances[1]. In national social security legislation of Brazil, WAs include injuries, professional diseases, work-related illnesses, and commuting accidents, among other situations provided by law[2].

The data from the Safety and Health Observatory of the Labor Prosecutor's Office (MPT, acronym in Portuguese) shows that there were over 5 million WA between 2012 and 2021 in Brazil, resulting in 18,000 deaths and approximately 170,000 cases of permanent disability[3]. A report from the International Labor Organization highlighted that countries may spend up to about 6% of their annual GDP on WA and occupational illnesses[4]. Such a scenario imposes great concern for public health and the countries' economies, as these events imply high social security costs.

The consequences of WAs are not limited to financial costs. Such events also have a significant impact on the health and quality of life of workers and their families since they can result in physical injuries that can affect the worker's ability to perform everyday tasks, leading to a reduction in quality of life, increased medical expenses, temporary or permanent disability, and consequently, may affect the victim's and their dependents' financial and emotional stability[5-7]. Moreover, workers and their families are often forced to resort to justice to receive compensation and labor rights due, which can generate even more physical and mental strain and costs in general.

Despite the importance of the topic, updated studies on the trend of WAs incidence by economic activity in Brazil are scarce, and the few existing ones focus on specific territorial divisions (such as states) instead of encompassing the entire national territory and disaggregating by economic sector. Although there is an increasing availability of official data by the responsible bodies for the social security and welfare sector, there is a lack of analyses that explore in detail the characteristics of these occurrences in the country.

This shortage of studies related to WA and illnesses makes it difficult to develop social security and intersectoral public policies, besides making the process of defining priorities, planning, and allocating resources for actions of the National Policy on Worker Health more difficult, and deprives society of important tools to improve living and working conditions[8].

In this context, monitoring the temporal trend of WA incidence in Brazil, in its federative units (FU), and according to the economic activity sector, becomes relevant to identify the areas and productive sectors that present a higher risk of occurrence of these diseases and direct efforts towards their prevention and reduction of indicators linked to this undesirable phenomenon.

This work aimed to evaluate the temporal trend of WA incidence in Brazil, across its FU, and according to economic activity sector, within the period from 2009 to 2019.

Method

This is an ecological time-series study. The units of analysis were Brazil and its 27 FU. The country covers an area of 8,510,345.538 km² and had an estimated population of 207.8 million people in 2022. At the end of 2022, there were about 48.7 million active employment relationships, with 82.6% being under the Consolidation of Labor Laws and 17.4% being statutory civil servants[9,10].

The analyses included data from all insured individuals to the Brazilian Social Security system who suffered some sort of occupational accident (with or without registration of a WA Communication form - CAT, acronym in Portuguese) during the period under investigation. Statutory civil servants and those with informal employment relationships were not part of the study population, as they are not part of the General Social Security System (RGPS, acronym in Portuguese).

Data from the historical database of Statistical Yearbook of Work-Related Accidents (AEAT InfoLogo, acronym in Portuguese), and the historical database of Statistical Yearbook of Social Security (AEAT InfoLogo, acronym in Portuguese), were used. These systems are the main instruments through which data on WA and those related to Social Security policyholders in Brazil are presented.

The AEAT InfoLogo and AEPS InfoLogo were developed by the Social Security Technology and Information Company (Dataprev, acronym in Portuguese) and allow the historical behavior of the main variables used to evaluate the evolution of WA in Brazil to be analyzed, thus making it possible to identify trends and measure the effects of health, social assistance, and social security policies implemented at the national level.

Data on WA from AEAT InfoLogo and AEPS InfoLogo mainly come from two sources of in-

formation: the WA Notification System (Catweb, acronym in Portuguese) and the Unique Benefit System (SUB, acronym in Portuguese), which is not exclusively for occupational injuries but includes benefit payments for work-related injuries granted by the National Institute of Social Security (INSS, acronym in Portuguese)[11].

WA registered in Brazil from 2009 to 2019 were selected for the country and by FU, economic activity section, health consequences, sex, and age group. Average numbers of employment relationships were also collected for each analyzed territoriality.

The data were tabulated, and the general and specific incidence rates for WA were calculated according to the equation recommended by the Ministry of Social Security: Incidence rate = (number of occupational accidents per territorial unit [total, health consequences, economic activity section, sex, age group] / average annual number of employment relationships in the territorial unit) x 1,000.

The variables of interest were the general and specific incidence rates for WA. The incidence rates for WA were related to location: Brazil and its FU; related to time: 2009 to 2019; and by sector of economic activity. This period was chosen to minimize the impacts resulting from the implementation of the Previdenciary Technical Nexus (NTEP, acronym in Portuguese) by the INSS in April 2007, which caused a significant variation in the number of WA reported in Brazil[12]. Thus, the months of 2007 and the first year of the NTEP's validity (2008) were excluded from the present analysis. The choice of 2019 as the end of the historical series was made to avoid any interference from the effects of the COVID-19 pandemic on WA indicators.

Graphical analysis is the initial step in understanding the underlying processes of sequentially ordered temporal measurements[13]. Therefore, in the pre-analytical stage, line graphs were constructed for all time series.

The Prais-Winsten generalized linear regression model was used for the temporal trend analysis, with models constructed where the dependent variables were the base 10 logarithmic transformations of WA incidence rates (Y), and the independent variable was the year of occurrence (X). The Durbin-Watson statistic was also applied to verify the presence of serial autocorrelation, as recommended[13].

The Prais-Winsten method is an alternative for trend estimation commonly used in epidemiological studies. This method is equivalent to a first-order autoregressive model, as it corrects for autocorrelation in the first-order residuals, specifically at lag 1. Consequently, the method does not account for all possible lags. In general, the correction of autocorrelation in the first-order residuals aids in the correction of other lags; however, sometimes it does not[14].

The average annual variation (APC) of the indicators and their respective 95% confidence interval (95%CI) were calculated using the following expressions: APC = $(-1+[10^{\beta 1}])$ x 100; and CI95% = $(-1+[10^{\beta 1lower}])$ x 100; $(-1+[10^{\beta 1upper}])$ x 100, where $\beta 1$ represents the regression coefficient and $\beta 1^{lower}/\beta 1^{upper}$ are its CI95% limits. A significance level of 5% was adopted. Trends were considered statistically significant when APC had a p-value <0 .05 and when their 95% CI did not include the value of zero. Significant p-values (p < 0.05) indicate a increasing or decreasing trend, depending on the positive or negative annual variation, respectively. And non-significant p-values (p ≥ 0.05) do not reject the hypothesis of stability[13].

Statistical analyses were performed using Stata software, version 17.0.

As this study used publicly available data, it was not necessary to submit the project to a Research Ethics Committee.

Results

The presented results demonstrate a decrease in the incidence rates of WA in Brazil and its FU between the years 2009 and 2019. During this period, there was a gradual reduction in the indicator, which decreased from 21.64 accidents per 1,000 links in 2009 to 13.72 in 2019, as illustrated in Figure 1.

The APC of the incidence rate of WA was -4.45%, indicating a yearly decrease in the incidence of these events in the country. The 95% confidence interval for the APC varied from -5.63% to -3.26% (p < .001), indicating that the trend in this indicator is significant.

Of the 27 FU, ten had an average WA rate of less than 12.1 cases per 1,000 links. On the other hand, ten had an average rate equal to or greater than 16.2 per 1,000 links. Seven were in an intermediate range, with an average incidence rate of WA between these values (Figure 2).

There was a decreasing trend in 26 FU, except for the state of Roraima, where an APC of 2.52% (95%CI: 0.33; 4.76) was recorded. The results in Table 1 show that the incidence rate of WA in Roraima increased on average by 2.52% per year between 2009 and 2019, while the trend in the other FU was a decrease. The highest reduction was recorded in Alagoas, with -11.20%
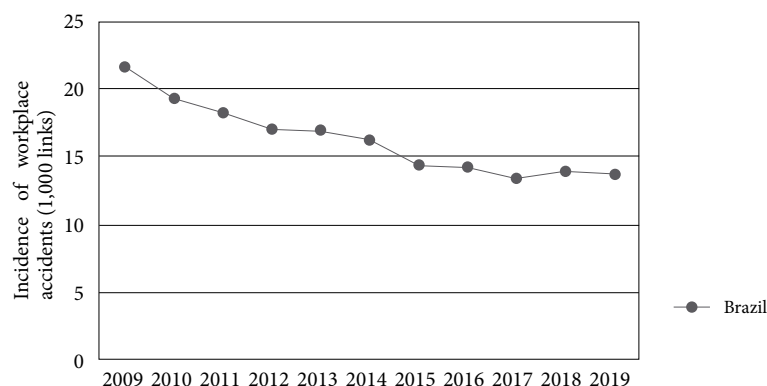
Figure 1. Historical series of the incidence rate of workplace accidents. Brazil, 2009-2019.
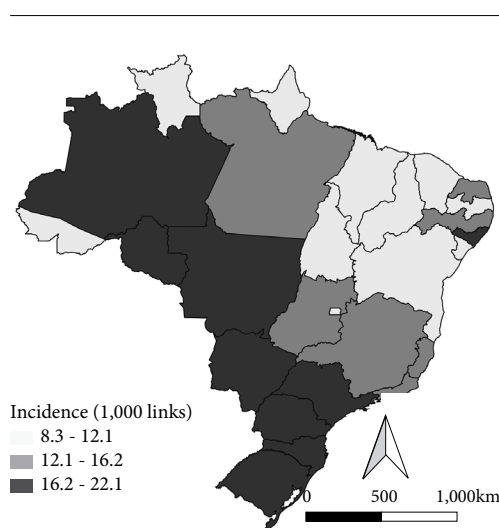
Source: Authors.

Figure 2. Spatial distribution of workplace accidents incidence, according to federal units. Brazil, 2009-2019.

Source: Authors.

(95%CI: -14.05%; -8.24%), and the lowest was in Espírito Santo (APC -2.95%; 95% CI: -4.66%; -1.21%).

Table 2 presents the trends and annual percent changes in the incidence rates of WA in Brazil according to the National Classification of Economic Activities (CNAE, acronym in Portuguese). Each CNAE section is represented by a letter, and trends are classified as increasing, decreasing, or stationary. In this table, classes A, B, C, D, F, H, J, K, L, M, N, Q, and R of CNAE

showed a decreasing trend, while E, G, I, O, P, S, T, and U showed a stationary trend.

The CNAE section with the highest average incidence rate of WA was E, with 43.44 per 1,000 links. The class with the lowest average rate was O, with 5.57 (Table 2). The CNAE section with the highest negative APC was A, with an APC of -6.57% (95% CI: -10.07; -2.94), indicating a strong downward trend over the years. The class with the lowest negative APC was Q, with -2.53% (95%CI: -2.93; -2.13).

Table 3 presents the trend and the APC of the specific incidence rates of WA in Brazil, disaggregated by sex, age group, and accident consequence. The average incidence rate was higher among men (20.88 per 1,000 employment links) than among women (11.75 per 1,000 employment links). However, the trend was decreasing in both sexes, with a negative annual percentage variation. There was a significant reduction in the incidence of WA in all age groups throughout the period. Workers aged 20 to 59 years had the highest average incidence rate of WA, with an average of 17.42 accidents per 1,000 employment links.

Both types of consequences showed a decreasing trend, indicating a reduction in WA resulting in medical assistance (APC -1.79%; 95%CI -3.06; -0.51) and in accidents resulting in disability (APC -4.94%; 95% CI -6.06; -3.80) during the analyzed period.

Discussion

In this study, we evaluated the temporal trend of the incidence of WA in insured workers of the

Table 1. Trend and annual percentage change (APC) of workplace accidents incidence, according to federative units. Brazil, 2009-2019.

FU	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	μ	APC (%)	95%CI		p	Trend
North																	
RO	24.99	22.33	22.45	21.82	22.47	20.35	17.78	18.25	16.66	18.01	15.84	20.51	-4.09	-4.97	-3.19	0.03	Decrease
AM	23.08	20.42	20.41	18.14	17.04	17.26	17.14	16.42	15.52	16.04	15.02	18.15	-3.76	-4.87	-2.63	<.01	Decrease
PA	19.29	16.66	14.96	13.99	13.91	14.10	12.24	10.86	10.87	11.39	10.38	13.83	-5.57	-7.02	-4.08	<.01	Decrease
AC	15.72	14.49	14.47	12.61	12.62	12.12	10.33	9.96	9.95	8.87	7.69	12.11	-6.39	-7.08	-5.69	<.01	Decrease
TO	14.45	10.05	9.77	8.12	7.10	7.14	6.33	6.95	6.44	6.97	6.12	8.33	-7.04	-10.58	-3.35	<.01	Decrease
AP	11.89	9.69	11.38	11.66	13.10	9.43	8.23	9.25	6.94	7.63	7.42	9.92	-5.05	-7.89	-2.12	<.01	Decrease
RR	11.67	9.24	10.25	8.98	11.58	13.11	9.51	11.57	12.94	13.42	11.34	11.23	2.52	0.33	4.76	<.01	Increase
Northeast																	
AL	32.33	30.15	28.53	23.28	18.30	15.49	13.14	12.36	11.32	11.38	10.25	19.63	-11.20	-14.05	-8.24	<.01	Decrease
RN	21.62	16.02	15.82	14.26	13.69	13.76	13.36	11.41	9.78	10.43	9.64	14.02	-6.67	-8.06	-5.25	<.01	Decrease
PE	18.82	18.08	16.63	14.78	14.87	14.23	12.03	12.01	11.11	11.17	10.56	14.37	-5.88	-6.64	-5.10	0.01	Decrease
BA	16.38	13.84	12.76	11.47	10.84	10.43	8.71	8.55	8.51	8.70	8.51	11.02	-6.32	-8.71	-3.86	<.01	Decrease
MA	15.36	14.34	13.57	9.87	9.62	10.02	8.57	8.27	7.33	6.98	6.85	10.39	-8.04	-9.61	-6.45	<.01	Decrease
PB	13.22	12.08	12.00	10.35	10.16	10.28	7.94	7.92	7.73	7.71	7.06	9.94	-6.20	-7.22	-5.17	<.01	Decrease
CE	12.65	11.76	10.74	10.64	10.75	10.16	8.85	9.26	8.69	8.97	9.01	10.25	-3.46	-4.57	-2.34	<.01	Decrease
PI	12.34	11.74	11.87	12.26	12.99	12.26	10.83	11.06	9.26	9.70	8.17	11.43	-3.69	-6.03	-1.29	<.01	Decrease
SE	11.81	11.07	11.49	10.13	9.87	9.19	7.98	8.11	7.61	7.22	7.26	9.45	-5.39	-6.11	-4.66	<.01	Decrease
Midwest																	
MT	25.75	22.70	21.24	19.35	19.21	18.39	16.50	16.56	16.24	16.13	15.87	19.21	-4.60	-6.13	-3.04	<.01	Decrease
MS	25.51	22.16	21.52	21.22	20.51	19.24	17.60	17.45	17.03	17.97	17.57	20.02	-3.57	-4.97	-2.14	<.01	Decrease
GO	17.56	14.71	13.46	12.88	13.22	12.85	11.77	12.07	11.66	12.18	12.13	13.24	-3.14	-5.03	-1.20	<.01	Decrease
DF	14.84	12.44	11.70	11.28	11.33	10.55	9.02	9.41	8.42	9.49	9.51	10.85	-4.34	-6.18	-2.47	<.01	Decrease
Southeast																	
SP	23.56	21.52	20.62	19.55	19.48	18.40	16.43	16.48	15.28	15.98	15.81	18.73	-4.07	-5.05	-3.08	<.01	Decrease
ES	21.07	17.79	16.84	15.50	15.62	16.52	15.16	14.46	14.03	14.68	14.98	16.17	-2.95	-4.66	-1.21	0.01	Decrease
MG	20.51	18.30	17.64	16.71	16.41	15.47	13.45	13.20	12.27	12.83	13.23	15.68	-4.62	-6.15	-3.08	<.01	Decrease
RJ	16.96	15.03	14.24	14.01	13.46	13.36	12.41	11.88	10.87	11.04	11.23	13.33	-4.02	-4.79	-3.25	<.01	Decrease
South																	
SC	30.03	26.63	24.54	22.57	22.57	21.39	18.15	18.19	17.65	19.19	18.95	22.09	-4.59	-6.87	-2.24	<.01	Decrease
RS	28.25	24.73	22.80	20.99	22.00	21.58	19.24	19.55	17.95	18.59	18.51	21.57	-3.81	-5.06	-2.55	<.01	Decrease
PA	24.05	21.51	19.69	18.40	18.68	18.44	16.80	16.04	15.42	16.40	16.09	18.54	-3.82	-5.34	-2.27	<.01	Decrease

RO: Rondônia; AM: Amazonas; PA: Pará; AC: Acre; TO: Tocantins; AP: Amapá; RR: Roraima; AL: Alagoas; RN: Rio Grande do Norte; PE: Pernambuco; BA: Bahia; MA: Maranhão PB: Paraíba CE: Ceará PI: Piauí SE: Sergipe; MT: Mato Grosso; MS: Mato Grosso do Sul; GO: Goiás; DF: Distrito Federal; SP: São Paulo; ES: Espírito Santo; MG: Minas Gerais; RJ: Rio de Janeiro; SC: Santa Catarina; RS: Rio Grande do Sul; PR: Paraná; FU: federative units; μ: average; APC: annual percent change; 95%CI: 95% confidence interval; p: p-valor.

Source: Authors.

Brazilian Social Security System, a group that represents the largest contingent of individuals with formal work ties in the national scope.

It was possible to observe a general trend of decreasing WA rates in the analyzed period in the different segments evaluated (FU, gender, age range, consequences of the WA, and economic activity sector). Overall, the rates showed a decreasing trend with a significant APC except for the incidence rate of WA in some categories of CNAE.

There are several factors that can explain the global decrease in the incidence rate of WA in the various Brazilian states. Among them, we can mention the institution of the Accident Prevention Factor (FAP, acronym in Portuguese), a mechanism adopted by the Federal Government to encourage companies to invest in safety and health at work, by reducing the rate of the Labor Incidence Degree Contribution resulting from Environmental Work Risks (GIL-RAT, acronym in Portuguese) formerly known as Work Acci-

Table 2. Trend and annual percentage change (APC) of workplace accidents incidence, according to CNAE section. Brazil, 2009-2019.

CNAE Section	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	μ	APC (%)	95%CI		p	Trend
A	19.57	18.74	17.16	16.15	15.16	23.68	12.47	10.63	10.56	10.81	11.29	15.49	-6.57	-10.07	-2.94	<.01	Decrease
B	34.09	30.35	30.22	30.34	28.02	23.04	20.84	19.13	17.76	19.06	20.61	25.28	-5.53	-8.52	-2.44	<.01	Decrease
C	36.00	32.14	30.23	28.29	28.18	23.00	21.09	21.68	20.97	22.81	22.68	26.44	-4.72	-7.50	-1.85	0.01	Decrease
D	29.32	26.09	25.44	25.00	25.99	32.47	22.57	20.77	19.83	19.50	19.49	24.70	-3.98	-6.60	-1.29	0.01	Decrease
E	55.02	49.77	47.93	46.44	44.79	35.79	35.10	37.46	38.68	43.42	42.28	43.44	-2.69	-6.22	0.96	0.13	Stationary
F	25.95	21.44	20.48	19.66	18.74	16.48	15.31	16.07	15.35	16.12	17.35	18.56	-4.02	-7.02	-0.92	0.02	Decrease
G	13.55	12.37	11.74	10.92	10.95	8.48	8.29	8.86	8.83	9.66	9.79	10.37	-3.43	-6.87	0.14	0.06	Stationary
H	28.55	26.07	24.22	23.30	23.38	18.49	18.68	20.11	19.48	19.23	17.64	22.15	-4.34	-6.06	-2.60	<.01	Decrease
I	14.20	13.14	12.42	11.48	11.77	8.53	8.23	9.42	9.45	10.21	10.23	10.89	-3.52	-7.32	0.43	0.07	Stationary
J	9.69	7.79	7.92	7.23	7.04	8.44	7.01	6.64	6.58	7.14	6.59	7.55	-2.59	-4.06	-1.10	<.01	Decrease
K	14.68	12.93	13.34	14.59	14.76	10.11	11.20	11.81	10.64	11.18	10.62	12.52	-3.20	-5.10	-1.26	0.01	Decrease
L	10.94	10.29	10.56	12.49	11.67	8.79	8.00	8.32	7.15	7.82	7.83	9.60	-4.24	-7.21	-1.17	0.01	Decrease
M	10.30	9.15	8.57	8.23	8.13	7.07	6.77	6.48	6.11	6.66	6.64	7.75	-4.45	-6.37	-2.49	<.01	Decrease
N	12.93	11.08	10.19	9.51	9.39	6.75	7.23	7.65	7.26	7.93	7.63	8.99	-5.07	-8.34	-1.69	0.01	Decrease
O	7.16	6.64	6.56	5.86	6.42	3.86	4.32	4.64	5.04	5.17	5.33	5.57	-3.51	-7.59	0.74	0.09	Stationary
P	6.86	6.24	6.05	5.60	5.76	6.94	6.93	5.29	5.05	5.64	5.70	6.04	-1.66	-4.12	0.85	0.17	Stationary
Q	41.90	39.05	37.89	36.83	37.28	34.56	34.45	33.89	31.84	32.65	31.97	36.03	-2.53	-2.93	-2.13	<.01	Decrease
R	13.44	11.97	11.15	9.90	9.10	7.25	6.94	7.52	7.58	7.44	7.37	9.23	-5.90	-9.39	-2.28	0.01	Decrease
S	12.30	10.52	9.79	8.66	8.54	8.14	7.64	8.03	8.05	8.55	8.65	9.02	-3.40	-6.91	0.24	0.06	Stationary
T	6.79	7.89	7.83	8.71	10.42	27.95	0.64	15.88	11.36	11.70	8.73	10.92	2.09	-11.12	17.26	0.74	Stationary
U	6.20	3.71	10.33	6.10	7.75	4.24	6.20	5.93	6.61	6.51	7.00	6.36	1.12	-2.74	5.13	0.54	Stationary

A: agriculture, livestock, forest production, fisheries and aquaculture; B: extractive industries; C: transformation industries; D: electricity and gas; E: water, sewage, waste management activities, and decontamination; F: construction; G: commerce; repair of motor vehicles and motorcycles; H: transport, storage and mail; I: accommodation and meals; J: information and communication; K: financial activities, insurance and related services; L: real estate activities; M: professional activities, scientific and technical; N: administrative activities and complementary services; O: public administration, defense and social security; P: education; Q: human health and social services; R: arts. Culture, sport and recreation; S: other service activities; T: domestic services; U: international organizations and other extraterritorial institutions; μ: average; APC: annual percent change; 95%CI: 95% confidence interval; p: p-valor.

Source: Authors.

dent Insurance (SAT, acronym in Portuguese) for companies that have a lower incidence rate of these events. This factor is calculated based on the frequency, severity, and cost of accidents and work-related illnesses of companies in a given period, compared to the average of other companies in the same economic sector.

Two national studies aimed to analyze the rates of risk of WA and illnesses in Brazil before and after the FAP came into effect. The first study concluded that the historical series of WA rates in Brazil had a strong trend of reduction during the FAP's validity period, unlike what happened in the period prior to this prevention policy[15]. The second study, in the same line, identified a reduction in the incidence of these conditions in different economic activities and in different severity groups, with a greater reduction in the accident rate in the manufacturing industry and in the production of goods and/or services, and

greater reductions in the incidence of musculo-skeletal and connective tissue diseases[16].

The influence of the FAP on the reduction of WA is indirect but important, as companies that invest in prevention measures - such as training, the use of personal protective equipment, adequate signage, and other resources - have the opportunity to pay fewer taxes related to WA, which can stimulate the adoption of prevention policies. An indirect example of the probable effect of this measure was found in the study conducted by Mesquita and colleagues, which showed that the use of PPE increased by 4.62% nationwide, and this increase was observed in all regions of the country, indicating greater awareness and investment in safety measures in the workplace[17].

It is important to recognize, however, that the implementation of FAP may also have generated a negative side effect, as it may have

Table 3. Trend and annual percentage change (APC) of specific workplace accidents incidence. Brazil, 2009-2019.

Variable	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	μ	APC (%)	95%CI		p	Trend
Sex																	
Male	27.71	24.88	23.43	21.90	21.85	20.19	17.74	17.54	16.43	17.11	16.76	20.88	-5.03	-6.32	-3.72	<.01	Decrease
Female	14.77	13.27	12.67	11.88	12.33	11.52	10.46	10.44	9.82	10.33	10.22	11.75	-3.60	-4.68	-2.51	<.01	Decrease
Age group																	
Up to 19 years	17.62	16.00	13.97	12.43	15.62	11.41	9.97	9.86	9.25	10.51	9.54	12.66	-6.08	-8.21	-3.90	<.01	Decrease
20 to 59 years	22.88	20.52	19.41	18.14	18.12	16.91	14.99	14.82	13.93	14.53	14.33	17.42	-4.67	-5.96	-3.37	<.01	Decrease
≥60 years	10.54	9.33	8.91	8.41	8.46	8.23	7.33	7.36	6.68	6.94	6.63	8.22	-4.22	-4.88	-3.56	<.01	Decrease
Consequence																	
Assistant doctor	3.04	2.66	2.58	2.60	2.56	2.46	2.33	2.35	2.45	2.42	2.46	2.55	-1.79	-3.06	-0.51	<.01	Decrease
Inability	18.64	16.67	15.67	14.44	14.40	13.81	12.10	11.93	11.08	11.54	11.28	14.03	-4.94	-6.06	-3.80	<.01	Decrease

μ: average; APC: annual percent change; 95%CI: 95% confidence interval; p: p-valor.

Source: Authors.

stimulated the underreporting of WA by companies in order not to harm their frequency and severity rates of accidents, and consequently their GIL-RAT rate. Assunção defends this point of view and mentions that the temporal trend of decreasing incidence of registered WA by official statistics, without evidence of the implementation of prevention measures in work environments, raises the discussion about the maintenance of the social invisibility of professional injuries in Brazil and the likely underreporting and under-registration of these harms[2].

There is also the possibility that in certain states, accidents are more easily covered up or neglected, especially mild accidents that do not result in disability or those that generate reduced disability. More severe cases of WA tend to be less underreported because they usually require more intensive medical treatment and may result in prolonged work absences, making these cases more visible and subject to registration by the competent authorities. However, less severe cases that do not require prolonged absences or intensive medical treatment can be neglected by both employees, due to the so-called "tolerance culture," and employers, resulting in underreporting[11,18].

The decreasing trend may also be a result of public policies implemented in the last two decades that aim to promote safer and healthier work environments, such as the Sustainable Work Program, the National Policy and Plan for Safety and Health at Work, the Safe Work Program, and the actions of the National Policy on Worker Health[19,20]. Other measures may have also contributed to this scenario, such as a possible intensification of the actions of la-

bor inspectors and the MPT (acronym in Portuguese); greater awareness among workers of the importance of accident prevention; and the increase in outsourced and informal work. Changes in the composition of the labor market and the economy, such as the recession of 2015 and 2016, when the country faced an increase in interest rates, unemployment, and a decrease in population income, among others, also contribute to this trend[21-23], in addition to the greater prominence of informal work and the expansion of precarious work in recent years in Brazil.

The incidence rate of WA among male workers remained significantly higher than among female workers, indicating a gender inequality. These findings are consistent with specialized literature that also reports a higher incidence and mortality from WA in men[18,24-28]. This phenomenon can be explained by various factors, including differences in occupations and exposure to occupational risks, as well as cultural and social issues that influence women's participation in the labor market, preferably in certain sectors of the economy[10]. It was also observed by an IBGE study in 2019 that women are more often employed informally[29].

Adult workers also had higher rates of WA in all analyzed years. One factor that may contribute to this group being in this condition is the fact that they represent the largest contingent of workers in the market. These individuals generally make up the majority of the economically active population, meaning those who are of working age and available to work, and therefore represent the largest number of employees in most sectors and branches of activity in the country. In addition, there is a greater presence

of these workers in higher risk sectors such as industry, construction, mining and agriculture, which further increases the chances of accidents occurring in this segment[10].

The reduction and decreasing trend in rates of disability and need for medical assistance may indicate that accident prevention policies and occupational health promotion have focused on reducing the number of WA with more serious consequences for workers. The reduction in these metrics is relevant both for society in general and for companies and workers, since serious injuries can lead to permanent or temporary disability, affecting the quality of life of the worker and their family, and resulting in loss of productivity and labor, disruption of activities, increased costs with compensation and legal proceedings, as well as overload of health and social security systems[6,30,31]. Work developed in Brazil that evaluated the temporal trend of non-occupational social security benefits revealed a behavior opposite to what was identified here, having identified that the incidence rates of non-occupational social security benefits presented stability between 2007 and 2015, followed by an annual increase of 6.7% from 2015 to 2018[32].

In Brazil, the Southeast and South regions have a greater concentration of economic and industrial activities, a scenario that can increase the risk of WA and may be a possible justification for the higher average incidence rate of WA in the state of Santa Catarina. In addition, these regions have a larger economically active population and a greater formalization of the labor market, which may increase exposure to occupational risks and inflate WA indicators. However, it is important to emphasize that the incidence of WA may vary within each sector, depending on the specific characteristics of the work environment, tasks performed by workers, safety measures adopted by companies, among others[33,34]. It is also possible that such measures may be influenced by the already mentioned phenomenon of underreporting[11,18].

The section of the CNAE with the highest average incidence rate of WA was section E, corresponding to waste management, water and sewage activities, with an average rate of 43.44 accidents per 1,000 links. This may be related to the activities carried out in this category, which often involve the handling of hazardous materials and unhealthy working conditions, increasing the risk of accidents occurring. A national study conducted in Belo Horizonte with workers in this category identified a high proportion of WA involving cuts and punctures in this pro-

fessional segment, and that 53.9% of WA in this category were of workers involved in domestic waste. Muscle injuries and fractures represented 25.7% and 12.5% of accidents, respectively[35].

On the other hand, the section with the lowest average rate was O, corresponding to public administration, defense and social security, with an average rate of 5.57 accidents per 1,000 employees, a sector in which workers usually perform administrative and office activities, being exposed to lower risk of WA than other activities. Section A of the CNAE, corresponding to agriculture, livestock, forestry production, fishing, and aquaculture, was the one that showed the greatest decrease over the years, with an APC of -6.57%. The class with the smallest reduction was Q, corresponding to human health and social services, with an APC of -2.53%. This scenario may be the result of investments in technology and safety equipment in the first mentioned field of work, and in the case of the latter, the growing demand for human health care activities in the country, in addition to the possibility of having been influenced by other variables already mentioned that led to the general trend of decreasing WA in Brazil.

It is important to highlight that the incidence rate of WA by CNAE may have also been influenced by the broad geographical coverage of this study and may not reflect the differences between regions, states, and municipalities in Brazil for this indicator. Thus, significant variations in the nature and working conditions in each sector may exist depending on the geographical location and work culture in each region. The results presented here may therefore not be generalizable to the various administrative divisions of the country. Thus, studies that analyze specific geographical regions may find different accident profiles by economic activity than those presented in this research.

Finally, although the data from AEAT InfoLogo and AEPS InfoLogo, sources of this research, are official and widely used in studies in the labor and social security spheres, it is important to note that they only include workers from the RGPS. Thus, they do not include statutory workers and those who do not have a formal employment record, who may be exposed to similar or even higher occupational risks than workers insured by Social Security. Moreover, it is important to note that the data used in this study may be subject to underreporting, which may lead to an underestimation of the true incidence of WA in the country. Therefore, it is important to consider these limitations and

not generalizing the results of this study to the general population of workers.

Another equally relevant factor is that this research focused exclusively on the total incidence rates of WA without exploring the distribution of these accidents by classification (typical, commuting accident, technical nexus, occupational disease), as well as other indicators such as mortality and lethality. Despite these limitations, the study provides a general and updated view of the WA situation in the country, filling a gap in knowledge about the trend of WA incidence in the context of Brazilian states and according to CNAE. The detailed analysis of other variables should be a point to be explored in future research on the subject, representing an opportunity to expand and deepen the understanding of WA in Brazil in future studies.

Conclusion

The results presented showed a general downward trend in the incidence rates of WA in Brazil between 2009 and 2019. The average rate of accidents per 1,000 employment links decreased from 21.64 to 13.72 per 1,000 employment links, representing an annual decrease of 4.45% in the total accident rate. The reduction was observed in all age groups, both sexes, and in all FU of the country, except for Roraima. In addition, there was a significant variation in incidence rates between different CNAE sections, and some activity categories showed a more significant decreasing trend than others. Furthermore, the incidence rates resulting in medical assistance or disability also showed a decreasing trend.

These results may be the outcome of public policies and strategies adopted in recent years to address WAs. Additional studies, assessing the impact of the implementation of public policies on occupational safety and health on the burden of the indicators mentioned throughout this study, should be developed to confirm this hypothesis.

Collaborations

CJ Santos Júnior: contributed to the study's design, data analysis and interpretation; drafted the article or provided relevant critical review of the content; approved the final version; and is responsible for all aspects of the work and ensuring the accuracy and integrity of the work. FM Fischer: contributed to the study's design, data analysis and interpretation; guided the research; provided relevant critical review of the content; approved the final version; and is responsible for all aspects of the work and ensuring the accuracy and integrity of the work. CB Miranda and JLF Aantunes: contributed to the critical review of the content; approved the final version; and are responsible for all aspects of the work and ensuring the accuracy and integrity of the work.

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