Journal of Ecohumanism
2025
Volume: 4, No: 1, pp. 3243– 3254
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i1.6144

A 32-Year Analysis of Occupational Safety and Health in Ecuador: Regulatory Impact on Workplace Morbidity and Mortality

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Abstract

Background: This study analyzed the evolution of work-related injuries and fatalities in the Republic of Ecuador from 1990 to 2022 using a time-series trend analysis, with the secondary objective of assessing the impact of public policies. Methods: The data were obtained from the administrative records of the Ecuadorian Social Security Institute and categorized into six periods based on the introduction of legal frameworks regulating social security. Epidemiological indicators, including morbidity, mortality, and lethality rates, were calculated using the working population insured and protected by General Insurance for Occupational Risk. Results: The results showed that between 1990 and 2022, 269,969 work-related injuries were classified, of which 2% were fatal (5,352 deaths). The overall morbidity rate remained stable, whereas the overall mortality and case fatality rates exhibited significant declining trends. Conclusion: Trend variations and significant differences between periods were observed for each indicator. Despite efforts to improve OSH in Ecuador, the lack of a consistent downward trend highlights the regulatory framework's limited effectiveness. The findings suggest the need for a more in-depth analysis to explain the factors underlying the differential effects between periods and the establishment of a robust national OSH policy aligned with ILO Conventions No. 155 and No. 187 to promote a proactive safety culture.

Keywords: *Work-related injuries, Trends, Legislation, Ecuador.*

Introduction

The evolution of the legislation on compensation for disabling injuries and illnesses of workers affiliated with the Social Security System of the Republic of Ecuador has shown a continuous evolution over time. Its historical background dates back to 1928. However, the creation of the Ecuadorian Social Security Institute in 1970 marked the beginning of the current General Insurance for Occupational Risks (Gómez García, 2021).

Since then, the protection of workers as a fundamental right has been reaffirmed through constitutional reforms and various legal frameworks (Carranza Barona & Villavicencio Salazar, 2022). An example is Executive Decree 2393, issued in 1986 and still in force, which establishes guidelines to promote the well-being of workers and improve working conditions. In addition, since 2001, the Social Security Law has included more specific reforms concerning the benefits of health injuries caused by accidents and occupational diseases. In 2004 and 2005, the regional agreements of the Andean Community of Nations were incorporated, while in 2010 and 2011, new provisions were introduced that represented a significant advance in protection against occupational risks. However, in 2016, these regulations were repealed by the current General Insurance for Occupational Risks Regulation (Comunidad Andina, 2003).

Previous regulatory reforms have been criticized for being rushed, as they were implemented over time without thorough analysis or adequate consideration of the positive effects they might have had if they had been maintained (Porras Velasco, 2015; Salcedo-Muñoz et al., 2019).

The International Labour Organization estimates that 374 million workers suffer non-fatal injuries and 2.72 million workers die each year, of which 0.32 million are due to injuries and 2.4 million are due to work-related diseases (International Labour Organization, 2019). The burden of mortality and morbidity due to work-related health problems remains a major unmet global challenge (Pega et al., 2022; Takala et al., 2024). In Latin America and the Caribbean, the situation is critical (Economic Commission for Latin America and the Caribbean [ECLAC]/International Labour Organization [ILO], 2021), with estimates that between

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27,000 and 68,000 people die each year as a result of occupational accidents, and between 20 and 80 million people suffer from work-related injuries or illnesses (Córdova Vilcapoma et al., 2022). In the Republic of Ecuador, recent studies have shown a trend towards a reduction in the number of occupational accidents covered by the General Insurance for Occupational Risks. However, the incidence of these events remains high (Instituto Ecuatoriano de Seguridad Social [IESS], 2023).

These statistics underscore the urgent need for better workplace safety and health policies, as work-related injuries and fatalities have significant economic and social impacts. Global efforts involving governments, employers, and international organizations are essential for implementing effective prevention strategies and improving worker protection. The development of sound regulatory frameworks and the implementation of effective national programs to ensure safe and healthy working environments are among the most important aspects contributing to the reduction of mortality and morbidity from work-related health problems (International Labour Organization, 2019; Takala et al., 2024). The ILO encourages member states to incorporate the Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187), its Recommendation (No. 197), and the Occupational Safety and Health Convention, 1981 (No. 155), into national legislation to ensure the principle of a fundamental right at work.

The Republic of Ecuador has not yet ratified any conventions. However, in line with the Sustainable Development Goals 2030 and the Action Plan on Workers' Health 2015-2025, the National Policy on Occupational Health 2019-2025 was created in 2019 as a strategy to materialize the regulatory standards on occupational safety and health (OSH) (Ministerio de Salud Pública del Ecuador, 2019). To the best of our knowledge, no study has analyzed the impact of regulations in this area over a long period of time, which limits the ability to guide the development of future strategies for the country. Given the above context, the first step would be to describe the evolution and behavior of this issue in public and occupational health. Therefore, a time-series analysis will make it possible to identify fluctuations in their historical data and assess the progress of OSH policies for the periods observed at each point in time.

Methods

Design and Source

A time-series trend study was conducted using administrative records available nationwide in the Republic of Ecuador from 1990 to 2022. The data were extracted from the latest statistical bulletin of the Actuarial, Research, and Statistics Directorate of the Ecuadorian Social Security Institute (IESS). This information includes the annual number of cases of work-related disabling and fatal injuries compensated by the General Insurance for Occupational Risks. However, the variables available in the records are limited, which may constrain the interpretation and scope of the analysis. This study relied on anonymized, open-access, publicly available data; therefore, approval from an ethics committee was not required.

Periods

The categorization of the time series into periods was determined using two criteria (Gómez García, 2021). First, various studies have demonstrated fluctuations in the annual number of workplace accidents, which are largely influenced by the introduction of legal frameworks that regulate social security. Second, the observed abrupt changes coincided with the year following the appearance of these legal bodies (see Figure 1 and notes).

Prior to Period 1, 1986 was considered a historic year in the country with the promulgation of the Regulations on the Safety and Health of Workers, which established the legal basis for the prevention of occupational risks. In the following years (1989 and 1990), the social security system was consolidated with the introduction of important reforms to the law on compulsory social security. This first period (1990-1994) was characterized by the extension of the coverage and protection of affiliated workers in the event of accidents at work and occupational diseases, a basis that has been maintained to the present day (Carranza Barona & Villavicencio Salazar, 2022).

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A second notable period (1995-1999) began in 1995 with the Agreement on Social Security in Ibero-America and the 1998 constitutional reform. In addition to granting the Ecuadorian Social Security Institute the autonomy of the General Compulsory Insurance and the responsibility for benefits for illness, disability, and death of affiliated workers, the management of private companies in this area was eliminated (Comunidad Andina, 2003).

The third period (2000-2004) marked another important new milestone in the development of benefits for affiliated workers. In addition to the decentralization of the Ecuadorian Social Security Institute, important legislative reforms have been carried out during these years. In 2001, the Social Security Act was approved, which included access to benefits for workers in informal situations, established protocols for medical care and rehabilitation for temporary or permanent disabilities, and strengthened the monitoring of working conditions in companies (Galiano Maritan & Bravo Placeres, 2019). At the end of the third period in 2004, the country ratified the Andean Instrument for Safety and Health at Work. This instrument encourages member countries to adopt a preventive approach to the management of occupational risks, emphasizing the control of hazards associated with work activities to reduce the incidence of occupational accidents and diseases. By ratifying this instrument, the country periodically updates its public policy on occupational safety and health, taking into account technological advances and economic changes that may generate new occupational risks. To this end, it stresses the importance of implementing effective registration and statistical analysis systems that will allow the impact of these reforms to be continually assessed and policies to be adapted to new needs (Ministerio de Salud Pública del Ecuador, 2019).

The regulations during the first three periods —Period 1 (1990-1994), Period 2 (1995-1999), and Period 3 (2001-2004)— focused on ensuring that workers had access to social protection, including medical care and compensation for disabling injuries and occupational diseases (Salcedo-Muñoz et al., 2019). As shown in Figure 1, the number of cases remained stable with no significant variation, indicating that the regulations during the first three periods were relatively deficient owing to their lack of specificity (Carranza Barona & Villavicencio Salazar, 2022).

In 2005, another transcendental event occurred that marked a difference from the previous period. For this fourth period (2005-2010), the Regulation of the Andean Instrument for Safety and Health at Work was ratified. However, it was not until the end of 2010 that it was incorporated into the national legal system with the approval of the Regulation on the Occupational Risk Audit System - "SART" (Comunidad Andina, 2003). In addition, important reforms have been carried out, such as those made to the Labor Code in 2005 and the Constitution in 2008. These changes reflected the commitment of the state and civil society to improve the quality of life of workers. In Period 4 (2005-2010), regional regulations from the Andean Community of Nations were incorporated, aimed at management systems to regulate and harmonize internal occupational safety and health policies within companies. Despite these robust regulations, there has been a trend of increasing workplace accidents, which can be attributed to the lack of effective implementation of OSH management systems, weak safety culture, and insufficient government supervision and control (Gómez García, 2021).

The fifth period (2011-2016), with the SART still in force, represented a significant advance in the General Insurance for Occupational Risks of the Ecuadorian Social Security Institute. The "SART" was a tool (OSH management model) that was mandatory for companies. In addition, its implementation is regularly verified through employer liability audits. In 2011, the General Insurance Regulations for Occupational Risks appeared, which required employers to report any injury resulting from an accident or any suspicion of work-related occupational disease. This regulation also established a more rigorous framework for the assessment and qualification of such events, with the aim of guaranteeing appropriate benefits and compensation to concerned workers. This period was marked by a series of awareness-raising campaigns on the importance of OHS, which promoted a significant cultural shift towards the prevention of occupational risks. These initiatives not only informed workers about their rights and responsibilities but also promoted a safer and more proactive working environment in identifying and mitigating risks (Ministerio de Salud Pública del Ecuador, 2019).

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Period 5 (2011-2016) marked a significant turning point in the country (Takala et al., 2024), demonstrating a shift from the previous period with a progressive increase in the number of qualified cases. However, in mid-2016, the regulations from the previous period were updated, and simultaneously, a reduction in qualified cases was observed during Period 6 (2017-2022) (Instituto Ecuatoriano de Seguridad Social [IESS], 2023).

Indicators

The following epidemiological indicators, designed to estimate the incidence rates of work-related injuries and fatalities in relation to the working population, provide a means to evaluate the impact and effectiveness of public policies in occupational health and safety (OHS). The Morbidity Rate (Indicator i) measures the frequency of disabling injuries within the working population, indicating how many workers experience injuries that impair their ability to work per 1,000 workers. The Mortality Rate (Indicator ii) measures the frequency of fatal injuries within the working population, showing how many deaths occur per 100,000 workers. The Fatality Rate measures the severity of injuries, indicating the proportion of these injuries that result in death.

i)

$$Morbidity\ rate = \frac{Number\ of\ Disabling\ Injuries}{Working\ Population} x\ 1{,}000$$

ii)

$$Mortality\ rate = \frac{Number\ of\ Fatal\ Injuries}{Working\ Population} x\ 100{,}000$$

iii)

$$Lethality\ rate = \frac{Number\ of\ Fatal\ Injuries}{Number\ of\ Disabling\ Injuries} x\ 100$$

Data for the working population insured and protected by the General Insurance for Occupational Risks were obtained from the latest statistical bulletin of the Ecuadorian Social Security Institute (IESS, 2023) (Figure 1, orange line). This population includes employees, the self-employed, and professionals with voluntary affiliation to the social security system. The number of workers affiliated with the social security system shows a constant increase despite the decrease in 2020.

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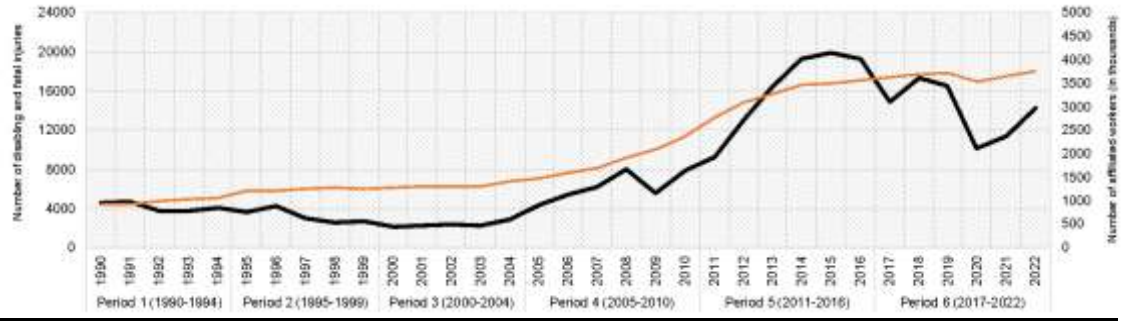
Figure 1. Evolution of Qualified Cases for Work-Related Accidents (Disability and Fatal) and Number of Affiliated Workers by Period in the Republic of Ecuador (1990-2022).



Notes

Period	Year	Regulations (in Spanish)
	1986	Reglamento de Seguridad y Salud de los Trabajadores. Registro Oficial No. 565, de 17 noviembre de 1986.
	1989	Ley Reformatoria de la Ley del Seguro Social. Registro Oficial No. 110, de 17 de enero de 1989.
1 (1990-1994)	1990	Ley Reformatoria de la Ley del Seguro Social. Registro Oficial No. 365, de 29 de enero de 1990.
2 (1995-1999)	1995	Acuerdo sobre la Seguridad Social en Iberoamérica.
	1998	Reforma a la Constitución de la República del Ecuador
3 (2000-2004)	2001	Ley de Seguridad Social. Registro Oficial Suplemento 465 de 30 de noviembre de 2001.
	2004	Instrumento Andino de Seguridad y Salud en el Trabajo. Decisión 584, de 7 de mayo de 2004.
4 (2005-2010)	2005	Reglamento del Instrumento Andino de Seguridad y Salud en el Trabajo. Resolución 957, de 23 de septiembre de 2005.
	2005	Reforma al Código de Trabajo. Registro Oficial Suplemento No. 167, de 16 de diciembre de 2005.
	2008	Reforma a la Constitución de la República del Ecuador.
	2010	Reglamento para el Sistema de Auditoría de Riesgos del Trabajo – "SART". Resolución No. C.D. 333, de 27 de octubre de 2010.
5 (2011-2016)	2011	Reglamento del Seguro General de Riesgos del Trabajo. Resolución No. C.D. 390, de 10 de noviembre de 2011.
	2016	Derogación del SART y Reglamento de 2011 por la Resolución No. C.D. 513, de 4 de marzo de 2016.
6 (2017-2022)		Current Reglamento del Seguro General de Riesgos del Trabajo, Resolución No. C.D. 513.

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Analysis

Measures of central tendency and dispersion were calculated. Similar to other studies (Noman et al., 2021; Takala et al., 2024), a simple linear regression analysis was conducted to assess whether the slope indicated an upward or downward trend. To assess the statistical significance of this trend, a 95% confidence level was used. A paired samples t-test was used to identify differences in means between periods. The discussion section presents the main findings of the analysis from socioeconomic and political perspectives. JAMOVI software (version 2.2.21.0) was used for data analysis, and Microsoft Excel (version 16.77) was used for figures.

Results

Between 1990 and 2022, the General Insurance for Occupational Risks classified 269,969 work-related injuries, of which 98% were disabling and 2% were fatal (5,352 deaths). From Period 4 onwards, there was a noticeable increase in the number of cases, with an even greater increase beginning in Period 5, as shown in Figure 1. Overall, the rates exhibited notable fluctuations over the more than 30 years of study. The overall morbidity rate (Figure 2.1) remained stable, with no significant trend changes observed (Slope: 0.01; p=0.243), and an average value of 3.43 (95% CI: 3.02–3.84). In contrast, the overall mortality rate (Figure 2.2) and the case fatality rate (Figure 2.3) exhibited significant declining trends (Slope: -0.04; p=0.000 for both rates), with average values of 3.43 (95% CI: 3.02–3.84) and 2.62 (95% CI: 1.95–3.29), respectively.

The following tables present the trends and changes between periods for each indicator considered in this study. The Morbidity Rate showed a similar trend in each period, with no significant changes in its overall behavior (Table 1). However, the t-test revealed significant differences between some periods, in particular between Periods 1 and 2 and between Periods 3 and 4. In contrast, there were no significant differences in the morbidity rates between Periods 5 and 6.

The Mortality Rate showed trend variations, with periods of stability and continuous decrease. Only Periods 2 and 3 exhibited significant changes. The results of the t-test indicate significant differences between Periods 1 and 2, 4 and 5, and 5 and 6 (Table 2). The Lethality Rate was generally stable, except in Period 2, where a significant decrease was observed, and in Period 3, where a significant increase was observed. It then remained stable during the last three periods. No significant differences in fatality rates were found between most periods, except for notable variation between Periods 3 and 4 (Table 3).

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Figure 2. Evolution of Morbidity (2.1), Mortality (2.2) and Lethality Rates (2.3) in the Republic of Ecuador (1990-2022).

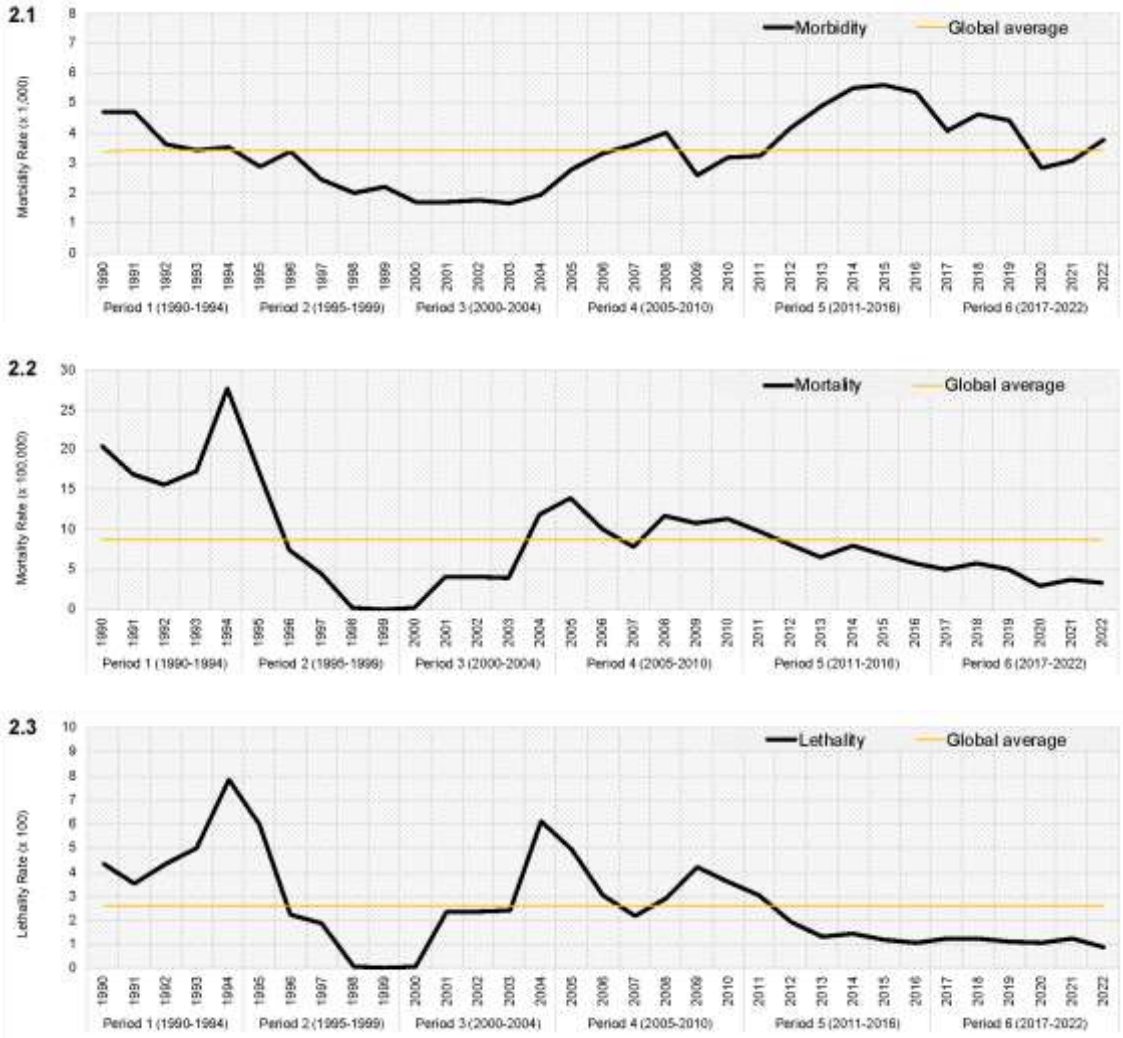

Table 1. Trends Morbidity Rate per 1,000 and Differences between Periods in the Republic of Ecuador (1990-2022).

Period	**1**	**2**	**3**	**4**	**5**	**6**
Years	**(1990-1994)**	**(1995-1999)**	**(2000-2004)**	**(2005-2010)**	**(2011-2016)**	**(2017-2022)**
Morbidity						
Average (SD)	4.02 (0.66)	2.59 (0.55)	1.76 (0.11)	3.26 (0.53)	4.80 (0.92)	3.81 (0.70)
CI 95%	3.20–4.84	1.91–3.27	1.63–1.89	2.71–3.82	3.83–5.77	3.07–4.54
Minimum	3.46	2.03	1.68	2.59	3.25	2.87
Maximum	4.75	3.38	1.94	4.03	5.61	4.61
Slope	-0.09	-0.11	0.02	0.00	0.09	-0.06
p-value	*0.559*	*0.590*	*0.918*	*0.993*	*0.403*	*0.647*
Trend	—	—	—	—	—	—

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t-test	-	12.64	3.12	-5.12	-4.06	1.66
p-value	-	*0.000*	*0.035*	*0.007*	*0.010*	*0.158*

Table 2. Trends Mortality Rate per 100,000 and Differences between Periods in the Republic of Ecuador (1990-2022).

Period	**1**	**2**	**3**	**4**	**5**	**6**
Years	**(1990-1994)**	**(1995-1999)**	**(2000-2004)**	**(2005-2010)**	**(2011-2016)**	**(2017-2022)**
Mortality						
Average (SD)	19.63 (4.89)	5.96 (7.17)	4.87 (4.29)	11.00 (1.97)	7.52 (1.45)	4.37 (1.11)
CI 95%	13.56–25.70	-2.95–14.86	-0.46–10.19	8.93–13.06	6.00–9.03	3.20–5.54
Minimum	15.67	0.08	0.15	7.93	5.74	3.09
Maximum	27.79	17.49	11.91	13.90	9.82	5.85
Slope	0.08	-0.95	0.54	-0.02	-0.09	-0.11
p-value	0.282	0.000	0.000	0.831	0.319	0.344
Trend	—	↓	↓	—	—	↓
t-test	-	3.27	0.23	-2.50	5.36	5.48
p-value	-	*0.031*	*0.832*	*0.067*	*0.003*	*0.003*

Table 3. Trends Lethality Rate per 100 and Differences between Periods in the Republic of Ecuador (1990-2022).

Period	**1**	**2**	**3**	**4**	**5**	**6**
Years	**(1990-1994)**	**(1995-1999)**	**(2000-2004)**	**(2005-2010)**	**(2011-2016)**	**(2017-2022)**
Lethality						
Average (SD)	5.02 (1.68)	2.04 (2.44)	2.68 (2.17)	3.48 (0.99)	1.67 (0.73)	1.14 (0.15)
CI 95%	2.93–7.10	-0.99–5.07	-0.02–5.37	2.44–4.52	0.91–2.44	0.99–1.30
Minimum	3.56	0.04	0.09	2.19	1.07	0.88
Maximum	7.88	6.03	6.12	4.95	3.02	1.27
Slope	0.17	-0.91	0.50	-0.02	-0.21	-0.05
p-value	*0.229*	*0.007*	*0.026*	*0.870*	*0.280*	*0.823*
Trend	—	↓	↑	—	—	—
t-test	-	1.84	-0.32	-0.70	5.31	1.98
p-value	-	*0.140*	*0.762*	*0.523*	*0.003*	*0.105*

Discussion

This study used administrative records of disabling and fatal occupational accidents and diseases and applied epidemiological indicators to describe their evolution and behaviour over a 32-year time series. The data were divided into periods corresponding to the OSH regulations in force at the time, in order to identify fluctuations and changes between periods, thus facilitating the evaluation of the effectiveness of OSH policies over time.

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Overall, the analysis revealed stability in the morbidity rate, accompanied by significant declines in mortality and case fatality rates. At first glance, the findings suggest substantial improvements in working conditions to prevent accidents and illnesses. However, significant fluctuations were identified between the periods. The results are analyzed below in the context of the socioeconomic and political perspectives of each period.

Período 1 (1990-1994)

This period marked the beginning of occupational safety and health (OSH) regulation in Ecuador, characterized by nascent legislation and limited capacity for implementation. The morbidity rate remained stable, reflecting a lack of effective preventive measures. Companies lacked systematic risk management systems, which hindered progress in reducing workplace accidents and occupational diseases. Moreover, insufficient investment in infrastructure and resources for oversight, along with a significant shortage of inspectors and specialized OSH professionals, contributed to the marginal impact of regulations. The technical capacity of the responsible agencies, including insufficient inspectors and human resources, also limited advancements (Galiano Maritan & Bravo Placeres, 2019; Ministerio de Salud Pública del Ecuador, 2019). Economic factors, such as the country's low level of industrialization and underdeveloped productive sector, further significantly restricted improvements in working conditions (Salcedo-Muñoz et al., 2019).

Período 2 (1995-1999)

During this period, the constitutional reform of 1998 established a more robust regulatory framework, promoting the autonomy of the Ecuadorian Social Security Institute (Constitución Política de Ecuador, 1998). This change was further complemented by Ecuador's adherence to international agreements, such as the International Labour Organization (ILO) Conventions, which encouraged the implementation of more structured policies for labor protection (ILO, 1998). However, despite these initiatives, there was limited progress in reducing labor morbidity. Although a slight decrease in the fatality rate was observed, improvements primarily focused on mitigating critical risks rather than comprehensively addressing precarious working conditions (Salcedo-Muñoz et al., 2019).

Moreover, challenges from the previous period persisted, such as insufficient investment in infrastructure and resources for oversight. Economic factors, including a weakened productive system and a lack of industrial dynamism, also hindered significant progress in improving working conditions (Galiano Maritan & Bravo Placeres, 2019). These issues underscore the need for more comprehensive efforts that combine national strategies with the effective fulfillment of international commitments.

Período 3 (2000-2004)

The decentralization of the social security system allowed for greater involvement of local actors in occupational risk management (IESS, 2004). During this period, the Ministry of Labor, under its designation at the time, assumed key responsibilities in regulating OSH. However, this transition also revealed a temporary increase in the fatality rate, possibly linked to a lack of training and standardization in new management approaches (Galiano Maritan & Bravo Placeres, 2019). During this time, Andean regulations, such as the Andean Instrument on Occupational Safety and Health, were adopted, providing guidelines to reduce workplace accidents in companies (Comunidad Andina, 2003). Nevertheless, these measures proved insufficient to achieve a sustained reduction in risks due to organizational resistance and a lack of financial and human resources (Salcedo-Muñoz et al., 2019). Additionally, the implementation of dollarization during this period brought about labor precarization and a reduction in investments allocated to OSH, significantly limiting the impact of these regulations (Ministerio de Salud Pública del Ecuador, 2019; Salcedo-Muñoz et al., 2019).

Período 4 (2005-2010)

The introduction of the Occupational Risk Audit System (SART) marked a significant advancement in the management of occupational safety and health (OSH) in Ecuador (Ministerio de Trabajo y Empleo, 2006).

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This system enabled companies to identify, evaluate, and control occupational risks more effectively, fostering a culture of prevention within the workplace. However, the implementation of SART was uneven, and limited oversight contributed to variability in safety indicators (Gómez García, 2021).

Although the morbidity rate increased during this period, this change was primarily associated with improvements in the reporting of workplace accidents rather than a genuine rise in incidents (Ministerio de Salud Pública del Ecuador, 2019). On the other hand, a progressive decrease in mortality was observed, reflecting advances in medical care systems and greater efficiency in emergency responses. Additionally, universities began to play a key role in the training and classification of specialized OSH technicians, which enhanced worker training and the application of preventive measures (Porras Velasco, 2015).

However, this period was also characterized by significant inequalities. Many companies failed to allocate sufficient resources for the implementation of regulations due to economic constraints. Labor precarization and a lack of investment in OSH remained major barriers to ensuring safe working conditions (Salcedo-Muñoz et al., 2019). These factors highlight the need to strengthen oversight and ensure equitable enforcement of labor policies across the country.

Período 5 (2011-2016)

During Period 5 (2011–2016), a significant turning point in occupational safety and health (OSH) management was observed compared to previous stages. This shift was characterized by increased awareness of workers' rights and the need to improve working conditions, leading to the implementation of Resolutions 333 and 390. These regulations established fundamental guidelines for the prevention of occupational risks and the promotion of safe working environments. Additionally, they specified procedures for reporting and classifying workplace accidents and occupational diseases, enhancing transparency and effectiveness in managing these events.

Regarding indicators, this period marked a shift in the trend of morbidity, with an increase in the rate of disabling injuries. This phenomenon could be interpreted as a reflection of greater emphasis on accident reporting, driven by the implementation of stricter regulations. However, while case detection improved, it also highlighted the need to continue enhancing preventive measures to reduce the occurrence of workplace accidents.

On the other hand, the mortality rate remained stable during these years, indicating that fatal workplace risks did not undergo significant variations. However, the fatality rate decreased, reflecting improved survival rates among workers affected by severe accidents. This suggests that the measures implemented not only contributed to better case identification but also to more effective emergency care, resulting in a reduction in the proportion of injuries leading to death.

Período 6 (2017-2022)

Finally (Period 6), the rates of the three indicators analyzed, although showing decreases compared to the previous period, have remained relatively constant without notable improvements. The repeal of Resolutions 333 and 390 through the implementation of Resolution 513 may have caused confusion or regulatory gaps (Carranza Barona & Villavicencio Salazar, 2022), potentially leading companies to adopt reactive rather than proactive strategies.

Additionally, it is possible that Resolution 513, although introducing new provisions for the classification of workplace accidents and occupational diseases, failed to fully guarantee protective mechanisms, particularly regarding fatality (Salcedo-Muñoz et al., 2019). While the reduction in mortality and morbidity are significant achievements, fatality becomes a key element in evaluating the effectiveness of preventive measures in terms of injury severity. Although this epidemiological indicator is rarely used in analyses by competent authorities in Ecuador, its application could offer a more specific approach by facilitating the identification of worker groups most vulnerable to fatal injuries and, in turn, justify the need to adjust or promote legislative reforms (Zoorob, 2018).

Journal of Ecohumanism
2025
Volume: 4, No: 1, pp. 3243– 3254
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v4i1.6144

Lastly, the economic crisis generated by the COVID-19 pandemic likely led companies to reduce costs allocated to occupational safety and health (OSH) management, weakening preventive measures and exacerbating the precarization of working conditions (Baek et al., 2021; Boucekkine et al., 2024). Government austerity policies during this period also likely reduced the capacity to effectively oversee workplace conditions in companies (Instituto Ecuatoriano de Seguridad Social [IESS], 2023). If the country's economic crisis persists, it is likely that the precariousness of working conditions will worsen further, potentially reducing job quality, limiting access to labor benefits, and increasing workers' exposure to occupational risks due to insufficient investment in OSH measures by companies.

Conclusions

The findings of this study reveal critical insights into the trends and effectiveness of occupational safety and health (OSH) regulations in Ecuador over a 32-year period. While significant declines in mortality and case fatality rates were observed, the persistent stability in morbidity rates underscores the limited effectiveness of existing frameworks in comprehensively improving workplace safety. These results highlight the importance of addressing both systemic and operational challenges in the OSH ecosystem.

From a policy perspective, the findings demonstrate the need for a more robust and coherent national OSH strategy aligned with International Labour Organization (ILO) conventions. Specifically, gaps in regulatory enforcement, inconsistent implementation of frameworks like the SART system, and inadequate investment in infrastructure and technical resources significantly undermine progress. These structural issues were compounded by economic challenges such as dollarization and precarious labor conditions, which limited corporate and governmental capacity to invest in safety measures.

For enterprises, these findings underscore the importance of adopting proactive risk management systems and investing in employee training to mitigate workplace hazards. The variability in indicators such as mortality between regions and industries suggests the need for tailored interventions that address sector-specific risks. Companies must also collaborate more actively with government bodies to align their practices with evolving OSH standards.

For employees, the results point to improved reporting and awareness mechanisms as key drivers for change. However, the persistent prevalence of precarious working conditions, particularly in informal sectors, emphasizes the urgent need for advocacy and policy adjustments to ensure equitable protection for all workers.

Implications for Ecuador's social security system include the necessity of strengthening the technical capacity of agencies like the IESS. Enhancing resources for inspection, oversight, and statistical analysis will ensure that future policies are data-driven and effective in addressing gaps.

Limitations

This study faced several limitations, including the reliance on secondary administrative records with limited variables, which constrained the depth of analysis. Additionally, the lack of granular data on regional and sector-specific differences limited our ability to make nuanced conclusions about the impact of regulations. The absence of longitudinal studies assessing causal relationships between policy changes and outcomes further restricted the scope of interpretation.

Recommendations for Future Research

Future investigations should explore the long-term impacts of OSH policies using more comprehensive datasets, integrating variables such as worker demographics, industry-specific conditions, and economic performance. Evaluating the effectiveness of recently implemented frameworks, particularly in light of challenges such as COVID-19, will also be critical. Moreover, comparative studies across Latin American

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DOI: https://doi.org/10.62754/joe.v4i1.6144

countries could provide valuable insights into best practices and innovative approaches to occupational risk management.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethics declarations

Not applicable.

Competing interests

The authors declare no competing interests.

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