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# Using Death Certificates to Estimate Work-related Fatalities from Falls from Height in the Construction Industry in Ecuador, 2013–2023

## Uso de Certificados de Defunción para Estimar las Muertes Laborales por Caídas desde Altura en la Industria de la Construcción en Ecuador, 2013–2023

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Falls from height, Death certificates, Work-related mortality, Construction industry, Ecuador.

**ABSTRACT**
Falls from heights (FFH) are a major cause of occupational fatalities in the construction industry. In developing countries, underreporting in social security records limits accurate knowledge of work-related mortality. This observational and descriptive study examined FFH deaths in Ecuador's construction sector from 2013 to 2023 using data from the Statistical Registry of General Deaths. Cases were identified through ICD-10 codes (W11, W12, W13, W17, W19) with the place of occurrence classified as construction (.6). Descriptive and inferential analyses were conducted (Kruskal–Wallis test, $p < 0.05$), and working years of potential life lost (WYPLLs) were estimated. Fatal FFH incidents increased until 2017 (14.0%), decreased during 2020–2021, and rose again in 2022–2023. Most deaths occurred in Pichincha (48.2%), primarily from falls from scaffolding (W12, 65.5%). The mean age was 39.6 years (95% CI: 38.3–40.9). Significant differences in age by cause were observed ($\chi^2 = 9.74$; $p = 0.045$), especially between W11 and W13 ($p = 0.040$). A total of 8,221 WYPLLs were estimated, mostly from scaffolding and building falls. These findings highlight a substantial mortality burden and the urgent need to reinforce preventive strategies, strengthen compliance and inspection systems, and promote safety culture within Ecuador's construction industry.

**PALABRAS CLAVE**
caídas desde altura, certificados de defunción, mortaldad laboral, industria de la construcción, Ecuador.

**RESUMEN**
Las caídas desde altura (CDA) son una de las principales causas de muertes laborales en la industria de la construcción. En los países en desarrollo, la subnotificación en los registros de seguridad social limita el conocimiento preciso de la mortalidad ocupacional. Este estudio observacional y descriptivo analizó las muertes por CDA en el sector de la construcción en Ecuador entre 2013 y 2023, utilizando datos del Registro Estadístico de Defunciones Generales. Los casos se identificaron mediante los códigos CIE-10 (W11, W12, W13, W17, W19) con lugar de ocurrencia clasificado como construcción (.6). Se realizaron análisis descriptivos e inferenciales (prueba de Kruskal–Wallis, $p < 0.05$) y se estimaron los años laborales de vida potencial perdidos (AVPP). Las muertes por CDA aumentaron hasta 2017 (14.0%), disminuyeron en 2020–2021 y repuntaron en 2022–2023. La mayoría ocurrieron en Pichincha (48.2%), principalmente por caídas desde andamios (W12, 65.5%). La edad media fue de 39.6 años (IC95%: 38.3–40.9). Se observaron diferencias significativas por causa ($\chi^2 = 9.74$; $p = 0.045$), especialmente entre W11 y W13 ($p = 0.040$). Se estimaron 8,221 AVPP, en su mayoría por caídas desde andamios y edificios. Los resultados evidencian la alta carga de mortalidad y la necesidad de fortalecer las medidas preventivas, la supervisión y la cultura de seguridad en la construcción ecuatoriana.

## 1. INTRODUCTION

Falls from height (FFH) are one of the most common causes of fatal traumatic injuries in the workplace worldwide [1]–[3], especially in high-risk sectors such as the construction industry [4]–[9]. In this industry, workers perform complex tasks at height that require the use of various auxiliary lifting equipment or structures, such as scaffolding, platforms, or ladders [4],[10]–[12]. The risk of mortality increases directly with the height of the fall [13,14]. Therefore, it is essential to adopt effective

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preventive measures to reduce the risk of FFH and prevent premature death among construction workers [15]–[19].

However, the availability of detailed information on occupational accidents in the construction industry remains limited in many low- and middle-income countries [20,21], making it difficult to gain a more accurate understanding of the problem for decision-making on occupational safety and health [22,23]. For example, in the Republic of Ecuador (hereinafter Ecuador), research on fatal injuries from work accidents remains scarce [24]. To our knowledge, only one study has identified the construction industry as the second most dangerous sector in the country [25]. The main limitation of existing analyses is that they do not take into account workers in informal employment, as they are based on accidents classified by the General Occupational Risk Insurance of the Ecuadorian Social Security Institute. In addition to potential underreporting [26], the available information lacks a breakdown by type of FFH. In this regard, current scientific evidence could generate a biased view among labor inspectors when verifying with greater emphasis the occupational risk control measures included in the recent safety regulations for construction sites [27].

Given these limitations, other studies have chosen to use general mortality administrative records as a complementary source of information to estimate work-related deaths [28]–[33]. Therefore, the use of death certificates for external causes is a valuable source of information that provides a more complete picture of the causes of premature mortality in the working population. In this context, the present study aimed to reduce the existing knowledge gap and describe the epidemiological profile of fatal traumatic injuries in the construction industry in Ecuador, using alternative sources of information to official occupational accident records, in order to provide a more accurate and up-to-date understanding of the situation in the country.

## 2. METHODOLOGY

This observational and descriptive study used publicly available databases from the Statistical Registry of General Deaths of Ecuador [34]. As it did not involve human subjects, it was exempt from review by an Ethics Committee. The identification and selection of fatal occupational injuries (FFH) in the construction industry followed a methodology consistent with previous studies [15,35], in line with international recommendations [36], and were based on the following inclusion criteria:

(i) Diagnostic codes (ICD-10): fall on or from ladders (W11), fall on or from scaffolding (W12), fall from, out of, or through a building or other construction (W13), other falls from one level to another (W17), and unspecified falls (W19).
(ii) Location of the event: construction (.6) as a specific subcategory of the code.
(iii) Age: ≥18 years.

The data were available only from 2013 onwards, covering a 10-year period (January 2013 to December 2023). The characterization of the profiles of deceased persons was limited by the variables available in the information source used. After a review of the records, a total of 336 deaths were selected (men only).

In addition to absolute (n) and relative (%) distributions, the statistical analysis focused on the age of deceased individuals (a continuous quantitative variable) and included measures of central tendency and dispersion. Given that the Shapiro-Wilk test indicated non-normality ($W = 0.968$; $p < 0.001$) [37], we used the nonparametric Kruskal–Wallis test [38] to identify patterns and differences in age by diagnostic codes. The level of statistical significance was set at $p < 0.05$, and all analyses were performed using Jamovi software [39].

As a complementary component of the study, working years of potential life lost (WYPLLs) due to these causes of death were estimated [40] to quantify their impact on premature mortality and provide an additional indicator of the occupational health burden associated with fatal occupational injuries. The age threshold was set at 64, following a previous study conducted in Ecuador [41]. It is important to note that the use of secondary data may involve certain limitations, such as possible errors in the coding of specific causes of death, which could lead to an underestimation of the actual number of work-related deaths in the construction sector.

## 3. RESULTS AND DISCUSSION

Between 2013 and 2019, the number of fatal traumatic injuries due to FFH increased, peaking in 2017 (14.0%) and remaining high in 2019 (13.4%). A marked decline occurred in 2020–2021, followed by a subsequent increase in 2022–2023. Most cases were concentrated in Pichincha (48.2%), with falls from scaffolding (W12, 65.5%) being the main cause (see Table 1).

The mean age of fatal cases was 39.6 years (95% CI: 38.3–40.9), with a median of 38 years. By cause (ICD-10), the highest mean age corresponded to falls from ladders (W11, 47.0 years), while the lowest was observed in falls from, out of, or through buildings or other constructions (W13, 35.1 years). The remaining categories (W12, W17, and W19) showed mean ages close to 40 years (see Table 2).

The results of the Kruskal–Wallis test showed statistically significant differences global in age according to the type of cause of death ($\chi^2 = 9.74$; $p = 0.045$). Therefore, the Dwass-Steel-Critchlow-Fligner (DSCF) test was applied to compare age between different types of causes and determine which causes of death show significant differences

($p < 0.05$) [42]. The DSCF post hoc test revealed a statistically significant difference ($p = 0.040$) only between falls from ladders (W11) and falls from, off, or through buildings or other structures (W13) (see Fig. 1).

Finally, a total of 8,221 WYPLLs of premature deaths attributable to FFH are estimated. Falls from scaffolding (W12) accounted for the highest social burden of mortality, with 5,275 WYPLLs, representing 64.2% of the total. This was followed by falls from buildings (W13) with 1,357 WYPLLs (16.5%). To a lesser extent, falls from unspecified levels (W19) accounted for 830 WYPLLs (10.1%), other falls from one level to another (W17) with 554 WYPLLs (6.7%), and falls from stairs (W11) with 205 WYPLLs (2.5%).

**TABLE I.**
Annual, provincial, and cause (ICD-10) distribution of fatal traumatic injuries due to FFH.

| | n | % |
|---|---|---|
| **Years** | | |
| 2013 | 30 | 8.9 |
| 2014 | 31 | 9.2 |
| 2015 | 30 | 8.9 |
| 2016 | 43 | 12.8 |
| 2017 | 47 | 14.0 |
| 2018 | 37 | 11.0 |
| 2019 | 45 | 13.4 |
| 2020 | 5 | 1.5 |
| 2021 | 6 | 1.8 |
| 2022 | 25 | 7.4 |
| 2023 | 37 | 11.0 |
| **Province** | | |
| Pichincha | 162 | 48.2 |
| Guayas | 53 | 15.8 |
| Azuay | 23 | 6.8 |
| El Oro | 10 | 3.0 |
| Chimborazo | 11 | 3.3 |
| Imbabura | 9 | 2.7 |
| Loja | 9 | 2.7 |
| Manabí | 8 | 2.4 |
| Tungurahua | 7 | 2.1 |
| Cotopaxi | 6 | 1.8 |
| Santo Domingo de los Tsáchilas | 6 | 1.8 |
| **ICD-10** | | |
| W11 | 12 | 3.6 |
| W12 | 220 | 65.5 |
| W13 | 47 | 14.0 |
| W17 | 23 | 6.8 |
| W19 | 34 | 10.1 |

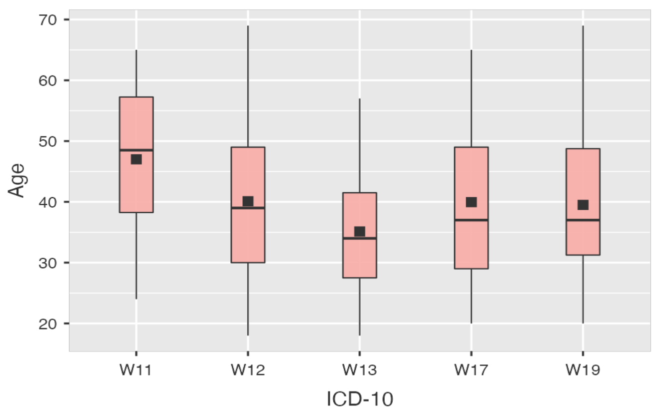
*Note:* ICD-10 = International Classification of Diseases 10th Revision. Provinces with ≤5 cases are not shown in the table.

**TABLE II.**
Age distribution of fatal traumatic injuries due to FFH by ICD-10 code.

| | Mean | 95% CI | | SD | Median | Min. | Max. |
|---|---|---|---|---|---|---|---|
| | | Lower | Upper | | | | |
| **ICD-10** | | | | | | | |
| W11 | 47.0 | 39.0 | 55.0 | 12.5 | 48.5 | 24 | 65 |
| W12 | 40.1 | 38.5 | 41.8 | 12.4 | 39.0 | 18 | 69 |
| W13 | 35.1 | 32.0 | 38.2 | 10.6 | 34.0 | 18 | 57 |
| W17 | 40.0 | 34.0 | 46.0 | 13.8 | 37.0 | 20 | 65 |
| W19 | 39.5 | 35.2 | 43.8 | 12.4 | 37.0 | 20 | 69 |
| General | 39.6 | 38.3 | 40.9 | 12.4 | 38.0 | 18 | 69 |

*Note:* ICD-10 = International Classification of Diseases 10th Revision. 95% CI = 95% Confidence Interval. SD = Standard Deviation. Min. = Minimum. Max. = Maximum.

**Fig. 1.**
Boxplot of age distribution by ICD-10 code among fatal traumatic injuries due to FFH.




*Note:* ICD-10 = International Classification of Diseases 10th Revision. The horizontal line within the box indicates the Median. The black dot marks the Mean.

**TABLE III.**
Pairwise comparisons of age by ICD-10 category, using the DSCF test.

| Comparison | | | W | *p* |
|---|---|---|---|---|
| W11 | – | W12 | −2.61 | 0.347 |
| W11 | – | W13 | −3.97 | 0.040 |
| W11 | – | W17 | −2.14 | 0.554 |
| W11 | – | W19 | −2.39 | 0.440 |
| W12 | – | W13 | −3.35 | 0.125 |
| W12 | – | W17 | −0.23 | 1.000 |
| W12 | – | W19 | −0.32 | 0.999 |
| W13 | – | W17 | 1.73 | 0.736 |
| W13 | – | W19 | 2.06 | 0.592 |
| W17 | – | W19 | −0.07 | 1.000 |

DSCF = Dwass–Steel–Critchlow–Fligner. W = standardized difference between the average ranks of groups in the DSCF test.

## 4. CONCLUSIONS

This study confirms that FFH are a major cause of occupational mortality in the construction industry in Ecuador, which is consistent with findings in other countries [2,3,6,10]. The high proportion of cases associated with falls from scaffolding (65.5%) and their geographical concentration in provinces with intense construction activity, such as Pichincha and Guayas, suggest a direct relationship between economic activity, exposure to risk, and the occurrence of fatal accidents [23, 26,43]. Specifically, the capital Quito (province of Pichincha) and the city of Guayaquil (province of Guayas) are where most high-rise building construction projects are taking place.

Although this study did not aim to explain the causes of deaths, it has been found that the main factors that increase the risk of FFH include poor planning, unsafe decisions, inadequate supervision, and failures in collective protection systems [6], [8]–[10]. In addition, the use of unsuitable auxiliary structures [1], lack of training, and the age and experience of workers [11,15,17] also play a role. Taken together, these findings indicate that FFH in construction is a persistent and underestimated problem in Ecuador, possibly associated with structural deficiencies and preventive management failures.

The use of alternative sources such as death certificates proved to be a valuable tool for supplementing official records and obtaining a more accurate picture of the actual occupational mortality burden in the construction industry. The findings of this study are expected to provide solid evidence for the design and implementation of specific intervention programs and contribute to strengthening occupational safety and health regulations in the country [27].

## REFERENCES

[1] C. M. Socias-Morales, C. K. Chaumont Menéndez, and S. M. Marsh, "Fatal work-related falls in the United States, 2003–2014," *American Journal of Industrial Medicine*, vol. 61, no. 2, pp. 111–119, 2018, doi: 10.1002/ajim.22810.

[2] F. Li *et al.*, "Work-related and non-work-related accident fatal falls in Shanghai and Wuhan, China," *Safety Science*, vol. 117, pp. 43–48, 2019, doi: 10.1016/j.ssci.2019.04.001.

[3] WHO/ILO, *WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury, 2000–2016: Global Monitoring Report*, Geneva: World Health Organization and International Labour Organization, 2021. [Online]. Available: https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@ed_dialogue/@lab_admin/documents/publication/wcms_819788.pdf

[4] E. A. Nadhim, C. Hon, B. Xia, I. Stewart, and D. Fang, "Falls from height in the construction industry: A critical review of the scientific literature," *International Journal of Environmental Research and Public Health*, vol. 13, no. 7, p. 638, 2016, doi: 10.3390/ijerph13070638.

[5] S. Konda, H. M. Tiesman, and A. A. Reichard, "Fatal traumatic brain injuries in the construction industry, 2003–2010," *American Journal of Industrial Medicine*, vol. 59, no. 3, pp. 212–220, 2016, doi: 10.1002/ajim.22557.

[6] Y. Halabi *et al.*, "Causal factors and risk assessment of fall accidents in the U.S. construction industry: A comprehensive data analysis (2000–2020)," *Safety Science*, vol. 145, p. 105537, 2022, doi: 10.1016/j.ssci.2021.105537.

[7] S. Jung *et al.*, "Epidemiology of occupational injuries in construction workers between 2009 and 2018 in South Korea," *American Journal of Industrial Medicine*, vol. 66, no. 2, pp. 155–166, 2022, doi: 10.1002/ajim.23448.

[8] T. Nowobilski and B. Hoła, "Methodology based on causes of accidents for forecasting the effects of falls from scaffoldings using the construction industry in Poland as an example," *Safety Science*, vol. 157, p. 105945, 2023, doi: 10.1016/j.ssci.2022.105945.

[9] A. D. Rafindadi *et al.*, "Data mining of the essential causes of different types of fatal construction accidents," *Heliyon*, vol. 9, e13389, 2023, doi: 10.1016/j.heliyon.2023.e13389.

[10] M. A. Camino López, D. O. Ritzel, I. Fontaneda González, and O. J. González Alcántara, "Occupational accidents with ladders in Spain: Risk factors," *Journal of Safety Research*, vol. 42, no. 5, pp. 391–398, 2011, doi: 10.1016/j.jsr.2011.08.003.

[11] M. Sawicki and M. Szóstak, "Quantitative assessment of the state of threat of working on construction scaffolding" *International Journal of Environmental Research and Public Health*, vol. 17, no. 16, p. 5773, 2020, doi: 10.3390/ijerph17165773.

[12] M. Fujii *et al.*, "Factors influencing the injury severity score and the probability of survival in patients who fell from height," *Scientific Reports*, vol. 11, no. 1, p. 15561, 2021, doi: 10.1038/s41598-021-95226-w.

[13] C. Palacio *et al.*, "Incidence of fall-from-height injuries and predictive factors for severity," *Journal of Osteopathic Medicine*, vol. 125, no. 5, pp. 229–236, 2025, doi: 10.1515/jom-2024-0158.

[14] A. A. Kiadaliri, B. E. Rosengren, and M. Englund, "Fall-related mortality in southern Sweden: A multiple cause of death analysis, 1998–2014," *Injury Prevention*, vol. 25, no. 2, pp. 129–135, 2019, doi: 10.1136/injuryprev-2017-042425.

[15] S. N. Min, M. Subramaniyam, S. J. Park, and K. S. Lee, "Development of the fall prevention index on the movable scaffold for construction workers," *Work*, vol. 65, no. 1, pp. 167–173, 2020, doi: 10.3233/WOR-193070.

[16] International Labour Organization (ILO), *Safe and Healthy Working Environment: Principles and Implementation*, Geneva: ILO, 2022. [Online]. Available: https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_dialogue/%40lab_admin/documents/publication/wcms_851909.pdf

[17] S. Abbaszadeh *et al.*, "Risk assessment of probable human errors in the scaffold erection and dismantling procedure: A fuzzy approach," *International Journal of Occupational Safety and Ergonomics (JOSE)*, vol. 28, no. 3, pp. 1773–1778, 2022, doi: 10.1080/10803548.2021.1932110.

[18] M. Abbasinia and I. Mohammadfam, "Identifying, evaluating and prioritizing the causes of occupational accidents in the construction industry using fuzzy AHP and fuzzy TOPSIS," *Work*, vol. 72, no. 3, pp. 933–940, 2022, doi: 10.3233/WOR-210024.

[19] Z. Ashuro *et al.*, "Prevalence of work-related injury and its determinants among construction workers in Ethiopia: A systematic review and meta-analysis," *Journal of Environmental and Public Health*, p. 9954084, 2021, doi: 10.1155/2021/9954084.

[20] M. Kyung, S. J. Lee, C. Dancu, and O. Hong, "Underreporting of workers' injuries or illnesses and contributing factors: A systematic review," *BMC Public Health*, vol. 23, no. 1, p. 558, 2023, doi: 10.1186/s12889-023-15487-0.

[21] J. Johansson *et al.*, "Occupational safety in the construction industry," *Work*, vol. 64, no. 1, pp. 21–32, 2019, doi: 10.3233/WOR-192976.

[22] L. Ensslin, A. Gonçalves, S. R. Ensslin, and A. Dutra, "Bibliometric and systemic review of the state of the art of occupational risk management in the construction industry," *International Journal of Occupational Safety and Ergonomics (JOSE)*, vol. 29, no. 3, pp. 1107–1120, 2023, doi: 10.1080/10803548.2022.2111893.

[23] A. R. Gómez-García, K. P. Córdova Falconí, P. Merino-Salazar, and J. García-Arroyo, "Fatal work accidents in Ecuador from 2014 to 2020: How the age of the deceased worker relates to the accidents' temporal and geographical characteristics," *Archives of Environmental & Occupational Health*, vol. 78, no. 5, pp. 305–311, 2023, doi: 10.1080/19338244.2023.2196051.

[24] M. Paguay, J. D. Febres, and E. Valarezo, "Occupational accidents in Ecuador: An approach from the construction and manufacturing industries," *Sustainability*, vol. 15, no. 16, p. 12661, 2023, doi: 10.3390/su151612661.

[25] A. R. Gómez-García, R. Gutierrez-Álvarez, A. H. Chang-León, and J. A. García-Arroyo, "What activity is the most dangerous to work in? Estimation of the risk level of economic activities in Ecuador," *Safety and Health at Work*, vol. 16, no. 2, pp. 172–179, 2025, doi: 10.1016/j.shaw.2025.03.004.

[26] A. R. Gómez-García, "Commentary on the current situation of occupational injuries in the construction sector of Ecuador," *INGENIO*, vol. 7, no. 1, pp. 1–3, 2024, doi: 10.29166/ingenio.v7i1.5787.

[27] Ministerio del Trabajo, *Acuerdo Ministerial Nro. MDT-2025-122. Reglamento de seguridad en el trabajo y prevención de riesgos laborales para la construcción y obras públicas y privadas*, Quito: Gobierno del Ecuador, 2025. [Online]. Available: https://www.trabajo.gob.ec/wp-content/uploads/2025/09/Acuerdo-Ministerial-Nro.-MDT-2025-122-signed.pdf

[28] K. J. Rauscher, C. W. Runyan, and D. Radisch, "Using death certificates and medical examiner records for adolescent occupational fatality surveillance and research: A case study," *Journal of Occupational and Environmental Hygiene*, vol. 9, no. 10, pp. 609–615, 2012, doi: 10.1080/15459624.2012.713764.

[29] R. Lilley *et al.*, "Decade of fatal injuries in workers in New Zealand: Insights from a comprehensive national observational study," *Injury Prevention*, vol. 27, no. 2, pp. 124–130, 2021, doi: 10.1136/injuryprev-2020-043643.

[30] S. Massari *et al.*, "Occupational mortality matrix: A tool for epidemiological assessment of work-related risk based on current data sources," *International Journal of Environmental Research and Public Health*, vol. 19, no. 9, p. 5652, 2022, doi: 10.3390/ijerph19095652.

[31] T. Kimura, M. Sasaki, and T. Hattori, "Estimation of the mortality rate of workers in Japan," *Journal of Occupational Medicine and Toxicology*, vol. 17, no. 1, p. 24, 2022, doi: 10.1186/s12995-022-00365-z.

[32] M. M. Richey *et al.*, "Trends in fatal occupational injuries in Latino/a workers relative to other groups, North Carolina 2000–2017," *American Journal of Industrial Medicine*, vol. 65, no. 4, pp. 242–247, 2022, doi: 10.1002/ajim.23331.

[33] F. G. Benavides, A. Vives, M. Zimmerman, and M. Silva-Peñaherrera, "Exceso de mortalidad en población en edad de trabajar en nueve países de Latinoamérica, año 2020," *Revista Panamericana de Salud Pública*, vol. 46, e75, 2022, doi: 10.26633/RPSP.2022.75.

[34] Instituto Nacional de Estadística y Censos (INEC), *Portal de Datos Abiertos del Ecuador*, Gobierno del Ecuador, 2025. [Online]. Available: https://www.datosabiertos.gob.ec/dataset

[35] R. Lilley *et al.*, "Identifying opportunities to prevent work-related fatal injury in New Zealand using 40 years of coronial records: Protocol for a retrospective case review study," *Injury Epidemiology*, vol. 6, p. 16, 2019, doi: 10.1186/s40621-019-0193-z.

[36] International Labour Organization (ILO), *Methodologies for the Collection and Analysis of Data on Occupational Accidents*, Regional Office for Latin America and the Caribbean, 2021. [Online]. Available: https://vzf.ilo.org/wp-content/uploads/2021/06/wcms_794841.pdf

[37] J. Rochon, M. Gondan, and M. Kieser, "To test or not to test: Preliminary assessment of normality when comparing two independent samples," *BMC Medical Research Methodology*, vol. 12, p. 81, 2012, doi: 10.1186/1471-2288-12-81.

[38] C. Fan and D. Zhang, "A note on power and sample size calculations for the Kruskal–Wallis test for ordered categorical data," *Journal of Biopharmaceutical Statistics*, vol. 22, no. 6, pp. 1162–1173, 2012, doi: 10.1080/10543406.2011.578313.

[39] The jamovi project, *jamovi (Version 2.3.21.0) [Computer software]*, 2025. [Online]. Available: https://www.jamovi.org

[40] Y. V. Chudasama *et al.*, "Estimates of years of life lost depended on the method used: Tutorial and comparative investigation," *Journal of Clinical Epidemiology*, vol. 150, pp. 42–50, 2022, doi: 10.1016/j.jclinepi.2022.06.012.

[41] A. R. Gómez-García, C. H. Tsao Wu, E. N. Ruiz Barzola, and A. H. Hacay Chang, "Social burden and economic cost estimation of fatal injuries in workers affiliated to social security in Ecuador: A shared challenge in public and occupational health," *Revista de Investigación e Innovación en Ciencias de la Salud*, vol. 7, no. 2, 2025, doi: 10.46634/riics.390.

[42] M. Hollander, D. A. Wolfe, and E. Chicken, *Nonparametric Statistical Methods*, Wiley Series in Probability and Statistics, 2015, doi: 10.1002/9781119196037.

[43] A. R. Gómez-García, M. L. Vega Chica, and J. A. García-Arroyo, "Relationship between the territorial distribution of labor inspectors and work accident injuries: Clustering Ecuadorian provinces into four management scenarios," *Safety Science*, vol. 158, p. 105956, 2023, doi: 10.1016/j.ssci.2022.105956.