Mapping the Accidents and Unsafe Conditions of Workers in the Automotive Sector

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ABSTRACT

Purpose: Their production processes involve several risks and repetitive tasks and adoption of penalizing postures, which can cause musculoskeletal disorders and occupational accidents. The objective of this paper is to elucidate the situation of Occupational Health and Safety in the automotive sector in the Agulhas Negras region and in Brazil.

Methodology/Approach: For this bibliographic research was carried out to characterize and define the processes and concepts pertinent to the economic activities of the sector; collect and treat the most frequently registered data and elaborate a comparative study for better visualization of the scenarios.

Findings: The result was the identification of different behaviours of the curves, which showed the national scenario being linear and constant, while the regional one proved to be unstable, with many variations over the years.

Research Limitation/Implication: The research was developed in a region of the State of Rio de Janeiro, and it is recommended to conduct a global survey.

Originality/Value of paper: The analysis of the characteristics of occupational accidents, with the most frequent type of injury, the most affected body parts, the groups of causative agents, and the most notified occupations in accidents.

Category: Research paper

Keywords: work accidents; automotive; health and workplace safety; underreporting

1 INTRODUCTION

The automotive sector can be divided into two main sets, automakers, and auto part suppliers. Its companies are recognized for their importance as transformation industries for carrying projects through from the planning to the sales of their products, besides their contributions to technological innovations, linkages with the segment of inputs, components, parts, and services (Wolniak, 2019; Barbosa et al., 2020; Doner, Noble and Ravenhill, 2021). Furthermore, the sector has economic relevance, with the generation of income, taxes, exports, and skilled jobs, and each of these elements are fundamental to the sustainable development plans of organizations in the sector (Araujo et al., 2021; Silva et al., 2021; Beier et al., 2022). The National Association of Motor Vehicle Manufacturers of Brazil (ANFAVEA, 2022) published the Brazilian Automotive Industry Yearbook, where the sector has 26 automakers and 484 auto parts suppliers installed in the country, generating about 1.3 million direct and indirect jobs. It also shows that the sector represented, in 2018, 3% of the Brazilian Gross Domestic Product (GDP) and 18% of the GDP of the manufacturing industry, in addition to being the 8th largest global producer of vehicles, and the 6th domestic market in 2019. Data that corroborate its economic importance to Brazil (ANFAVEA, 2022).

The state of Rio de Janeiro has an important automotive complex in the south of Rio de Janeiro, located in the Agulhas Negras (AN) region, an area that includes the municipalities of Resende, Porto Real, Itatiaia and Quatis, which stands out for the diversity of products such as popular and luxury automobiles, buses, trucks, and heavy equipment. It is the second largest automotive complex in number of companies, the fourth in production capacity and the sixth in number of employees, with five assembly plants and eighteen suppliers, employing approximately 15,000 direct automotive employees and 45,000 indirect employees (ANFAVEA, 2022). The automotive industry requires workers to perform many types of repetitive assembly tasks, which use excessive force. It requires a high level of quality work to meet customer demands (Doiro et al., 2017; Sá et al., 2019; Lee and Jung, 2020; Sales et al., 2022), often with the help of lean tools (Silva et al., 2020; Rodrigues et al., 2019).

The intensity of manual, repetitive, monotonous work, with high demand of physical effort can affect the health and safety of workers. It is due to the moving of loads and penalizing postures, with tension in the fingers, hands, and wrists, standing postures with displacement for long periods without the alternation with sitting postures, rotation, and flexion of the trunk in various postures, and activities with overhead work and arms above the shoulder line. On the assembly lines, cognitive and physical factors often demand high human performance, resulting in errors, quality deficiencies, and other assembly-related failures (Santos and Barbosa, 2006; Hermans et al., 1999; Stoyneva et al., 2015; Cheng, Li and Chen, 2019). The working conditions mentioned, and the high number of employees exposed to various risks are conducive to the occurrence of accidents. The National Institute of Social Security (INSS), Ministry of Labor and

Employment (MLE) and the Statistical Yearbook of Work Accidents (AEAT), show two economic activities of the automotive sector recorded the highest rates, in absolute numbers, of work accidents in Brazil, between 2012 and 2020. They are due manufacturing of automobiles, vans and Sport Utility Vehicle (SUVs), and manufacturing of parts and accessories for motor vehicles, which include non-electrical components, upholstery and safety components.

In the classification of the highest accident records in the same period, these activities stand, respectively, at the 40th and 17th positions in the national scenario, and the 1st and 2nd in the AN region, formed by four cities: Itatiaia, Resende, Porto Real and Quatis. Both manufacturing processes were registered as the most frequent causes of injuries of the cut, laceration, contused wound, and puncture types, affecting mainly fingers and hands of vehicle assemblers in the assembly lines. Based on official data from governmental agencies on accidents at work in the country, the article presents three main research questions: what are the indicators of accidents at work in the AN region in relation to Brazil? Are there more workers injuring the AN region than the national average? What are the characteristics of the accidents? To answer these questions, this paper aims at analysing health and safety aspects to draw the profile of accidents at work in the automotive industry comparing the AN region and Brazil. This research is justified by the economic and social importance of this industry and its physical and organizational characteristics.

2 METHODOLOGY

The present research can be classified as hybrid (qualitative and quantitative) with literature review procedures followed by systematic content analysis. This method identifies and describes the important phenomena contained in the analysed documents whose results are concepts and categories that describe and allow analysing the phenomenon (Araujo et al., 2019; Cardoso et al., 2022; Sampaio et al., 2022). The work used official data from governmental agencies on accidents at work from 2002 to 2020, to obtain the historical series of accidents in the Working Accident Communication (WAC). It was for the population with regular employment and the estimate of underreporting in the communication of accidents at work that resulted in social security leave from the INSS data present in the WACWEB system for the communication and official record of WAC, according to the Decree No. 3048 (Civil House, 1999).

Between 2002 and 2020, due to the availability of official data in the agencies, we used the prevalence, which is the measure of the total number of existing cases of an occurrence at a point or period and in a given population exposed to a risk. In the study, there was no distinction between new and old cases, and the indicating points of the magnitude of the accident in the population, in this case, the working population in the formal labour market with regular employment. The used data were on the reported work accidents in relation to the number of cases per ten thousand workers with formal employment.

Official data from governmental agencies on occupational accidents, between the years 2002 and 2021, for two activities in the automotive sector, Manufacturing of automobiles, vans and utility vehicles, and Manufacturing of parts and accessories for motor vehicles, were collected: absolute numbers of WACs, most frequent occupations cited in the WACs, most frequent causative agents cited in the WACs, most frequent injuries cited in the WACs, and most affected body parts according to the WACs. All data are related to workers with formal employment ties, and information about informal workers without formal employment ties is not considered. The agencies consulted were INSS, MLE, and AEAT, through the Digital Observatory of Health and Safety at Work. The time interval selected was due to the availability of the database of official agencies.

3 RESULTS

Accidents occur when there is a loss of control, whether organizational, managerial, or technical, where interactions violate the constraints imposed on a system that maintains safety. Accidents at work result in physical and mental harm to workers and affect the companies' business performance due to work stoppages, damage to the corporate image, worsening labour relations, and money spent on compensation expenses for damages (Dekker, 2014; Kim and Park, 2021). The Brazilian legislation, in its Law No. 8.213, in article 19, considers as a work accident not only the act itself, but also the commuting ones, occurred on the way between the residence and the workplace, and the occupational diseases resulting from the work activity itself (Civil House, 1999). It also provides that all occurrences must be reported to Social Security, through the WAC, regardless of whether the employee has no medical leave. Brazil has occupational accident rates in 2020 that ranked the country fifth in the world (Associação Brasileira do Cobre, 2020) and the second G-20 country in terms of fatalities, with six deaths per 100,000 workers, according to the Public Ministry of Labour (2022).

Fig. 1 shows the historical evolution of the absolute number of notifications of occupational accidents considering the population with regular employment in Brazil and in the studied region, the Black Needles, respectively, between the years 2002 and 2021. It is possible to note different behaviours between the country and the region where the variations in the indicators of occupational accidents are affected by economic cycles, with a close relationship to the GDP and to periods of reduced economic activity with a decrease in indicators (Anyfantis, Boustras and Karageorgiou, 2018). Fig. 2 illustrates the profile in absolute number of work-related accidents per 10,000 regularly employed workers with official WAC reporting and registration.

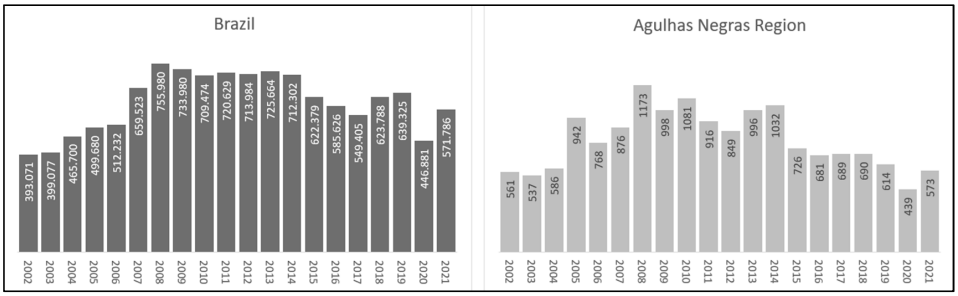

Figure 1 – Historical Series of Accidents at Work in Absolute Numbers (Adapted from MLE, 2022)

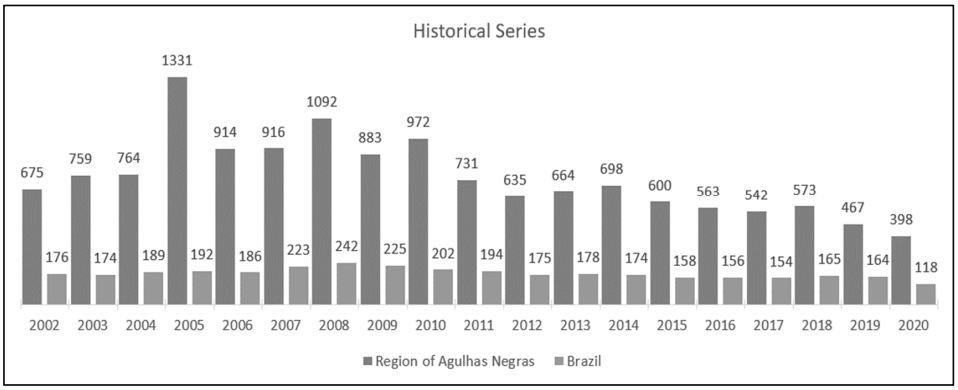

Figure 2 – Prevalence of Work Accident Notifications in every 10,000 Workers (Adapted from MLE, 2022)

Data from the Public Ministry of Labor (2022) estimate that Brazil underreported, in 2018, 25% of the occupational accidents. Fig. 3 and Fig. 4 show the behaviour of the WAC of the country and the region under study, respectively, regarding the emission and absence of WAC in percentage of underreporting between the years 2012 and 2021. According to such data, the WAC omission in the cities of the region was always below the national estimate, having 15% of underreporting in 2021.

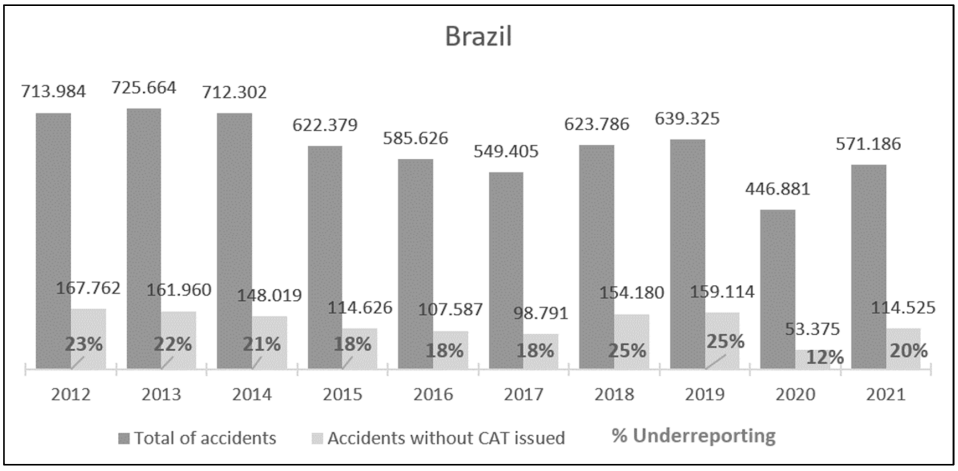

Figure 3 – Estimate of Work Accident Underreporting in Brazil (Adapted from Public Ministry of Labor, 2022)

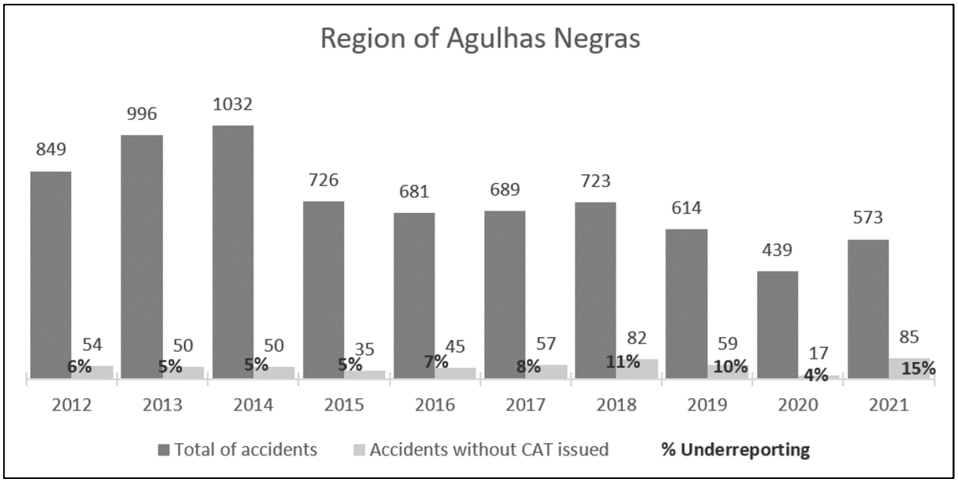

Figure 4 – Estimate of Work Accident Underreporting (WAU) in the AN Region (Adapted from Public Ministry of Labor, 2022)

When analysing the work accident indicators by economic activity, the automotive sector is responsible for approximately 31% of occurrences in the AN region, and 4% in the country, with two activities that stand out with higher numbers between the years 2012 and 2021. They are due the manufacturing of automobiles, vans, and SUVs, occupying the 46th position in the Brazilian classification, and 1st, in the AN region; and the manufacturing of parts and accessories for motor vehicles not previously specified, referring to the production of non-electrical components, upholstery, and safety items, ranked 17th in Brazil and 3rd in the Black Needles region, respectively. In these data, only the records of work-related accidents of workers with formal jobs are considered (ANFAVEA, 2022).

Tab. 1 presents a statistical analysis which calculations were made for the values of mean, standard deviation, and Pearson's Coefficient of Variation (PCV) for the two studied activities. It used the PCV of because it assesses the relationship between reported and unreported accident variables. The PCV allows the dispersion of such data to be analysed through the quotient between the two other indicators presented. The lower the result, the more homogeneous the data. The PCV was applied due to the peaks in the data, especially those of the AN region.

Table 1 – Statistical Analysis of the officially Reported Occupational Accidents (Adapted from Public Ministry of Labour, 2022)

Activity	**Manufacture of automobiles, vans, and utility vehicles**		**Manufacture of parts and accessories for motor vehicles not specified above**	
Location	Brazil	Region	Brazil	Region
Average	2,382.10	59.20	4,299.00	42.20
Standard Deviation	1,600.96	21.43	1,486.69	22.94
PCV	67%	36%	35%	54%
Classification of PCV	Very high	Very high	Very high	Very high

Notes: PCV – Pearson's Coefficient of Variation.

By analysing the official notifications of occupational accidents available in the period between 2012 and 2021, we can see that most records of WAC are related to the occupation of vehicle assembler on the assembly line according to Brazil's National Classification of Economic Activities (CNAE) in the economic activity Manufacturing of automobiles, vans, and SUV (Fig. 5). CNAE are the codes for manufacture of automobiles, vans, and utility vehicles. This may be associated with a larger number of employees in this occupation in relation to other occupations of the companies. In addition to the exposure of these workers to high demand of physical effort, with repetitive, monotonous, manual work, with load movement (Lee and Jung, 2020), by imposing penalizing postures, with overhead work, rotation and flexion of the trunk (Hermans et al., 1999; Dalle Mura and Dini, 2019). And with complexity of the operator selection process in each assembly task (Zhu et al., 2008) and industrial physical arrangement of the production line (Comper et al., 2017). These factors were further combined with organizational factors such as fast production pace, cycle time, long working hours, and production targets.

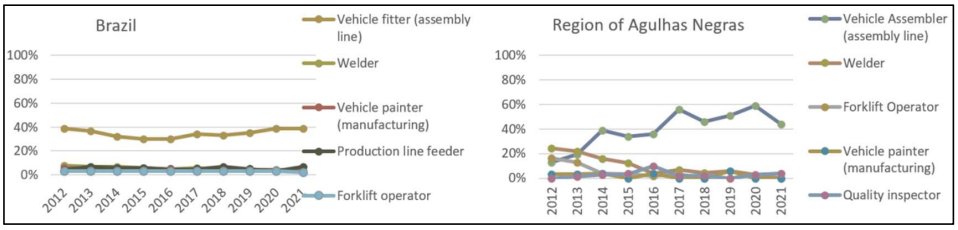

Figure 5 – Occupations with More Accidents CNAE 2910-7/01 (Adapted from MLE, 2022)

In relation to the economic activity manufacturing of parts and accessories for motor vehicles (Fig. 6), the occupations with the highest accident rates are also those that deal directly with the production process, the production line feeders, in the case of Brazil. In the AN region, the occupations are machine tool operators and vehicle assemblers, which can also be associated with the characteristics of the production system, with collaborative work with machines, monotony, manual load movement and repetitive work.

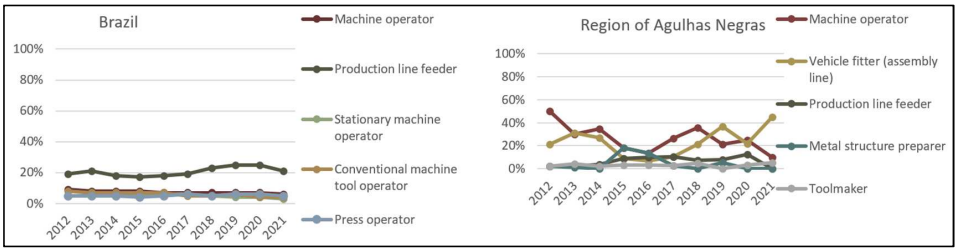

Figure 6 – Occupations with the Highest Accident Rates in the CNAE 2949-2/99 (Adapted from MLE, 2022)

The main groups of agents causing accidents in the two studied economic activities, between 2012 and 2021, were chemical agents, machinery, and equipment, as can be seen in Fig. 7 and Fig. 8. The former can be explained by the high exposure of employees to welding dusts, gases such as carbon monoxide, paint mists, or vapours, which can be absorbed by the respiratory route, ingestion, or contact (Blunt and Balchin, 2002). While the second group of accident-causing agents by economic activity corresponds to Collaborative Operations, where the workspace is shared with industrial robots. This man-machine proximity has increased the likelihood of situations that result in accidents.

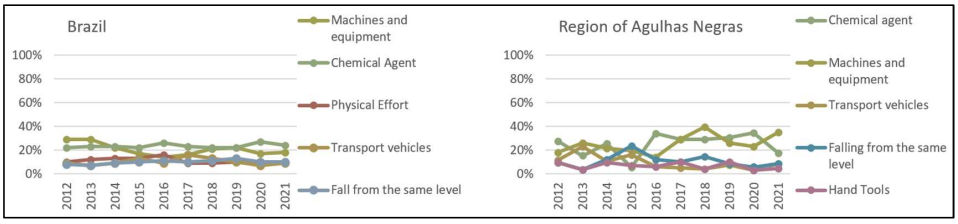

Figure 7 – Groups of Agents Causing Accidents in the CNAE 2910-7/01 (Adapted from MLE, 2022)

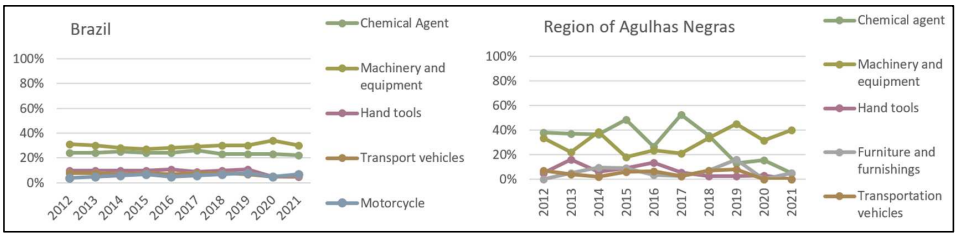

Figure 8 – Groups of Agents Causing Accidents CNAE 2949-2/99 (Adapted from MLE, 2022)

The characteristics of the production line are associated with the most frequent injuries in work accidents recorded with WAC in both economic activities and locations in the same period being of the type cut, laceration, contused wound, or puncture (Hermans et al., 1999; Dalle Mura and Dini, 2019) (Fig. 9 and Fig. 10). The second most reported type was contusion or crushing, which is related to the intense movement of cargo and materials, use of machinery, and storage and stockpiling activities (Lee and Jung, 2020).

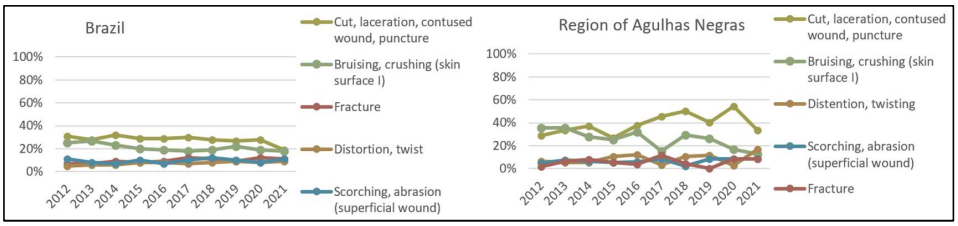

Figure 9 – Groups of Agents Causing Accidents CNAE 2949-2/99 (Adapted from MLE, 2022)

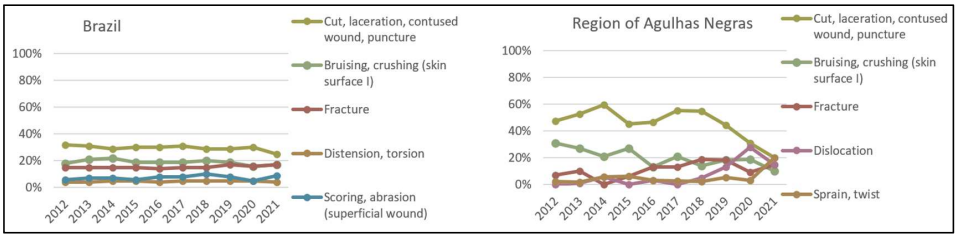

Figure 10 – Most Frequent Injuries in Accidents CNAE 2949-2/99 (Adapted from MLE, 2022)

When considering the occupations with the highest occupational accident rates and the causative agents in both economic activities, it is possible to notice that the extremities of the upper limbs of these workers are the most used in the work activities. This aspect is combined with the particularities of the automotive sector, mainly because the work still has several manual and repetitive activities. In this direction, fingers and hands are the main parts of the workers' bodies with the highest rates of work accident records, as shown in Fig. 11 and Fig. 12.

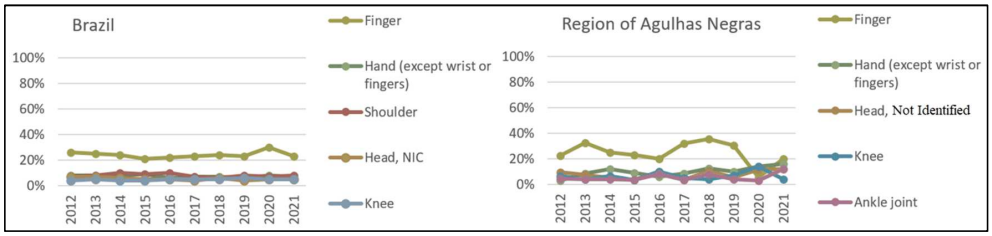

Figure 11 – Body Parts Most Affected in Work Accidents in the CNAE 2910-7/01 (Adapted from MLE, 2022)

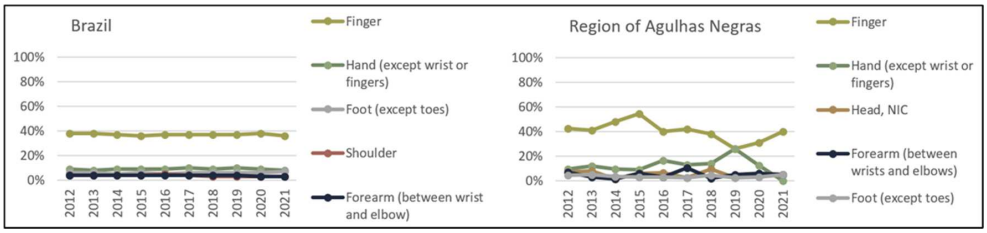

Figure 12 – Body Parts Most Affected in Work Accidents in the CNAE 2949-2/99 (Adapted from MLE, 2022)

4 DISCUSSION

From the analysis of the graphs with the data and profile of occupational accidents in the economic activities Manufacturing of automobiles, vans, and SUVs and Manufacturing of parts and accessories for motor vehicles, it is possible to answer the question concerning the characterization of occupational

accidents. Between 2012 and 2021, accidents in the automotive sector were more frequent with vehicle assemblers on assembly lines, affecting their fingers and hands with injuries of the cut, laceration, and contusion type, caused mainly by chemical agents and machinery or equipment.

This may be related to the particularities of the assembly lines of the companies installed in the AN region, which demand a high physical effort from the workers with manual, repetitive, and monotonous work execution of activities. Also with the adoption of penalizing postures, standing for long periods, with rotation of the trunk or arms above the shoulder line, in conjunction with the accelerated production rhythm and the sharing of workstations with automated equipment.

In relation to the two other raised questions concerning the current situation of the indicators and comparison of the regional and national average of accidents, they can be answered by the analysis of the profiles of the work accident record curves of the two analysed economic activities in the studied period shown in the results. The national scenario has a different behaviour from the regional one, presenting itself with less abrupt variations throughout the years, which shows that the NA region has more accidents among its employees.

Among some hypotheses that may justify this scenario are the economic variations suffered by the country because of the impacts of the global crisis in 2008 added to the political crisis in Brazil in 2014 (Dulci, 2021), especially in the period between 2014 and 2017, in which GDP per capita fell by approximately 9% (Barbosa Filho, 2017). In 2015, the automotive production shrank, reaching the same level as in 2006, which directly affected jobs with the closure of about 10.2% of jobs nationwide (ANFAVEA, 2022). The Region had its worst performance between 2014 and 2015, laying off about 20% of its employees and had another 20% on compulsory vacation, day-off, or reduced workday, staying with rates above the national average. According to data from the INSS, it is estimated that in 2018, about 25% of accidents had no issued WAC in the country and 16%, in the Black Needles Region. Although it was lower than the national percentage, it is important to note that one of the four cities that compose the AN region failed to present some information about some of the analysed years, which makes the actual comparison between the regional and national percentages impossible.

Underreporting can occur both on the part of the companies, when they do not issue the WAC to avoid financial impacts, and on the part of the employees and health professionals, who often omit or are pressured not to report the occurrences regardless of the absence of the employee. Thus, workers give up on notifying the company when they have an accident, even when they seek diagnoses from private doctors, due to the embarrassment, the difficulty of finding compatible work, and the fear of dismissal (Biblin et al., 2018; Vieira et al., 2022). Access to accurate data and statistics on work-related accidents is essential for developing effective programs to prevent future work-related

accidents so that companies can properly manage health and safety issues (Azaroff, Levenstein and Wegman, 2002; Tucker et al., 2014).

Another factor that may influence the underreporting or omission of work-related accidents is the activity of unions. Studies, by Maitan Filho and Guedes (2018), point out that these have low representation in the Agulhas Negras region, which is one of the reasons why the automakers have settled in this location and may contribute to the fact that workers feel less comfortable informing the company when they have an accident.

The third hypothesis is that there may be insufficient supervision of the companies, allowing them to notify less than they should. According to Vasconcelos (2014), it is attributed exclusively to the Union the organization, maintenance, and execution of labour inspection, having the Ministry of Labour Employment as responsible, and the Unified Health System as a collaborator. The same author affirms that the number of Labour Inspectors has been decreasing in the last years, while the number of employees and employers has grown exponentially. Besides, many budget restrictions prevent investments and maintenance of vehicles, equipment, and the management of systems and travels, especially in the second half of the year.

The fourth hypothesis is that the origin of the organization can influence occupational health and safety (OHS) management since cultural issues can be important obstacles to implementing necessary changes (Gonçalves Filho, Andrade and Marinho, 2011). Company culture affects employees' attitudes, which directly impacts their view of their occupational safety (Kalteh et al., 2021). Studies show that companies with lower accident rates have a more advanced OHS culture maturity (Lee et al., 2019).

According to Gonçalves Filho et al. (2011), a major challenge to improving the work environment and consequently reducing workplace injuries is the integration of occupational safety and organizational culture. The safety behaviours of workers and managers impact safety behaviour and performance in many industries and can influence occupational health and safety, organizational reliability, and product safety (Xu et al., 2014). In this sense, training can positively influence behaviour and attitudes in a safety culture (Marquardt, Hoebel and Lud, 2021). Any production system in which the environment is not safe or healthy is not socially sustainable since it causes accidents, mutilations, occupational diseases, or even the death of its workers.

Another possibility that points to the identified scenario in the AN region may be related to low investments by companies in safety and ergonomics. Industries that integrate ergonomics into production systems reduce absenteeism and accidents, increase productivity, quality, process and product efficiency, and workers' quality of life with the reduction of musculoskeletal disorders (Thun, Lehr and Bierwirth, 2011; Zare et al., 2016).

5 CONCLUSION

The automotive sector is of great economic importance for Brazil and the AN Region since it is responsible for generating thousands of direct and indirect jobs, having a representative impact on the gross domestic product of the transformation industry and the country. However, the characteristics of the production processes in the automotive companies and the existing working conditions, especially in automobile assemblers and their suppliers, can lead to several negative impacts on the health and safety of their workers, such as musculoskeletal disorders, occupational diseases, and work accidents. Based on official governmental data from the Occupational Safety and Health Observatory, it was possible to make a comparative analysis between the officially recorded numbers, both in the country and in the AN Region, where the second largest Brazilian automotive center in number of companies, the fourth in production capacity, and the sixth in the number of employees is located. With these data, it was possible to analyse the characteristics of occupational accidents, with the most frequent type of injury, the most affected body parts, the groups of causative agents, and the most notified occupations in accidents. The result was the identification of different behaviours of the curves, which showed the national scenario being more linear and constant, while the regional one proved to be unstable, with many variations over the years. To better understand the pointed-out differences, some hypotheses were raised with the objective of finding answers to the context identified in the AN region, such as the economic variability faced by Brazil. The underreporting of work accident data, insufficient inspection by the Ministry of Labour and Employment, and how the cultural origin of the organization can influence the management in health and safety and the safety culture itself.

The analysis of the accident rates and related indicators is important to help in the decision-making process and the development of internal policies for companies and external policies by the government. Because it allows the understanding of how companies act about the health and safety of their employees and which points need to be improved to promote decent work and the social and economic sustainability of the sector. To be efficient, it is necessary that the data be reliable and representative of what occurs in the organizations. For future work, an in-depth study of aspects of the culture and organizational climate of companies in the AN region is recommended, to understand their practices and perspectives on health and safety. On the other hand, to analyse the data on social security leaves and absenteeism from work and relate than to work accidents to identify their origins and understanding their behaviours.

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CONFLICTS OF INTEREST

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