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Article

Gender disparities in occupational morbidity: A study on the prevalence of carpal tunnel syndrome in ecuadorian workers

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Abstract: Introduction: The heterogeneity of occupational morbidity by gender in those suffering from carpal tunnel syndrome (CTS) has been little studied in the Latin American context. The objective of this study was to estimate the incidence and prevalence of CTS of occupational origin in the Ecuadorian salaried population according to gender, In addition, the differences in risk between women and men are compared. Methods: We use the only administrative registers of CTS qualified as occupational diseases in the country between the years 2017 and 2019. Period incidence rates were estimated to compare the risk in women versus men (*RR*, CI 95%) by age group and economic activity. Results: CTS is the second most common occupational disease in Ecuador. Women workers are more likely tosuffer from CTS and showed twice the risk compared to men [*RR* = 2.10 (95%CI: 1.94–2.11); $p = 0.000$]. This risk increases with age and for the vast majority of economic activities. The occupations of agriculture and warehousing stand out for their importance. Conclusions: The results shown in this study raise the fundamental need to improve epidemiological surveillance systems and occupational health policies by considering gender differences in order to adequately address risks and promote safe and healthy working environments for all.

Keywords: carpal tunnel syndrome; gender; occupational epidemiology; ecuador

1. Introduction

The hand/wrist is the body region of the upper extremities that most frequently suffers damage related to work activity, both due to injuries and diseases (Bensefa and Choudat, 2013). Among the most common occupational diseases is Carpal Tunnel Syndrome-CTS (Kao, 2003; Newington et al., 2015). CTS is considered the most frequent entrapment neuropathy caused by compression of the median nerve within the carpal tunnel in the working population (Atroshi et al., 1999). This occupational disease is a public and occupational health problem due to the significant human, social, and economic cost (Ibrahim, et al., 2012; Rempel et al., 1998).

The occupational etiology of CTS is multifactorial (Ashworth, 2010; Cranford et al., 2007) and clinically confirmed as an occupational disease if the causal relationship with the activity of the affected worker is demonstrated (Harris-Adamson et al., 2022; Lewczuk et al., 2002; Newington et al., 2015). Various epidemiological studies have confirmed the relationship between exposure to risk factors present in working conditions and CTS (Kozak et al., 2015; van Rijn et al., 2009).

Among the factors of biomechanical origin, it has been shown that manual tasks that require high duration and intensity of force and repetitive movements of the hands with hyperextension-hyperflexion of the wrist show a greater probability of

developing CTS (Barcenilla et al., 2012; Hassan et al., 2022). Likewise, CTS has been associated with prolonged use of the mouse and computer keyboards, particularly due to posture, repetition, and force on the wrist and thumb-index finger during use (Shiri and Falah-Hassani, 2015). Regarding physical risks, exposure to vibrations in tasks that demand hand strength in the use of mechanical tools (Vihlborg et al., 2022) and in conditions of extreme cold temperatures, have been considered as determining factors in the appearance of the STC (Altuntaş and Çankaya, 2020).

In the same way, although at first organizational and psychosocial factors had been related as the cause of this occupational disease (Harris-Adamson et al., 2013; Rigouin et al., 2014), their scientific evidence is currently limited (Mansfield et al., 2018; Roquelaure et al., 2020). However, it is true, that combined exposure together with ergonomic risk factors increases the probability of suffering CTS (Harris-Adamson et al., 2013).

In this sense, the previously mentioned occupational exposure factors tend to occur in certain occupational groups and in specific economic activities, for example, more among manual occupations in the industrial sector and among skilled occupations in the service sector (Harris-Adamson et al., 2022; Jackson et al., 2018). Similarly, it occurs more frequently in women, with a 3 times higher probability of suffering from it compared to men (Jenkins et al., 2013; Jackson et al., 2018; Möllestam et al., 2021). In this sense, the need arises to address such gender differences in occupational diseases to ensure safe and healthy working conditions in women due to the variation according to the industry and the geographical region.

The analysis of administrative records on occupational diseases provides valuable information for the formulation of public policies on safety and health at work. The cost of occupational diseases, such as carpal tunnel syndrome (CTS), includes not only direct medical expenses but also loss of productivity in the workplace, absenteeism, and costs associated with temporary replacement or of the affected workers and duly reported.

In addition, they also facilitate the design of campaigns to prevent and mitigate the risks present in working conditions. For example, the breakdown by gender makes it possible to assess differences to the extent that men and women in the same working population are susceptible to suffering from an occupational disease and, therefore, helps to prioritize specific actions in the most vulnerable groups. However, this task is not without difficulties. The main limitation lies in the availability and quality of the data (ILO, 2021). Latent reality in many countries of the world. However, existing registries, with their advantages and limitations, must be taken advantage of.

Recent studies have consistently highlighted the significant gender disparities in the prevalence of Carpal Tunnel Syndrome (CTS), particularly among female workers in various occupational sectors. For instance, Padua et al. (2016) demonstrated that women are disproportionately affected by CTS, especially in healthcare professions, where repetitive hand movements and non-neutral wrist postures are common. Similarly, research by Riccò and Signorelli (2017) found high incidences of CTS among women working in the meat processing industry in Northern Italy, linking the condition to repetitive manual tasks and poor ergonomic conditions. Furthermore, Mondelli et al. (2006) observed a greater prevalence of CTS among female manual laborers, particularly in the cleaning and maintenance sectors, emphasizing the role of

biomechanical stress in these populations. Despite these global findings, there is limited research on CTS in Latin American countries. However, studies such as García Gómez et al. (2017) provide valuable insight into gender disparities in occupational health within the region, revealing that women are more susceptible to work-related musculoskeletal disorders, including CTS. This gap in the literature, particularly in the context of Ecuador, highlights the need for further exploration into the occupational risks and gender differences associated with CTS, especially in under-researched regions like Latin America.

In the Republic of Ecuador, as in most countries, companies are required to notify suspected cases of possible illnesses related to work activity among affiliated workers and are protected by General Occupational Risk Insurance Office. In this way, once the cases are classified as occupational diseases according to diagnostic criteria, they are included in a publicly accessible statistical information system (https://www.iess.gob.ec/es/web/guest/visor-riesgos #), see 05/27/2023). However, the data visible on the web is outdated (data up to 2017) and does not show a breakdown by type of occupational disease. In March 2016, the list of occupational diseases was updated, the date from which CTS is included in the subgroup of diseases of the musculoskeletal system (IESS, 2016).

In our country, until now, the scientific literature on occupational diseases is scarce. Given the importance of this problem in occupational health, the objective of this study was to estimate the incidence and prevalence of CTS of occupational origin in the Ecuadorian salaried population according to gender. In addition, the differences in risk between women and men are compared.

This study makes a significant contribution to the literature on Carpal Tunnel Syndrome (CTS) by focusing on the working population of Ecuador, a Latin American country with few studies on this occupational disease (Kao, 2003; Newington et al., 2015). The research highlights gender differences in the incidence of CTS, as well as its relationship with age groups and specific economic sectors, allowing for comparisons with studies conducted in international contexts (Jenkins et al., 2013; Messing et al., 1998). This approach is crucial, as most of the literature on CTS comes from high-income countries, leaving a gap in knowledge about its prevalence in Latin America (Hassan et al., 2022). Furthermore, this study provides unique data that can be used to develop prevention strategies and labor policies aimed at addressing gender inequalities in the region.

2. Methodology

An observational and descriptive epidemiological study using CTS cases registered by the General Occupational Risk Insurance Office (SGRT). The Ecuadorian Observatory for Occupational Safety and Health (OESST) of the Espíritu Santo University (UEES) formally requested the microdata files from the General Occupational Risk Insurance Office. The (SGRT), belonging to the Ecuadorian Institute of Social Security (IESS), is the body in charge of qualifying and granting medical care and economic benefits to affiliated workers who have suffered damage to health due to, consequence of, or due to work activity.

It should be noted that only the processes of cases closed in the year of qualification were available, even though these were notified in previous years. Likewise, no information was available on those processes in the process of qualification. In addition, it was decided to discard two years because the number of cases was very low in relation to other years (2016 with 39 cases from April 1 to the end of the year and 2020 with 44 cases until December 24), a fact attributable to the update of the list of occupational diseases in 2016 (IESS, 2016) and the extraordinary year as a result of the COVID-19 pandemic. Therefore, this study corresponds to the period between 2017 and 2019.

The variables contained in the database were limited to gender, age and province. Age was recoded into groups (25–34, 35–44, 45–64 and 65+ years) according to the minimum (20 years) and maximum (66 years) age of the records and in accordance with international recommendations (ILO, 2015; ILO, 2021). Likewise, the database provided included information concerning the occupational category (International Standard Classification of Occupations, ISCO-08) and economic activity (International Standard Industrial Classification, ISIC-04) according to the country's classification.

For the purpose of this study, the prevalence of CTS (%n) by gender was calculated due to the concentration or overrepresentation of men compared to women (García Gómez et al., 2017; Messing et al., 2003). The means of age were compared by gender using the Student's t test ($p < 0.05$), after checking the distribution of normality.

In accordance with international recommendations (Carder et al., 2015; Takala et al., 2014), cumulative incidence rates per 100,000 were estimated and rate differences were compared using relative risk (*RR*; 95% CI), with men as the reference. The exposed population was made up of all salaried and self-employed workers with affiliation to social security. This information was retrieved from the Social Security Employment Statistical Registry (REESS: https://empleadoregistrado.ecudataanalytics.com) as it is the most up-to-date and reliable to date. The population figures for the study period did not show representative changes ($p = 0.969$) between 2017 (3.24 million) and 2019 (3.32 million). It was not possible to calculate the rates by occupational category due to incomplete information in the REESS.

For the management and analysis of the data, the statistical package SPSS from IBM® (version 25) and Excel from Microsoft® (version 16.69.1) for Mac were used. As these were anonymized records, the approval of a Review Committee was not required. Ethics. This study belongs to the research project "Working Conditions and Labor Accidents in Ecuador" of the OESST.

3. Results

The prevalence of CTS cases in relation to all qualified musculoskeletal system diseases during the study period was 21.3% (7.1% male workers and 36.8% female workers). A total of 499 cases were classified as CTS, an annual average of 166.3 ± 15.6 (95%CI: 165.9–166.8).

Both the prevalence and incidence of CTS increase with age in female workers, with the highest rates observed in those aged 35–44 (12,4 per 100,000) and 45–64 (18.0 per 100,000) (**Figure 1**).

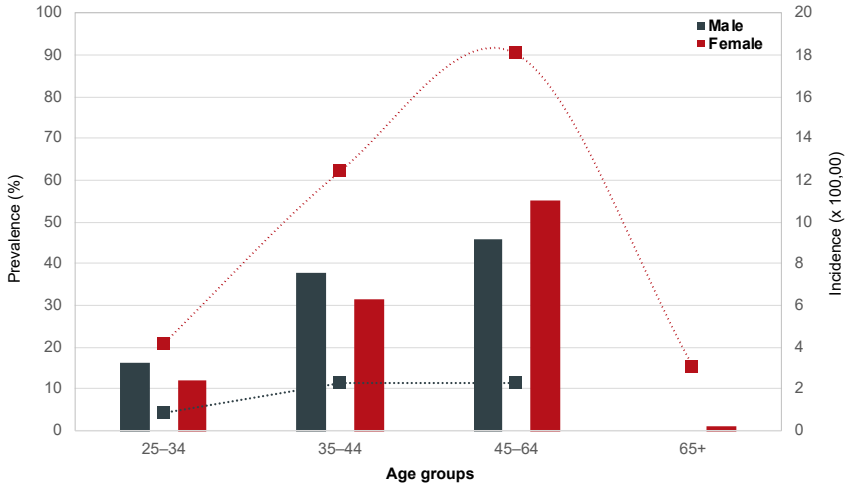

Figure 1. Prevalence of cases registered by the STC and Incidence by age group and gender, republic of ecuador (2017–2019).

The mean age of the affected workers was 46.1 ± 9.5 (95%CI: 45.3–47.0) years, with statistically significant differences by gender ($p = 0.023$): males 44 ± 8.8 (95%CI: 42.1–45.9) and females 46.6 ± 9.7 (95%CI: 45.6–47.5). Of the 24 provinces in the country, Pichincha (65.5%) recorded the highest concentration of cases, followed by Guayas province (10.8%). The remaining provinces report prevalences below 4%. No significant differences were observed by gender ($p = 0.438$).

There were gender differences in the distribution of STC cases by occupation and economic activity ($p = 0.003$ and $p = 0.001$ respectively). Professional and administrative workers (groups 2 and 3) and skilled manual trades (group 5) accumulated the largest number of cases (**Figure 2**). In relation to the prevalence by economic activities (**Figure 2**), STC cases fell mainly among workers in the services and commerce sectors, followed by industrial activities and agriculture. Women in the public administration (Section O) and manufacturing industries (Section C) stood out.

The estimated value of the global incidence rate for CTS during the study period was 5.06 cases per 100,000 affiliated workers: 10.24 in women and 1.49 in men. The economic activities that showed the highest incidence rates among male workers corresponded to Section Q (Activities, social and health services) with 4.16 cases per 100,000 affiliated workers and Section Q (Financial and insurance activities) with 4.12 cases per 100,000 affiliated workers.

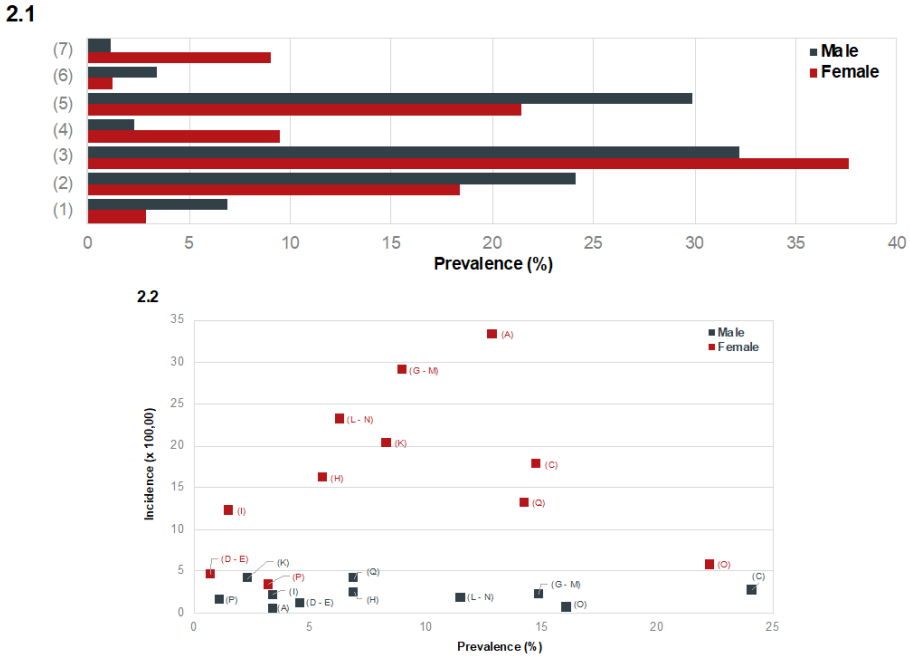

Figure 2. Prevalence (2.1) of cases registered by the STC and incidence (2.2) by occupation and economic activity according by gender, republic of ecuador (2017–2019).

On the contrary, among female workers the incidence rates exceeded 5 cases per 100,000 affiliated workers in most economic activities. The highest figures stand the Section A (Agriculture, livestock, forestry and fishing) with 33.41 cases and Sections G–M (Commerce and professional activities) with 29.12 cases and Sections L–N (Real estate and administrative services) with 23.15 cases.

Occupational categories (ISCO-8): (1) Directors and Managers, (2) Professionals and Mid-Level Technicians, (3) Administrative support staff, (4) Services and sellers of shops and markets, (5) Officials, operators and artisans, (6) Operators of facilities and machines, and (7) Elementary occupationsSections (ISIC–04): (A) Agriculture, livestock, hunting, forestry and fishing, (B) Exploitation of mines and quarries, (C) Manufacturing industries, (D–E) Electricity, gas...water and sewage, (F) Construction, (G–M) Commerce and professional activities, (H) Transportation and storage, (I) Accommodation and food service activities, (K) Financial and insurance activities, (L–N) Real estate and administrative services, (O) Public administration, (P) Teaching, and (Q) Activities, social and health services.

Notes: own calculations, based on the administrative records of General Occupational Risk Insurance Office (2017–2019). Not included in **Figure 2**, 1 STC case for the section U (Activities of extra-territorial organisations) and 8 cases without specification of the economic activity.

In general, female workers were more likely to develop CTS than male workers [*RR* = 2.10 (95%CI: 1.94–2.11); $p = 0.000$], with the risk increasing with age. Females aged 45-64 years had the highest risk compared with males in the same age group [*RR* = 2.05 (95% CI: 1.94–2.15); $p = 0.000$], **Figure 3**. Likewise, the *RR* for economic activities was higher and significant ($p < 0.05$) for female workers compared to male workers, except for section I ($p = 0.288$) and sections D–E ($p = 0.111$). The economic

activities with the highest risks were section A [*RR* = 3.92 (95%CI: 1.94–2.15)], section H [*RR* = 3.57 (95%CI: 2.92–4.26)], sections L–N [*RR* = 2.55(95%CI: 2.06–3.10)] and section C [*RR* = 2.43 (95%CI: 2.13–2.74)].

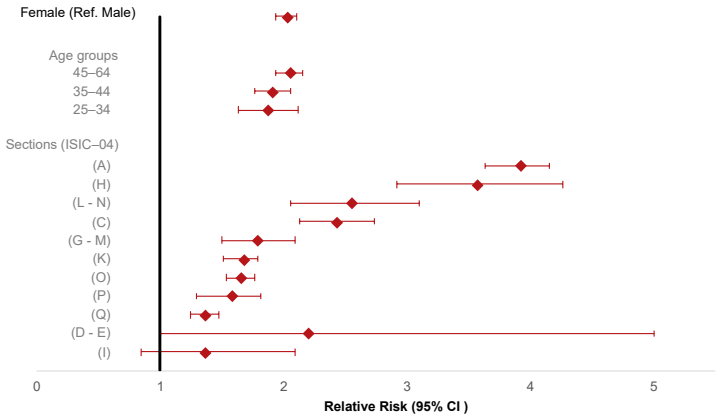

Figure 3. CTS risk of female workers compared to male workers by age groups and economic activities.

Sections (ISIC–04): (A) Agriculture, livestock, hunting, forestry and fishing, (B) Exploitation of mines and quarries, (C) Manufacturing industries, (D–E) Electricity, gas...water and sewage, (F) Construction, (G–M) Commerce and professional activities, (H) Transportation and storage, (I) Accommodation and food service activities, (K) Financial and insurance activities, (L–N) Real estate and administrative services, (O) Public administration, (P) Teaching, and (Q) Activities, social and health services.

4. Discussion and conclusions

This study, as far as we know, is the first to reveal the problem of CTS caused by work in the Ecuadorian population. The results place women workers in a vulnerable situation compared to men.

Our results are consistent with previous literature. It has been observed that this occupational disease is more frequent in women older than 45 years (Padua et al., 2016). Among the possible explanations, it could be due to the trinomial: exposure to biomechanical risk factors, natural history of this disease, and additional activities that women mostly perform and that are related to non-work tasks (Cadena et al., 2020). This situation of vulnerability requires special attention in those women at an early age that allows early detection, as well as in those cases with prolonged symptoms for the relocation of tasks that imply less use or effort of the hands.

On the other hand, women have a higher risk of CTS than men for most economic activities. This finding is consistent with previous studies conducted in other contexts. For example, the study carried out by McDiarmid et al. (2000), in which they only considered occupations whose most significant population is female and demonstrated the high risk of suffering CTS. It was also shown that, in other occupations where women are a minority, the risk of suffering from this disease continues to be higher in relation to men (Barnhart et al., 1991; Margolis and Kraus, 1987; Mondelli et al., 2006; Osorio et al., 1994; Riccò and Signorelli, 2017).

Other studies have also shown that even if a woman performs an occupation that does not belong to the group of high-risk occupations, the incidence of developing CTS is still significantly higher than in men, because women perform a much wider variety. of work and non-work activities (Messing et al., 1998).

Our findings align with previous studies that demonstrate a higher prevalence of Carpal Tunnel Syndrome (CTS) in women, particularly in sectors such as healthcare, manual labor, and manufacturing (Mondelli et al., 2006; Padua et al., 2016; Riccò and Signorelli, 2017). Similar to global trends, our results indicate that women in Ecuador are disproportionately affected by CTS, particularly in repetitive and physically demanding occupations. However, certain discrepancies exist when comparing our results to studies from high-income countries, particularly regarding the incidence rates and severity of CTS. For example, while Riccò and Signorelli (2017) observed high rates of CTS in industrial workers, our findings suggest lower incidence rates in Ecuador's manufacturing sector, which may be attributed to underreporting or the informal nature of many jobs in this sector.

These discrepancies may also be explained by contextual factors specific to Ecuador, such as the limited implementation of ergonomic interventions and restricted access to occupational health services, particularly in rural areas. Furthermore, cultural and socioeconomic factors, including the predominance of women in informal and lower-wage jobs, may contribute to the higher prevalence of CTS in women compared to men. Thus, while our findings are consistent with the broader literature on gender disparities in CTS, they also underscore the need for localized strategies and policies that account for the unique geographic and social context of Ecuador.

The study has limitations. In the first place, the database provided conditioned the length of the period and the performance of more exhaustive analyzes due to the absence of other variables that would have been of great value, for example, the days of incapacity for work. Therefore, it is essential to improve the quality of official statistics and continue with studies of trends and behavior of CTS with a view to designing more specific prevention strategies by economic activity or occupation. On a second point, we must recognize that the administrative records used are not fully exhaustive due to the underreporting of cases. In addition, it is probable that some of the reported cases were considered common diseases due to the absence of a complete occupational clinical history of the affected worker and that makes it impossible to establish causal relationships of CTS with past occupational exposure. In this sense, it is suggested that occupational physicians pay more attention to epidemiological monitoring to promote prevention and strengthen the quality of diagnosis of possible occupational diseases, such as CTS. Third, the denominator used to estimate incidence rates by economic activity could affect the results due to horizontal segregation by gender. The Ecuadorian female labor force is mainly concentrated in economic activities in the service sector, this information was retrieved from the Social Security Employment Statistical Registry (REESS).

The findings of this study not only confirm the high prevalence of CTS in female workers but also underscore the need for ergonomic interventions tailored to the sectors where women are most affected (McDiarmid et al., 2000; Riccò and Signorelli, 2017). Additionally, this research provides a solid empirical foundation for the formulation of public occupational health policies that include improvements in

workplace environments and specific strategies for preventing CTS (Roquelaure et al., 2018). Given that previous studies have shown women to be more vulnerable to this condition, especially in repetitive and manual labor activities (Mondelli et al., 2006; Padua et al., 2016), our results offer a novel perspective that can guide the development of more inclusive and effective policies to improve occupational health in the Latin American context.

Despite these limitations, this study could be considered one of the first in the country by providing an approximate image with a sufficient level of detail about the profile of CTS in the affiliated working population and, in turn, reveals the situation of vulnerability of women by presenting a greater risk of suffering from CTS compared to men, a situation similar to the commented scientific literature (Hassan et al., 2022).

The strategies aimed at preventing CTS in the workplace are different (Trillos et al., 2021). However, reducing repetition and hand/wrist force in manual tasks has proven to be the most effective action compared to other possible ergonomic intervention measures, such as active breaks or postural hygiene education for the hand/wrist. wrist (Roquelaure et al., 2018). We are aware that the industrialization of processes is not always possible, even more so in the case of Ecuador where ergonomic risks in manual occupations are still present for most economic activities.

In light of the findings, it is imperative to address the risk factors associated with Carpal Tunnel Syndrome (CTS) through the implementation of ergonomic prevention strategies, especially for women, who are disproportionately affected by repetitive and force-intensive tasks (Cullum and Molloy, 1994). Key measures include optimizing workplace ergonomics, such as adjusting the height of workstations, and encouraging regular breaks to reduce hand muscle strain. Additionally, exercises designed to improve blood circulation in the carpal tunnel can mitigate the risk of developing CTS (Berezutsky, 2018). These interventions not only enhance employee well-being but also contribute to a reduction in workplace injuries, absenteeism, and healthcare costs, while promoting productivity and sustainability in industries where repetitive physical tasks are common.

A systematic review by Trillos et al. (2021) identifies various ergonomic interventions to reduce occupational risks associated with Carpal Tunnel Syndrome (CTS); however, the conclusions suggest limited evidence regarding their overall effectiveness. While ergonomic interventions are widely recommended, their long-term effectiveness in preventing CTS remains inconclusive. For example, studies indicate that tools such as vertical mice and ergonomic mouse pads may alter wrist position but do not necessarily reduce pressure on the carpal tunnel (Schmid et al., 2014). Nevertheless, the use of appropriate tools and regular wrist breaks in the agricultural sector have shown promise in significantly reducing risk (Jirapongsuwan et al., 2023). Similarly, regular exercise programs for administrative workers engaged in office tasks have demonstrated improvements in forearm and wrist muscle strength (Łach and Cygańska, 2024). As a result, future research should focus on evaluating the impact of specific ergonomic measures on CTS incidence and severity, particularly in diverse workplace settings (Lincoln et al., 2000). Moreover, examining the cost-effectiveness of these interventions could provide valuable insights for organizations looking to implement ergonomic solutions tailored to individual worker needs and

preferences. A systematic, long-term evaluation is essential to establish more effective ergonomic interventions aimed at reducing CTS risks in women while ensuring they align with the specific demands of various industries.

In conclusion, it is necessary to develop additional research that allows a more explanatory capacity to understand in greater depth the interactions between working conditions and other specific risk factors among women.

Author Contributions: Conceptualization, MLVC; methodology, ARGG and MLVC; software, ARGG; validation, ARGG; formal analysis, MLVC; investigation, ARGG and MLVC; resources, ARGG; data curation, ARGG and MLVC; writing—original draft preparation, MLVC; writing—review and editing, MLVC; visualization, MLVC; supervision, MLVC; project administration, MLVC. All authors have read and agreed to the published version of the manuscript.

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