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Asthma and severe asthma diagnoses across professional groups: a retrospective study

Diagnóstico de asma e asma grave em diferentes grupos profissionais: um estudo retrospectivo

Abstract

Introduction: Occupational asthma and work-aggravated asthma are common but often underdiagnosed conditions affecting workers in high-risk industries. **Objective:** To evaluate the prevalence of severe asthma among individuals diagnosed at a peripheral hospital's Pulmonology Service, with particular attention to the documentation of occupational exposures in their clinical records. **Methods:** This retrospective study included 431 individuals diagnosed with asthma at a Pulmonology Service in Alto Ave, Portugal. Data were collected through detailed reviews of electronic medical records. Data collected included occupational history, age of asthma onset, and need for biological treatment. Occupational exposures were categorized based on occupational groups, reflecting the main professional activities and industries in which workers were employed. **Results:** Among the 431 individuals diagnosed with asthma, 309 (72%) were female, and 65 (15%) met the criteria for severe asthma (GINA Step 5). The highest prevalence of severe asthma was in the textile industry (40%), followed by construction and footwear. Among individuals with severe asthma, 15.4% lacked documented occupational exposure assessments, and only 1 of 36 adult-onset cases underwent serial Peak Expiratory Flow (PEF) testing. **Conclusion:** These findings highlight the need for standardized protocols for diagnosing occupational asthma, particularly in severe adult-onset cases, to improve management and reduce healthcare costs.

Keywords: Asthma, Occupational; Severe Asthma; Occupational Exposure; Occupational Health.

Resumo

Introdução: A asma ocupacional e a asma agravada pelo trabalho são entidades clínicas frequentes, mas geralmente subdiagnosticadas, com impacto importante na saúde dos trabalhadores, sobretudo em contextos laborais de alto risco. **Objetivo:** Descrever a prevalência de asma grave entre usuários do Serviço de Pneumologia da Unidade Local de Saúde do Alto Ave, Portugal, com enfoque na caracterização das exposições ocupacionais informadas nos registros clínicos. **Métodos:** Foi realizado estudo retrospectivo descritivo com dados sobre histórico ocupacional, idade de início da asma e necessidade de terapêutica biológica. As exposições ocupacionais foram agrupadas segundo categorias profissionais, representativas dos principais setores de atividade dos trabalhadores. **Resultados:** Foram incluídos 431 indivíduos diagnosticados com asma, dos quais 65 apresentavam critérios para asma grave (GINA Step 5). A indústria têxtil foi o setor mais representado (26/65), seguida pela indústria do calçado. Em 15,4% dos casos de asma grave não foi realizada avaliação da exposição ocupacional. **Conclusão:** Os resultados reforçam a importância de implementar protocolos clínicos padronizados para rastreio e diagnóstico de asma ocupacional, sobretudo em casos graves ou com início na idade adulta, nos quais a suspeição etiológica é crucial para uma intervenção precoce.

Palavras-chave: Asma Ocupacional; Asma Grave; Exposição Ocupacional; Saúde do Trabalhador.

Introduction

Asthma is a pulmonary condition marked by airway inflammation and narrowing, with occupational asthma being a significant subtype¹. According to the American Lung Association, asthma is the most prevalent work-related pulmonary pathology², with the National Institute for Occupational Safety and Health estimating that over 2 million individuals may be affected by occupational asthma³. Epidemiological studies indicate that 16% of cases of adult-onset asthma are attributable to occupational exposures^{4,5}.

Occupational asthma (OA) and work-aggravated asthma (WAA) are two asthma subtypes linked to workplace exposure but differ in pathophysiology and onset. While OA arises from exposure to sensitizers or irritants in the workplace (with sensitizing agent-induced asthma, resulting from sensitization to a substance; and irritant-induced asthma, also known as reactive airway dysfunction syndrome (RADS), caused by single or repeated exposure to high concentrations of an irritant), WAA exacerbates preexisting asthma without being its primary cause^{6,7}. These differences are crucial for management, as OA often requires complete removal from exposure, whereas WAA focuses on mitigating workplace triggers⁸.

In addition to the comprehensive overview provided, it is crucial to emphasize the significance of evaluating occupational causes in cases of severe asthma, as classified by step 5 of the Global Initiative for Asthma (GINA) guidelines¹. Many individuals with severe asthma may have underlying occupational factors exacerbating their condition, which could potentially be managed through other measures like removing the worker from the hazardous workplace environment and relocating them to a position where there is no longer exposure, before considering advancing to therapeutic interventions such as biological treatments. OA can negatively impact the quality of life, employment opportunities, and financial stability. A national study conducted in the United States on adults with asthma found that individuals with work-related asthma experienced poorer health-related quality of life, with a higher likelihood of physical and mental challenges as well as activity restrictions⁹.

Despite the availability of diagnostic tools, there remains a significant gap in the identification of OA, especially among individuals exposed to sensitizing agents over prolonged periods¹⁰. This discrepancy is partly due to the general focus on treating asthma symptoms without exploring the occupational causes. A study in Ontario showed that the average time to the medical diagnosis of OA among workers was 2 to 3 years after the onset of symptoms, highlighting the delays in recognizing and addressing occupational factors¹¹. The issue is further exacerbated by the lack of standardized screening protocols in clinical settings, leading to both missed diagnoses and underreporting of cases. As a result, many individuals continue working in environments that aggravate their condition, contributing to chronic inflammation and worsening of asthma control. Furthermore, underdiagnosis of OA can also have a negative economic impact, both on healthcare systems and employers. Follow-up studies on cases of OA have documented prolonged unemployment rates varying between 14% and 69%, along with income losses ranging from 44% to 72%¹².

OA continues to present a significant burden in high-risk industries, not only due to its direct health impacts but also because of the preventable nature of many contributing factors. Effective workplace interventions are not universally adopted, despite evidence supporting their ability to reduce exposure to sensitizing agents and improve health outcomes. These interventions include engineering controls to improve ventilation, safer chemical substitutions, and better enforcement of protective measures. However, the variability in implementation across industries highlights the need for standardized policies and tailored approaches to effectively mitigate risks.

Given these challenges, this study focuses on identifying the most common industrial sectors in which workers present with severe asthma. The study also examined the proportion of individuals whose occupational history was assessed and recorded, highlighting gaps in clinical practice that may contribute to delays in recognizing and managing OA.

These insights aim to enhance diagnostic accuracy, optimize management strategies, and reduce the socioeconomic burden of OA.

Methods

Study Design

This study adopts a retrospective design, analyzing clinical data from individuals diagnosed with asthma by the Pulmonology Service at the Local Health Unit of Alto Ave, Portugal, during the period 2023–2024.

Participants

The inclusion criteria focused on individuals with a confirmed diagnosis of severe asthma, as defined by the following GINA criteria¹:

1. **High-dose ICS/LABA:** Individuals requiring high doses of inhaled corticosteroids combined with long-acting beta-agonists or other controllers to maintain asthma control.
2. **Uncontrolled asthma:** Persistent symptoms despite treatment, including frequent activity limitations or nighttime awakenings.
3. **Frequent exacerbations:** Two or more asthma exacerbations requiring systemic corticosteroids, emergency department visits, or hospitalizations in the previous year.
4. **Need for biologic therapies:** Individuals requiring biologic treatments for disease control.

Individuals with incomplete medical records were excluded.

Study Size

The initial sample included 450 individuals diagnosed with asthma and treated at the Local Health Unit of Alto Ave.

Data Collection

Data were collected through detailed reviews of electronic medical records using the SClínico platform, an integrated electronic medical records system widely used in Portugal to manage patient health data.

Occupational Data Analysis

Further data analysis was carried out to identify the potential occupational patterns associated with OA. This included a sector-by-sector analysis to pinpoint industries where workers were more likely to develop or exacerbate asthma. The results aimed to provide a comprehensive occupational risk profile that could inform future interventions and prevention strategies.

The grouping of professionals' occupations for this study was based on the nature and environment of the tasks and the industry to which each profession belongs, with the aim of facilitating a clearer interpretation of the results regarding OA. Occupations were categorized into broad sectors, including:

- **Operational Assistants:** Roles such as hospital and care home assistants.
- **Domestic Workers:** Occupations involved in domestic cleaning and laundry.
- **Agriculture and Livestock:** Occupations involved in farming, as well as occupations requiring animal handling, such as veterinarians and livestock handlers.
- **Construction:** Trades such as masonry, carpentry, and plumbing.
- **Textile Work:** Roles like seamstresses and textile manufacturing.
- **Food Industry:** Occupations such as cooks, bakers, and restaurant staff.
- **Additional categories included:** Drivers, Footwear and Related Industries, Technicians, Beauty and Esthetics, Sales and Retail, Warehouse Workers, and Other Factory Workers.

Each grouping was designed to reflect common occupational exposures that could contribute to the development of OA, facilitating targeted analysis and interpretation of the results.

Occupations that were not considered high-risk for the development of OA—such as models, electricians, equestrian instructors, unemployed individuals, retirees, police officers, psychomotor therapists, students, teachers, shopkeepers, and administrative technicians—were grouped under the “others” category. This decision was made to maintain the clarity and conciseness of the results, as the inclusion of low-frequency, non-high-risk occupations individually would have resulted in an overly detailed and less interpretable analysis. This classification allowed for a focused examination of occupations most relevant to the development of OA.

Development of an Action Protocol

After identifying the industries with the highest risk of the development of severe OA, an action protocol was developed to streamline the diagnosis and management of these individuals. This protocol, which aims to facilitate early identification and improve clinical outcomes, is detailed in **Figure 1**.

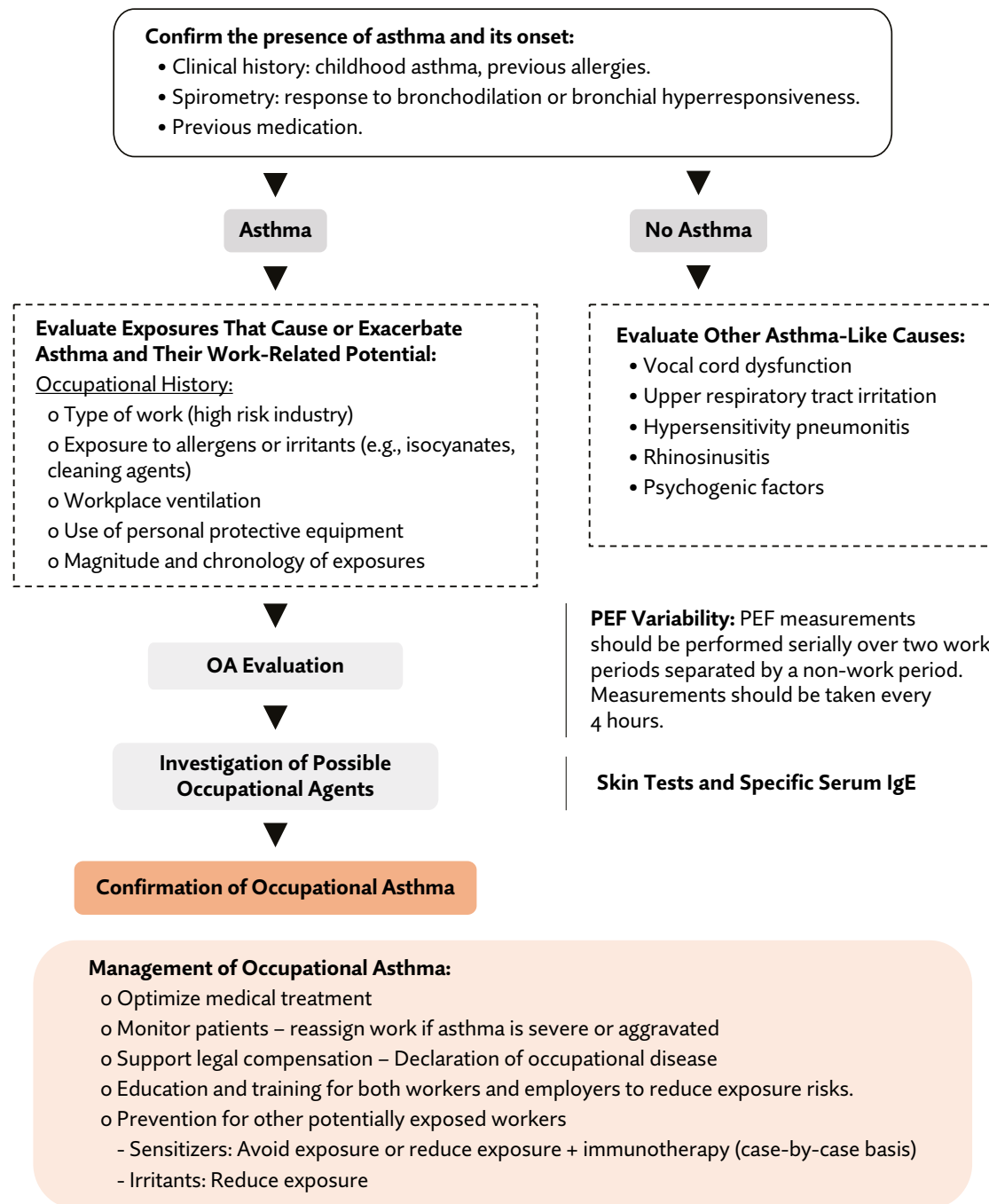


Figure 1 Flowchart for the Diagnosis and Management of Occupational Asthma (OA)

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics® software, version 29. Statistical significance was set at 5%. Sample characterization was carried out through simple descriptive analysis of the study variables, using the mean (M), standard deviation (SD), median (Mdn), and interquartile range (IQR) for continuous variables, or absolute frequencies (n) and percentages (%) for categorical variables¹³. The normality of the data was assessed using the Shapiro-Wilk test, skewness and kurtosis measures, as well as histogram analysis^{14,15}.

Ethical Considerations

This study was conducted in compliance with the principles of the Declaration of Helsinki. Ethical approval was waived by the local ethics committee in view of the retrospective nature of the study. Patient data were anonymized to ensure confidentiality.

Results

Among the 450 individuals diagnosed with asthma in the Local Health Unit of Alto Ave, 19 were excluded due to incomplete clinical data, which precluded a comprehensive analysis of their diagnostic and occupational history. **Figure 2** illustrates the distribution of asthma diagnoses across various professional groups, highlighting the frequency of cases within each industry sector.

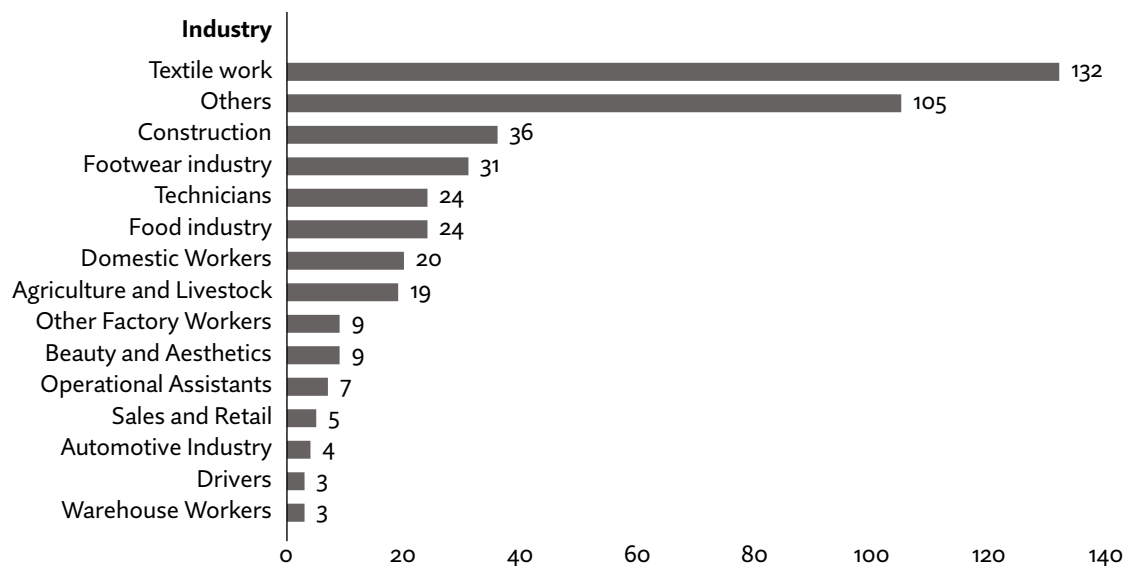


Figure 2 Frequency of occupations associated with asthma among individuals diagnosed by the Pulmonology Service at the Local Health Unit of Alto Ave, Portugal, 2023–2024 (n = 431)

As depicted in **Figure 2**, the highest frequency was observed in the “textile industry”, accounting for over 30% (n = 132) of the cases, followed by “construction” (n = 36, 8.35%), “footwear and related industries” (n = 31, 7.19%), and the “food industry” (n = 24, 5.57%). These findings suggest that industries with exposure to dust, chemicals, and particulates are particularly prone to higher asthma incidence and underscore the need for targeted preventive measures in these industries.

Table 1 Demographic and Clinical Characteristics of individuals with Asthma Treated at the Local Health Unit of Alto Ave, Portugal, 2023–2024 (n = 431)

Variable	n	%	Mean (SD)	Range
Age (years)	-	-	59.99 (17.02)	19-93
Sex				
Male	122	28.3	-	-
Female	309	71.7	-	-

Continue

Continuation				
Childhood Asthma				
Yes	161	37.4	-	-
No	270	62.6	-	-
Biological Treatment				
Yes	22	5.1	-	-
No	406	94.2	-	-
Considering	3	0.3	-	-

Table 1 presents the demographic and clinical characteristics of the 431 individuals diagnosed with asthma and treated at the Local Health Unit of Alto Ave between 2023 and 2024. The mean age was 59.99 years (SD $\pm$ 17.02), with ages ranging from 19 to 93 years. The majority of the individuals were female (71.7%), while males accounted for 28.3% of the sample. A history of childhood asthma was reported by 37.4%, whereas 62.6% did not report this condition. Regarding biological treatment, 5.1% of the individuals were receiving such treatment, while 94.2% were not. An additional 0.3% were considering initiating biological therapy.

From the total sample, 65 individuals were identified with severe asthma, as detailed in **Table 2**. **Table 2** provides a demographic and clinical characterization of the study sample, highlighting key variables such as age, sex, and biological treatment status.

Table 2 Demographic and Clinical Characteristics of individuals with Severe Asthma Treated at the Local Health Unit of Alto Ave, Portugal, 2023–2024 (n = 65)

Variable	n	%	Mean (SD)	Range
Age (years)	-	-	58.94(12.32)	31-82
Sex				
Male	14	21.5	-	-
Female	51	78.5	-	-
Childhood Asthma				
Yes	29	44.6	-	-
No	36	55.4	-	-
Biological Treatment				
Yes	21	32.3	-	-
No	41	63.1	-	-
Considering	3	4.6	-	-

This subgroup had a mean age of 58.94 years (SD: 12.32), of which 51 were female (51/65). Childhood asthma was reported in 29 of these cases, while the remaining 36 developed asthma in adulthood. Among individuals with severe asthma, 21 were undergoing biological therapy, while 3 were being considered for such treatment.

Table 3 further explores the occupational context of these individuals. The textile industry remained the most prevalent, accounting for 26/65 cases, followed by the footwear industry with 5 individuals.

Table 3 Prevalence of Severe Asthma by Occupation among individuals with Severe Asthma Treated at the Local Health Unit of Alto Ave, Portugal, 2023–2024 (n = 65)

Profession	n
Textile Industry	26
Footwear Industry	5
Not Explored	10
Others	24
Total	65

Notably, in 15.4% of the cases, occupational exposure as a potential etiological factor for severe asthma was not investigated. This gap was also evident among individuals undergoing biological therapy, where 2 cases lacked any assessment of work-related factors.

Among the 36 individuals who developed asthma in adulthood, only one had serial peak expiratory flow (PEF) testing conducted to investigate OA. The limited use of serial PEF testing indicates a critical gap in the diagnostic evaluation of OA, which may lead to underdiagnosis and suboptimal management.

Discussion

The findings of this study partially align with the existing literature that identifies certain high-risk industries, such as the textile and footwear sectors, as being associated with the development of asthma in adulthood.

In the textile industry, occupational exposure to agents like cotton dust and textile dyes has been well-documented as a potential cause of OA^{16,17}. Similarly, the footwear industry presents significant risks due to the use of isocyanates in adhesives, which are known sensitizers capable of triggering asthma even at low exposure levels¹⁸. In addition, the processes involved in footwear production, such as glueing and drying, often release chemical vapors, including volatile organic compounds, contributing to prolonged respiratory exposure¹⁹.

However, this study did not observe a similar prevalence of severe asthma among workers in cleaning occupations, despite cleaning being a well-established high-risk profession for the development of OA. A study by Mwanga et al. highlighted cleaning occupations, both domestic and industrial, as major contributors to OA due to frequent exposure to cleaning agents, disinfectants, and aerosols, which can act as both irritants and sensitizers²⁰. The lack of a noticeable higher asthma prevalence in cleaning workers within this study’s sample may be attributed to several factors, including potential underrepresentation of this occupational group among cases of severe asthma or variability in the levels and types of exposures encountered.

This divergence underscores the complexity of identifying occupational risk factors in different industries and highlights the need for further research to elucidate the mechanisms and circumstances under which specific occupational exposures lead to asthma.

Another key observation is the sector-specific frequency of severe asthma, with predominance of the textile industry. This finding emphasizes the need for targeted interventions in high-risk industries, where preventive strategies such as improved workplace ventilation, substitution of hazardous substances, personal protective equipment (PPE), and regular health monitoring can significantly reduce exposure-related risks²¹. For instance,

a study by Baur et al.⁵ reported that improved workplace ventilation and the substitution of harmful substances reduced asthma exacerbations by up to 50%. Similarly, Nicholson et al.²² demonstrated that the use of PPE significantly decreased the frequency of asthma-related symptoms among exposed workers. In addition, there is evidence that highlights a link between a prior history of atopy and the development of OA in these high-risk industries. Identifying such individual risk factors before employment and recognizing early atopy can enhance medical surveillance for exposed workers. This proactive approach can also minimize the latency between the onset of respiratory symptoms and the diagnosis of OA, thereby contributing to better disease management and reduced underdiagnosis²³.

Evidence from systematic reviews demonstrates that workplace interventions, such as removal from exposure or reduction of exposure, can lead to improved symptoms and enhanced lung function in patients with OA. However, the review also highlighted an increased risk of unemployment following removal from exposure, emphasizing the need to balance health benefits with socioeconomic implications²⁴.

In this study, occupational exposure was not evaluated in 15.4% of severe asthma cases, which reflects a critical gap in clinical practice. This highlights systemic barriers in the collection and evaluation of occupational histories, which are essential for identifying links between workplace exposures and asthma symptoms. As noted in the literature, large gaps in asthma care, management, and diagnosis are often attributed to the failure of physicians to take accurate or detailed workplace histories²⁵. Studies reveal that only a small proportion of individuals presenting with asthma symptoms are asked about their employment or workplace exposures, a shortcoming often attributed to the limited time available during consultations²⁶.

Tiotiu et al. highlighted that another contributing factor is that individuals may not always recognize the connection between their symptoms and their occupational environment²⁷. The typical presentation of OA involves symptom onset or worsening at work and improvement outside the workplace. However, asthma symptoms may also occur outside work as late asthmatic reactions or be triggered by non-specific stimuli like cold air, fumes, or exercise. Additionally, the remission of symptoms during evenings or weekends tends to disappear with continued exposure to the sensitizing agent, which can then delay diagnosis.

The diagnostic gap observed in this study is further compounded by the limited awareness of OA among healthcare providers. This lack of knowledge leads to underdiagnosis, missed opportunities for early intervention, and suboptimal management. Insufficient collaboration between pulmonologists and occupational health specialists exacerbates the issue, delaying accurate diagnosis and tailored treatment²⁸.

To address these systemic issues, it is vital to incorporate structured protocols into routine clinical practice, emphasizing detailed occupational histories during patient evaluations. Clinics with occupational health specialists have demonstrated better outcomes, including reduced workplace-related anxiety, fewer mood disturbances, and improved collaboration between workers and employers²⁵. Additionally, increasing education and awareness among healthcare providers regarding the relevance of occupational factors in asthma and allocating sufficient time for comprehensive assessments could significantly bridge this gap and improve care for patients with OA.

Notably, among the 36 patients who developed asthma in adulthood, only one underwent serial PEF testing to investigate OA. This underdiagnosis is consistent with findings in the literature. A study by Ellis PR et al highlighted that OA is often under-recognized, leading to missed opportunities for early intervention and management²⁹. The low utilization of serial PEF monitoring in our study is concerning, given its established role in diagnosing OA. Moore et al. conducted a systematic review demonstrating that serial PEF measurements reported a pooled sensitivity and specificity of 82% and 88%, respectively³⁰.

To address the diagnostic and management gaps in severe asthma, implementing standardized occupational history assessments is critical. The British Thoracic Society recommends that a thorough occupational history be an integral part of the evaluation for all asthma patients, particularly those with severe asthma, to identify workplace exposures that may contribute to the condition³¹.

The implementation of these types of protocols facilitates the early recognition of OA, allowing for the early identification of occupational triggers and targeted interventions that mitigate symptoms and prevent further disease progression³². By integrating these protocols into routine clinical practice, healthcare systems can ensure that occupational exposures are adequately considered in both diagnosis and management. Furthermore, a multidisciplinary approach is essential for the effective management of severe asthma.

This study highlights the need for continued vigilance in high-risk industries and improved research methodologies to clarify the link between occupational exposures and asthma severity. Future studies should focus on large-scale assessments to better define these associations.

Limitations

This study has several limitations. First, it relied on data from medical records, which were sometimes incomplete or inconsistent.

The sample size for severe asthma cases was relatively small, which could limit the ability to generalize the findings. The study also focused on a single health unit in Portugal, so the results may not apply to other regions with different occupational exposures or healthcare systems.

Another limitation is that this study did not account for other factors influencing asthma severity, such as smoking, coexisting medical conditions, or environmental exposures outside the workplace. These omissions may lead to biased conclusions regarding the role of occupational factors.

Additionally, although this study suggests a possible link between occupational exposure and asthma severity, a definitive diagnosis of OA could not be established because serial PEF monitoring or specific bronchial challenge tests were not systematically performed. This highlights the need for further investigation.

Despite these limitations, the study provides important insights into the role of occupational factors in severe asthma and highlights areas for improvement in diagnosis and management.

Conclusion

This study underscores the critical role of occupational factors in the development and management of asthma, particularly in high-risk industries such as textiles and footwear. Despite the established link between workplace exposures and asthma, the findings reveal significant gaps in the diagnostic evaluation of OA, especially in severe cases. The underutilization of diagnostic tools, such as serial PEF monitoring, and the lack of thorough occupational history assessments highlight systemic shortcomings that impede timely diagnosis and effective management.

Patients with severe asthma, who often require expensive biological therapies, may benefit from targeted interventions addressing workplace exposures. Evidence from the literature supports the implementation of workplace modifications, such as exposure reduction or removal, as effective strategies for improving clinical outcomes. However, these interventions must be carefully balanced with the socioeconomic implications for the affected individuals.

The study also emphasizes the importance of standardized occupational history assessments and the integration of multidisciplinary approaches involving pulmonologists, occupational health specialists, and workplace safety experts. These strategies are essential for addressing the diagnostic and management challenges posed by OA. Furthermore, the development of screening protocols tailored to severe asthma cases could enhance the early identification of occupational triggers, leading to improved patient outcomes and reduced healthcare costs.

Future research should focus on larger, more diverse populations to explore the complex associations between specific occupational exposures and asthma severity.

References

1. Global Initiative for Asthma. Global strategy for asthma management and prevention: 2024 update. GINA; 2024 [cited 2024 Dec 26]. Available from: www.ginasthma.org
2. American Lung Association. Asthma in the workplace. 2008 [cited 2024 Dec 26]. Available from: <https://www.lung.org/lung-health-diseases/lung-disease-lookup/asthma/managing-asthma/workplace>.
3. National Institute for Occupational Safety and Health. Occupational respiratory diseases. 2012 [cited 2024 Dec 26]. Available from: <https://www.cdc.gov/niosh>
4. Kogevinas M, Zock JP, Jarvis D, Kromhout H, Lillienberg L, Plana E, et al. Exposure to substances in the workplace and new-onset asthma: an international prospective population-based study (ECRHS-II). *Lancet* (London, England), 370(9584), 336–341. [https://doi.org/10.1016/S0140-6736\(07\)61164-7](https://doi.org/10.1016/S0140-6736(07)61164-7).
5. Baur X, Sigsgaard T, Aasen TB, Burge PS, Heederik D, Henneberger P, et al. Guidelines for the management of work-related asthma. *Eur Respir J*. 2012;39(3):529–545. <https://doi.org/10.1183/09031936.00096111>
6. Canadian Centre for Occupational Health and Safety. Work-related asthma. 2018 [cited 2024 Dec 26]. Available from: <https://www.ccohs.ca/oshanswers/diseases/asthma.html>
7. Mapp CE, Boschetto P, Maestrelli P, Fabbri LM. Occupational asthma. *Am J Respir Crit Care Med*. 2005;172(3):280–5. <https://doi.org/10.1164/rccm.200311-1575SO>
8. Harber P, Redlich CA, Henneberger PK. Work-exacerbated asthma. *Am J Respir Crit Care Med*. 2018;197(2): 1–2. <https://doi.org/10.1164/rccm.1972P1>
9. Knoeller GE, Mazurek JM, Moorman JE. Health-related quality of life among adults with work-related asthma in the United States. *Qual Life Res*. 2013 May;22(4):771–80. <https://doi.org/10.1007/s11136-012-0206-7>
10. Lau A, Tarlo SM. Update on the management of occupational asthma and work-exacerbated asthma. *Allergy Asthma Immunol Res*. 2019;11(2):188–200. <https://doi.org/10.4168/aair.2019.11.2.188>
11. Santos MS, Jung H, Peyrovi J, Lou W, Liss GM, Tarlo SM. Occupational asthma and work-exacerbated asthma: Factors associated with time to diagnostic steps. *Chest*. 2007;131(6):1768–77. <https://doi.org/10.1378/chest.06-2487>
12. Vandenplas O. Socioeconomic impact of work-related asthma. *Expert Rev Pharmacoecon Outcomes Res*. 2008;8(4):395–400. <https://doi.org/10.1586/14737167.8.4.395>
13. Hanusz Z, Tarasińska J. Normalization of the Kolmogorov–Smirnov and Shapiro–Wilk tests of normality. *Biometr Lett*. 2015;52(2):85–93. <https://doi.org/10.1515/bile-2015-0008>
14. Mohd Razali N, Wah YB. Power comparisons of Shapiro–Wilk, Kolmogorov–Smirnov, Lilliefors, and Anderson–Darling tests. *J Stat Model Anal*. 2012;2(1):102–77.
15. Chan YH. Biostatistics 102: quantitative data: parametric & non-parametric tests. *Singapore Med J*. 2003;44(8):391–6.
16. International Labour Organization. Respiratory effects and other disease patterns in the textile industry. 2011 Mar 30 [cited 2024 Dec 26]. Available from: <https://www.iloencyclopaedia.org/part-xiv-42166/textile-goods-industry/item/891-respiratory-effects-and-other-disease-patterns-in-the-textile-industry>
17. Chaari N, Amri C, Allagui I, Bouzgarrou L, Henchi MA, Bchir N, et al. Work-related asthma in the textile industry. *Recent Pat Inflamm Allergy Drug Discov*. 2011 Jan;5(1):37–44. <https://doi.org/10.2174/187221311794474838>
18. Coureau E, Fontana L, Lamouroux C, Pélissier C, Charbotel B. Is isocyanate exposure and occupational asthma still a major occupational health concern? Systematic literature review. *Int J Environ Res Public Health*. 2021;18(24):13181. <https://doi.org/10.3390/ijerph182413181>
19. European Agency for Safety and Health at Work. Preventing chemical risks in the manufacture of shoes. Bilbao: European Agency for Safety and Health at Work; 2015, [cited 2024 Dec 26]. Available from: <https://osha.europa.eu/en/themes/dangerous-substances/practical-tools-dangerous-substances/preventing>
20. Mwanga HH, Dumas O, Miguères N, Le Moual N, Jeebhay MF. Airway diseases related to the use of cleaning agents in occupational settings. *J Allergy Clin Immunol Pract*. 2024 Aug;12(8):1974–86. <https://doi.org/10.1016/j.jaip.2024.02.036>
21. Tarlo SM, Lemiere C. Occupational asthma. *N Engl J Med*. 2014;370(7):640–9. <https://doi.org/10.1056/NEJMra1301758>
22. Nicholson PJ, Cullinan P, Newman Taylor AJ, Burge PS, Boyle C. Evidence-based guidelines for the prevention, identification, and management of occupational asthma. *Occup Environ Med*. 2005 May;62(5):290–9. <https://doi.org/10.1136/oem.2004.016287>

23. Rui F, Otelea MR, Fell AKM, Stoleski S, Mijakoski D, Holm M, et al. Occupational asthma: The knowledge needs for a better management. *Ann Work Expo Health*. 2022 Mar;66(3):287-90. <https://doi.org/10.1093/annweh/wxab113>
24. Henneberger PK, Patel JR, Groene GJ, Beach J, Tarlo SM, Pal TM, et al. Workplace interventions for treatment of occupational asthma. *Cochrane Database Syst Rev*. 2019 Oct;(10):CD006308. <https://doi.org/10.1002/14651858.CD006308.pub4>
25. MacKinnon M, To T, Ramsey C, Lemi re C, Loughheed MD. Improving detection of work-related asthma: a review of gaps in awareness, reporting and knowledge translation. *Allergy Asthma Clin Immunol*. 2020;16:73. <https://doi.org/10.1186/s13223-020-00470-w>
26. Parhar A, Lemiere C, Beach JR. Barriers to the recognition and reporting of occupational asthma by Canadian pulmonologists. *Can Respir J*. 2011 Mar-Apr;18(2):90-6. <https://doi.org/10.1155/2011/754726>
27. Tiotiu AI, Novakova S, Labor M, Emelyanov A, Mihaicuta S, Novakova P, Nedeva D. Progress in occupational asthma. *Int J Environ Res Public Health*. 2020 Jun;17(12):4553. <https://doi.org/10.3390/ijerph17124553>
28. Walters GI, Fishwick D. Barriers to collaboration between pulmonologists and occupational health specialists in the diagnosis of occupational asthma. *BMJ Open Respir Res*. 2021;8(1):e000938. <https://doi.org/10.1136/bmjresp-2021-000938>
29. Ellis PR, Walters GI. Missed opportunities to identify occupational asthma in acute secondary care. *Occup Med*. 2018;68(1):56-9. <https://doi.org/10.1093/occmed/kqx167>
30. Moore VC, Jaakkola MS, Burge PS. A systematic review of serial peak expiratory flow measurements in the diagnosis of occupational asthma. *European Respiratory Journal*, 38, 4941. 2011 [cited 2024 Dec 26]. Available from: https://occupationalasthma.com/fulltexts/A_Systematic_Review_of_Serial_Peak_Expiratory_Flow_Measurements_in_the_Diagnosis_of_Occupational_Asthma.pdf
31. Barber CM, Cullinan P, Feary J, Fishwick D, Hoyle J, Mainman H, Walters GI. British Thoracic Society Clinical Statement on occupational asthma. *Thorax*. 2022 May;77(5):433-442. doi:10.1136/thoraxjnl-2021-218597. Epub 2022 Mar 21. PMID: 35314486.
32. Kongsupon N, Walters GI, Adab P, Jordan RE. Screening tools for work-related asthma and their diagnostic accuracy: a systematic review protocol. *BMJ Open*. 2022 Sep 23;12(9):e058054. doi: 10.1136/bmjopen-2021-058054. PMID: 36153029; PMCID: PMC9511564.

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