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Emissions of volatile organic compounds in the context of respiratory diseases: scoping review[1]

Emissões de compostos orgânicos voláteis no contexto das doenças respiratórias: revisão de escopo

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ABSTRACT
Volatile organic compounds are characterized by being highly toxic chemical substances with rapid evaporation when in contact with the atmosphere. They are found in a wide variety of products, including fossil fuels causing respiratory diseases. Therefore, this study aims to describe the emissions of volatile organic compounds in the context of respiratory diseases. This is a scope review protocol that follows the guidelines of the Joanna Briggs Institute (JBI) and has as inclusion criteria: national and international articles from the last five years researched using the search equation [Health Monitoring AND Volatile Organic Compounds AND Respiratory Disease], complete and freely available in Lilacs databases via VHL, Medline and Gray Literature source – Google Scholar, without date or language limits. Your search strategy will be used for extracting, converting, combining, building and using - ECCCU. It will follow the PCC acronym, with P(problem) = Health Monitoring, C(concept) = Volatile Organic Compounds, and C(context) = Respiratory Disease. Data will be evaluated by two reviewers and, in case of discrepancy, by a third reviewer. The results will be presented in tables and graphs, with comparative frequency analyzes that will explain the information extracted, in addition to having a critical discussion.

Keywords: Monitoring. Volatile organic compounds. Respiratory disease.

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RESUMO

Os compostos orgânicos voláteis (COV) são caracterizados por serem substâncias químicas de alto teor tóxico com evaporação rápida quando em contato com a atmosfera. São encontrados em grande diversidade de produtos, dentre estes os combustíveis fósseis acarretando doenças respiratórias. Portanto, este estudo tem como objetivo descrever as emissões de compostos orgânicos voláteis no contexto das doenças respiratórias. Trata-se de protocolo de revisão de escopo que segue as orientações do Joanna Briggs Institute (JBI) e tem como critério de inclusão: artigos nacionais e internacionais dos cinco últimos anos pesquisado a partir da equação de busca [Health Monitoring AND Volatile Organic Compounds AND Respiratory Disease], completos e disponíveis nas bases de dados Lilacs via BVS, Medline e fonte de Literatura Cinzenta, sem limite de data ou idioma. Sua estratégia de busca será usada para extração, conversão, combinação, construção e uso. Seguirá o acrônimo PCC, com P(problema) = Health Monitoring, C(conceito) = Volatile Organic Compounds e C(contexto) = Respiratory Disease. Os dados serão avaliados por dois revisores e, em caso de divergência, por um terceiro revisor. Os resultados serão apresentados em tabelas e gráficos, com análises frequenciais comparativas que explicitarão as informações extraídas, além de dispor de discussão crítica embasada.

Palavras-chave: Monitoramento. Compostos orgânicos voláteis. Doença Respiratória.

Introduction

According to the International Energy Agency (IEA, 2013), oil still comprises 31.5% of the total primary energy supply, followed by coal at 28.8% and natural gas at 21.3%. Consequently, the expansion of fuel retail activity and the growth of the automobile sector in urban regions have led to increased atmospheric pollution, posing significant challenges to people's living conditions.

As a result, it is imperative to acknowledge sanitary measures aimed at preventing respiratory diseases since

> [...] the automation and increasingly profitable processes involved in the extraction and production of petroleum derivatives expose a significant portion of workers to chemical agents, both carcinogenic and non-carcinogenic in nature (LIMA *et al.*, 2017, p. 3).

Volatile Organic Compounds (VOCs) are substances found in numerous commercial products, including fire extinguishers, paint removers, gasoline, aerosol propellants, and refrigerants. These compounds vaporize rapidly upon contact with the environment, contributing to the onset of various diseases.

This assertion is supported by evidence showing that "the development of diseases such as asthma, Chronic Obstructive Pulmonary Disease (COPD), and lung cancer in workers is linked to their exposure to air polluted by Polycyclic Aromatic Hydrocarbons" (LEACHI, 2022, p. 4).

Consequently, the question arises: what is the current status of monitoring emissions of volatile organic compounds concerning respiratory diseases?

Hence, this study holds significance as it could lead to a reduction in the incidence of respiratory diseases caused by emissions of volatile organic compounds. The objective of this research is to delineate the emissions of volatile organic compounds within the context of respiratory diseases by reviewing existing studies and exploring technologies developed for this field.

1 Materials and methods

Scoping reviews aim to synthesize evidence and determine the extent of knowledge generated on a specific topic. This study will adhere to a five-step process: 1) identifying the research question; 2) identifying relevant studies; 3) selecting studies; 4) mapping data; and 5) grouping, summarizing, and reporting results (Nyanchoka et al., 2019; Peters et al., 2017). The review synthesis will follow the recommendations of the PRISMA extension checklist for scoping reviews (TRICCO et al., 2018). The protocol for this study is registered on the Open Science Framework, with DOI 10.17605/OSF.IO/RGYSH.

The study will adopt the guidelines of the Joanna Briggs Institute (JBI), with the search strategy being developed based on Health Science Descriptors (DeCS) and Medical Subject Headings (MeSH) to ensure comprehensive coverage in the databases. The search equation will consist of key terms derived from these descriptors to facilitate a broader search.

Inclusion criteria for the review will encompass national and international articles from the past five years, retrieved using the search equation [Health Monitoring AND Volatile Organic Compounds AND Respiratory Disease]. Articles must be complete and freely available in the Lilacs databases via the Virtual Health Library (VHL), Medline, and Gray Literature sources such as Google Scholar, without any restrictions on publication date or language.

The search strategy will follow the ECCCU framework (Extraction, Conversion, Combination, Construction, and Use) (ARAÚJO, 2020) and utilize the PCC acronym: P(problem) = Health Monitoring, C(concept) = Volatile Organic Compounds, and C(context) = Respiratory Disease.

To define eligibility criteria, the study will consider: 1) all studies focused on health monitoring of volatile organic compound emissions in the context of respiratory diseases; and 2) studies published in scientific journals, government websites, and/or entities representing environmental health.

Data evaluation will involve two reviewers, with discrepancies resolved by a third reviewer if necessary. Results will be presented through tables and graphs, accompanied by comparative frequency analyses to elucidate the extracted information and facilitate a robust critical discussion.

2 Results

Table 1 - PCC framework.

	P (Problem)	**C (Concept)**	**C (Context)**
Extraction	Health Monitoring	Volatile organics compounds	Respiratory diseases
Mesh	Health Monitoring	*Volatile Organic Compounds*	*Respiratory Tract Diseases*
Decs conversion - Portuguese	Monitoramento sanitário	Compostos orgânicos voláteis	Doenças respiratórias
Conversion (DECS) English	*Health Monitoring*	*Volatile Organic Compounds*	*Respiratory Tract Diseases*
Conversion (DECS) Spanish	*Fiscalización Sanitaria*	*Compuestos Orgánicos Volátiles*	*Enfermedades Respiratorias*

Source: the authors.

The VHL database was consulted using the search equation: ("Health Monitoring" AND "Volatile Organic Compounds" AND "Respiratory Disease"), resulting in 76 articles published over the last five years. Subsequently, a refinement process was conducted to select the relevant databases.

Table 2 - Characteristics of studies retrieved using the search equation.

Base	Language	Search equation	Number of articles	Link
Lilacs	Portuguese	Health Monitoring AND Volatile Organic Compounds AND Respiratory Disease	0	https://pesquisa.bvsalud.org/portal/?fb=&output=site&lang=pt&from=1&sort=&format=summary&count=20&page=1&range_year_start=2017&range_year_end=2022&skfp=&index=&q=%28respiratory+diseases+%29+OR+%28volatile+organic+compounds+%29+OR+%28monitoring%29%29&where=&filter%5Bdb%5D%5B%5D=LILACS&filter%5Bmj_cluster%5D%5B%5D=Doen%C3%A7as+Respirat%C3%B3rias&filter%5Bmj_cluster%5D%5B%5D=Insufici%C3%AAncia+Respirat%C3%B3ria&filter%5Bmj_cluster%5D%5B%5D=Infec%C3%A7%C3%B5es+Respirat%C3%B3rias&filter%5Bmj_cluster%5D%5B%5D=Fatores+de+Risco&filter%5Bmj_cluster%5D%5B%5D=Sistema+Respirat%C3%B3rio&filter%5Bmj_cluster%5D%5B%5D=Polui%C3%A7%C3%A3o+do+Ar&filter%5Btype_of_study%5D%5B%5D=case_reports&filter%5Btype_of_study%5D%5B%5D=risk_factors_studies&filter%5Bla%5 D%5B%5D=pt
Pubmed	English	Health Monitoring AND Volatile Organic Compounds AND Respiratory Disease	38	https://pubmed.ncbi.nlm.nih.gov/?term=HEAlTH+MONITORING+AND+Volatile+Organic+Compounds+AND+RESPIRATORY+DISEASE&filter=simsearch2.ffrft&filter=datesearch.y5

Gray literature (Google Scholar)	English (Portuguese version unavailable)	Health Monitoring AND Volatile Organic Compounds AND Respiratory Disease	34	https://scholar.google.com.br/scholar?hl=ptBR&scisbd=1&as_sdt=0%2C5&as_vis=1&q=Health+Monitoring+AND+Volatile+Organic+Compounds+AND+Respiratory+Dise ase&btnG=

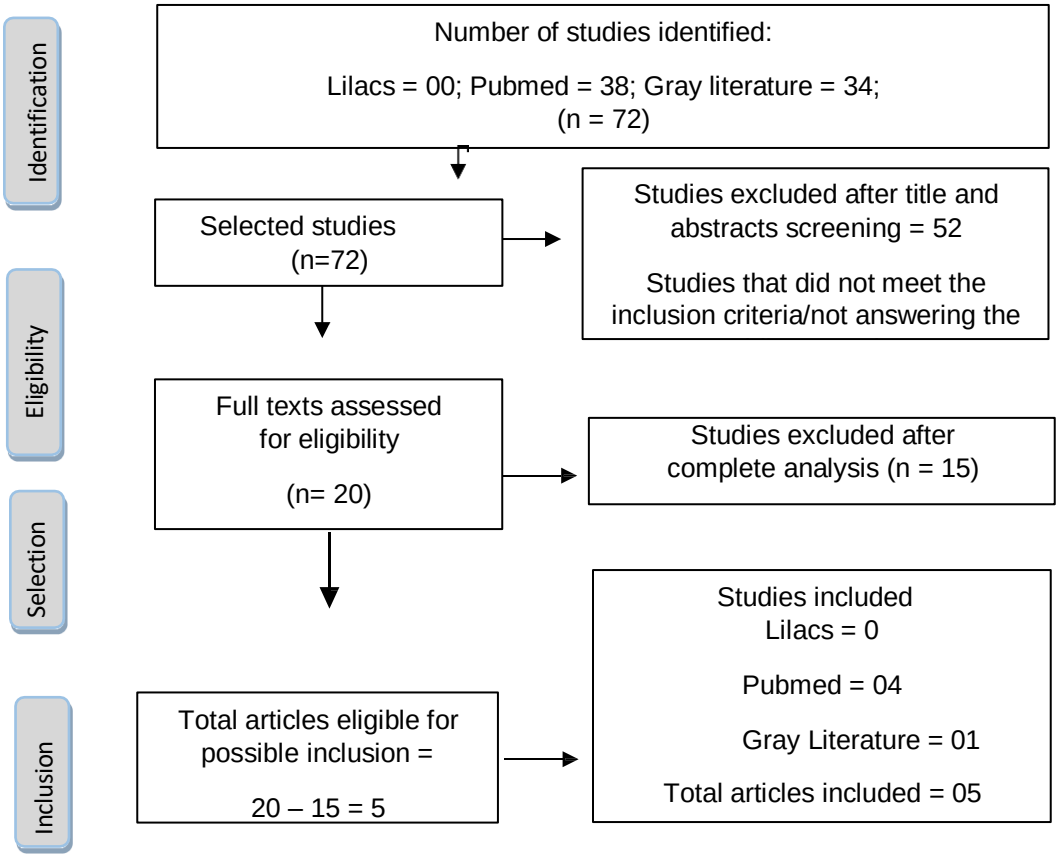
Source: literature data, 2022.

The results found in the databases were exported to Microsoft Word® and duplicate articles were excluded. Subsequently, the selection and screening of studies were conducted independently by two researchers.

The titles and abstracts of the remaining articles were then reviewed to determine their suitability for inclusion in the present scoping review. Articles that passed this initial screening were read in full to assess their relevance. Justifications for excluding articles at this stage were documented. Additionally, all references of the included articles were reviewed to identify other potentially important studies.

All selection steps were recorded in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews - PRISMA-ScR) flowchart diagram, shown in Figure 1 below.

Figure 1 - Flowchart of article selection following PRISMA (ScR)



Data extraction was carried out independently by two researchers using an extraction table that included information on the characteristics of the studies: title, country, language, intervention, and comments.

The results were presented in a descriptive format, utilizing tables to aid in the clear presentation of the data.

Table 3 – Characterization of studies.

No.	Title	Country	Language	Participants and scenario
1	Breathomics for the Clinic: The use of organic volatile compounds in respiratory diseases	UK	English	Study carried out in the United Kingdom in 2021, stating that volatile organic compounds (VOCs) have been proposed as biomarkers possible elective diagnoses and prognoses for unknown respiratory problems.
2	Volatile organic compounds in exhaled breath as fingerprints of lung cancer, asthma and COPD	Poland	English	Research carried out in Poland in 2020, showing a worldwide increase in inflammatory diseases such as lung cancer, chronic obstructive pulmonary disease (COPD) and asthma, constituting a significant public health problem.
3	Source-Specific Volatile Organic Compounds and Emergency Hospital Admissions for Cardiorespiratory Diseases	China	English	Study produced in China in 2020, identifying gaps in knowledge about impacts of cardiorespiratory diseases caused by Volatile Organic Compounds in the general population.
4	Indoor Air Pollution and Health of Vulnerable Groups: A Systematic Review Focused on Particulate Matter (PM), Volatile Organic Compounds (VOCs) and Their Effects on Children and People with Pre-existing Lung Disease	UK	English	Analysis carried out in the United Kingdom in 2022, investigating indoor air pollution with a focus on children and adults with respiratory diseases who were included in the Web of Science database, between the years 1991 and 2021.
5	Surveillance of Indoor Air Concentration of Volatile Organic Compounds in Luxembourgish Households	Luxemburg	English	Research carried out in Luxembourg in 2022, studying Volatile Organic Compounds in homes, aiming to calculate the risks caused by them to people throughout their adult lives.

Source: research data, 2022.

Following the characterization of the studies, the results were summarized specifically in relation to the guiding question, as shown in Table 4 below.

Table 4 – Association between emissions of volatile organic compounds and respiratory diseases, Teresina, Piauí, Brazil, 2022.

No.	Title	Intervention	Association between VOC emissions and respiratory diseases
1	Breathomics for the Clinic: The use of organic volatile compounds in respiratory diseases	No	The analysis of VOCs also found that respiratory diseases are among the leading causes of death worldwide. The World Health Organization estimates that they will cause one in five deaths by 2030.
2	Volatile organic compounds in exhaled breath as fingerprints of lung cancer, asthma and COPD	No	Diagnostic devices for these types of diseases are not only expensive, but also aggressive, adding to people's stress. However, it has been found that analyzing traces of VOCs in exhaled breath could provide cheaper, more accurate and non-invasive screening approaches to identify and monitor lung disease.
3	Source-Specific Volatile Organic Compounds and Emergency Hospital Admissions for Cardiorespiratory Diseases	No	Positive associations of volatile organic compounds from gasoline emissions, architectural paints, and household products with emergency hospital admissions for chronic obstructive pulmonary disease have been discovered. This study also suggested that environmental VOCs may exacerbate cardiovascular and respiratory diseases, particularly chronic obstructive pulmonary disease (COPD).
4	Indoor Air Pollution and Health of Vulnerable Groups: A Systematic Review Focused on Particulate Matter (PM), Volatile Organic Compounds (VOCs) and Their Effects on Children and People with Pre-existing Lung Disease	No	Inhalation is the primary means by which humans ingest particles and VOCs, and the process can also occur through the skin and eyes. The number of relevant studies is still small, but some say it is likely that VOCs cause irritation of the upper respiratory tract.
5	Surveillance of Indoor Air Concentration of Volatile Organic Compounds in Luxembourgish Households	No	The study found that the risks to human health are linked to the concentration of Volatile Organic Compounds analyzed in Luxembourg and that it presented results similar to those found in neighboring countries. It was also noted that the country needed a surveillance system, as well as greater support for doctors when prescribe care for patients, in addition to better defining public health priorities for the country, in the field of internal pollution.

Source: research data, 2022.

3 Discussion

At the outset of the discussion, it was noted that the five studies unanimously emphasized the relevance of VOCs as something harmful to human health, as they are associated with the occurrence of numerous diseases, including respiratory diseases.

One study suggested that VOCs in the environment may stimulate the aggravation of cardiovascular and respiratory diseases, especially chronic obstructive pulmonary disease (Ran, 2020).

In an analysis of VOCs, one of the authors pointed out that respiratory diseases are among the leading causes of death in the world, which allows the World Health Organization to estimate that this situation will lead to one in five deaths by 2030 (Ibrahim, 2021).

It has been found that the burden of devices to detect respiratory diseases causes stress in people and that the analysis of signals from volatile organic compounds (VOCs) in exhaled breath can provide cheaper, more rigorous and non-proliferative methods to detect and monitor lung diseases (Ratiu, 2020).

Another study also found positive associations between VOCs emitted by fuels, architectural paints and household products and emergency hospital admissions for chronic obstructive pulmonary disease (Ran, 2020).

One article found that the skin and eyes also facilitate the absorption of particles and VOCs, with inhalation being the main method by which people do this (Maung, 2022).

Final considerations

Therefore, it is concluded that there is an increasing need to create new studies on VOCs, which must be carried out with the efforts of governments and organizations to reduce the damage caused by VOCs to human health.

The development of new technologies for monitoring VOC emissions, as well as their dissemination and applicability, is also important, since a large part of society is not even aware of what already exists in this área.

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