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# Noise Pollution Studies in the Arab World: A Scientometric Analysis and Research Agenda

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**Abstract:** This review analyzed scientific publications on noise pollution in 22 Arab countries from 1983 to 2022. The objective of this study was to assess the current state of research on noise pollution in the Arab world, identify trends and gaps in the literature, and subsequently formulate a thorough research agenda. A comprehensive search of the Scopus database was conducted using relevant search terms and inclusion criteria. Out of 249 results, 104 studies were selected. The data extraction from the 104 studies includes the country where the study was conducted/designed; the publication year; the journal of publication; sponsorship details; and the research methodology used. VOSviewer software (VOSviewer 1.6.18) was used to visualize the literature data and co-occurrence networks, collaborations, and research fronts. The analysis revealed that Saudi Arabia, Jordan, and Kuwait were the most active countries in noise pollution research, while Sudan and Libya had the lowest number of publications in this field. Additionally, countries like Somalia, Syria, Yemen, and Mauritania had no publications on this subject. Research on noise pollution in this region mainly focuses on noise in urban zones and workplaces, particularly in Saudi Arabia, Kuwait, and Jordan. Topics vary across other Arab countries. The results highlight the increasing significance of noise pollution research in the Arab world, particularly evident in recent periods. However, scientific output from Arab countries remains significantly limited compared to other global contexts. This study emphasizes the pressing requirement for increased investment in noise pollution research, aiming to achieve knowledge of the acoustic situation in Arab countries in order to develop strategies to mitigate population exposure to noise pollution, improve the well-being of citizens, and protect public health.

**Keywords:** noise pollution; Arab countries; sound environment; VOSviewer



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## 1. Introduction

Noise pollution refers to unwanted or harmful outdoor and indoor sound levels that can negatively impact human health and well-being. It is a well-known problem that is closely linked to rapid urbanization and the modern lifestyle. Noise pollution has become one of the major challenges facing humanity and is a growing concern, especially in developed countries [1,2]. In addition to causing sleep disturbances and nuisances [3–5], exposure to excessive noise levels can also have negative effects on human health, such as hearing loss [6] and mental pathologies [7]. It can also lead to high blood pressure, cardiovascular effects [8,9], and even death [10]. As a result, noise pollution ranks as the third most dangerous type of environmental pollution for human health, following air and water pollution [11]. Furthermore, noise pollution also has adverse effects on biodiversity and the environment [12–15].

The European Environment Agency highlights the substantial health impacts of noise, particularly from traffic. It affects millions in Europe, causing disturbance to sleep, hypertension, and even hospitalization [16–20]. To address this problem, the European scientific community is increasingly interested in understanding the nature and extent of noise pollution in European countries to develop effective strategies for managing and reducing its effects. On the other hand, statistics on the impact of noise on health and the environment in Arab countries are lacking, even in the most developed countries such as Saudi Arabia, Qatar, and the UAE. This topic remains in a grey area with limited research being conducted [21].

In developed regions such as Europe, extensive systematic research has been conducted to examine the scientific literature on noise pollution [7,22,23] and soundscapes [24–26] in both outdoor and indoor environments. These studies seek to uncover current trends and knowledge gaps, aiming to guide future research towards areas that have not been adequately explored and demand more attention.

Conversely, despite the significance of this topic, a noticeable absence of literature reviews on this subject within the Arab world has been observed. Based on the authors' knowledge, there has been no published systematic review on noise pollution studies in the Arab world, and only one systematic review paper on soundscape studies was published in 2024 [27]. This lack of scholarly work underscores a considerable gap in academic discussion. The apparent scarcity of this topic in the Arab scientific literature has motivated the present study. Understanding the current state of research on noise pollution in Arab countries is crucial for identifying knowledge gaps and guiding future research endeavors. This is particularly important in a region that comprises 22 countries members in the Arab League, with a total population of 456.8 million, accounting for 5.8% of the world's population [21,28,29].

The objective of this study was to evaluate the current level of knowledge on this subject in this geographical region. Various key aspects of noise pollution research were examined, including trends in the number of publications and citations, institutions active in the field, peer-reviewed journals, and geographical distribution of scientific publications. Additionally, collaboration networks between authors and institutions in the context of noise pollution were investigated. By identifying trends, research priorities, and challenges, this study provides an overview of research priorities and landscapes in the field of noise pollution in the Arab world. It also contributes to a better understanding and the identification of new research avenues and subsequently proposes a comprehensive research agenda to guide future research.

## 2. Materials and Methods

The methodology of this research was designed based on previous systematic reviews [24,27,30]. This study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [31] (see Supplementary Materials). It is organized into several key phases, beginning with the formulation of the research question followed by the development and design of a detailed review protocol, outlining this review's objectives, the criteria for study selection, and the strategies for data analysis. Subsequently, a comprehensive literature search was conducted in the Scopus database to gather relevant studies. The subsequent phase involved screening these studies to identify those pertinent to our research question, setting the stage for data extraction. This process facilitated the commencement of the analysis, aiming to synthesize the findings systematically [32].

### *2.1. Data Search and Visualization*

This research on noise pollution studies in the Arab world was conducted using a systematic and quantitative approach [33]. A comprehensive search of the relevant literature was carried out, which provides ample data for analysis, including the title, authors, institutions, countries, abstract, keywords, references, citations, impact factor, etc. [34]. Although systematic review studies often utilize two or three databases such

as Scopus, Web of Science, and PubMed, it has been demonstrated that relying solely on the Scopus database effectively covers the most relevant literature in the field of built environment studies, especially in acoustics [23,27,30,35].

This research was carried out using the Scopus database tools, using the following terms with the associated meanings: subject = noise pollution OR nuisance AND country by country (covering the 22 Arab countries included in this study located in Africa (Algeria, Comoros, Djibouti, Egypt, Libya, Mauritania, Morocco, Somalia, Sudan, and Tunisia) and Asia (Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, UAE, and Yemen)); language = all; type of document = all (to gain a general overview of scientific publications); and no time limits for the search were applied. The last search was performed on 10 December 2022. The preliminary result was 249 articles; after removing duplicates, two authors independently screened titles and abstracts and selected 159 papers for further analysis, of which 65.41% are peer-reviewed papers, 30.82% are conference papers, 2.52% are book chapters, and 1.26% are books. From this total, the authors focused only on peer-reviewed journal articles, which represent a total of 104 articles, and eliminated other types of documents (see Figure 1). Focusing on the peer-reviewed literature enhances the credibility of this review, making its findings more reliable. However, it is important to recognize that an exclusive focus on the peer-reviewed literature may limit the review's scope. Significant findings shared in conference papers, books, theses, and other forms of grey literature could be inadvertently overlooked [27,33].

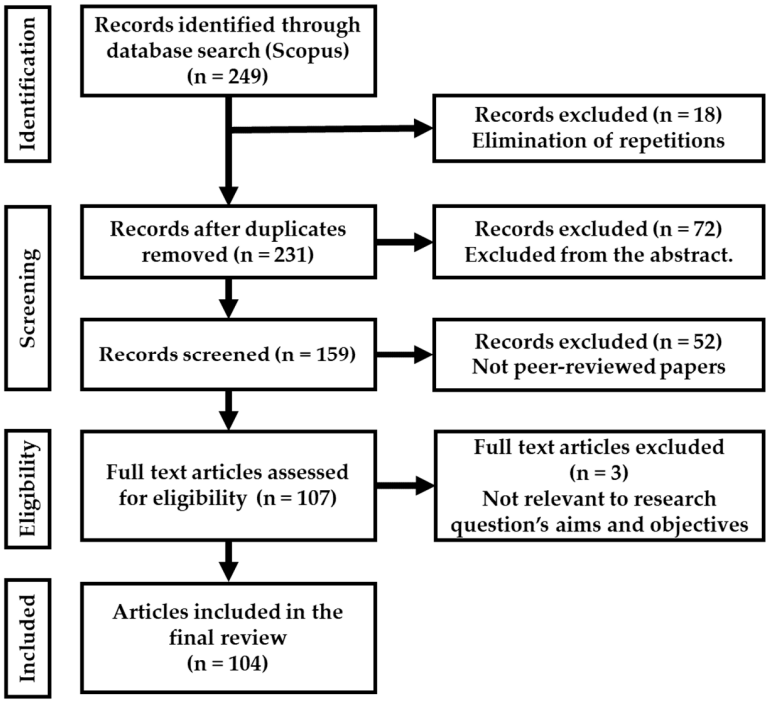


**Figure 1.** Flow of information through the different phases of the systematic review.

The inclusion criteria for studies were as follows: (1) the study had to focus specifically on noise pollution, and (2) the study had to be conducted within the Arab world or have a case study within the Arab region. By restricting the selection to these articles, it was ensured that studies relevant to the research questions, aims, and objectives were included.

Two authors extracted data from each included study, focusing on (1) the country where the study was conducted/designed; (2) the publication year; (3) the journal of publication; (4) the language of the paper; (5) sponsorship details; (6) the author's affiliation; (7) the methodology, indicating whether the study relied on measurements, software simulations, and/or others; (8) case studies and the studied cities; (9) noise sources; and (10) keywords.

The bibliometric data collected in this study were visualized using VOSviewer software, which is specifically designed for visualizing relationships between bibliometric

variables. This software is capable of creating co-occurrence networks of articles, authors, and keywords, as well as identifying research themes and concentrations [36,37]. Overall, the aim of this methodology was to provide a comprehensive and objective evaluation of the current state of research on noise pollution in the 22 Arab countries and to identify potential future research directions.

### *2.2. Data Analysis*

The articles analyzed in this study were systematically examined using multiple points of analysis. The publication year of each article was noted to observe trends and changes in research on noise pollution in the Arab world over time. The number of articles per country was also analyzed to identify the geographical distribution of research on noise pollution in the Arab world and the regions with a higher concentration of research in the field. The journals in which the articles were published were examined not only to evaluate their credibility, relevance, and quality but also to identify the most prolific sources of publications on noise pollution in the Arab world. Additionally, this evaluation can help identify Arab journals specializing in this field, if they exist.

The language of the articles was recorded to assess the global scope of the research as well as the languages used in this region where the official language is Arabic. Furthermore, the sponsor and main contributing institutions were identified to better understand the financial and academic support for research on this topic. The research topics and themes were also studied because it is important to conduct an in-depth analysis of the main research topics and themes in this region. This will allow us to determine trends and research gaps in the field, as well as identify areas where further research is needed. To do this, a thematic analysis of the articles included in the systematic review using a stratified method was conducted. This analysis included elements such as noise sources and areas studied, as well as prevention and reduction measures. By examining the results of this analysis, it is possible to determine key areas that require further research and contribute to the advancement of knowledge in the field of noise pollution in the Arab world.

An analysis of the research methods used in Arab noise pollution studies was carried out to understand the quality and relevance of these studies and to identify general methods, temporal trends, and geographical differences. To conduct this analysis, data from the methods of each study were extracted, tabulated, and interpreted to answer specific questions about the methods used in research on noise pollution in Arab studies. In addition, an analysis of the study cities and case studies was conducted to determine which Arab cities were included and which cities and case studies were most frequently discussed and to identify research gaps in specific cities or regions. This study also identified the primary noise sources investigated in the Arab world studies to comprehend the challenges posed by noise in the region and recorded keywords for each article to better understand the scope and context of the studies.

## 3. Results

### *3.1. Historical Analysis of Publications*

#### 3.1.1. Chronological Evaluation of Publications in the Arab World

The chronological evaluation of publications in the Arab world is visually represented in Figures 2 and 3, which display the temporal evolution of publications and illustrate the changing trends over time. In 1983, the first publication on the subject of noise pollution appeared in Saudi Arabia [38]. Between 1989 and 1994, only Jordan and Saudi Arabia were identified as the countries that published articles on this topic, indicating relatively limited research activity in the region during that period. However, in the late 1990s, Kuwait emerged with an increasing number of publications. Subsequently, in the early 2000s, Palestine and Lebanon joined the list of publishing countries, in 2000 and 2001, respectively. Between 2003 and 2005, Jordan's publications experienced a sharp decline, persisting until 2008, after which they began a gradual recovery. However, in 2006, Jordan's publications declined sharply and continued to decline until 2008, after which they gradually recovered. In the years

that followed, other countries such as Iraq, the United Arab Emirates, and Algeria began to publish more frequently, while Saudi Arabia and Kuwait maintained consistently high levels of research activity. The data also indicate an increase in research activity in all countries in 2021, with Algeria, Egypt, and Saudi Arabia having the highest number of publications.

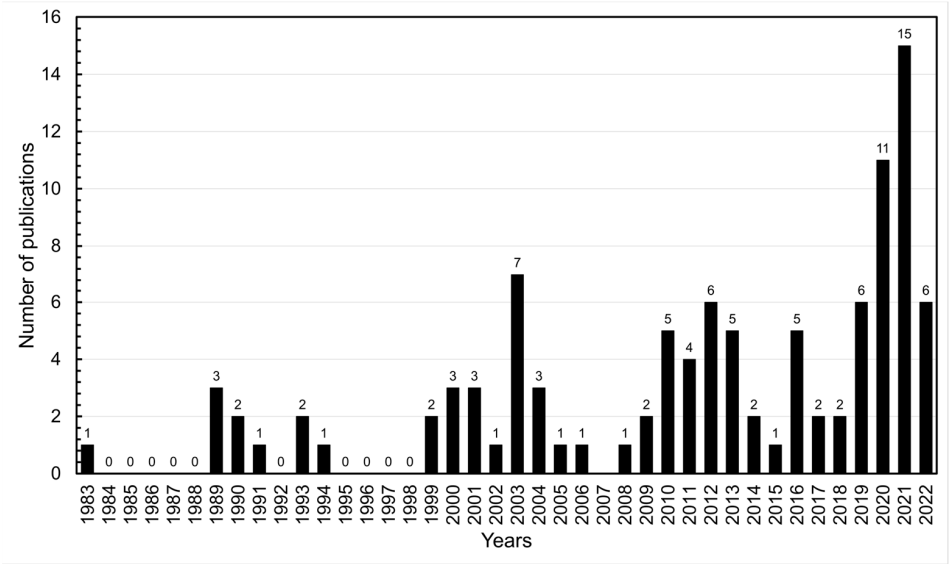


**Figure 2.** The annual number of noise pollution studies published in the Arab world until 2022.

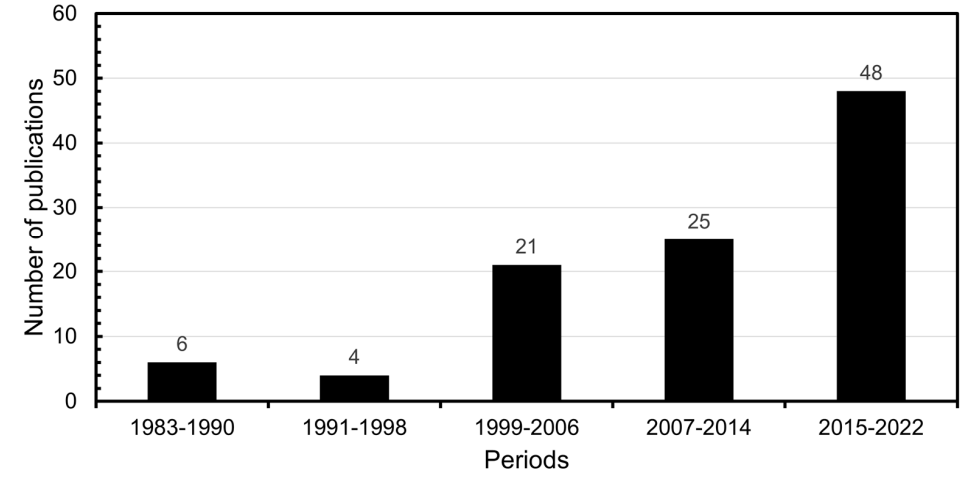


**Figure 3.** Temporal trends in research publications on noise pollution in the Arab world by periods.

The data show variations from year to year. However, it should be noted that the average annual number of scientific publications in the Arab world is very low, around 2.5 articles. In some years, such as 2003, 2010, 2020, and 2021, the number of research publications was well above average. On the other hand, there are several years without any publications: 1984, 1985, 1986, 1992, 1995, 1996, and 1997. With six publications in 2022 and fifteen in 2021, these last years have seen a clear increase above the average in the number of scientific publications on noise pollution in the Arab world.

It is noteworthy that the number of countries appearing each year has increased over time, with eight countries appearing each in 2021 and 2022. This shows that noise pollution is becoming a bigger issue in countries in the Arab world, but the number of publication on this topic is still very low compared to other regions [21,39,40].

Figure 3 presents a comprehensive overview of the temporal trends in research publications on noise pollution in the Arab world. The period from 2008 to 2023 has been

divided into five groups, with each group representing a coherent yearly publication pattern. This division facilitates the analysis of publication rates, offering a broader perspective on trends over multi-year blocks rather than annually. Such an approach is instrumental in identifying notable shifts in research focus or intensity over time.

Interestingly, during the period from 1983 to 1990, the output displayed a modest count of six papers, indicating a relatively conservative research emphasis on this subject during this initial phase. The subsequent period, from 1991 to 1998, witnessed a slight decline in the number of published papers, with only four publications. The decrease can be attributed to a combination of factors, particularly disruptions arising from regional conflicts such as the Gulf War and the Algerian Civil War, along with economic crises in various countries. These conflicts not only triggered economic consequences and interruptions in education but also resulted in a significant brain drain, as researchers and intellectual minds sought security and opportunities abroad. However, starting from 1999 to 2006, a notable surge in scholarly activity is evident, with the publication count reaching 21 papers. This considerable increase indicates a growing recognition of noise pollution as an area deserving substantial attention within the Arab world. The years 2007 to 2014 continue this upward trajectory, with a marked rise to 25 papers. This trend points to a sustained and expanding interest in comprehending and addressing the implications of noise pollution across various contexts within the region. The most recent period, spanning from 2015 to 2022, demonstrates a substantial leap in research output, with 48 papers published. This sharp rise likely reflects an even more pronounced recognition of the significance of noise pollution, suggesting that the academic and scientific community is actively engaging with this subject. However, it is worth noting that the number remains relatively modest for 22 Arab countries, particularly when juxtaposed with the scientific productivity of other regions.

#### 3.1.2. Geographical Distribution of Publications in the Arab World

According to the data of this study, the number of scientific articles per country varies between zero and seventeen. Moreover, countries with the highest number of articles also have a greater temporal continuity. Based on the number and publication frequency, the Arab countries can be divided into five groups.

Group 1 includes Jordan, Kuwait, and Saudi Arabia, with a relatively high number of publications of 17, 15, and 16, respectively. The second group includes Iraq, Egypt, and the United Arab Emirates with ten, nine, and eight research papers, respectively. The third group includes Algeria, Lebanon, Palestine, Oman, Tunisia, and Morocco, with six, four, four, five, five, and two articles, respectively. A fourth group consists of countries with only one article, such as Libya and Sudan. Finally, and as illustrated in Figure 4, a fifth group is composed of countries that have not published any articles on noise pollution, including Bahrain, Comoros, Djibouti, Somalia, Syria, Yemen, and Mauritania.

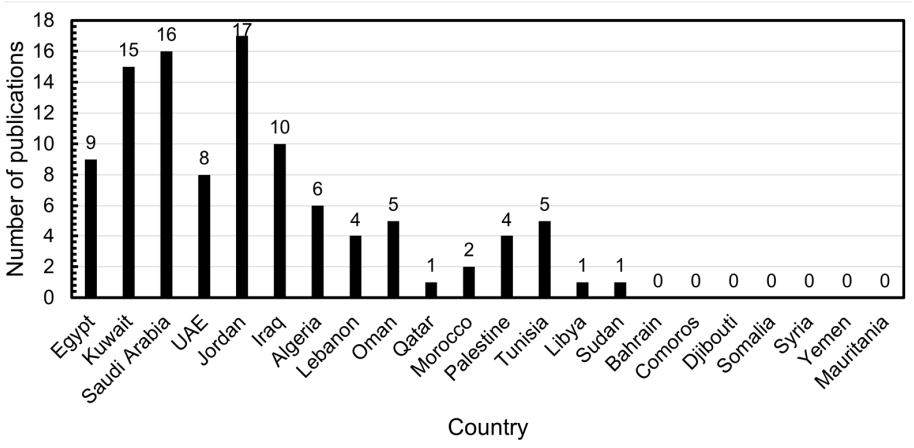


**Figure 4.** Distribution of articles by countries between 1983 and 2022.

### 3.2. Keywords of Research

In this part, the keywords used in research on noise pollution in the Arab world were examined. Keywords play a crucial role in understanding the research topic and the main content of scientific publications. By analyzing the evolution of keywords, trends in research on this topic can also be observed.

By analyzing the centrality and frequency of co-occurring keywords, a network graph was generated with forty-three nodes and six clusters using Vosviwer software (Figure 5). The results showed that "noise pollution" is the most commonly used keyword with 20 occurrences and a total link strength of 25, indicating a significant relationship with other relevant keywords like "road traffic noise" and "soundscape" cited only once in 2021. Furthermore, there was a noticeable presence of keywords associated with noise annoyance, such as "annoyance", "noise", and "noise annoyance".

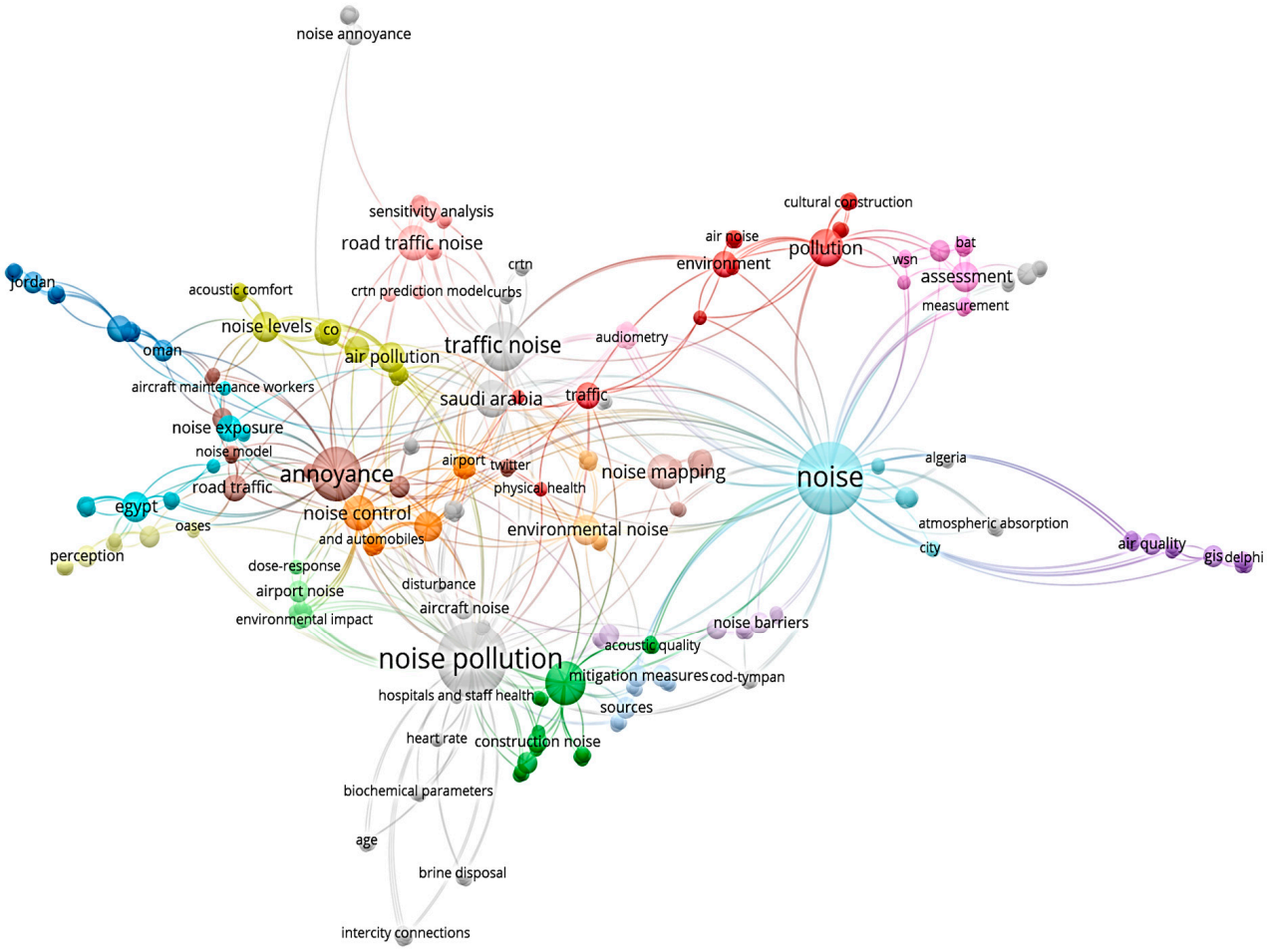


**Figure 5.** Cluster map of author keywords.

The keywords used in Arabic research on noise pollution showed a different geographical distribution of search topics for each country. Research in Algeria, Iraq, and Oman focused primarily on environmental noise, noise pollution, occupational health, air quality, and noise levels, as well as environmental policies, mitigation measures, and the fight against noise pollution. In contrast, research in Egypt, Jordan, Saudi Arabia, and Kuwait has focused on acoustic quality, annoyance, perception, noise levels, and durability. The studies also included assessments of acoustic quality in city parks, schools, working conditions, and social surveys. In Iraq, research focused on statistical models to assess noise pollution, environmental policy, and environmental security, while research in Lebanon focused on the statistical analysis of noise pollution in urban areas. In Libya, research focused on environmental management of noise pollution effects, and in Morocco, research focused

on urban planning, sustainability, environmental health, and effects of noise on health. The used keywords in the Arab noise pollution studies can be grouped into six groups according to the theme of research:

1. Noise: this category includes keywords related to noise, such as "noise", "noise annoyance", "construction noise", "aircraft noise", "road traffic noise", "traffic noise", "sound levels", and "noise reduction".
2. Noise measurement and mapping: this category includes keywords related to noise measurement and mapping, such as "noise measurement", "noise mapping", and "noise levels".
3. Health and environment: this category includes keywords related to health and the environment, such as "air pollution", "air quality", "environmental health", "health effects", "exposure", "hypertension", and "noise-induced hearing loss".
4. Perception and social surveys: this category includes keywords related to perception and social surveys, such as "annoyance", "perception", "social survey", and "soundscape".
5. Specific regions: this category includes keywords related to specific regions, such as "Egypt", "Jordan", "Kuwait", "Makkah", "Saudi Arabia", and "Oman".
6. Others: this category includes keywords that are not directly related to the other families, such as "assessment", "co", "SIG", "hajj", "high blood pressure", "road traffic", "traffic", "sensitivity analysis", and "noise sources".

It is noteworthy that this analysis clearly highlights that the topic of noise pollution was often studied in conjunction with air quality and atmospheric pollution in studies focusing on environmental quality.

### *3.3. Journals, Sponsors, and Language of Published Papers*

#### 3.3.1. Journals

This analysis summarizes the sources of publications about noise pollution in the Arab world. The 104 articles examined in this study were published in 73 scientific journals. In this section, journals that published two or more articles were analyzed; this filter makes it possible to select the journals which have devoted more attention and resources to the field of urban acoustics. It should be noted that the largest number of publications by a single journal is seven publications; we have selected the journals with a minimum of two articles for this analysis, so this is relative to the low number of publications in this region. Table 1 shows the number of articles published in each journal, classified by quartiles according to their SJR position in the year 2022. Nineteen scientific journals focusing on acoustics environmental science and engineering focused on acoustics, environmental sciences, and engineering were identified. The most common source is "*Applied Acoustics*" with seven publications, followed by the "*Environmental Research and Public Health journal*" and the "*Environmental Monitoring and Assessment journal*" with five publications each. Other journals such as "*Acoustical Science and Technology*", "*Jordan Journal of Civil Engineering*", and "*Transportation Research Record*" also have three publications. It is interesting to note that several journals published by Arab institutions, such as the *Arab Gulf Journal of Scientific Research* and the *Jordan Journal of Civil Engineering*, have contributed to the publication of research on noise pollution in the region. However, it should be noted that no specialized journal on the subject of environmental acoustics is published by publishers in the Arab region.

**Table 1.** Prominent journals in noise pollution research in the Arab world.

| SJR Quartile (SCImago 2023) [41] | Journals | Papers |
|---|---|---|
| Q1 | *Applied Acoustics* | 7 |
| | *International Journal of Environmental Research and Public Health* | 5 |
| | *Transportation Research Part D: Transport and Environment* | 2 |
| | *Journal of Urban Planning and Development* | 2 |
| | *Environmental Science and Pollution Research* | 2 |
| Q2 | *Environmental Monitoring and Assessment* | 5 |
| | *Transportation Research Record* | 3 |
| | *The Journal of the Egyptian Public Health Association* | 2 |
| | *Journal of Environmental Science and Health. Part A: Environmental Science and Engineering and Toxicology* | 2 |
| Q3 | *Jordan Journal of Civil Engineering* | 3 |
| | *Acoustical Science and Technology* | 3 |
| Q4 | *Indian Journal of Environmental Protection* | 2 |
| | *Arab Gulf Journal of Scientific Research* | 2 |
| | *Annales de Cardiologie et d'Angeiologie* | 2 |
| Information not available | *Acustica* | 2 |
| | *Environmentalist* | 2 |
| | *Indian Journal of Forensic Medicine and Toxicology* | 2 |
| | *Kuwait Journal of Science and Engineering* | 2 |

#### 3.3.2. Sponsors and Language of Papers

In the Arab world, English dominates as the main language used for scientific publications on noise pollution, representing a high percentage of 97%. Arab researchers prefer English-language international journals for wider dissemination of their work and greater visibility. However, there are scientific publications in French and Arabic, but they remain very limited, representing only 2% and 1%, respectively. This situation is mainly due to the limited availability of Scopus-indexed scientific journals in these languages, as well as the low international recognition of research published in them [42].

The importance of sponsors in the field of scientific research cannot be underestimated. They play a crucial role in funding studies, which can be costly and require significant resources. According to the data from Scopus, in the field of noise pollution research, sponsors from various industries, including noise engineering, acoustics, computer science, and technology from different geographic regions, have funded 16.4% of studies on noise pollution in the Arab world. As shown in Table 2, the most active sponsor was the International Institute of Noise Control Engineering (I-INCE) (Switzerland) which funded six studies. Other sponsors such as RAVE-Rede Ferroviária de Alta Velocidade, S.A. (Portugal), International Institute of Acoustics and Vibration (IIAV) (USA), KTH Royal Institute of Technology (Sweden), and Scandinavian Vibration Society (SVIB) (Sweden) each funded two studies. Other sponsors such as the City of Vienna and the Vienna Convention Bureau (Austria) funded only one study. It is important to note that no sponsor from the Arab region supported research on noise pollution in the region.

**Table 2.** Sponsorship in noise pollution research in the Arab world.

| Sponsors | Count of Sponsors |
|---|---|
| International Institute of Noise Control Engineering (I-INCE) (Switzerland) | 6 |
| Rede Ferroviaria de Alta Velocidade, S.A. (RAVE) (Portugal) | 2 |
| International Institute of Acoustics and Vibration, IIAV (USA); | 2 |
| Royal Institute of Technology, KTH (Sweden) | 2 |
| Scandinavian Vibration Society, SVIB (Sweden) | 2 |
| City of Vienna; Vienna Convention Bureau; Austrian Airlines; Dantec Dynamics (Austria) | 2 |

### *3.4. Main Contributing Institutions*

Research on noise pollution in the Arab world has been published by researchers from 181 institutions, including universities, laboratories, and research institutes, as illustrated in Figure 6. Analysis shows that there is no institution dedicated solely to noise pollution research in the Arab world. The number of articles published by the researchers of these institutions varies between one and five.

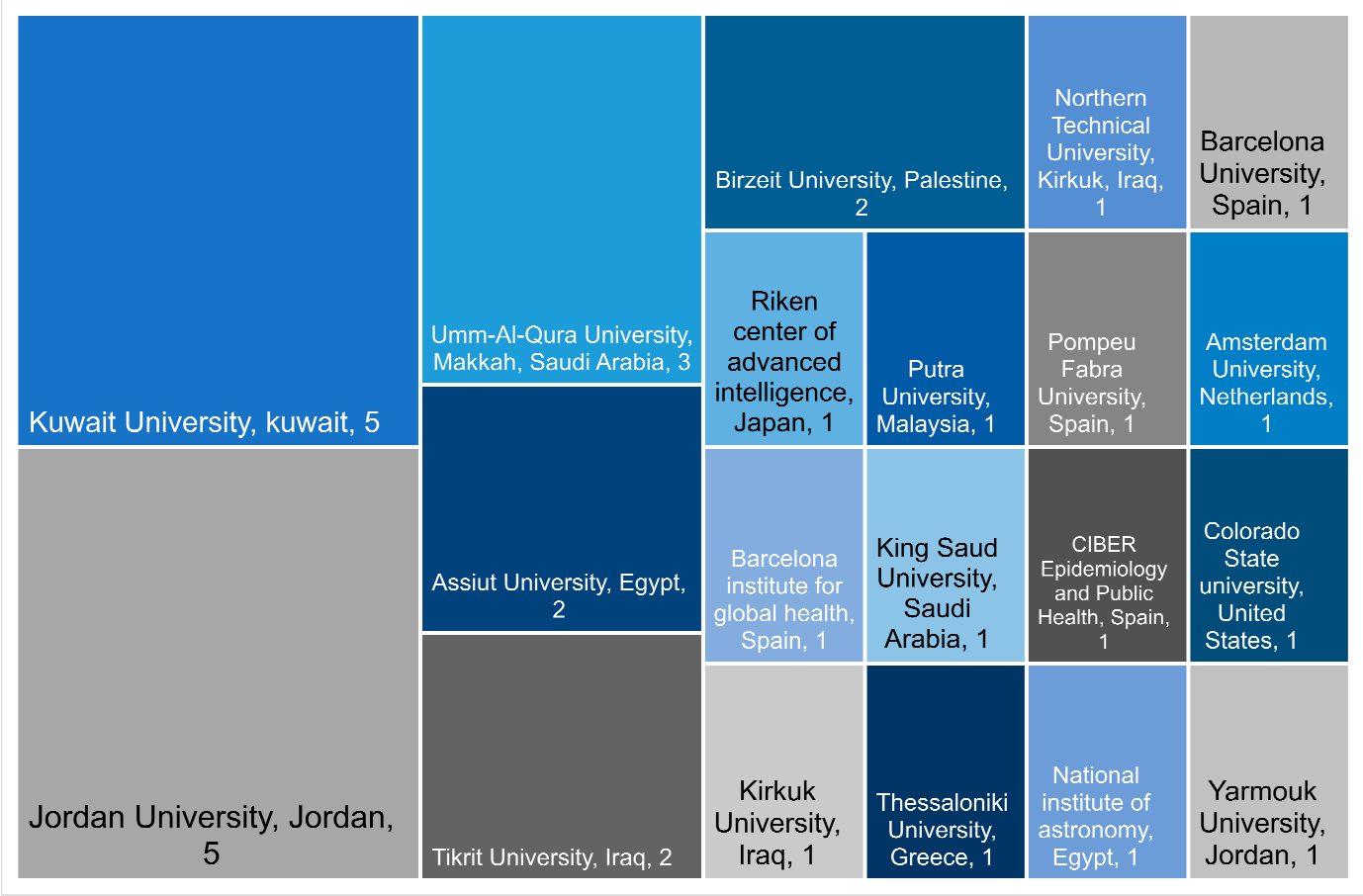


**Figure 6.** Main institutions contributing to research on noise pollution in the Arab world.

These institutions can be divided into three categories according to the number of publications. The first category includes organizations that have published three or more articles. Specifically, Kuwait University, Jordan University in Amman, and Umm Al Qurah University in Makkah, Saudi Arabia, have published five, five, and three papers, respectively. The second group includes organizations with two articles, including Assiut University, Egypt; Birzeit University, West Bank, Palestine; and Tikrit University, Tikrit, Iraq. The third group consists of 175 organizations located in different Arab and non-Arab countries, including the United States, Spain, Japan, Algeria, Saudi Arabia, and the United Arab Emirates. These institutions each conducted one study, indicating limited involvement in the field of acoustics. The situation underscores the clear absence of cooperation and synchronization among researchers focusing on noise pollution within the Arab world. Equally, it points to the limited availability of experts in this particular field. It is worth noting is that no researcher has exceeded two articles in their contributions, representing the maximum publication count by an individual.

### *3.5. Studied Cities*

Figure 7 shows Arab cities studied for noise pollution. Kuwait is the most studied city in eleven studies, followed by Jeddah in eight studies and Cairo in five studies. The

sound environment of these three cities seems to be the most studied in the Arab world. Additionally, other cities such as Amman, Makkah, Beirut, Sfax, Irbid, Baghdad, Riyadh, Abu Dhabi, Sharjah, Dubai, and Muscat were surveyed multiple times, three to four times each. However, there are also a number of cities which have been studied less often than those mentioned previously, such as Nablus, Salalah, Tripoli, Biskra, Oran, Khartoum, Doha, Tetouan, Oran, Irbid, Amman, Najaf, Algiers, Assiout and Samara, Baghdad, Mafraq, Sousse, Monastir, Tikrit, Mosul, Sharjah, Abu Dhabi, Dammam, and Kurdistan.

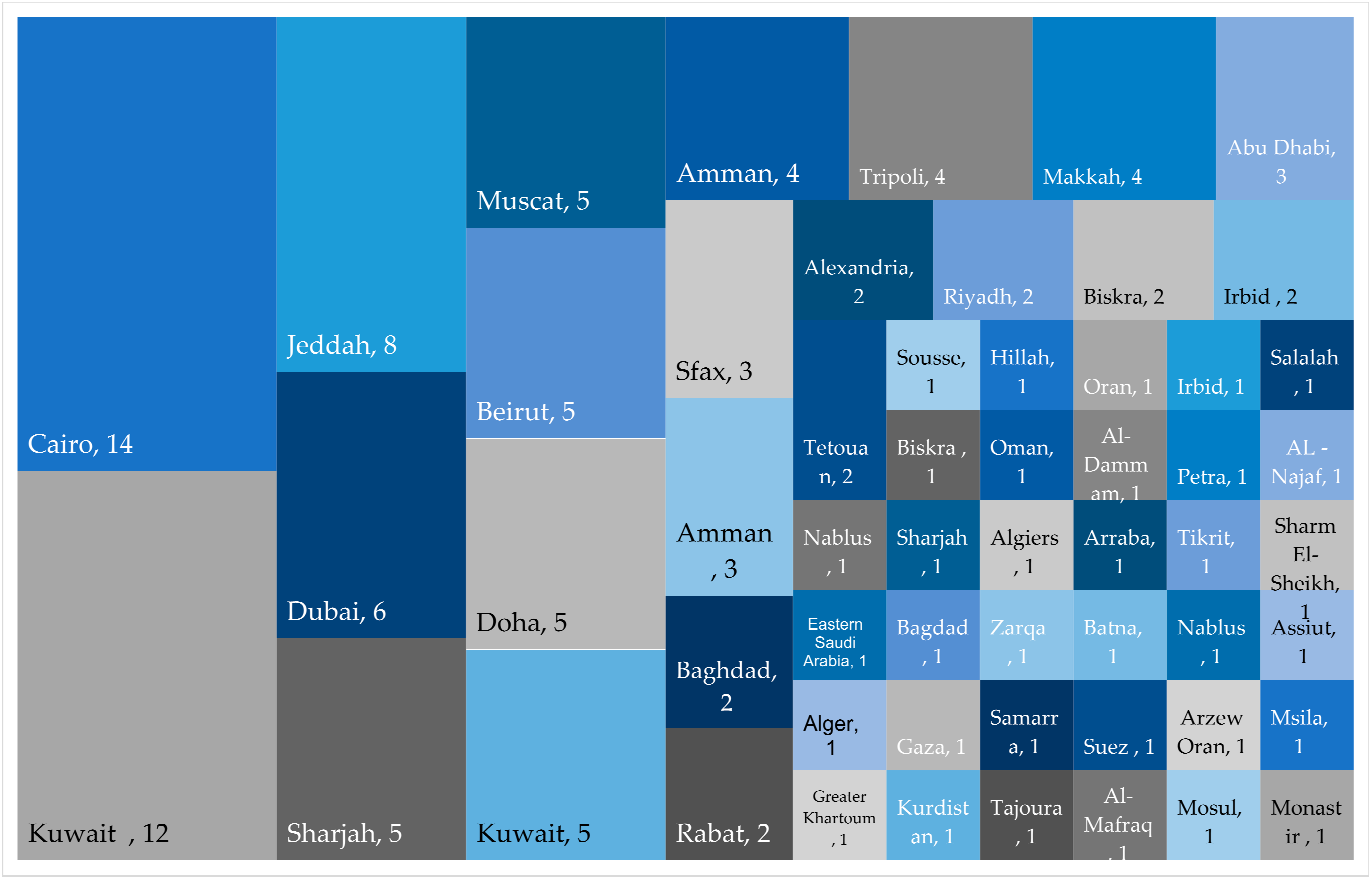


**Figure 7.** Number of studies on noise pollution in Arab cities.

### *3.6. Exploring Research Environments, Themes, Case Studies, Methods, and Noise Sources in the Arab World*

#### 3.6.1. Research Environments

Based on the research problems, objectives, and findings, the articles reviewed in this study have been classified into six distinct research themes. The first theme, urban environment, pertains to studies focusing on high sound levels generated by various sources in urban settings, such as traffic, construction, and other activities. The second theme, work environment, encompasses studies that have examined the sound environment and workplace noise resulting from various non-industrial activities, including noise in offices, commercial areas, and large shopping centers. The third theme, buildings environment, is concerned with studies investigating excessive noise levels that can impact structures such as hospitals, schools, residential buildings, and other facilities that require a quiet environment for optimal functioning. The fourth theme, industrial environment, focuses on studies exploring noise in industrial areas and the sound produced by machinery, equipment, and other industrial processes. The fifth theme, laboratory conditions, refers to studies specifically addressing noise emitted directly from the source, such as machinery or equipment, within research laboratories. Lastly, the sixth theme, major equipment environment, centers on the noise generated in large infrastructures such as ports and

airports. This category of studies aims to comprehend and mitigate the noise produced by these significant infrastructures, taking into account their environmental impact, the quality of life for nearby populations, and the protection of employees.

It can be observed that research conducted in the Arab world primarily focuses on the topic of urban environment, which comprises 82% of the studies conducted. The topics buildings environment and industrial environment come in second place with 18% of research, and the topic major equipment environment comes in third place with 14% of studies. On the other hand, topics such as laboratory conditions and work environment have a less prominent presence with respective percentages of 4% and 3%.

In the field of research on noise pollution in the Arab world, the chronological analysis of research topics reveals a trend towards broadening the scope of investigation over time. As illustrated in Figure 8, the early 1980s saw a focus on urban environment [38], with the addition of the two topics industrial environment and the major equipment environment in 1989 [43,44]. In the following years, research expanded to include work environment in 1990 and buildings environment in 1991 [45,46]. By 2000, laboratory conditions became a topic of investigation [47]. Overall, it is evident that research topics in noise have expanded over time, and it should be noted that the appearance of these research topics in certain countries does not necessarily guarantee their importance or significant presence in the field of research in those specific countries.

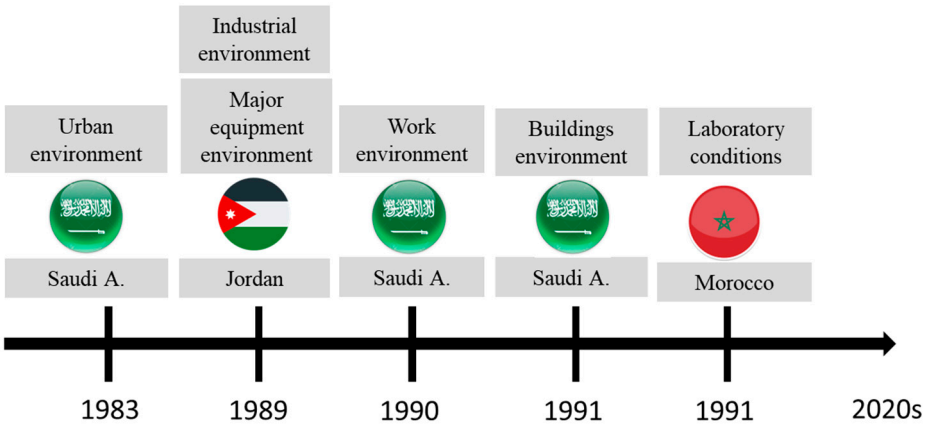


**Figure 8.** The first appearance of the various research topics studied in the Arab world.

### 3.6.2. Research Themes

Focusing on research themes related to noise pollution in the Arab world, it has been found that the nature and number of research topics vary considerably from one country to another. Saudi Arabia, Kuwait, and Jordan have addressed the highest number of research themes on this subject. In particular, research has focused on urban noise pollution, noise in sensitive buildings, the impact of noise on workers' health, and noise in schools. However, other Arab countries such as Tunisia and Morocco have also contributed to research on multiple subjects but in a less diversified manner, including topics like urban noise, wind farm noise, and the impact of work noise on worker health. On the other hand, Palestine, Egypt, Oman, Qatar, and Sudan have tackled a limited number of subjects. Table 3 provides an overview of research themes, countries, and years of publication related to noise research in the Arab world. It includes fifteen different research subjects, distributed across five main research themes which are (1) the characterization of the sound environment, (2) the effects of noise on quality of life, (3) noise control, (4) noise sources, and (5) building acoustics.

**Table 3.** Research themes on noise pollution: country and year analysis.

| Research Theme | Research Subject | Country | Year |
|---|---|---|---|
| Characterization of sound environment | Urban noise | Iraq | 2020 |
| | | Jordan | 2004, 2006, 2008, 2010, 2012, 2015, 2021 |
| | | KSA | 1983, 1989, 1993, 2010, 2011, 2012, 2016, 2021 |
| | | Kuwait | 1990, 1999, 2001, 2002, 2009, 2011, 2014, 2021 |
| | | Lebanon | 2001, 2003, 2012, 2016 |
| | | Oman | 1999, 2020, 2021 |
| | | Palestine | 2000 |
| | | Qatar | 2022 |
| | | Algeria | 2018 |
| | | Tunisia | 2012, 2019 |
| | | UAE | 2010, 2012, 2016, 2017, 2019, 2021, 2022 |
| | | Iraq | 2021 |
| | | Sudan | 2011 |
| | Urban noise in oasis | Algeria | 2020 |
| Effects of noise on quality of life | Effects of noise on learning achievement | Iraq | 2021 |
| | | Jordan | 2020 |
| | Impact of work noise on worker health | Algeria | 2013, 2016 |
| | | Egypt | 2013 |
| | | Jordan | 1989, 2005 |
| | | KSA | 1990, 2003, 2004 |
| | | Kuwait | 2000, 2003, 2004 |
| | | Oman | 2022 |
| | | Palestine | 2013 |
| | | Tunisia | 2019 |
| | | UAE | 2012 |
| | | KSA | 2013 |
| | Risk to health awareness assessment | Jordan | 2019 |
| | | Kuwait | 2003 |
| Noise control | Construction noise | Egypt | 2011 |
| | Highway noise | Jordan | 2001 |
| | Industrial noise | Jordan | 1989 |
| | | Libya | 2016 |
| | | Algeria | 2021 |
| | Noise in schools | KSA | 1994 |
| | Noise barriers | Iraq | 2022 |
| | Railway noise | Kuwait | 2020 |
| Noise sources | Noise from diesel particulate filters | Jordan | 2020 |
| | Noise from generators | Iraq | 2020, 2021 |
| | Wind farm noise | Morocco | 2018 |
| Building acoustics | Building acoustics | Iraq | 2020 |
| | | KSA | 1991 |
| | | Egypt | 2022 |

Iraq, Jordan, Egypt, Saudi Arabia, and Kuwait are the most represented countries. Some research topics have been studied in greater depth than others, with the characterization of the sound environment being the most researched theme, followed by the effects

of noise on the quality of life. The table also shows that some research themes have been studied in several countries, such as urban noise, while others have only been studied in one country. The research topics and countries covered in Table 3 provide an overview of the specific challenges that different countries and regions face in managing and mitigating noise such as generator noise; for example, in countries that suffer from electricity problems, like Iraq, this subject is present.

#### 3.6.3. Case Studies

The analysis of studies on noise pollution in the 22 Arab countries shows that residential urban areas are the most studied, in 59% of all studies. They have been examined in the following countries: Saudi Arabia, Kuwait, Jordan, Algeria, Egypt, Iraq, Lebanon, Oman, Palestine, Qatar, Sudan, Tunisia, and the United Arab Emirates. Industrial areas have been studied in 16% of research papers and were examined in the following countries: Saudi Arabia, Algeria, Egypt, Jordan, Kuwait, Libya, Morocco, Tunisia, and the United Arab Emirates. Airports (Algeria, Jordan, Saudi Arabia, Kuwait, Oman, and UAE), universities (Egypt and Iraq), construction sites (Egypt and Kuwait), hospitals (Iraq, Saudi Arabia, and Palestine), and schools (Egypt and Saudi Arabia) each had less than six studies, representing 6%, 5%, 4%, 4%, and 4% of the total, respectively. Regarding commercial areas, only Jordan was studied (2% of the total studies). Noise from ports is the least studied subject in the Arab world, with only one study examining noise pollution in the port of Tripoli (see Table 4).

**Table 4.** Countries, case studies, and year analysis.

| Country | Case Study | Year |
|---|---|---|
| Algeria | Algiers civil airport | 2013 |
| | Industrial zone | 2021 |
| | Iron factory | 2016 |
| | Oasis | 2020 |
| | Urban zones | 2018, 2021 |
| Egypt | Assiut schools | 2013 |
| | Building syndrome among office workers | 2013 |
| | Construction projects | 2011 |
| | University classroom | 2022 |
| | Urban zones | 2003 |
| Iraq | Hospitals | 2020 |
| | Residential complexes | 2022 |
| | University | 2020, 2021 |
| | University halls of sport | 2020 |
| | Urban zones | 2010, 2020 |
| Jordan | 26 factories in Jordan | 1989 |
| | Coffee grinding shops | 2020 |
| | Noise from diesel particulate filters | 2020 |
| | Queen alia international airport, Amman | 1989 |
| | Risk to health awareness assessment | 2019 |
| | Urban zones | 2001, 2004, 2005, 2008, 2010, 2012, 2015, 2021 |
| | Urban zones W/O barrier | 2006 |

**Table 4.** *Cont.*

| Country | Case Study | Year |
|---|---|---|
| KSA | 20 schools in Jeddah | 1994 |
| | Hospitals | 1991 |
| | Impact of work noise on worker health | 1990, 2004, 2013, 2014 |
| | Urban zones | 1983, 1989, 1993, 2010, 2011, 2016, 2021 |
| | Urban zones (El Haje) | 2010, 2012 |
| Kuwait | Construction projects | 2004 |
| | Impact of work noise on worker health | 2000, 2003, 2021 |
| | Risk to health awareness assessment | 2003 |
| | Urban zones | 1990, 1999, 2001, 2002, 2009, 2011, 2014, 2020, 2021 |
| Lebanon | Urban zones | 2001, 2003, 2012 |
| | The port of Tripoli | 2016 |
| Libya | Tajoura reverse osmosis desalination plant | 2016 |
| Morocco | Wind farm | 2018 |
| Oman | International airport | 2022 |
| | Urban zones | 1999, 2020, 2021 |
| Palestine | Hospitals | 2013 |
| | Urban zones | 2000 |
| Qatar | Urban zones | 2022 |
| Sudan | Urban zones | 2011 |
| Tunisia | Electricity production company | 2019 |
| | Urban zones | 2012, 2019, 2020 |
| UAE | Two steel factories | 2012 |
| | Urban zones | 2010, 2012, 2016, 2017, 2019, 2021, 2022 |

#### 3.6.4. Noise Sources

The data from this study show that urban noise, in particular traffic noise, was the most studied noise source in 55.43% of the studies conducted (see Figure 9), followed by industrial noise in 15.22%. Aircraft noise was studied in 7.61% of studies, and traffic noise was studied in 5.36% of studies. Other sources of noise such as indoor noise, generator noise, construction noise, and other noise sources were each investigated in less than three studies. Other sources of noise such as public broadcasting systems, wind farms, and harbors were each examined in only one study.

Table 5 provides a list of the different sources of noise, the Arab countries where studies on their impact on noise pollution have been carried out, and the corresponding years of study. The main sources of noise identified in this study include aircraft, construction projects, power generators, industrial facilities, interior noise, diesel particulate filter noise, ports, railways, public address systems, road traffic, urban noise, urban parking lots, and wind farms.

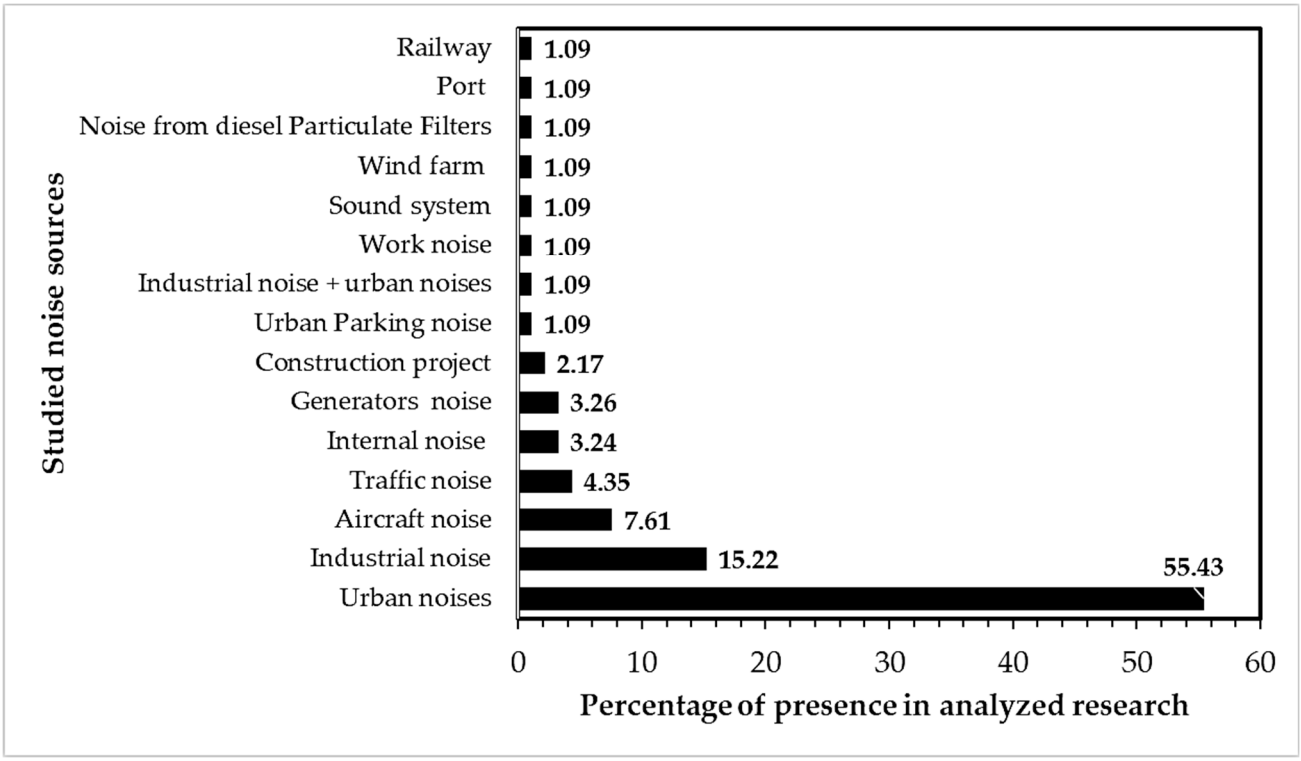


**Figure 9.** Studied noise sources in the Arab region (percentage).

**Table 5.** Study of noise sources in the Arab world over the years.

| Noise Source | Country | Years |
|---|---|---|
| Aircraft noise | Algeria | 2013 |
| | KSA | 2013 |
| | Kuwait | 2009 |
| | Oman | 2021, 2022 |
| | UAE | 2012, 2022 |
| Noise from construction work | Kuwait | 2003, 2004 |
| Generator noise | Iraq | 2020, 2021 |
| Industrial noise | Algeria | 2016, 2018, 2021 |
| | Jordan | 1989, 2020 |
| | KSA | 1990, 2003, 2004, 2014 |
| | Kuwait | 2000, 2021 |
| | Libya | 2016 |
| | Oman | 2021 |
| | Tunisia | 2019 |
| | UAE | 2012 |
| | Morocco | 2018 |

**Table 5.** *Cont.*

| Noise Source | Country | Years |
|---|---|---|
| Internal noise | Iraq | 2020 |
| | KSA | 1991 |
| Noise from construction work | Egypt | 2011 |
| Noise from diesel particulate filters | Jordan | 2020 |
| Port noise | Lebanon | 2016 |
| Railway | Kuwait | 2020 |
| Sound systems | Egypt | 2022 |
| Traffic noise | Algeria | 2021 |
| | Jordan | 2005 |
| | KSA | 2016 |
| | Sudan | 2011 |
| Urban noise | KSA | 2012 |
| | Lebanon | 2003 |
| | KSA | 1994 |
| | Palestine | 2013 |
| | Algeria | 2020 |
| | Egypt | 2003, 2013 |
| | Iraq | 2010, 2021, 2022 |
| | Jordan | 1989, 2001, 2004, 2006, 2008, 2010, 2012, 2015, 2021 |
| | Kuwait | 1999, 2001, 2002, 2003, 2009, 2011, 2014, 2021 |
| | Lebanon | 2012 |
| | Oman | 1999, 2020 |
| | Palestine | 2000 |
| | Qatar | 2022 |
| | Tunisia | 2012, 2019, 2020 |
| | UAE | 2010, 2016, 2017, 2019, 2021 |
| Urban parking noise | Lebanon | 2001 |
| Work noise | Egypt | 2013 |

Many countries, such as Jordan, Saudi Arabia, Kuwait, and the UAE, have conducted studies on various sources of noise. Jordan has conducted studies on noise from aircraft, industrial equipment, traffic, and various types of urban noise sources. KSA investigated aircraft, generators, industrial facilities, traffic, and urban noise sources. Kuwait conducted research on construction projects, generators, industrial facilities, traffic, and sources of urban noise. The United Arab Emirates has conducted research on aircraft, indoor noise, and various types of urban noise sources. Other countries focus on specific noise sources. For example, noise from ports and urban car parks has been studied in Lebanon, and noise from wind farms has been studied in Morocco. Overall, the table shows that noise pollution is a pervasive problem in the Arab world, contributed to by a variety of sources.

### *3.7. Methods of Studying Noise in the Analyzed Articles*

Since 1983, several methods have been adopted to measure and analyze ambient noise (see Table 6). The oldest and most widely used method is noise measurement (in situ noise monitoring), which provides objective data on sound levels. In 1990, noise

mapping (visualization of noise levels across an area, providing a spatial representation of noise pollution) was used for the first time in Kuwait in a study titled "Noise control: Experimental research in Kuwait" [48], followed by the use of questionnaires in 1993 by Koushki, P.A. et al. in a study in Riyadh, Saudi Arabia, to collect information on people's attitudes and perceptions towards noise and its consequences [49]. During the 2000s, noise mapping became more common [50,51]. Noise simulation and GIS techniques have also been used to model traffic and wind turbine noise, often in conjunction with noise measurement, noise mapping, and statistical analysis. Clinical tests and questionnaires have also recently been used to assess the impact of noise on health [50,52–54]. Many researchers have combined different methods in their studies to understand noise pollution in all its facets and have a more global view of this research topic in the Arab world [15,51,55,56].

**Table 6.** Research methods used in the studied articles.

| Method Used. | Number of Uses |
|---|---|
| Noise measurement | 34 |
| Noise mapping | 8 |
| Surveys | 9 |
| Noise simulation | 2 |
| Noise measurement + surveys | 25 |
| Noise measurement + noise mapping | 12 |
| Noise measurement + sound recording | 1 |
| Noise measurement + clinical measurements + surveys | 6 |
| Noise measurement + noise mapping + GIS techniques | 1 |
| Noise measurement + GIS techniques | 2 |
| Noise measurement + noise mapping + surveys | 4 |

## 4. Discussion

### *4.1. Synthesizing the Findings*

The analysis of scientific publications on noise pollution in the Arab world reveals a trend of an increasing number of articles, although the interest in this topic varies considerably from one country to another. While some Arab countries like Jordan, Kuwait, and Saudi Arabia have a long tradition of contributions in this field (see Figure 10), others such as Comoros, Djibouti, Somalia, Syria, Yemen, and Mauritania have not yet recorded any publications on this subject in the Scopus database. This disparity could be attributed to the attention given to other research areas deemed more urgent in these countries, where instability and conflicts are often predominant. It is plausible that the allocation of resources and research efforts is directed towards addressing more pressing issues in their local contexts than the question of the sound environment, which may be perceived as a luxury science in some countries, despite its strong relationship not only with comfort but also with public health. It is also noteworthy that the average annual number of publications remains significantly limited, especially compared to other regions such as Europe [21,39,40].

Furthermore, only 16% of studies on noise pollution in the Arab world are funded by European and American sponsors, with no contributions from Arab sponsors, even in the wealthiest countries in the region. This highlights the need for increased support from sponsors and local governments to encourage researchers to focus on this important topic. Moreover, no specialized institution is dedicated to this issue in the region, and published articles come from various departments, including civil engineering, architecture, and environmental engineering. Additionally, researchers seem to operate in isolation, without apparent collaboration among themselves or with local institutions, which could

limit scientific production in this field and hinder the development of a national or regional research strategy.

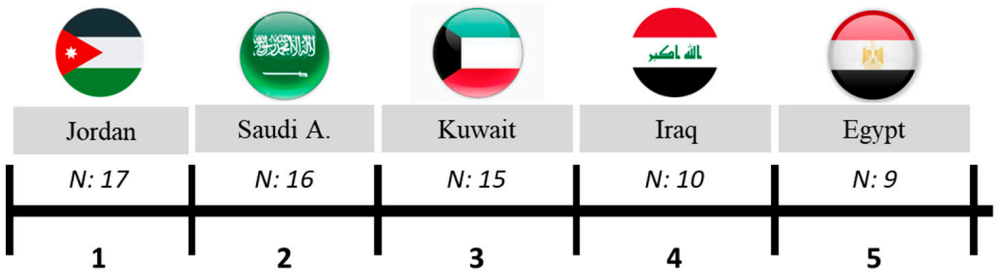


**Figure 10.** The top five countries with the highest number of publications on noise pollution.

Research on noise pollution in the Arab world primarily focuses on urban noise, followed by workplace noise, while topics such as building noise and health effects are less frequently addressed, with a weaker presence in publications. Countries like Saudi Arabia, Kuwait, and Jordan have addressed a large number of topics related to noise pollution, focusing primarily on urban noise and noise in sensitive buildings such as hospitals and schools, as well as the impact of noise on the health of workers and students. However, the number and nature of research topics on noise pollution vary considerably in other Arab countries, and additional studies are needed to understand the logic behind the selection of these topics. Additionally, researchers have addressed the issue of environmental noise from the perspective of nuisance sources and the assessment of the degree of noise pollution. This is evident from central keywords such as "noise", "noise pollution", and "annoyance", which highlight the negative perspective of noise perception. However, the positive side of sound perception, which may be related to certain sound sources, is weakly present in some studies attempting to understand the soundscape. Moreover, studies have also examined environmental quality, including noise pollution, by coupling the assessment of air pollution with that of noise pollution. Hence, keywords related to air quality are also found.

Regarding the cities studied, major cities in the region such as Kuwait, Jeddah, and Cairo are the most studied in terms of noise pollution, followed by other cities and capitals like Amman, Beirut, Sfax, Irbid, Baghdad, Riyadh, Abu Dhabi, Sharjah, Dubai, Muscat, and Mecca. Urban areas are the most studied, followed by industrial areas, airports, universities, construction sites, hospitals, schools, and commercial areas. In contrast, noise pollution from ports is the least studied topic in the Arab world, having been addressed in only one study in Lebanon. The methods used to measure and analyze environmental noise in Arab countries have evolved over time, with noise measurement being the oldest and most widely used method. Other methods such as sound mapping, questionnaires, statistical analysis, noise simulation, GIS techniques, clinical tests, and questionnaires have also been used to provide a more comprehensive understanding of the issue. Many researchers have combined different methods in their studies to understand noise pollution in all its facets.

### *4.2. Strengths and Limitations of this Study*

This study has several strengths, including a systematic review approach that ensures an objective and comprehensive assessment of the literature on noise pollution in the Arab world. In addition, the study used a large reputable database (Scopus) to collect the relevant literature. The emphasis on peer-reviewed research articles allowed for the analysis of high-quality research studies. This study also used bibliometric data and VOSviewer software to analyze and visualize networks of coexistence, collaboration, and research fronts, providing insight into the current state of research and potential research directions. The relatively long duration (40 years) of the analyzed literature provided a comprehensive historical perspective and highlighted trends and changes over time. Finally, the results of

this research can be used to guide future research efforts and inform policies and strategies for managing and reducing the effects of noise pollution in the Arab world. However, it is important to note that this study also has several limitations. More importantly, the findings may not provide a comprehensive overview of the existing literature on noise pollution in the Arab world. This limitation arises from our exclusive reliance on studies available in the Scopus database, which resulted in the exclusion of research from other databases such as the Web of Science or PubMed, as well as the gray literature. Conducting systematic reviews using additional scientific databases is necessary, as it would enhance this study and provide a comprehensive overview of the scientific landscape addressed in this paper. Moreover, our inclusion criteria were limited to studies published in peer-reviewed journals, potentially disregarding valuable insights from alternative sources such as conference proceedings or books [57–59]. Finally, relevant studies were selected only on the basis of the title, keywords, and abstract, which could lead to the exclusion of studies that did not use these terms in the abstract or title.

## 5. A Research Agenda to Study Urban Noise Pollution in the Arab World

In the section dedicated to the research agenda, the primary findings of this study reveal a relatively low publication rate concerning noise pollution in the Arab world, characterized by a modest number of annual publications. Although signs of progression may be discerned, particular attention must be paid to the enhancement of this trend. With this aim in mind, the present section endeavors to formulate a comprehensive research agenda, structured around guiding questions intended to steer future inquiries on this subject. The objective is to contribute significantly through a thorough evaluation of the existing scientific literary landscape. The specific lines of research are organized into five distinct categories, each aiming to illuminate a specific aspect of this vast and multidisciplinary field of research:

1. Health and economic impacts: Future research should prioritize investigating the effects of noise pollution on human health and well-being, particularly among vulnerable groups such as the elderly, children, and individuals with specific health conditions susceptible to noise-related harm as well as assessing the economic costs associated with noise-related health issues and loss of productivity. These studies can inform the development of targeted policies and interventions aimed at mitigating adverse health outcomes associated with noise exposure.
2. Environmental impacts: There is a pressing need to expand research efforts to examine the effects of noise pollution on the environment and wildlife. This includes studying the ecological consequences of noise pollution on biodiversity and ecosystem health. Understanding these impacts can guide the implementation of effective mitigation strategies and policies.
3. Policy and legal framework: This research axis concentrates on examining the political and legislative context surrounding noise pollution in the Arab world. It seeks to analyze existing policies and regulations related to noise pollution, identify gaps or areas for improvement, and propose strategies for effective enforcement. Furthermore, this axis advocates for public awareness campaigns and community engagement initiatives to foster compliance with noise pollution regulations. It should be noted that an article on this subject is already available online [21].
4. Socio-economic and cultural influences: This research axis investigates the socio-economic and cultural factors shaping perceptions and responses to noise pollution in the Arab world. It aims to assess the socio-economic impacts of noise pollution, explore cultural attitudes towards noise, and understand how urbanization and cultural practices influence noise levels. Additionally, this axis proposes culturally sensitive interventions to address noise pollution in diverse Arabic-speaking communities.
5. Evaluation of intervention effectiveness: Future research should focus on evaluating the effectiveness of noise pollution interventions and policies implemented in the Arab world. This includes assessing the impact of noise abatement techniques, noise

barriers, and land use planning strategies. By evaluating the outcomes of these interventions, policymakers can identify the most effective strategies for mitigating noise pollution in various contexts.

6. Identification of unique noise sources: Future research should pay attention to investigating the various sources of noise pollution in the Arab world, particularly those that are unique to the region, such as diesel generators used extensively in countries experiencing unstable electricity supply, such as Lebanon and Iraq. By gaining a better understanding of these sources, researchers can develop targeted strategies and interventions to address specific sources of noise pollution effectively.

Collaborative interdisciplinary research is urgently needed to address noise pollution in the Arab world. By integrating disciplines such as acoustics, environmental sciences, engineering, public health, and social sciences, we can better understand the complex factors contributing to this issue and develop more effective interventions. These research efforts aim to improve urban residents' quality of life and protect public health, especially for vulnerable demographics. Through comprehensive identification of noise sources, evaluation of their health and environmental impacts, and formulation of regionally tailored mitigation strategies, we strive to create a safer and healthier sonic environment for all inhabitants in the Arab region.

## 6. Conclusions

In conclusion, due to the detrimental impacts of noise pollution on both human health and the environment, it has emerged as a foremost challenge faced by communities worldwide, increasingly drawing attention, notably in developed countries. However, a noteworthy gap persists in terms of research dedicated to this issue, particularly within developing countries such as those in the Arab region. This dearth of comprehensive investigation prompted the initiation of the present bibliometric study, encompassing an analysis of 104 scientific articles spanning from 1983 to 2022 and originating from 22 Arab nations. The findings of this study underscore the significant involvement of certain countries in addressing noise pollution. Saudi Arabia, Jordan, and Kuwait emerge as frontrunners in noise pollution research, while Sudan and Libya exhibit comparably lower contributions in this domain. As demonstrated, this study outlines the escalating significance of noise pollution research within the Arab world, particularly in recent years. However, it remains evident that the proportion of research dedicated to this subject, when contrasted with other countries, remains notably limited.

Given these insights, this study's outcomes underscore the pressing need for the endorsement and sustenance of research endeavors within this realm. To comprehensively address and mitigate the detrimental impacts of noise pollution on health and the environment in the Arab region, concerted efforts are imperative. Drawing inspiration from research endeavors in developed countries and tailoring them to the unique challenges of Arab nations holds the promise of fostering effective strategies.

In essence, this study serves as a call to action, urging the reinforcement of noise pollution research across the Arab world. By investing in comprehensive studies, informed policymaking, and cross-disciplinary collaborations, Arab countries can contribute significantly to curbing the negative effects of noise pollution and enhancing the quality of life for their citizens, aligning with the global pursuit of a healthier and more sustainable environment.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16114350/s1, PRISMA 2020 Checklist [60].

**Author Contributions:** T.A.K.B., D.B., J.M.B.M., G.R.-G. and D.M.G. contributed to the study conception and design. Data collection was performed by T.A.K.B. and D.B. T.A.K.B., D.B., J.M.B.M., G.R.-G. and D.M.G. contributed to data analysis. The first draft of this manuscript was written by T.A.K.B. and D.B., and all authors commented on previous versions of this manuscript. All authors have read and agreed to the published version of the manuscript.

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