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ENVIRONMENTAL NOISE IN HOSPITALS: A RAPID REVIEW OF TRENDS AND POSSIBLE DEVELOPMENTS

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ABSTRACT

Research interest in noise in hospital environments has been growing significantly over the years. This is probably due to several aspects, among them: firstly, the concern expressed by the World Health Organization (WHO) about the effects that noise can have on people; secondly, the scientific evidence that has highlighted how noise can affect the clinical outcomes of patients and the work performance of staff.
The studies that can be found in literature are numerous. Some focus on the detection and quantification of noise; others investigate the correlation between noise and physical or psychophysical parameters; still others evaluate possible strategies to mitigate noise or improve the acoustic environment.
In this paper, a rapid review of the literature published from 2020 to 2024 and indexed in Scopus database is proposed in order to assess research trends and outline possible future developments in the topic.

Keywords: *noise, acoustic quality, hospital environment, healthcare facilities, systematic review*

1. INTRODUCTION

The World Health Organization's (WHO) concern about the issue of noise in hospitals is reflected by a growing interest of the scientific community in investigating this field. According to the WHO, noise can directly affect people's health, especially the health of vulnerable people such as children, the elderly and people who are ill or hospitalized [1].
In hospitals, noise can have direct effects on the health and well-being of patients and staff [2-3].
Numerous scientific researches have highlighted how in-patient environment can affect the recovery process of patients [4]. Patients have an increased sensitivity to noise due to their particular condition. For this reason, any unnecessary sound should be avoided in hospital wards [5].
For this reason, the WHO has defined desirable sound pressure levels within healthcare environments attended by patients. Specifically, L_{Aeq} should not exceed 30 dBA and L_{Amax} should not exceed 40 dBA [6].
Unfortunately, noise levels inside hospitals are usually much higher than the WHO standards and the noise levels are increasing year by year [7].
There are two systematic reviews in the literature concerning acoustic comfort and noise in hospital environments. These reviews show the state of the art up to the year 2020 [8-9].
Wallis and colleagues pointed out that from 2008 to 2018, few studies (14.5%) contained sufficient technical information to replicate environmental noise measurement processes. Most of the studies deal with sound pressure level measurements, in terms of daytime (6:00-22:00) A-weighted equivalent sound level ($L_{Aeq-16h}$), nighttime (22:00-6:00) A-weighted equivalent sound level (L_{Aeq-8h}) or maximum A-weighted sound level measured with Fast time weighting (L_{AFmax}), as proposed by the WHO. Furthermore, most studies focus on the measurement of sound pressure levels within

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intensive care units (ICU), using a sound level meter placed close to the patient's bedside. Other contexts, such as medical general wards, are neglected [8].
In the De Lima Andrade and colleagues' review, the keywords "noise" and "hospital" were used in the scientific databases of Scopus, Web of Science and Science Direct, considering the years from 2015 to 2020. This review shows how the topic is multidisciplinary, covering areas of interest in acoustics, but also medicine, physics, architecture and engineering. Furthermore, studies focusing on sound pressure levels measurements generally take place in a single hospital. The most examined areas are those with the most sensitive patients and the most critical sound levels, such as intensive care units (ICU). A considerable number of studies compare the measured sound levels with the recommended ones, without proposing strategies to contain these levels [9].
In both reviews, a lack of studies carried out within ordinary wards is noticeable. In addition, a lack of a shared and replicable field investigation method emerges, outlining a global problem, which concerns not only the issue of noise in hospital (problem to be solved), but also the scientific context (investigation method to be defined).
In order to gain a critical overview of new trends about this topic in recent years, our rapid literature review focused on the period between 2020 and 2024. This review was performed as a complementary part of the literature study conducted during three years of a PhD Programme. During these years, the PhD project dealt with the improvement of in-patient acoustic comfort during the recovery process.

2. METHODS

Starting from the main topic "acoustic quality and noise in healthcare environments", our research focuses on medical general wards in order to improve the acoustic comfort of the patient during the recovery process.
To perform the rapid literature review (RLR), keywords were chosen (noise, acoustic comfort, acoustics, hospital, healthcare facilities) and combined by means of logical operators (AND, OR, (...), '...').
The rapid review can be used to get a overview of a specific topic. In this paper, we will show a preliminary review performed in the Scopus database only, using the following filters:

- Only articles published between 2020 and 2024.
- Papers belonging to each area of interest.
- Only scientific articles in their final state.
- Only English language papers.
- Only Open access publications.

Additional filters were applied to the identified articles: first filter deleted all duplicate papers; second filter excluded all papers with titles outside the research context; third filter excluded all papers with abstracts not satisfying the research objective.

3. RESULTS

The rapid literature review of the Scopus-indexed articles published between 2020 and 2024 identified 43 papers on the "acoustic quality and noise in healthcare environments" topic [10-52]. A critical analysis of these papers was carried out covering both general aspects, such as the geographical location of the research groups and fields of interest of the journals, and content-specific aspects.
Over the last five years, the country that has most addressed the issue of acoustic well-being in hospitals is China (22%), followed by Turkey (12%), and then Italy (7%), Australia (7%), USA (5%), Iran (5%), Netherlands (5%), UK (5%), Jordan (5%) and India (5%). To a lesser extent Africa (2%), Austria (2%), Belgium (2%), Brazil (2%), Canada (2%), Denmark (2%), New Zealand (2%), Portugal (2%), Spain (2%) and Sultan Qaboos (2%) (grouped in "Other" (22%), in Fig. 1).

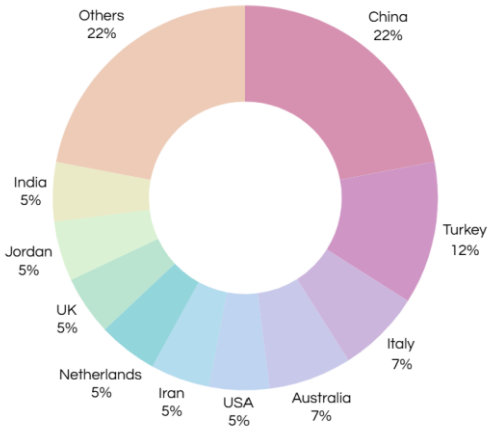

Figure 1. Scientific research on the topic (2020-20204) - geographical origin.

In Fig. 2 are shown the journals fields of interest. The journals fields of interest are Medicine (26%), Acoustics (23%), Architecture and Engineering (16%), Nursing (14%), multidisciplinary journals (10%), and Pediatrics

(5%). In addition, journals on social work (2%), environmental science (2%) and psychology (2%) also appear (grouped in "Other" (6%), in Fig. 2).

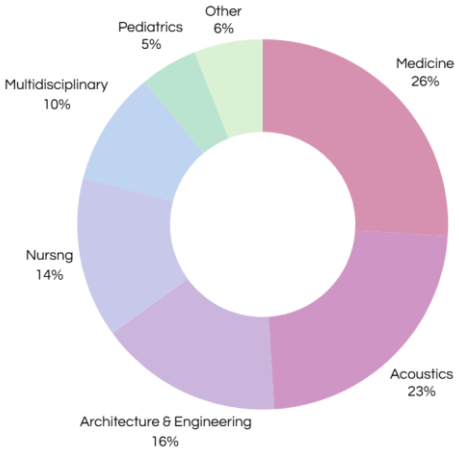

Figure 2. Scientific research on the topic (2020-20204) - Journals fields of interest.

From the review of the literature, several focuses emerge. There are many studies dealing with the effects of noise on users in general (9%), or specifically on patients (19%) or staff (19%). This is followed by studies dealing with noise measurements (14%), and those concerning possible intervention strategies (12%) or their application in a single case study (12%). Some articles deal with the effectiveness of using music and music therapy (7%) to reduce detrimental effect of noise. Finally, further researches focus on the identification of best practices B.P. (2%) or occupant behavior O.B. (2%), comparison of international acoustic standards (2%), and effects of alarms emission (2%).

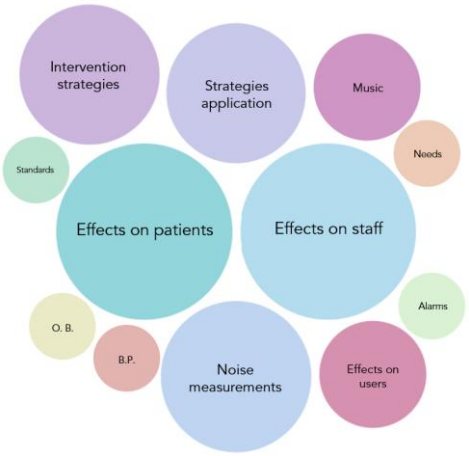

Figure 3. Scientific research on the topic (2020-20204) – Research focus.

In addition, the systematic review allowed the comparison of the hospital areas that are mainly addressed in the research between 2020 and 2024.
Most of the research took place in inpatient wards (30%), followed by intensive care units ICU (14%), neonatal intensive care units NICU (12%), various areas (13%), and operating theatres (7%). In addition, some studies were carried out in the Emergency Department (5%), the Surgery Department (5%) and in private clinics (5%). To a lesser extent, some studies took place in Radiotherapy (2%), nursing homes (2%), recovery rooms (2%) and rehabilitation centers (2%) (grouped in "Other" (8%), in Fig. 4).

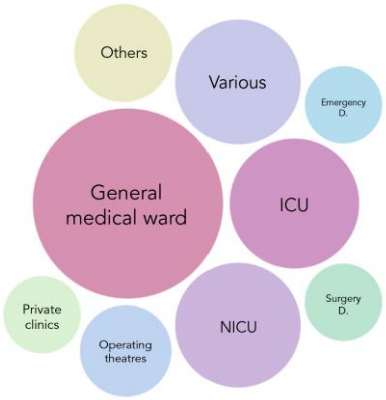

Figure 4. Scientific research on the topic (2020-20204) - most investigated hospital areas.

4. DISCUSSIONS

The literature review shows that the journals dealing with the topic of noise in hospitals are varied, highlighting how this topic is characterised by a marked multidisciplinarity. The multidisciplinarity of the sources is also reflected by the authors' field of interest. These results are in line with what was reported by De Lima and colleagues in 2021, with Medicine and Architecture in first place [9].
The presence of different areas of interest is probably due to the complexity of the topic, which encompasses physical and psychophysical health, metrological, design, management and behavioral aspects.
A comparison of the results with what was published in the last systematic reviews [8-9] shows that in recent years

there has been an increasing interest in the topic by Acoustics journals. Furthermore, there is an interesting shift in research interest towards places that were little investigated in 2020, such as general medical ward. The increase in publications in acoustics journals coupled with the interest in general medical ward probably reflects the intention of the scientific community to address the lack of a replicable measurement protocol for assessing these types of environments that has emerged in previous literature reviews. Despite this, the literature shows that some choices within the survey protocol are still not clearly specified. Furthermore, the assessment of the acoustic quality of the medical general ward is still limited to the detection of sound pressure levels.
Another interesting aspect that emerges comparing the results with those of previous literature reviews is the increase in the number of studies dealing with possible solutions and their applications in real-contexts. Unfortunately, no studies have been found in the literature that deal with investigating the needs of users and their subjective experience in defining intervention strategies.

5. CONCLUSIONS

Interest in the subject of noise in hospitals has been growing year by year. This growth in interest is probably due to the numerous published evidences concerning the effects of noise on people.
Within inpatient wards, noise exposure can influence the recovery process of patients.
In the latest published reviews on the "noise in hospitals" topic, there was a lack of studies on medical general wards, compared to other critical environments such as intensive care units ICU. Furthermore, the latest literature reviews highlighted the lack of both a replicable survey protocol to assess acoustic in general medical wards and studies proposing strategies to address the noise problem.
This paper showed part of the results of the rapid literature review conducted during a doctoral course. The review was conducted within the Scopus database, regarding papers published between 2020 and 2024.
From the analysis of the literature, the multidisciplinary nature of the topic has been confirmed, and some trend changes that have occurred in the past 5 years have been identified.
Compared with 2020, there has been an increase in the number of studies conducted in general medical wards with the purpose of proposing survey methodologies and solution strategies. This result shows a shared intention of the scientific community to fill what was a scientific gap in the past.
Some areas for further investigation have been identified, such as: making choices within survey protocols more explicit; using additional methods to support the monitoring of sound pressure levels in the acoustic assessment of hospital wards; and investigating user needs for the definition of noise mitigation strategies.

6. LIMITATIONS OF THE STUDY AND FUTURE DEVELOPMENTS

This study was conducted by a single group of researchers by analyzing the Scopus data base only.
Future developments of the study will include a focus on papers dealing with the effect of noise on hospital staff. In addition, the Web of Science and Science Direct databases will be included.

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