A Review of the Impact of Noise Pollution on Students in Architecture Studios in Universities

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ABSTRACTS

Noise is everywhere in varying degrees and its effects are debilitating. The adverse effects of noise pollution on human health are well-documented, encompassing various physical, psychological, and social dimensions. This research endeavours to review the impact of noise pollution on students specifically within architecture studios in universities. Architectural studios are recognized as pivotal environments where students invest a substantial amount of time whilst training to become an architect. Through an extensive literature review, the study observed the multifaceted repercussions of exposure to noise pollution spanning: physical ailments such as hearing impairment, stress, and sleep disturbances; psychological manifestations including reduced concentration and irritability; as well as social ramifications like communication barriers and decreased job satisfaction. Given the critical importance of understanding noise pollution within architectural studios, the study concludes that noise has severe effects on health and well-being of architecture students, and recommends for the implementation of noise level assessments to provide crucial insights into the prevailing conditions within university architecture studios.

Keywords: *Noise, Noise Pollution, Health Effects, Architectural Studios, Learning Environment, Universities, South-East Nigeria.*

1. INTRODUCTION

Numerous scholarly investigations [1] [2] [3] [4] [5] have defined noise pollutants as unwelcome or excessive sounds that disrupt daily activities or upset the natural equilibrium of an environment. Predominantly originating from human activities, noise disproportionately affects urban dwellers, with its prevalence increasingly pervasive, particularly in developing nations, infiltrating educational settings [6].

The adverse impact of noise pollution on human health manifests in various forms, encompassing hearing impairment, disrupted sleep patterns, and heightened stress levels [7] [8] [9] [10]. Correspondingly, Kiernan [11] observed that even low levels of noise detrimentally affect human well-being, potentially leading to hypertension, sleep disturbances, or hindering cognitive development in children. Prolonged exposure to excessive noise carries severe ramifications, including mental health disorders and irreversible memory decline [12]. Studies have underscored the multitude of negative consequences stemming from sudden or prolonged exposure to excessive noise. Despite its insidious nature, little concerted effort has been directed towards ameliorating noise levels in educational environments, particularly within architectural studios in Nigeria.

In architectural studios, students engage in learning various skills either under the guidance of their instructor or independently. According to Corona-Martinez [13], designing within the architectural studio is deemed a fundamental skill crucial for aspiring architects. Thus, the studio serves as a pivotal component in nurturing the development of proficient designers. Additionally, Ledewitz [14] underscores the architectural studio as a physical environment where students are primarily introduced to new concepts, skills (such as visualization and representation), and architectural thinking, all integral to architectural education. Pedagogically, some scholars argue that the interactions between students and instructors within the architectural studio foster a conducive learning atmosphere [15] [16]. Students amalgamate knowledge and skills acquired from other courses within the architectural studio [13] [17] [18], often leading to prolonged stays, with instances of students even residing within their studios in certain institutions. Consequently, among all the classrooms within the university, the architectural studio emerges as the space where students dedicate the most time to studying and working. Therefore, exposure to excessive noise within this critical learning environment can have detrimental effects on students' hearing, learning, physical, and mental health [19].

Addressing noise pollution issues in classrooms, particularly within architectural studios, is imperative to provide students with a healthy and supportive learning environment. Unlike conventional classroom settings, the impacts of noise pollution on health and well-being in architectural studios remain inadequately explored. For architectural educators seeking to enhance teaching and learning within these spaces, these knowledge gaps pose a challenge as they hinder the comprehensive understanding of both instructors' and students' experiences in the studio. Understanding the effects of noise pollution on individuals' health and well-being in architectural studios is crucial for several reasons. Firstly, as spaces where professionals and students spend substantial amounts of time, exposure to loud noises can result in fatigue, stress, and hearing impairment. Secondly, noise can disrupt concentration and communication—essential elements in design-related tasks. Lastly, architects have a responsibility to design environments that promote sustainability and health, necessitating an understanding of how noise influences human well-being.

2. RELATED LITERATURES

2.1 Noise in schools

Noise pollution negatively impacts learning by directly affecting information processing and indirectly influencing teachers, students, and classroom communication dynamics. Shield and Dockrell [20] emphasize that the primary function of a classroom is to foster an environment conducive to knowledge exchange between educators and learners. Previous research has investigated the long-term effects of noise exposure within school environments on the health of community members [21]. In addition to being bothersome, noise in educational settings impedes students' completion of academic tasks [22]. To facilitate effective learning, students must feel relaxed, comfortable, and safe [23]. A plethora of studies correlates noise levels with specific outcomes [24] [25] [26] [27], demonstrating that noisy environments directly impede learning, particularly in language and reading skills development, while also indirectly affecting students by causing agitation or distraction.

Noise affects students' behaviour and comprehension during class, with extremely noisy environments hindering learning and complicating instruction [28]. Elevated noise levels adversely impact students' verbal communication quality and intellectual development, resulting in learning difficulties spanning speaking, writing, reading comprehension, and vocabulary growth [29].

Prolonged exposure to noise diminishes cognitive performance [20]. Research links noisy environments to deficiencies in pre-reading skills [30], reading challenges [31] [32] [33], and broader cognitive impairments [34], suggesting that environmental noise pollution may contribute to developmental issues, particularly those concerning reading, speech, and language. These findings imply an increased likelihood of academic difficulties for students attending schools situated near continuous noise sources. In educational contexts, noise disrupts concentration and attention, as noted by Fernandez and Menendez [35], highlighting the significant role of inadequate acoustics in schools, which can lead to health issues for both educators and learners. Prolonged exposure to noise can compromise one's ability to discern sounds, thereby impacting academic performance [36]. The issue of noise in educational settings has predominantly focused on its broader impact on students' learning difficulties attributable to internal noise sources within schools. Further consequences of noise in educational settings include students' diminished focus, weakened reading and critical thinking abilities, and decreased academic performance [19].

2.2 Human and health implication of noise

Numerous scholarly investigations have revealed that noise pollution exerts widespread effects beyond auditory discomfort, impacting various physiological systems and mental well-being. These effects encompass cardiovascular disorders, endocrine disturbances, physical ailments, and emotional issues such as irritability, stress, and fatigue, both in occupational and domestic settings [37] [38] [3] [39]. Passchier-Vermeer [40] posits that noise-induced annoyance, characterized by feelings of resentment, dissatisfaction, and discomfort, arises when noise disrupts cognitive processes, emotions, or daily activities, a phenomenon frequently observed within educational environments.

Extensive research underscores the detrimental consequences of frequent and prolonged exposure to elevated noise levels on physical and mental health. These repercussions encompass irritability, ischemic heart disease, hypertension, hearing impairment, and sleep disturbances [41] [8] [42] [9] [10] [43]. Despite the severe impacts of noise pollution, its significance is often overlooked, yet it poses substantial threats to human and environmental well-being [44].

Moreover, loud noise exposure can induce tinnitus, a condition characterized by persistent ringing, buzzing, or clicking sounds in the ears, affecting millions of individuals, with severe cases significantly impairing daily functioning [45]. Notably, noise pollution extends its effects beyond auditory organs, manifesting in non-auditory repercussions measurable despite the absence of hearing impairment. These effects include elevated blood

pressure, sleep disturbances, altered respiratory patterns, changes in brain chemistry, and heightened cardiovascular stress, as outlined in the World Health Organization's community noise guidelines [3]. Such non-auditory effects can lead to social dysfunction, diminished productivity, impaired learning outcomes, increased substance use, and absenteeism from work or school. Coping with these effects may elicit negative social behaviours, irritability, fatigue, heightened agitation, and impaired mental health, highlighting the multifaceted impacts of noise pollution on human well-being and societal functioning.

Lopez [46] [47] and Moreno [48] have highlighted the adverse health implications of noise pollution, particularly emphasizing hearing impairment and bilateral symmetrical perception deafness as prominent outcomes. Environmental noise exposure can result in both auditory and non-auditory health effects. Auditory effects encompass issues such as sound masking and noise-induced hearing loss, while non-auditory effects include disturbances in sleep patterns, elevated blood pressure, cardiovascular diseases, and negative emotional states like annoyance, anger, disappointment, and depression [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60].

Concerning cognitive performance, noise exposure can significantly impact students' behaviour and comprehension, with excessively noisy environments impeding learning and prolonging instructional time. Various studies [61] [62] [63] [64] [65] [66] [67] have explored the effects of ambient noise on learning outcomes and job performance, revealing potential detriments including cognitive impairment, pain, frustration, heightened arousal, communication difficulties, and annoyance. Additionally, noise exposure may disrupt sleep patterns and hinder performance [63] [64] [62] [61].

Epidemiological investigations [68] [69] [55] [70] [71] [72] [73] [74] have underscored the association between air pollution, noise exposure, and health outcomes such as hypertension, coronary heart disease, and myocardial infarction. Various psycho-physiological effects, including elevated vital parameters (e.g., body temperature, heart rate, blood pressure, and respiration rate), stress reactions, and sleep disturbances, have been linked to noise exposure [75] [76] [77] [78] [79] [80].

The most robust evidence regarding the detrimental health effects of ambient noise pertains to sleep disturbances, cognitive function, and annoyance, impacting both adults and children [81] [82]. Muscular and behavioural alterations following loud noise exposure have been documented, persisting over time [83]. Chiang and Lai [19] have outlined a range of psychological and physiological effects associated with noise exposure, including headache, tinnitus, facial pallor, dyspepsia, poor appetite, slowed movements, heart hypertrophy, and occupational hoarseness among teachers, along with feelings of anger and anxiety.

2.3 Types of noise pollution

According to Cirrus Research [84], various types of noise are identified, including low-frequency noise, intermittent noise, impulsive noise, and continuous noise. Within architectural studios, different noise pollutants are prevalent, such as continuous noise, which presents as a steady, uninterrupted sound from sources like HVAC systems, background music, or electronic devices. Impulsive noise, characterized by sudden bursts of sharp sounds, can arise from power tools or machinery like drills or saws. Low-frequency noise, typically below 200 Hz, poses challenges in control and can easily penetrate barriers, examples being traffic rumble or nearby construction activities. High-frequency noise, above 2000 Hz, is generated by electronic devices such as cell phone notifications or printers. Additionally, echo and reverberation, resulting from sound wave reflections off hard surfaces like concrete walls or floors, can contribute to noise buildup in large, open spaces. These diverse noise pollutants within architectural studios can detrimentally affect employees' health, well-being, and productivity. Hence, it is imperative for architectural studios to implement measures for mitigating noise pollution, which may include employing sound-absorbing materials, conducting regular equipment maintenance, and establishing guidelines to maintain appropriate noise levels.

3. MATERIALS AND METHODS

The review focused on the impact of noise pollutants on health and wellbeing in architectural studios. The specific inclusion criteria used for the selection procedure are addressed hereinafter.

The literature search was carried out from November 2022 to August 2023, which involved searching several electronic databases. Data sources comprised results of literature search of Web of Science, Scopus and Google Scholar; across different fields of interest, such as architecture, public health, environmental sciences, health sciences, psychology and sociology using terms such as *noise pollutants, noise pollution, environmental noise, effects, impacts, learning environment, classrooms, architectural studio, studio, school, school environment, health, wellbeing, factors affecting impact of noise, best practices* and relevant additional terms derived from the papers retrieved. In addition, the references of retrieved articles were scanned for additional relevant materials and earlier studies, significant in informing the investigation.

Priority was given to the reporting of empirical studies from peer-reviewed journals. There was no restriction to article publication dates. Articles were selected based on the title and the abstract; in cases of uncertainty, the

entire article was read. Consequently, the review was restricted full-text articles available or converted to English language while excluding monographs, book reviews, news items, duplicates, encyclopaedia articles and editorial. The review also includes hand search of reference lists of relevant sources to identify other studies of related interest as it was not possible to rely only on simple electronic search. The selection process was oriented by the distinction of the four different clusters of using Boolean operators, specific keywords combinations were identified for each cluster.

This narrative review establishes the effects of noise pollutants on health and wellbeing in architectural studios with a particular focus on the factors that impact noise pollutants. In additions, this paper also elucidates the best practices for reducing the impact of noise pollutants in architectural studios.

4. RESULTS AND DISCUSSION

The literature search was intentionally wide ranging including not only architectural studios but also classrooms in universities, colleges, secondary, primary and elementary schools. This was because all these spaces are learning environments and should be designed in accordance to WHO guidelines on noise.

The results of this review demonstrated that a well-designed architectural studio has the potential to impact on the health and wellbeing of occupants in several distinct ways, which include improving communication and collaboration, increasing concentration, efficiency and job satisfaction, reducing staff stress, fatigue and other possible negative outcomes, and improving occupants' health and wellbeing.

Exposure to noise pollutants in architectural studios can have a variety of negative effects on the health and well-being of occupants. These effects are categorised into physical, psychological and social effects.

4.1 Physical effects

Occupants' exposure to noise pollutants in architectural studios can have various physical effects on their health and well-being. These physical effects include:

a. *Hearing damage:* Researches have shown that prolonged exposure to high levels of noise can cause hearing loss or other hearing-related problems [46] [47] [48] [41] [8] [42] [9] [10] [43]. This can lead to difficulty in communicating and performing job tasks, as well as reduced quality of life.
b. *Stress and anxiety:* From the researches reviewed, it was discovered that noise pollution can cause stress and anxiety, leading to physical symptoms such as headaches, fatigue, and irritability [37] [38] [7] [39]. Chronic stress can also increase the risk of cardiovascular problems, digestive problems, and other health issues.
c. *Cardiovascular problems:* Studies have shown that exposure to high levels of noise pollution can increase the risk of cardiovascular problems such as hypertension, heart disease, and stroke [55] [56] [57]. This is because noise pollutants can cause the release of stress hormones that can raise blood pressure and disrupt normal heart rhythms.
d. *Sleep disturbances:* It was also observed from researches that noise pollutants can interfere with sleep patterns, leading to insomnia and other sleep-related problems [51] [52] [53] [54]. Lack of sleep can affect mood, productivity, and overall health.
e. *Physical discomfort:* Exposure to noise pollution can cause physical discomfort, such as headaches, muscle tension, and fatigue [83] [19]. This can affect job performance and overall well-being.

Generally, the physical ramifications of noise pollution in architectural studios are considerable and can detrimentally affect the health and well-being of studio occupants.

4.2 Psychological effects

Noise pollutants exposure in architectural studios can also have various psychological effects on the health and well-being of occupants. These psychological effects include:

a. *Stress and anxiety:* Noise pollutants can cause stress and anxiety, leading to psychological symptoms such as mood swings, irritability, and restlessness [37] [38] [3] [39]. Chronic stress can also increase the risk of mental health issues such as depression, anxiety, and burnout.
b. *Reduced concentration:* Noise pollutants can interfere with concentration, making it difficult for employees to focus on their work [85] [86] [25]. This can lead to reduced productivity and job performance.
c. *Irritability and aggression:* Exposure to excessive noise can also lead to irritability and aggression, as well as conflict between colleagues [87] [8] [42] [9]. This can create a negative work environment and impact overall job satisfaction.
d. *Decreased job satisfaction:* Chronic exposure to noise pollutants can lead to decreased job satisfaction and motivation, making it difficult for teachers to perform at their best and leading to reduced zeal to mentor the students. [88] [40] [89].

e. *Fatigue:* Noise pollutants can also lead to fatigue and exhaustion, which can impact overall health and well-being [90] [91] [92]. This can also make it difficult for employees to perform their job tasks effectively and safely.

Mostly, the psychological effects of noise pollution on health and well-being in architectural studios can be significant and can impact job satisfaction, productivity, and overall quality of life.

4.3 Social effects

Exposure to noise pollutants in architectural studios can also have various social effects on the health and well-being of employees. These include:

a. *Communication difficulties*: Excessive noise can make it difficult for teaching staff to communicate effectively to the students, leading to misunderstandings and reduced collaboration [61] [62] [63] [64] [65]. This can impact the studio dynamics and overall job performance.
b. *Reduced job satisfaction*: Chronic exposure to noise pollutants can lead to reduced job satisfaction and motivation, making it difficult for staff to perform at their best and leading to higher turnover rates [88] [40] [89]. This can also impact the social atmosphere of the workplace, as staff may feel less connected to their colleagues and more isolated.
c. *Conflict between colleagues*: Noise pollutants can also lead to irritability and aggression, as well as conflict between colleagues [93] [94] [83] [95]. This can create a negative work environment and impact overall job satisfaction.
d. *Decreased social interaction*: Exposure to excessive noise can also lead to employees avoiding social interaction, as they may find it difficult to communicate or feel too stressed and fatigued to engage with their colleagues [15] [16]. This can impact team dynamics and overall studio culture.
e. *Impacts on job performance*: Noise pollutants can also impact job performance and productivity, leading to delays or mistakes that can impact the work of the staff in the affected studio space [61] [62] [63] [64] [65] [66]. This can create tension and conflict within the architectural studio.

The social effects of noise pollutants on health and well-being in architectural studios can be consequential and can impact workplace culture, team dynamics, and overall job satisfaction.

CONCLUSION

This study concludes that noise has severe effects on health and well-being of students in schools, especially in architectural studios where students work for prolonged hours. The effects of noise pollution on health includes physical, psychological and social effects. Mitigating noise pollution in architectural studios is necessary in order to promote a healthy and productive work environment. This can be achieved by establishing guidelines that conform with global standards around appropriate noise levels. Hence, it is important for the university management to be aware of these effects of noise pollution on students in architectural studios and provide support and enabling environment where necessary to promote a healthy and productive work environment.

LIMITATIONS OF THE STUDY

This research adopts a literature review method in which data was collected from secondary and tertiary sources, and as such did not elicit user's perceptions in the architectural studios. As a result of this, there is need for a further study on assessment of noise pollution effects in architectural studios in universities. This will enable the collection of primary data for statistical analysis.

AREAS FOR FUTURE RESEARCH

There is need to assess current noise pollution levels in architectural studios of universities in South-East Nigeria

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