EXAMINING EFFECTS OF NOISE POLLUTION ON PSYCHOSOMATIC SYMPTOMS AMONG TEACHERS IN VIETNAM

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ABSTRACT

EXAMINING EFFECTS OF NOISE POLLUTION ON PSYCHOSOMATIC SYMPTOMS AMONG TEACHERS IN VIETNAM

Ryan Gabriel McDonough

Noise pollution is an environmental stressor with broad costs to society, both through its health impacts and its influence on the social environment. The health effects of noise pollution include changes in regulation of heart rate, blood pressure, and overall vascular health, in addition to effects on hearing. However, it is unclear whether these adverse effects result from noise exposure directly or from stress secondary to noise. Therefore, this study aimed to assess the impact of both exposure to noise and noise-related stress on psychosomatic symptoms in a sample of 1961 teachers in Vietnam. We measured noise-related stress with a 4-item self-report questionnaire and psychosomatic symptoms with a 10-item questionnaire, which assessed the frequency of symptoms including headaches, stomach aches, and back pain. We tested effects of noise exposure and noise-related perceived stress on psychosomatic symptoms in multiple regression analyses controlling for age, experience, gender, and grade level(s) taught. Data showed significant positive associations of reported noise exposure and noise-related perceived stress with psychosomatic symptoms. We also evaluated noise-related stress as a mediator of these relations and found both indirect and direct effects of noise exposure on psychosomatic symptoms, suggesting partial mediation. Findings highlight the

importance of both direct and indirect effects of noise exposure on the physical health of teachers in Vietnam. Both structural and individual-level factors likely drive psychosomatic complaints. Multi-level interventions may be needed to support teacher health. Such interventions could focus on reducing noise throughout the school system, as well as helping teachers modulate their stress.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The rise in urbanization and population density has led to a growing apprehension regarding noise issues. These concerns encompass social noise, including noise from activity and personal noise-emitting gadgets such as mobile phones and music players, as well as environmental noise attributed to factors like increased vehicular traffic, expanded rail and air transportation, disturbances from cinemas, and noise emissions from nearby industries (Raja et al., 2019). Noise pollution is most common in urban settings but can impact individuals living outside of major city centers as well. Approximately 22 million American workers encounter unsafe noise levels during their employment, resulting in an annual expenditure of around $242 million in compensation for hearing loss disability (Basner et al., 2014). Estimates suggest that approximately 20% of the land area in the United States is directly affected by traffic-related noise. Likewise, more than 80% of specific rural landscapes encounter heightened noise levels due to industrial energy extraction activities (Francis et al., 2012).

Noise is characterized by intensity, frequency, and duration, and can come from various sources. Decibels (dB) are commonly used to measure noise. Managing noise in educational settings is crucial as it can impact students and teachers negatively. Noise pollution, broadly described as unwanted or excessive noise, is a common environmental stressor (Francis et al., 2012). Noise pollution can be attributed to causes including expanding transportation networks, growing urban centers, and increased industrial activity (Goines & Hagler, 2007). Noise pollution holds significant implications for public health, and has been related to adverse health effects, emphasizing the importance of managing and minimizing chronic noise exposure (Basner, 2014).

Noise Regulations and Policy

Guidelines differ across regulatory bodies as to what level of noise constitutes noise pollution. For example, according to the American National Standards Institute (ANSI), the acceptable level of background noise in the classroom is 35 dB (A), and for efficient communication, the difference between background noise and the vocal signal emitted by the teacher must be more than 15 dB(A) (American National Standards Institute, (ANSI) 2002). Influential guidelines from the World Health Organization (WHO) also support the guidelines provided by the ANSI, advising individuals to maintain noise levels below 30 dB(A) in bedrooms during nighttime to ensure a high-quality sleep experience, and below 35 dB(A) in classrooms to produce a conductive sub-environment for teaching and learning (World Health Organization, 2010). In situations in which achieving the recommended guideline of 40 dB for the prevention of noise-related health issues is not immediately feasible, the WHO suggests an interim target of 55 dB for the equivalent A-weighted nighttime noise level outside (LAeq) (Munzel and Sørensen, 2016). As cities continuously grow, the population continues to expand as well, leading to increasing levels of noise in the surrounding environment caused by both road air traffic transportation services, as well as construction services (Goines & Hagler, 2007).

Unlike some more stringent guidelines, the US Occupational Safety and Health Administration (OSHA) advocates relatively lenient standards by establishing a permissible exposure limit of 90 dB(A); a level of noise comparable to a running vacuum cleaner. Nevertheless, per OSHA rules, employers are obligated to institute a hearing conservation program whenever workers experience exposure levels surpassing an

LAeq8h of 85 dB (i.e., the equivalent of a full 8-hour working day of consistent exposure to 85 dB noise on average).

Prevalence of Noise Exposure

As per a European Union (EU) report, over 56 million people (54%) in the EU, residing in areas with 250,000+ inhabitants, face health risks due to road traffic noise exceeding 55 dB annually (Basner, 2014). During daytime, around 20% of the population is subjected to noise levels exceeding 65 dB(A), and at night, over 30% experience noise levels higher than 55 dB(A). Comprehensive global data is scarce regarding the health effects of environmental noise, with preliminary estimates published by WHO in 2011 being the primary source of information available (World Health Organization, 2010). According to the Environmental Protection Agency report on environmental impact on human health, Paris, Rome, and London residents experience less noise-related issues than those in other European capitals (Shushunova et al., 2020). Globally, cities like New York, Calcutta, Karachi, Moscow, and Tokyo rank as the noisiest (Shushunova et al., 2020). In Moscow, primary noise sources include highways, airports, metro sections, trains, power plants, and construction sites (accounting for up to 80% of noise pollution) (Shushunova et al., 2020).

Social Costs of Noise Pollution

Noise pollution has broad costs to society through its health impacts, but also generates significant costs through its influence on the social and economic environment. For example, various studies assessing the costs of noise pollution have examined the economic impact of aircraft noise on nearby communities. These studies provide differing empirical estimates of the cost of aircraft noise as a percentage of property

value. Notably, research has shown that the effect of noise on property value varies depending on the type of property, with higher-value properties experiencing a more significant impact (Lazic & Golaszewski, 2006). Data indicate that the percent change in property value per one-decibel increase in noise level was estimated at 0.65 percent for detached houses, 0.90 percent for condominiums, and 0.16 percent for vacant land.

Noise Effects on Hearing

The most well-documented consequence of noise pollution is its direct effect on hearing. In industrial settings, exposure to a continuous level of noise between 85–90 dBA can progressively deteriorate hearing in the long term and lead to a heightened auditory sensitivity threshold which may increase susceptibility to future damage (Stansfeld & Matheson, 2003). The most common disorder stemming from chronic exposure to elevated noise is tinnitus, which has a high rate of comorbidity with hearing loss more broadly (Basner et al., 2014). Hearing loss can create difficulties for occupational functioning, and undiagnosed hearing loss has also been associated with accidents and falls, and associated increases to mortality risk. Noise-induced hearing loss is commonly associated with industrial environments, and individuals engaged in alternative professions like musicians or those within the military also significantly contribute to the collective impact of noise-induced hearing loss. Even with the implementation of hearing protection guidelines, the decrease in workplace noise exposure in developed nations, and significant public health initiatives, the issue of work-related hearing loss persists and continues to be a subject of comprehensive investigation. Exposure to noise pollution can also significantly impact both physical and mental health (Stansfeld & Matheson, 2003; Tan, 2021).

Noise as a Physiological and Psychological Stressor

Noise pollution exposure also operates as a physiological and psychological stressor that can negatively affect physical and mental health. According to a literature review carried out by Wokekoro (2020), noise pollution can lead to a range of adverse effects beyond hearing impairment, including disturbances in sleep patterns, cardiovascular issues, limitations in social functioning, decreased occupational efficiency, undesirable social conduct, feelings of irritation, higher rates of absenteeism, and a heightened risk of accidents. Additionally, it diminishes the ability of property owners and occupants to enjoy peaceful surroundings and leisure activities, while also elevating the occurrence of antisocial behaviors (Wokekoro, 2020). In a separate literature review conducted by Caswell in 2022, substantial evidence indicates that excessive noise has detrimental effects on both sleep quality and cognitive function. Moreover, it has been associated with a higher likelihood of developing hypertension and cardiovascular diseases across studies (Caswell, 2022).

Researchers have also devoted considerable attention to the impacts of noise on health at the individual level. Noise exposure triggers physiological arousal, which entails heightened heart rate and blood pressure, and peripheral vasoconstriction, consequently leading to elevated peripheral vascular resistance (Stansfeld & Matheson, 2003). The primary mechanism underlying these effects can be attributed to the subconscious physiological stress resulting from interactions between the auditory system and the central nervous system, ultimately impacting the body's homeostasis (Raja et al., 2019). Excessive noise exposure not only results in physical harm, but is also linked to heightened stress, anxiety, increased annoyance, depression, and fatigue (Grebnikov &

Wiggins, 2006). These subjective and psychological experiences of noise can themselves generate health consequences.

Psychosomatic Symptoms

Psychosomatic symptoms reflect a range of physical health complaints stemming from psychological factors such as stress and distress. Psychosomatic symptoms can manifest as a range of physical health complaints including headaches, stomach pain, back pain, feeling down, irritability, feeling nervous, fatigue, dizziness, anxiety, and sleep deprivation. Chronic stress has been observed as a contributing factor to various psychosomatic symptoms, such as asthma, digestive tract disorders, heart diseases, migraines, and chest/back pain (Grebnikov & Wiggins, 2006).

Psychosomatic symptoms have been shown to have significant consequences on the workforce. For example, in a recent longitudinal study by Bauer et al. (2006), the authors tested the association between psychosomatic disorders (e.g., burnout syndrome), and the increasing rates of premature retirement in a sample of 438 grammar school teachers. Bauer et al. (2006) measured the occupational burden and psychological strain among teachers using the measure of coping capacity questionnaire (MECCA) to evaluate psychopathological and psychosomatic symptom load. The authors found that, upon the second evaluation, teachers' psychological and psychosomatic complaints were the most common reason for early retirement among teachers. Therefore, this finding may have significant clinical implications for other studies examining relations between psychological and psychosomatic complaints, and teacher's health in a general educational context.

Effects of Noise on Psychosomatic Symptoms

Studies over time have drawn attention to the detrimental impact of noise pollution on human health, revealing an association between exposure to noise and psychosomatic symptoms, such as headaches (Shushunova et al., 2020). Sleep disturbance is also a commonly reported consequence of noise pollution. According to Stansfeld & Matheson (2003), if there are over 50 noise events per night that reach a peak indoor level of 50 dBA or higher, the likelihood of objective sleep disturbance increases. Exposure to noise while sleeping can lead to elevated blood pressure, increased heart rate, and an increase in body movements. Furthermore, there can be residual effects during the day following disrupted sleep. Perceived sleep quality, mood, and performance, particularly in terms of reaction time, all exhibited declines following sleep disturbances caused by road traffic noise (Stansfeld & Matheson, 2003).

In a recent systematic literature review by De Sio et al. (2023), the authors examined extra-auditory effects of noise exposure, including effects on cognitive functioning, burnout, stress/mood, and psychosomatic symptoms including headache, sleep disorders, and fatigue. The authors reviewed 4,363 articles published between 2008 and 2022. Included articles must have examined extra-auditory effects of noise, be conducted in a school setting, and focus on the health of school workers. They also examined whether preventative interventions were applied in schools in response to concerns about noise. Following these criteria, 30 articles were included. The majority of studies were cross-sectional and examined attention deficit, vocal disorders, and hypertension as extra-auditory outcomes (De Sio et al., 2023). The most commonly identified extra-auditory consequences of noise were vocal disturbances, cognitive

effects, stress/mood and sleep dysfunction. Among extra-auditory outcomes, psychosomatic symptoms were relatively understudied. In addition, 14 out of the 30 included studies employed preventative measures to reduce these consequences.

In a recent meta-analysis, Mealings et al. (2023) hypothesized that excessive classroom noise can result in negative health outcomes and poorer well-being for teachers. The authors reviewed 33 articles that primarily studied the impact of classroom acoustic conditions and associated differences in noise on teacher's health. According to the authors, most studies focused on reported vocal health by teachers, in addition to other effects, such as stress, fatigue, job satisfaction, and social climate. Of the 33 articles reviewed, 27 used questionnaires, 3 used interviews, 7 used physiological measures, and 1 study used cognitive tests. In their synthesis of results, the authors reported that 61% of articles showed a negative effect of higher noise levels, while 36% showed no effect, and 3% showed a positive effect of higher noise levels on noise-related stress in teachers (Mealings et al., 2023). The authors then quantified the level of noise reported throughout the studies, finding a minimum range of 28 dBa, up to a maximum range of 117 dB (Mealings et al., 2023). In addition, the data indicated that higher noise levels was associated with a negative effect on teacher's overall health and well-being. In addition, longer reverberation times also were associated with the same negative effect, which suggests that noise can be a significant factor in influencing psychosomatic effects such as fatigue and burnout. These findings are consistent with De Sio et al. (2023) and provide evidence that noise exposure can influence psychosomatic symptoms in teachers.

Other effects of high noise levels in the classroom

High noise levels in the classroom can cause significant disruptions. Based on a review article by Higgins et al. (2005), noise can cause students in the classroom to become distracted and divert their attention from their classwork. In a longitudinal study by Hygge (2003) showed in a sample of 1,358 children (12-14 years old) that the encoding process of memory, particularly recall and recognition ability, may be impaired by noise from vehicular transportation (airplanes, roads, and trains). Increased demands on student attention can translate to increased demands on teachers to manage distracted students and help them to re-engage.

Noise related stress as a potential mediating pathway

Noise exposure affects health through a range of different pathways, including auditory and non-auditory effects (Basner et al., 2014). Part of the reason why psychosomatic symptoms may be likely to occur as a result of noise exposure is because noise is both a physiological and psychological stressor. Some studies have looked at noise exposure itself (e.g., Raja et al., 2019, Shushunova et al., 2020, Lazic & Golaszewski, 2006), while other studies have looked at stress from noise (e.g., Basner et al., 2014, Bauer et al., 2006, De Sio et al., 2023, Mealings et al., 2023). In addition, some studies have examined how noise influences physiological responses and emotional responses (e.g., Stansfeld and Matheson 2003). However, data simultaneously examining direct effects of noise exposure and indirect effects through noise-related stress are more limited. Despite consistent support in the literature for the effect of noise exposure on physical health, studies to date have yet to evaluate the extent to which the health effects of noise exposure depend on the perception of stress associated with noise levels.

Noise Pollution in Vietnam

Noise pollution is a significant problem in Vietnam. However, effects of noise on health are relatively understudied in southeast asia relative to the US and EU. According to Tan (2021), approximately 13 million people in Ho Chi Minh City, Vietnam currently reside in areas heavily affected by air and noise pollution. Since 2017, the rate of air and noise pollution has exponentially increased, exceeding Vietnamese standards (Tan, 2021). The National Technical Regulation on Noise has set a parameter for the maximum number of allowed decibels during the day, particularly in special and regular areas (Huong et al., 2022). In particular, special areas are settings where properties such as medical facilities, libraries, kindergartens, schools, churches, communal houses, or other types of religious buildings are located (Huong et al., 2022). Vietnamese government laws (e.g., Decree No. 155 /2016/ND-CP), outline the penalties for violating the acceptable limit of decibel level during a certain timeframe (i.e. 6 am to 9 pm ICT) (Huong et al., 2022). These penalties include monetary fines, with a minimum of 1 millionVietnamese Dong (VND) VND to a maximum of 160 million VND, to total suspension of operational activity of an establishment for 6 to 12 months (Huong et al., 2022).

Though limited, some existing data has highlighted the negative consequences of noise exposure for teachers in Vietnam. For example, Huong and colleagues (2022) examined the noise level in schools according to teacher reports and actual measured data, in a sample of 233 teachers from 6 schools from urban and suburban Hanoi city. To reduce noise in schools, the authors suggested ten strategies and asked teachers to evaluate how effective the strategies were, based on how often they were used (Huong et

al., 2022). Teachers' most common method of reducing noise in schools is to close windows. In addition, constructing a fence around the school and building it in a deserted area were considered to be the least effective options (Huong et al., 2022). Several problems have been identified as a result of the negative impact of noise pollution in schools on teachers' health: anxiety, stress, panic, problems with appearance, irritability, fatigue, etc. Among the three problems teachers thought were most affected by the average score analysis were pain/headache, stress, and attention. There were no significant differences in how much overall health was affected by noise at school among teachers living in different regions or of different genders. Based on the findings of Huong et al., 2022, male teachers have more significant symptoms of anxiety under the impact of noise at school (Huong et al., 2022). Urban teachers experienced significantly more anxiety issues, panic/confusion, vision problems, stomach problems, hearing loss, and word comprehension difficulties compared to suburban teachers. On the other hand, suburban teachers reported significantly higher levels of pain/headache and tinnitus problems than their urban counterparts (Huong et al., 2022).

In a study by Phan and colleagues (2008), the authors evaluated social surveys on community response to road traffic noise and noise measurements in a sample of 1,503 participants in Hanoi, and 1,471 in Ho Chi Minh City. These surveys filtered for information regarding resident's living environment, noise annoyance/indoor activity interferences, self-reported sensitivity, attitude towards noise source, and sociodemographic variables. According to the authors, motorbikes emitting frequent horn sounds were the most frequently occurring sound that composed road traffic noise in both cities. In their analysis, linear regression models revealed a significant effect of noise

exposure on annoyance among Hanoi respondents (Phan and colleagues, 2008). Furthermore, there was a small effect of living room window direction on listening disturbance (e.g., indoor conversation, listening to telephone, listening to radio/TV), in which residents in Hanoi were found to be more disturbed compared to Ho Chi Minh City. Additionally, in Ho Chi Minh City, a small effect of noise exposure on sleep disturbance was found (Phan and colleagues, 2008). The authors found that there was a significant correlation between noise exposure and noise sensitivity in both cities. No significant correlation was found between noise exposure and attitudes to noise sources in both cities. Overall, Pham and colleagues found from their analysis that exposure to noise was strongly associated with annoyance, from noise, particularly in Ho Chi Minh City.

The majority of studies of the impact of noise pollution within an educational context have focused on effects on students. But there is still an abundance of research that has examined the effects of noise exposure on teachers' physical health in Western culture. In Southeast Asia, primarily in Vietnam, noise exposure has been scarcely documented, with only one study measuring the impact of noise exposure on psychosomatic symptoms, headache. stress, fatigue, and others as predictors (e.g., Huong et al. 2022). To our knowledge, no studies to date have simultaneously examined effects of reported noise exposure and perceived noise-related stress on psychosomatic symptoms among teachers in Vietnam.

Aims & Hypotheses

Therefore, the aim of our study is to assess the impact of both exposure to noise and noise-related stress on psychosomatic symptoms in a sample of 1961 teachers in Vietnam. Additionally, we evaluate noise-related stress as a mediator of the link between

noise exposure and psychosomatic symptoms. We hypothesized that both noise exposure and noise-related stress would be independently associated with greater reports of psychosomatic symptoms. Additionally, we hypothesize that noise-related stress would mediate the association between noise exposure and psychosomatic symptoms, consistent with the notion that there are both direct physiological and indirect psychological impacts of noise pollution on physical health.

METHOD

K-12 teachers in Vietnam were identified through contact with administrators from participating school districts. Permission to distribute the survey to teachers was obtained from school administration prior to online survey distribution. The survey invitation was accessed 4,245 times, with 1,961 submitted responses, for a total completion rate of 46.2%. In 2,283 cases, the survey invitation was accessed but not submitted. Partially complete responses were removed to uphold subjects' right to withdraw and to ensure data quality. Our final analytic sample includes individuals who submitted their responses after viewing the entire survey (n = 1961). Our sample was predominantly female (n=1511, 77%) and ranged in age from 21–60 years (M=38.23, SD=8.29). Years of teaching experience ranged from 0 - 42 years (M=14.64, SD=8.97). Most teachers were employed by public schools (n=1797, 92.77%) with a smaller percentage employed by private (n=110, 5.68%), semi-public (n=13, 0.67%) or other schools (n=17, 0.88%). Most teachers taught in elementary schools (n=1162, 64.63%), followed by middle (n=537, 29.87%), high (n=57, 3.17%), and pre-k/kindergarten (n=22, 1.22%), with 20 teachers (1.11%) teaching multiple grade levels. The majority of teachers worked in rural schools (n=1355, 69.70%), with fewer working in suburban (n=215, 11.06%), urban (n=324, 16.67%), or other schools (n=50, 2.57%).

Procedure

All participants were provided with informed consent and voluntarily agreed to participate. Data for this study was collected anonymously. No personal identifying information was recorded as part of the teachers' participation. The study was approved by the institutional review board (IRB) of St. John's University.

Measures

Participants completed questionnaires including demographic and professional role information and measures of noise pollution exposure, noise-related stress, and psychosomatic symptoms. Noise exposure was assessed using a visual-analog scale on which teachers compared the noise level in their school to the noise level of familiar sounds (e.g., wind in trees, motorcycle engine). Noise-related stress was assessed with a 4-item questionnaire (e.g., "The noise in the school is stressful"). Psychosomatic symptoms were measured with a 10-item questionnaire assessing frequency of symptoms (i.e, headache, stomach pain, back pain, feeling down, irritability, feeling nervous, fatigue, feeling dizzy, feeling anxious, and sleep deprivation).

RESULTS

Preliminary Analyses

ANOVAs and bivariate correlations examined demographic and professional role variations in key variables. Women reported greater noise exposure ($F(1, 1680) = 6.61$, $p = .010$), greater noise-related stress ($F(1, 1811) = 7.40$, $p = .007$), and a higher frequency of psychosomatic symptoms ($F(1, 1856) = 33.04$, $p = <.0001$). Teachers who worked in private schools reported significantly greater noise exposure than teachers in public or semi-public schools ($F(3, 1722) = 8.31$, $p < .0001$). There were no grade level differences.

Association of Noise Exposure to Psychosomatic Symptoms

Multiple regression models including noise exposure and noise-related stress and controlling for age, experience, gender, and grade level(s) taught showed significant positive associations of reported noise exposure ($\beta = 0.07$, $p = .028$) and perceived stress from noise ($\beta = 0.26$, $p < .0001$) with psychosomatic symptoms.

Noise-Related Stress as a Mediator

We also examined noise-related stress as a mediator of relations between noise exposure and psychosomatic symptoms using the PROCESS macro (Hayes, 2017). There was a significant indirect effect of noise exposure on psychosomatic symptoms through noise-related stress (β=.004, SE=.001, CI=.003–.005). The direct effect of noise exposure remained significant, suggesting partial mediation (β=.004, SE=.001, $p = .028$).

DISCUSSION

The current study examined the interconnection between noise exposure and physical health, as well as the mediating role of noise-related stress on the association of noise exposure and psychosomatic symptoms. In fully adjusted models, psychosomatic symptoms were positively associated with noise exposure and noise-related stress. The associations of noise exposure and noise-related stress with psychosomatic symptoms were stronger for female teachers compared to their male counterparts. Results support the notion that the effects of noise exposure on psychosomatic symptoms may depend on gender. Further, this difference may be explained by stress, as studies examining trajectories of teacher health have identified job insecurity and emotional demands as associated with psychological and psychosomatic symptoms (Scheuch et al., 2015). These findings highlight the importance of both direct effects of noise exposure and indirect effects through noise-related perceived stress on the physical health of teachers in Vietnam. Both structural and individual-level factors drive psychosomatic complaints. Multi-level interventions may be needed to support teacher health. These interventions could focus on reducing noise throughout the school system, as well as helping teachers modulate their stress.

School Level Engineering Approaches

Various noise mitigation strategies include noise screens, active noise-canceling devices, and advanced active blanking systems. Active blanking systems are highly efficient in protecting students from intense acoustic decibel levels by reducing noise in high-traffic areas (Shushunova et al., 2020). Other soundproofing materials used in construction, such as greening system installations on building walls and roofs, gain

popularity globally for noise reduction and air quality improvement (Shushunova et al., 2020). Green wall panels, with wave-like structures, do better than conventional walls in sound absorption (Shushunova et al., 2020). Results from other studies tests conducted using these tactics of noise mitigation confirm their effectiveness, provided noise insulation level standard (Shushunova et al., 2020). However, considering the noise source and direction, placement of these green systems must be installed accurately to ensure compliance with regulatory limits for a healthier urban environment (Shushunova et al., 2020).

Individual Stress Management

The impact of noise in schools on both teachers and students is significant. Teachers and students exposed to noise pollution can face consequences including hearing difficulties and negative impacts on health (Stansfeld & Matheson, 2003). For example, in an original research study by Grebnikov & Wiggins (2006), the authors examined the relationship between exposure to excessive classroom noise and psychosomatic symptoms, in a sample of 25 teachers across Western Sydney, Australia. The authors hypothesized that noise causes persistent stress in early childhood education settings, with limited means to reduce its effects. Therefore, Grebnikov & Wiggins (2006) measured how teachers become affected by noise-related stress by evaluating vocational strain, interpersonal strain, and defensive functioning using multiple regression analyses. The authors found that teachers often adopt coping strategies to create a mental barrier to block out their self-awareness of the noise's adverse effects, and assist in cognitively avoiding perceived noise-related stress, thus reducing psychosomatic symptoms. In their results, the authors found the denial coping strategy lessens the

conscious perception of stressors (Grebnikov & Wiggins, 2006). Thus, despite the adverse challenges noise exposure presents, denial serves as an effective coping mechanism for educators in noisy environments, providing relief from stress (Grebnikov & Wiggins, 2006).

Policy Interventions

To reduce public health consequences, government regulations aimed to limit noise pollution have established cutoff noise levels to limit potentially harmful levels of noise. In 2009, the World Health Organization (WHO) released the Night Noise Guidelines for Europe, which represent a collective expert agreement that links four levels of noise exposure to common associated adverse health effects, spanning from 'negligible biological impact' to 'heightened cardiovascular disease risk'. Noise-induced hearing loss is primarily characterized by the damage or loss of auditory sensory cells within the cochlea. Since these hair cells cannot regenerate in mammals, there is no possibility of recovery or remission once the damage occurs. Therefore, the sole means of preserving one's hearing is through the prevention of noise-induced hearing loss. This type of hearing impairment, which can result in difficulties comprehending speech in everyday situations, can have profound social consequences.

Bauer et al. (2006) documented consistent adverse effects of psychosomatic complaints on teacher health but did not find effects of noise exposure on teacher burnout. These results are consistent with the pattern of this study. These effects may be impacted by the effect of noise-related stress on psychosomatic symptoms. Noise exposure seems to influence the quantity and intensity of psychosomatic symptoms, with noise-related stress producing increased feelings of these symptoms. Teachers may

integrate various coping strategies to deescalate psychosomatic symptoms to achieve a positive mental health framework (Bauer et al., 2006). However, the capacity for an individual to shift their mental state of mind from negative to positive requires significant cognitive energy and increases the susceptibility to experience symptoms of psychosomatic complaints more likely.

Contrary to our findings, Huong et al. (2022) found that male teachers were more likely to suffer from psychosomatic symptoms such as headaches and inability to concentrate, compared to their female counterparts. In addition, Huong et al. (2022) reported that the teachers' evaluation of the impact of school noise on their health was inconsistent. According to their results, the louder the noise, the lower the health impact (Huong et al., 2022). Since the authors measured noise exposure in various locations, the permitted noise level is different, thus the noise acceptance level of the population in that area is also different (Huong et al., 2022).

In the current study, the data collected from Vietnamese teachers suggests that direct noise exposure and noise-related stress impact psychosomatic symptoms. Although future research is needed, these results may be explained by the suggestion of Huong et al. (2022), that some areas in Vietnam may be more noise-polluted than others, thus prompting newer studies to evaluate the impact of objective noise exposure, compared to noise exposure that is assessed subjectively. Further, our data provides evidence that perceived noise-related stress serves as a partial mediator of the effects of noise pollution exposure on psychosomatic symptoms. These findings highlight the importance of both direct effects of noise exposure and indirect effects through associated perceived stress on physical health within an occupational context. Interventions to improve teacher well-

being may benefit from addressing both structural contributors to noise levels and individual contributors to perceived stress associated with noise.

Limitations and Future Directions

The findings of the current study should be interpreted in the context of several limitations. All measures of noise exposure were self-reported and therefore, susceptible to recall bias. Studies employing decibel meter measurement can shed further light on the effects of noise exposure. Future research efforts should engage in longitudinal investigations to explore underlying mechanisms of noise exposure, and its impact on psychosomatic symptoms. Given that noise exposure might consistently influence individuals over an extended period, it is important to explore any potential recurring and persistent effects.

CONCLUSION

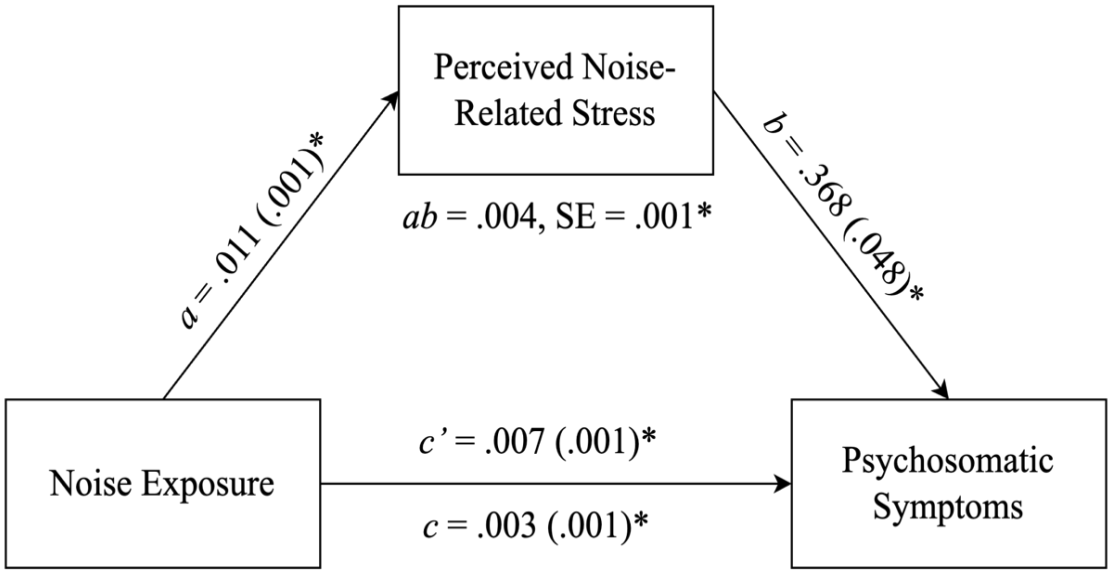
This study extends support for the notion that noise pollution exposure negatively impacts physical health to teachers in Vietnam. Our study tested a multilevel mediation model examining the psychological consequences of exposure to noise in a diverse sample. Multiple dimensions of noise-related stress were identified, including both direct and indirect effects of noise exposure on the physical health of teachers in Vietnam. The level of noise exposure seems to be a driving factor for the association between noise-related stress and psychosomatic symptoms. Findings from this study suggest that chronic exposure to noise in school settings increases the likelihood some teachers may experience some degree of noise-related stress, with at least one type of psychosomatic complaint. Despite consistent support in the literature for an effect of noise exposure on health, studies to date have yet to evaluate the extent to which the health effects of noise exposure depend on the perception of stress associated with noise levels. Therefore, our study proposes for future research, that studies should examine how chronic noise exposure impacts psychosomatic symptoms, particularly when examining the physiological connection that mediates noise exposure, noise-related stress, and psychosomatic symptoms.

Table 1: Sample Characteristics	
Variables:	Full Sample (n=1961)
Age	
[M (SD) Range]	M=38.23, SD=8.29
Gender	
Female	n=1511, 77%
Male	n=450, 23%
School Sector	
Private	n=110, 5.68%
Public	n=1797, 92.77%
Semi-Public	n=13, 0.67%
Other	n=17, 0.88%
School Location	
Rural	n=1355, 69.70%
Suburban	n=215, 11.06%
Urban	n=324, 16.67%
Other	n=50, 2.57%
Grade Level Taught	
Pre-K or Kindergarten	n=22, 1.22%
Elementary School	n=1162, 64.63%

Middle School	n=537, 29.87%
High School	n=57, 3.17%
Multiple	n=20, 1.11%

Figure 1:

Noise-Related Stress as a Mediator of Relations Between Noise Exposure and Psychosomatic Symptoms



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