Original Article

Noise Annoyance Among College Students: A Qualitative Analysis of Complaint Emails in a Chinese University

Jialin Fan[1,2], Yuyang Chen[1], Andrew P. Smith[3], Yuting Liu[1]

[1]School of Psychology, Shenzhen University, Shenzhen 518052, China, [2]Shenzhen Humanities and Social Sciences Key Research Bases of the Center for Mental Health, Shenzhen 518000, China, [3]School of Psychology, Cardiff University, Cardiff, CF10 3AS, UK

Abstract

Background: Accelerated urbanization has exacerbated global noise issues, particularly on university campuses, affecting students' sleep and study efficiency. Previous studies mainly used interviews or surveys to investigate noise annoyance, which may lead to data distortion influenced by researchers. **Materials and Methods:** From January 3, 2020 to March 18, 2022, we collected 623 complaint emails containing noise-related keywords from the student complaint mailbox of a university in southern China. A total of 401 valid complaint emails ultimately included for thematic and quantitative analysis to better understand the effect of noise on college students' lives and health. **Results:** The results indicate that construction noise is the most common source of noise complaints, followed by residential noise and machinery/equipment noise. Students are most significantly disturbed by noise during the night and morning, which severely affects their sleep quality and study efficiency. The impact of noise on sleep was found to be significantly associated with its effect on mental health ($P = 0.002$) and study efficiency ($P < 0.001$). **Conclusion:** This study demonstrates that campus noise affects students' sleep quality, study efficiency, and mental health. It is recommended that universities strengthen campus noise control and ensure that on-campus construction activities do not interfere with students' study and rest.

Keywords: campus, college student, construction noise, noise, qualitative analysis

Key messages

(1) The present study investigated college students' noise annoyance using public complaint mailboxes
(2) The themes that appeared most frequently in the complaint emails include construction noise, followed by residential noise and machinery/equipment noise.
(3) Students' passive measures to cope with noise are often ineffective.
(4) Campus noise during both day and night affects students' sleep quality, study efficiency, and mental health.

Introduction

With the development of urbanization, noise issues are increasingly exacerbated worldwide.[1] Noise, as a psychosocial stressor, negatively impacts human health by disrupting daily activities and contributing to problems such as stress, insomnia, hearing loss, and cardiovascular diseases.[2,3] Although governments worldwide have implemented various measures to control noise and address its adverse effects; however, noise issues persist and still seriously intrude on seemingly tranquil environments, such as university campuses.[4,5]

Noise Problem on Campus: A Growing Issue

A survey conducted by a Chinese university found that college students exhibited a high level of aversion to noise.[6] Construction noise, residential noise, traffic noise, and noise in study rooms can all lead to student frustration, affecting both their health and academic performance.

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Address for correspondence: Jialin Fan, School of Psychology, South Campus, Shenzhen University, L3-1206, NO. 3688 Nanhai Ave., Shenzhen 518052, China.
E-mail: FanJL@szu.edu.cn
ORCID: 0000-0003-1530-4739

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Previous studies have indicated that construction noise is one of the most common noise sources in Chinese colleges, occurring both during the day and at night.[7,8] These noise sources are more than just an inconvenience; they directly impair students' mental health and academic success.[9] A study conducted in 30 dormitories across several universities in China found that traffic noise and noise from indoor activities affected students' sleep and daily routines.[10,11] Another study on the soundscape of Chinese universities reported that roommates' conversations were considered the main source of noise affecting students' sleep quality.[12] Similar findings have been observed at universities in other countries. Field measurement studies on noise have found that the highest noise levels are mainly associated with commercial areas, parking lots, canteens, residential buildings, open spaces, and traffic corridors.[13-15] A study conducted at a Nigerian school found that students were exposed to noise from various machines and equipment.[16] Similar findings were also observed in a study conducted at a university in Malaysia.[17] Moreover, previous findings also reveal that the use of digital devices in libraries has resulted in an upsurge in noise levels.[18]

Students' sleep quality is seriously affected by nighttime noise,[19,20] while their study efficiency is affected by daytime noise.[21] However, the current understanding of this growing issue on campus—its different sources and its effect on students—remains insufficient.

Current Research Limitations and New Methods

Most existing noise studies primarily focus on the physical properties of noise, such as its loudness, to assess its severity.[22] However, this approach often overlooks people's subjective experience and perception of noise, and fails to genuinely deconstruct noise from a perceptual perspective. Moreover, some complex human experiences, such as noise annoyance in daily life, are challenging to replicate in laboratory settings.[23] For example, the exact timing or location of noise exposure is often impossible to simulate, making it challenging to recreate genuine annoyance. Fink[24] suggested that research on noise pollution should consider whether it is "harmful" as a measure. For example, even if the noise level in a library does not exceed 40 decibels, it should still be regarded as a noise disturbance if it disrupts students' concentration. Similarly, investigations into the effect of noise on university life have shown that measured noise levels often do not align with students' perceptions.[25] Therefore, an increasing number of studies focus on examining noise from the perspective of its harmfulness and mainly adopt socioacoustic methods, which include face-to-face interviews or questionnaire surveys as well as actual noise measurements.[26] However, these methods often lead researchers to construct questions that presuppose "noise has disturbed me," which can bias participant responses.

To address these concerns, our study adopts a novel qualitative research method by analyzing students complaints submitted through the campus complaint mailbox. These complaint emails are spontaneous expressions from students, offering higher ecological validity and reflecting the real-world noise disturbances in students' daily lives. By leveraging these data, we aim to better understand students' subjective noise annoyance, primary noise sources, and the impacts of noise on their sleep, mental health, and study efficiency.

Materials and Methods

Complaint Mailbox

The data for this study were collected from the complaint mailbox on an online feedback platform of a university in China. Students and staff can submit feedback on various school-related matters through the university's internal network. It features a paginated, list-style interface and supports keyword searches, with submission and feedback records publicly displayed for a period of 2 years. In this platform, users can choose to make the email content anonymously public or keep it confidential between users and the relevant college office.

Keywords Extraction

We employed a keyword-based method to collect emails related to noise complaints. First, we entered the term "noise" to search for emails on the platform and randomly selected 10 emails related to noise complaints. These 10 emails were imported into the specialized keyword extraction web application, Weiciyun (Beijing Jiahe Tianyuan Technology Development Co., Ltd., https://www.weiciyun.com/), for high-frequency keyword analysis. Ultimately, we identified several Chinese keywords commonly used in these complaints related to noise: "吵(noisy)," "噪 (noise)," "声(sound)," "音 (tone)," "静(quiet)," "扰民 (disturbance)," "刺耳 (piercing)," "嘈杂 (cacophonous)," "喧 (clamorous)," "响 (loud)," and "闹 (uproar)."

Complaint Emails Collection

Data collection and analysis were conducted using the Houyi Collector V.3.6.0 (Hangzhou QuickMemory Technology Co., Ltd., Hangzhou, China), a tool designed for comprehensive and systematic data extraction and processing. The data collection period spanned from January 3, 2020 to March 18, 2022. A total of 623 emails containing the keywords were collected, of which 222 were excluded due to the exclusion criteria. Finally, a total of 401 valid complaint emails were retained for analysis. Figure 1 shows the details.

Inclusion and Exclusion Criteria

Inclusion criteria: (1) public emails from the complaint mailbox; (2) emails containing any of the keywords: "noisy," "noise," "sound," "tone," "quiet," "disturbance," "piercing," "cacophonous," "clamorous," "loud," and "uproar"; and (3) emails written by students.

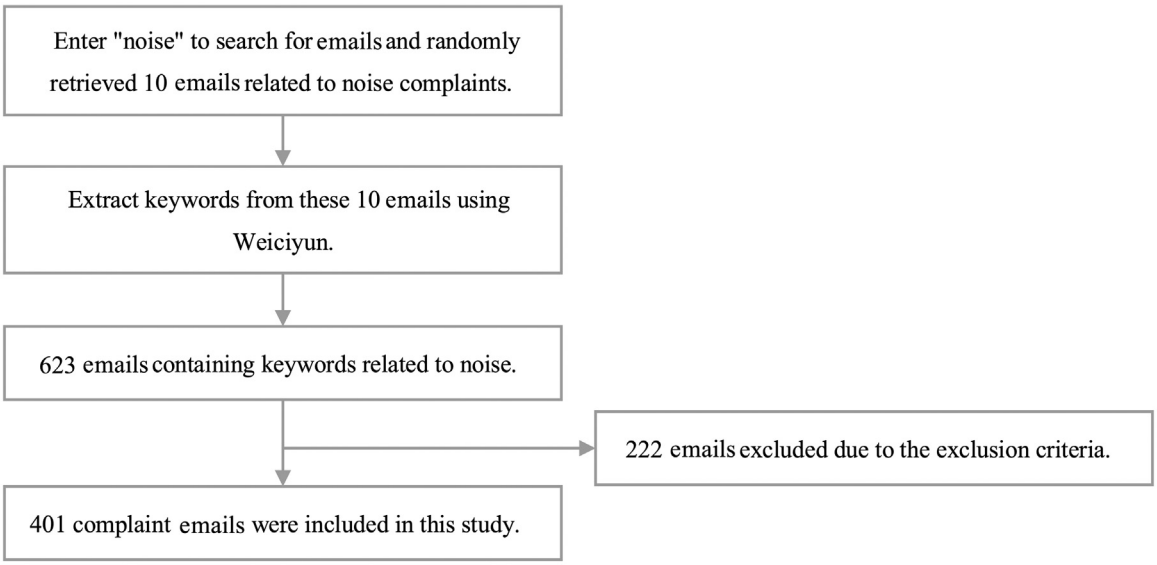

Figure 1: Flowchart of complaint email screening.

Exclusion Criteria: (1) the email content is unrelated to noise complaints; (2) the email contains fewer than five characters; and (3) the email appears more than once.

Coding Process

To analyze the qualitative data, we employed a thematic analysis strategy in our study by using NVivo V.1.6.1 (Lumivero, Denver, USA),[27] which involved familiarizing ourselves with the data, creating initial codes, identifying and reviewing themes, consolidating titles and definitions, and reporting the findings.

Each complaint email included a reception date, a description of the complaint, and a title. A thematic grid was developed for the analysis of complaints and was divided into three main categories:

Noise types

Noise types refer to the specific noise sources mentioned in the emails, with supplementary judgment conditions such as the location of the noise occurrence and descriptions of the sounds.

The time of noise complaints

Before coding, the framework for noise complaint time was established based on the following criteria:

(a) Early Morning (before 9:00): Mention of specific time points within the coded time range; use of terms such as "early morning" or "dawn."
(b) Noon (12:00–14:00): Mention of specific time points within the coded time range; use of the word "noon" in the email.
(c) Daytime (9:00–18:00): If the email mentions only "morning" or "afternoon," or refers to "daytime," the time is coded as "daytime"; if the email includes references to two or more time periods within the daytime range (e.g., "It was noisy both at noon and in the afternoon!").
(d) Night (18:00–23:00): Mention specific time points within the coded time range; use the word "evening," explicitly excluding events occurring after midnight.
(e) Late night (23:00 and later): Mention of specific time points within the coded time range; use of the term "late night"; descriptions of time periods falling under the midnight category.
(f) All day: Explicit phrases such as "all day long" or "day and night" are mentioned; References to two or more time points, emphasizing both daytime and nighttime, indicating a prolonged period.
(g) Not mentioned: emails that do not mention the specific time.

Outcomes of noise

We categorized the outcomes of noise into three aspects: sleep, study, and mental health. The severity of noise affecting these outcomes was coded at three levels: 0 (no effect), 1 (mild effect), and 2 (severe effect). If none of the three outcomes are present, a score of zero will be assigned across all categories.

(1) Level 0: No mention of the effect of noise on any particular dimension.
(2) Level 1: The effect of noise on a particular dimension is mentioned, such as "Noise makes me feel depressed," but no degree adverbs or concrete examples are provided to emphasize the severity of the effect.
(3) Level 2: The severity of the effect on a particular dimension is emphasized using degree adverbs, and the severity is further supported by concrete

examples, such as citing a diagnosis of a mental health disorder. For example, "Because of noise, I have been diagnosed with neurasthenia!"

Based on this thematic grid, we performed a descriptive analysis of the complaint emails using NVivo software V.1.6.1 (Lumivero, Denver, USA). The complaints were analyzed following an inductive approach. The coding was conducted by one member of the research team and then validated by two other members. After completing the coding for all complaints, some categories were renamed, others were merged, and some were broken down further to make the coding more precise.

Statistical Analysis

The coded data were further analyzed using the Chi-squared test to assess statistical significance in SPSS 26.0 (IBM Corporation, New York, US), providing insights into the most common noise-related complaints. We also use the Chi-squared test to analyze the associations among the three outcomes of noise (i.e., sleep, mental health, and study relations). The figures were created by Microsoft® Word for Mac, Version 16.54.

Results

Thematic Analysis

Six themes were obtained through thematic analysis. Construction noise was the most common theme, followed by residential noise, machine equipment noise, study area noise, traffic noise, and other unknown noises. The frequency of these themes is shown in Figure 2.

Construction Noise

Construction noise was the most frequently mentioned theme, with 241 complaint emails (60.10%) referencing its impact. Figure 3 shows the construction sites and affected areas in and around the university. The sounds of welding, pile driving, and various machinery operations, producing sharp, low-pitched, and other mixed types of noise, were described as unbearable for the students, affecting them in the early morning and late night. All the following English versions of the emails were translated from the original Chinese versions. Excerpts from the content analysis are presented in italics.

> Email No. 11: *" . . . During class, the sound of drilling and hammering from outside was louder than the teacher's voice through the microphone. Is no one addressing this? . . . "*
>
> Email No. 49: *" . . . The day before yesterday, construction started at 6 a.m., and yesterday it began before 7 a.m. Now it's already 12:30 a.m., and it's still ongoing. Isn't this unreasonable?..."*
>
> Email No. 96: *" . . . there are welding sounds, machinery noises, hammering, and more . . . "*
>
> Email No. 318: *" . . . Sometimes it's late at night, around 11:00 or 12:00, and other times it's early in the morning, around 5:00 or 6:00. What used to be a solo performance seems to have recently upgraded to a symphony . . . "*

Construction noise has the most severe effect on students' sleep ($n = 167$), followed by their study efficiency ($n = 103$), and lastly, their mental health ($n = 43$).

Email No. 362: *" . . . Now, it's even worse. The construction crew has been hammering away since 7:00 or 8:00 in the morning. I take sleeping pills and melatonin, but they still wake me up. It's unbearable. My sleep quality is terrible every day..."*

Email No. 53: *" . . . can hardly rest properly in our rooms due to the proximity to the construction site. Even studying*

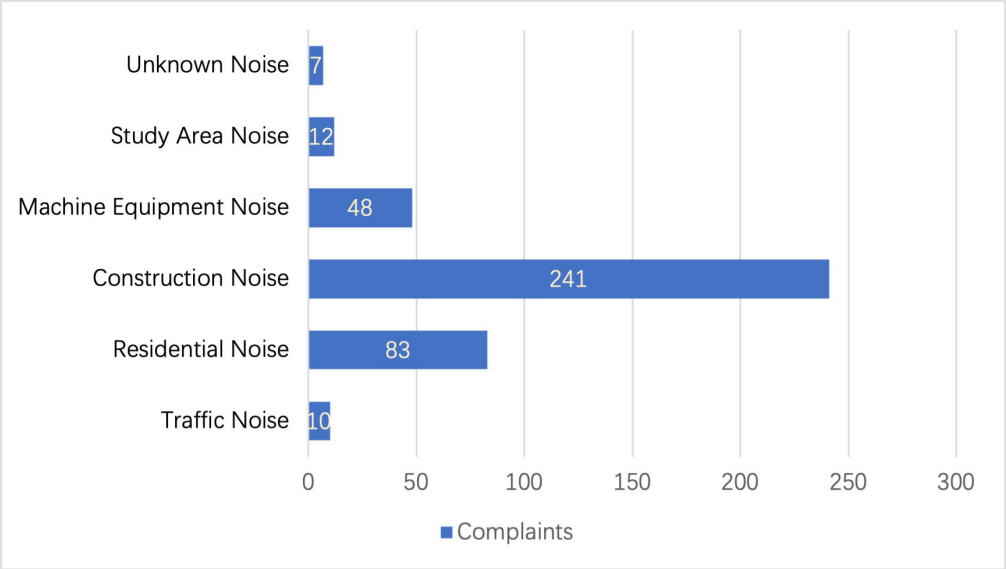

Figure 2: Number of complaints on each theme.

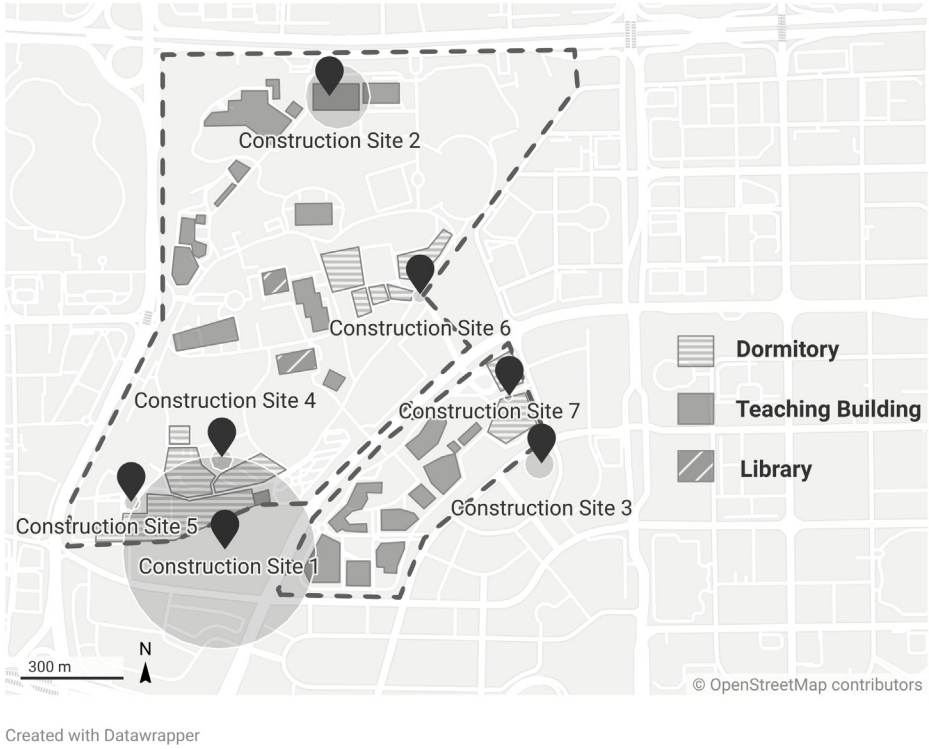

Figure 3: Campus map and construction sites in and surrounding the university.
Note: The map was made by Datawrapper (Datawrapper GmbH, Berlin, German, available at: https://www.datawrapper.de/).

quietly in the first-floor study rooms is impossible. By the end of the day, our heads are buzzing. . . . "

Email No. 86: *" . . . The noise and vibrations from the construction sites have made the self-study room even noisier than the Avenue, significantly affecting my study efficiency . . . "*

Residential Noise

Residential noise is the second most common theme in the complaint emails ($n = 83$, 20.70%). It primarily refers to noise disturbances in residential areas (dormitories, dormitory public areas, and cafeterias), including voices, footsteps, singing sounds from loudspeakers, loud activities (e.g., parties or events), and other residential noise.

Email No. 249: *" . . . Someone is singing loudly under the dormitory building. The open plaza amplifies the sound, and the entire building can hear it whenever they start singing, even from far away. . . . "*

The most severe effect of residential noise is mainly on sleep ($n = 53$), followed by study ($n = 35$), affecting them significantly in the daytime, followed by late night.

Email No. 111: *"In the daytime, there was some kind of activity downstairs in the South District dormitory building, and the noise was extremely loud. It wasn't just in the corridor; it could be heard clearly throughout the entire building. The most disturbing part is that their so-called 'singing' is unbearable. It sounds like it's literally costing lives. I hope all such noise-polluting events held downstairs in the dormitory building will be stopped."*

Email No. 202: *" . . . I live on the dormitory at the Lihu Campus and have been woken up . . . bugle sound falls within a range that even earplugs cannot block . . . the noise persists and has significantly affected my mental and psychological well-being . . . "*

Email No. 249: *" . . . I haven't had a good night's sleep for half a month. Outside the Southwest dormitory area, loud noises and conversations from passersby can be heard around 1–2 a.m. I hope the relevant authorities can step in to address this issue. . . . "*

Machine Equipment Noise

Machine equipment noise is the third most common theme in the complaint emails ($n = 48$, 11.92%). The main sources include sounds from unknown machines ($n = 20$), water heater/hot water pumps ($n = 6$), water pipe/faucet ($n = 6$), air ducts ($n = 5$), washing machines ($n = 4$), elevators ($n = 3$), lawnmowers ($n = 2$), water dispenser ($n = 1$), and smart storage cabinet ($n = 1$).

Email No. 381: *" . . . This noise seems to be a low-frequency vibration caused by electromechanical equipment, occurring both day and night, but particularly frequent at night and during winter. Measurements at night show it to be around 65 dB. . . . "*

The primary effect of noise on the students is sleep, with some effect on mental health as well, and the most severe effect occurs late night ($n = 21$).

Email No. 246: *" . . . At 2:58 a.m., writing this mail with a headache, anger, and enduring 60 decibels of noise, I want to recount what happened. The top floor of our dormitory has always had a very loud noise, resembling the roar of machinery. Sometimes it stops for a short while. The first time I was seriously affected was in late September—it was so noisy I couldn't sleep until 4:00 a.m. . . . suspected that it might be a malfunction of the solar water heater on the roof, but since it wasn't running in the morning, they couldn't identify the problem, and the matter was left unresolved. . . . "*

Study Area Noise

Study area noise is the fourth theme in the complaint emails ($n = 12$, 2.99%). The effect on the study is the most severe. The times mentioned in the complaint emails mostly occur during the daytime.

Email No. 186: *" . . . However, some students using computers in the library may not have noticed that the mouse and keyboard they are using produce noise, which affects the study environment of surrounding students. . . . "*

Traffic Noise

Only 10 students (2.49%) mentioned this type of noise in their complaint emails. The emails reflected its effect during late-night and early morning hours. All reported effects of the noise were related to sleep disturbances.

Email No. 336: *"Over the past two nights, starting around midnight, large vehicles have been passing by intermittently and have not stopped even now. The noise they generate is extremely loud and has greatly affected rest, especially during the final exam period. . . . "*

Email No. 268: *"It is currently exam week, and while students are busy with intensive study, it is also crucial for them to ensure proper rest, especially good sleep quality. However, late at night, transport trucks outside the dormitories keep running nonstop. Both the frequency of their movements and the volume of the noise make it impossible to get a good rest. . . . "*

Unknown Noise

The content under this theme indicates that the complainants did not specify the exact source of the noise but provided a very vague description of the sound ($n = 7$, 1.75%).

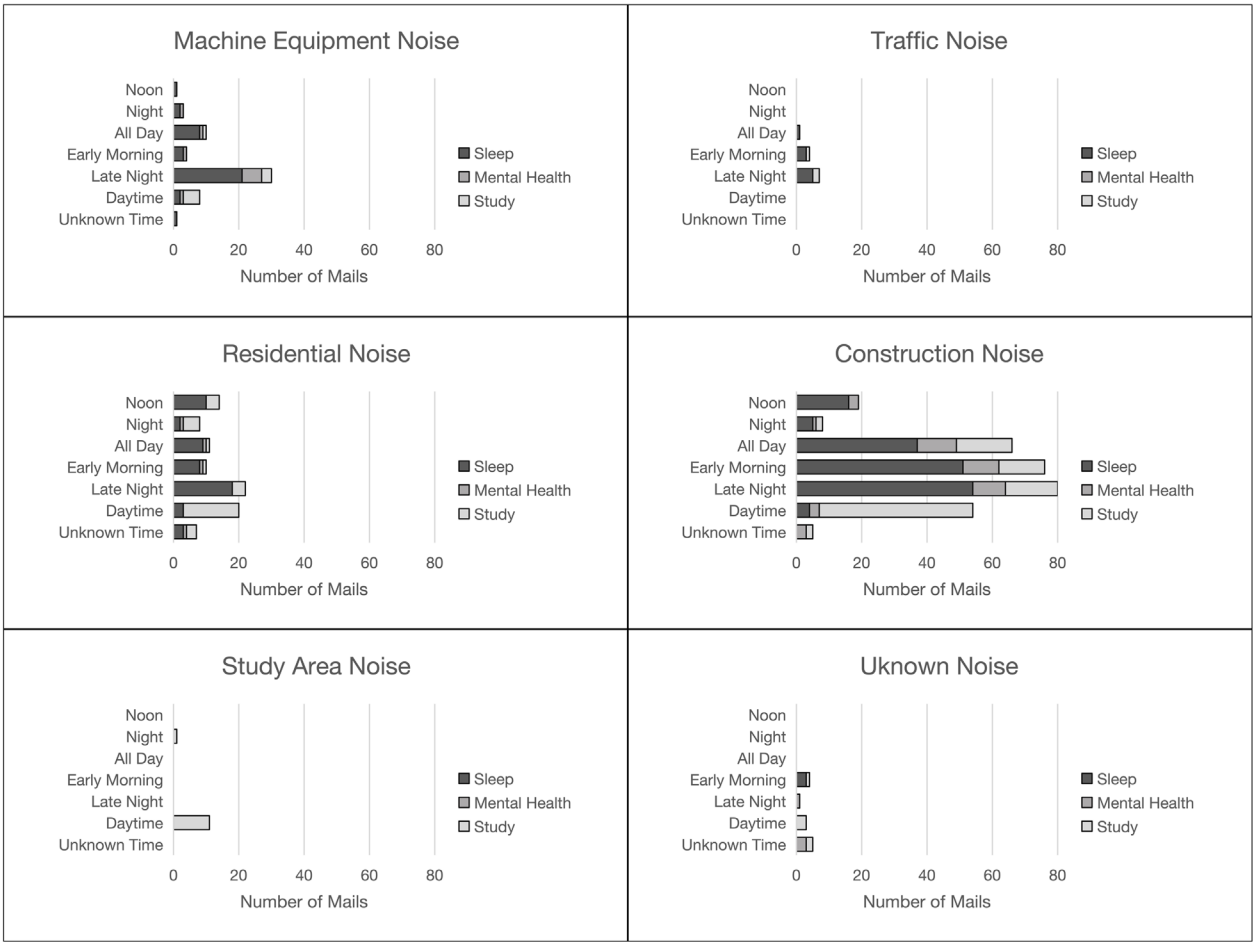

Figure 4: Effects of different noises across different time.

Email No. 6: *"here has been a constant 'beeping' sound near the dormitory all night, severely affecting rest. I hope this issue can be resolved."*

Quantitative Analysis

Effects of Different Noises across Different Time

Figure 4 shows that construction noise has the greatest effect on sleep, followed by study and mental health. It has the most severe effect on sleep during early morning and late-night hours, while its effect on study is most severe during daytime. Residential noise primarily affects students' sleep and study. Its effect on sleep is most severe late night, whereas its effect on study is most pronounced during daytime. Machine equipment noise also has the most severe effect on sleep, with late night being the most affected period. Study area noise affects only study, with its effect concentrated mainly during daytime. Traffic noise most significantly affects sleep, mainly during late-night and early morning periods.

Effects of Noise Sources and Occurrence Time on the Three Outcomes

Table 1 presents the effects of various noise sources on the three outcomes. The results show that different noise sources have significantly different effects on sleep and study, while no significant difference was observed in their effect on mental health ($P > 0.05$). Specifically, construction noise received the highest number of complaint emails for the effects on sleep, followed by residential noise and machine equipment noise, while the highest proportion of emails about noise affecting sleep is attributed to traffic noise, reaching 90%. Study area noise has the greatest effect on study.

Table 2 shows that different time periods of noise occurrence have significantly different effects on sleep, mental health, and study. Specifically, noise occurring during late night, early morning, and noon has the most severe effect on sleep. Noise that persists throughout the day has the greatest effect on mental health, while daytime noise most significantly impacts study.

Associations among Sleep, Mental Health, and Study

A chi-square test was performed to examine the associations among the three outcomes of noise, as presented in Tables 3 to 5. The results showed a significant association ($P = 0.002$) between the effect of noise on sleep and mental health [Table 3], and a significant association ($P < 0.001$) between sleep and study [Table 4], but no significant association was observed between study and mental health [Table 5].

Table 1: The Effects of Different Noise Sources on Sleep, Mental Health, and Study.

Noise Source	Sleep (%)			Total	χ^2	*P*	Mental Health (%)			Total	χ^2	*P*	Study (%)			Total	χ^2	*P*
	0	1	2				0	1	2				0	1	2			
Construction noise	74 (30.7)	38 (15.8)	129 (53.5)	241	43.646	<0.001	198 (82.2)	26 (10.8)	17 (7.1)	241	16.930	0.076	138 (57.3)	42 (17.4)	61 (25.3)	241	32.761	<0.001
Machine equipment noise	10 (20.8)	10 (20.8)	28 (58.3)	48			38 (79.2)	4 (8.3)	6 (12.5)	48			39 (81.3)	7 (14.6)	2 (4.2)	48		
Residential noise	30 (36.1)	21 (25.3)	32 (38.6)	83			79 (95.2)	2 (2.4)	2 (2.4)	83			48 (57.8)	13 (15.7)	22 (26.5)	83		
Study area noise	12 (100.0)	0 (0.0)	0 (0.0)	12			12 (100.0)	0 (0.0)	0 (0.0)	12			0 (0.0)	4 (33.3)	8 (66.7)	12		
Traffic noise	1 (10.0)	0 (0.0)	9 (90.0)	10			10 (100.0)	0 (0.0)	0 (0.0)	10			7 (70.0)	2 (20.0)	1 (10.0)	10		
Unknown noise	4 (57.1)	0 (0.0)	3 (42.9)	7			6 (85.7)	0 (0.0)	1 (14.3)	7			3 (42.9)	2 (28.6)	2 (28.6)	7		
Total	131 (32.7)	69 (17.2)	201 (50.1)	401			343 (85.5)	32 (8.0)	26 (6.5)	401			235 (58.6)	70 (17.5)	96 (23.9)	401		

Discussion

The present study aimed to investigate the most significant aspects of noise complaints on campus. It conducted a detailed qualitative analysis of noise-related complaints, utilizing word frequency analysis and thematic analysis.

Table 2: The Effects of Noise Occurrence Time on Sleep, Mental Health, and Study.

Time	Sleep (%)			Total	χ^2	*P*	Mental health (%)			Total	χ^2	*P*	Study (%)			Total	χ^2	*P*
	0	1	2				0	1	2				0	1	2			
Early morning	10 (12.8)	14 (17.9)	54 (69.2)	78	242.141	<0.001	65 (83.3)	7 (9.0)	6 (7.7)	78	22.682	0.031	61 (78.2)	11 (14.1)	6 (7.7)	78	143.739	<0.001
Daytime	87 (90.6)	5 (5.2)	4 (4.2)	96			92 (95.8)	3 (3.1)	1 (1.0)	96			13 (13.5)	20 (20.8)	63 (65.6)	96		
Noon	2 (6.9)	8 (27.6)	19 (65.5)	29			26 (89.7)	2 (6.9)	1 (3.4)	29			20 (69.0)	4 (13.8)	5 (17.2)	29		
Night	7 (43.8)	3 (18.8)	6 (37.5)	16			13 (81.3)	2 (12.5)	1 (6.3)	16			8 (50.0)	3 (18.8)	5 (31.3)	16		
Late night	3 (3.0)	20 (19.8)	78 (77.2)	101			84 (83.2)	9 (8.9)	8 (7.9)	101			76 (75.2)	18 (17.8)	7 (6.9)	101		
All day	9 (14.1)	16 (25)	39 (60.9)	64			50 (78.1)	5 (7.8)	9 (14.1)	64			45 (70.3)	12 (18.8)	7 (10.9)	64		
Unknown time	13 (76.5)	3 (17.6)	1 (5.9)	17			13 (76.5)	4 (23.5)	0 (0.0)	17			12 (70.6)	2 (11.8)	3 (17.6)	17		
Total	131 (32.7)	69 (17.2)	201 (50.1)	401			343 (85.5)	32 (8.0)	26 (6.5)	401			235 (58.6)	70 (17.5)	96 (23.9)	401		

Table 3: Association between the Effect of Noise on Sleep and Mental Health.

Sleep	Mental Health/*n*(%)			Total	χ^2	*P*
	0	1	2			
0	119 (90.80)	9 (6.9)	3 (2.3)	131	16.571	0.002*
1	65 (94.2)	3 (4.3)	1 (1.4)	69		
2	159 (79.1)	20 (10.0)	22 (20.9)	201		
Total	343 (85.5)	32 (8.0)	26 (6.5)	401		

* $p < 0.05$.

The results offer valuable insights into the nature of noise disturbances on campus, including their sources, timing, and outcomes.

Construction noise was the most frequently mentioned noise source, followed by residential noise, machine equipment noise, and study area noise. Specifically, construction noise had the greatest effect on sleep and mental health, with its effects on sleep being most pronounced during early morning and late night, which aligns with previous research.[6] However, another study conducted across 30 dormitories in three representative major urban universities in a provincial capital city in China found that college students were more affected by noise primarily due to traffic noise and indoor activities.[10] The observed differences may stem from regional variations in local conditions. In our study, the presence of multiple ongoing construction projects operating day and night, within and around the campus, likely contributed to the numerous complaints. Residential noise also generated lots of complaints, likely due to the dense living conditions in Chinese university dormitories, where close quarters amplify the effects of even moderate conversations on students' sleep and daily life. This observation aligns with studies indicating that dense, enclosed living spaces are prone to noise complaints, with residential noise being the most common source of sleep disruption.[12,28] Complaints about machine equipment noise frequently appeared in students' reports, with the main complaints focusing on its effect on sleep during late-night hours and on study during the daytime. Previous studies on campus noise, both in China and abroad, have also documented the effects of this type of noise source, such as sounds from heating equipment, air conditioning units, and ventilation equipment.[17,29] Machine equipment noise on campus may be attributed to outdated equipment, as damaged facilities in both the dormitories and teaching areas generate high levels of noise, severely affecting students' sleep—especially during late-night hours.

Our study found significant differences in the effect of various noise sources on sleep and study, while no significant difference was observed in the effect on mental health. Among them, construction noise, machine equipment noise, and residential noise had the greatest effect on sleep, which aligns with previous findings on the environmental effect of Chinese university campuses by Wu *et al*.[6] Traffic noise accounted for the largest proportion of complaints

Table 4: Association between the Effect of Noise on Study and Sleep.

Sleep	Study/*n* (%)			Total	χ^2	*P*
	0	1	2			
0	40 (30.5)	22 (16.8)	69 (52.7)	131	93.695	<0.001*
1	52 (75.4)	11 (15.9)	6 (8.7)	69		
2	143 (71.1)	37 (18.4)	21 (20.4)	201		
Total	235 (58.6)	70 (17.5)	96 (23.9)	401		

* $p < 0.05$.

Table 5: Association between the Effect of Noise on Study and Mental Health.

Study	Mental Health/*n* (%)			Total	χ^2	*P*
	0	1	3			
0	199 (84.7)	23 (9.8)	13 (5.5)	235	4.986	0.289
1	58 (82.9)	6 (8,6)	6 (8.6)	70		
2	86 (89.6)	3 (3.1)	7 (7.3)	96		
Total	343 (85.5)	32 (8.0)	26 (6.5)	401		

related to severe sleep disruption among all noise sources, which aligns with a previous study on Chinese universities.[11] International studies that mapped noise levels have also identified parking lots and traffic corridors as major sources and locations of noise.[13,14] Additionally, complaints about study area noise accounted for the highest proportion of reports related to its effect on study among all noise sources. A previous study found that the self-reported effect on reading and mental tasks by noise was associated with a worse grade point average.[30] Therefore, the schools need to address the negative effects of noise on students and take effective measures to mitigate campus noise pollution. The effect of noise occurrence time shows significant differences in its effects on sleep, study, and mental health, indicating that noise occurring at different times of the day has markedly different effects on students. Specifically, noise during the early morning and late-night hours has the most severe effect on sleep, which aligns a previous study focusing on the noise effects of dormitories in China.[10] This may be because nighttime noise leads to awakenings and transitions to lighter, less restorative sleep, thereby disrupting sleep pattern.[20] Notably, most complaints about noise affecting study were reported during the daytime. This may be because most students study during the daytime, and noise during this period directly impacts their study efficiency. Students may tend to report the direct effects of noise in their complaints while placing less emphasis on its indirect effects.

Consistent with our expectations, the effect of noise on sleep was found to be significantly positively associated with its effect on mental health. This aligns with previous findings, as a study on college students also suggested that nighttime noise disturbances negatively affect their mental health through their sleep quality.[19] At the same time, our study revealed a significant association between the reported effect of noise on sleep and its effect on study in the complaint emails. Our study also found no significant association between the effect of noise on mental health and study. This may be because many students are unaware of the potential relationship between the two and therefore do not necessarily mention the other when complaining about one.

Coping Strategies for Noise

This study demonstrates that addressing campus noise issues cannot rely only on students' passive coping strategies. Instead, the university administrators must recognize that it is important to control noise on campus. They can implement measures such as coordinating with nearby construction teams to schedule their construction activities according to students' study and rest time. The administrators can also enhance the campus soundscape construction, such as water features or green spaces with birdsong, to create a peaceful atmosphere and reduce noise disturbances.[25] Additionally, soundproofing measures such as noise barriers or strategic placement of trees, can help minimize traffic noise.

Limitations

The data of this study were collected from one university in southern China, potentially limiting the generalizability of the findings to other institutions due to regional differences and specific student demographics. Future research could expand to include a wider variety of areas and universities to overcome these limitations. Subsequent studies could also explore using qualitative methods to analyze noise complaint texts and examine how various types of noise affect mental health, study efficiency, and social interactions.

Conclusion

This study highlights the impact of noise pollution on campus through the analysis of spontaneous complaint emails from students at a university. Construction noise was found to be the main noise source, significantly disrupting students' sleep and study, particularly during late night and early morning. These findings offer direction for future research to control noise pollution in universities. Passive defenses, such as using earplugs to mitigate noise, were likely to be ineffective. Systemic solutions, such as stricter noise control policies and adjusted construction schedules, should be implemented

to protect students' sleep quality, study efficiency, and mental health.

Availability of data and materials

Data supporting the findings of this study are available from the corresponding author upon reasonable request. Access requests will be reviewed to ensure compliance with ethical and privacy guidelines.

Author contributions

J.F. designed and supervised the whole work. Y.C. and Y.L. performed data collection and data analysis. J.F., Y.C., and Y. L. performed data coding. J.F. and Y.C. prepared and wrote the original draft of the paper. J.F. and A.P.S. reviewed and edited the draft. All authors have read, critically revised, and approved the final version of this manuscript. J.F. is responsible for the overall content (as guarantor).

Ethics approval

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Research Ethics Committee of the School of Psychology at Shenzhen University (SZU_PSY_2024_114).

Consent to participation

This study has received approval for the waiver of informed consent.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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