Original Article

Community Noise Exposure and Annoyance, Activity Interference, and Academic Achievement Among University Students

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Abstract

Background: Noise annoyance and effects on academic performance have been investigated for primary and secondary school students but comparatively little work has been conducted with university students who generally spend more time in dormitories or accommodation for their self-study. **Objective:** To determine, using a socio-acoustic approach involving face-to-face interviews and actual noise measurements, the effect of various community noise sources on student activities in accommodation both inside and outside a university precinct and also relationships with cumulative grade point average (GPA). **Materials and Methods:** The study sample comprised a student group resident off-campus ($n = 450$) and a control group resident in dormitories on-campus ($n = 336$). Noise levels [L_A (dB)] were measured at both locations according to International Organization for Standardization standards. The extent of community noise interference with the student activities was examined with bivariate and stratified analyses and results presented as Mantel–Haenszel weighted odds ratios (OR_{MH}) with 95% confidence intervals. Binary logistic regression was employed to assess the association between noise-disturbed student activities and dichotomized GPA values and derive odds ratios (ORs) for these associations. **Results:** Measured noise levels were all significantly ($P < 0.05$) higher for off-campus students. This was not reflected in the interviewed students' subjective perceptions of how "noisy" their respective environments were. The off-campus student cohort was, however, more annoyed by all community noise categories ($P < 0.001$) except road traffic noise. For impact on specific student activities, the largest differences between on- and off-campus students were found for telephone and personal communication regardless of the type of community noise. There was no significant difference in the relationships between perceived annoyance due to community noise categories and cumulative GPA in the off-campus group compared to those for on-campus residents with OR_{MH} values ranging from 1.049 to 1.164. The most important noise-impacted factors affecting off-campus students' cumulative GPA were reading and mental tasks (OR = 2.801). Rest disturbance had a positive influence on cumulative GPA for on-campus students. **Conclusion:** These results provide support that various contemporary community noise sources affect university students' activities and possibly influence their educational achievement as well.

Keywords: Community noise, grade point average, Mantel–Haenszel odds ratio, noise annoyance, university academic performance

Introduction

A wide range of sources can produce noise, and it is generally regarded as an environmental stressor. Noise annoyance can have serious physiological, psychological, and social consequences. These include feelings of disruption, stress reactions together with sleep disorders, hormonal changes, increased blood pressure and risk of myocardial infarction, and a general deterioration of well-being and quality of life. Noise annoyance can be partly explained by acoustic factors such as sound level, frequency, spectrum, and source. It is recognized, however, that non-acoustic factors, for example, personal and social factors that affect a person's awareness of and the attitude toward noise also play a role in annoyance felt. In addition, previous works have shown that subjective sensitivity to noise is a significant predictor noise

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annoyance.[1,2] The relative importance of some of these factors may vary according to the number and type of noise sources as well as the duration and frequency of noise events, that is, the acoustic environment one lives in.[3,4]

Many studies reveal that road traffic is a predominant source of noise annoyance in residential and urban areas.[3-6] However, communities are also subject to ambient noise from a non-traffic origin (such as sounds made by neighbors, elevators, air conditioners, animals, entertainment venues, and so on).[7,8] Previous studies indicate that such community noise, both traffic and non-traffic in origin, causes significant effects on adult residents' health and well-being in both Asian and European cities.[5,7,9-11] In Thailand, community noise has become a major environmental issue, with an increasing number of complaints caused by non-traffic noise sources being reported in many municipalities.[12]

The presence of uncontrollable noise can also significantly impact cognitive capability.[4,13-15] Experimental and epidemiological studies have both identified that long-term exposure to noise affects the brain's organization of speech processing and attention control, resulting in decreased academic performance.[16-18]

In the context of academic performance evaluation, grade point average (GPA) is an accessible and quantifiable measure that reflects the influence of many aspects, including personal and environmental ones, involved in student learning. For example, the amount of time spent studying in a relatively quiet environment would be a contributing factor to better academic achievement as denoted by a high GPA or examination score.[19] Despite this, many universities worldwide are located in acoustic environments that may cause noise annoyance and affect not only students' everyday activities but also their learning ability.

Noise annoyance and effects on academic performance have been investigated for primary and secondary school students,[16,18,20,21] but there has been comparatively little work conducted among university students. Among the few relevant studies, the authors are aware of Weinstein's work[22] showing that noise-sensitive US college students tended to have lower scholastic ability and Czech work showing the increased levels of noise and university students' annoyance in surveys conducted in 1989 and 1999, although no effect on academic performance was investigated.[23]

The aims of this study were, therefore, to determine the influences of various contemporary community noise sources on university student activities in accommodation both inside and outside a university precinct, and also to assess the effect of community noise and affected student activities on cumulative GPA. In recognition of the influence of acoustic and non-acoustic factors on these research questions, a socio-acoustic approach was taken involving face-to-face interviews for a questionnaire as well as actual noise measurements.

Materials and Methods

Characteristics of the study site and student sample

The participants taking part in this study were students registered at Silpakorn University (Sanamchantra Palace Campus), Nakhon Pathom Province, Thailand. The campus covers an area of 11.2 km^2 and had a total enrolment in the 2016 academic year of 11,508 undergraduate students and 1,567 graduate students. Residential neighborhoods as well as small commercial areas surround the university. Various community noise sources such as road traffic, building construction, mobile advertising vehicles and bars and karaoke venues are found in the area that would be typical of many urban areas in South East Asia. Undergraduate students studying for more than 2 years were selected for the study. A total of 786 students took part in interviews, 27.0% male and 73.0% female. The gender ratio in this sample of 2.7 in favor of females was comparable to the ratio for the whole university students (2.3 in favor of females). The sample comprised a control group of students residing in the dormitories inside the campus ($n = 336$) and those staying in private accommodation outside ($n = 450$). The respondents represented a homogenous sample in respect of comparable age and educational attainment [Table 1].

Noise exposure measurements

Noise levels at both on-campus [the inside group (IG)] and off-campus [the outside group (OG)] locations were measured using sound level meters (RION Models NL-06 and NL-22) according to the recommendations of International Organization for Standardization (ISO) standard 1996-2: 2017.[24] The on-campus dormitories are located an average of 300 m away from the nearest main roads and have vegetation surrounding them. OG residential locations include several multistory accommodation blocks that are impacted by a variety of community noise sources, that is, local road traffic, construction sites, open-air markets, and entertainment venues. Such noise sources also impact the IG but generally with a lower intensity. To quantify this, separate noise measurements were undertaken at OG and IG sites.

A-weighted outdoor equivalent noise level [L_A (dB)] measurements were made every 15 min over a 24-h period at 20 measuring stations (10 for IG and 10 for OG) situated 2 m from building facades. From the obtained L_A levels, daytime L_{eq} (L_d; 07:00–19:00), evening L_{eq} (L_e; 19:00–22:00), and nighttime L_{eq} (L_n; 22:00–07:00), as well as the 24-h equivalent level $L_{eq,24h}$ and the day, evening, and night level L_{den} were then calculated. The L_{den} was obtained from the logarithmic formula specified in the ISO document on the measurement and assessment of environmental noise (ISO standard 1996-1: 2016)[25] and corresponding noise rating levels for those time periods were derived from the European Union's Environmental Noise Directive 2002/49/EC. The purpose of these noise measurements was to

Table 1: Summary characteristics of the student cohorts from the questionnaire survey for the off-campus (OG) and on-campus (IG) university student cohorts

Variable	Outside group (OG)(n = 450)		Inside group (IG)(n = 336)		P value
	N	(%)	*N*	(%)	
Gender					
Male	129	28.7	83	24.7	0.210
Female	321	71.3	253	75.3	
Age (years)					
Male	21.16 ± 1.44		20.61 ± 1.21		<0.001
Female	20.73 ± 1.08		20.51 ± 1.06		
Flat noise					
In noisy area	229	50.9	181	53.9	0.410
In quiet area	221	49.1	155	46.1	
Flat position					
Ground floor and 1st floor	50	11.1	15	4.5	<0.001
2nd–4th floor	271	60.2	305	90.8	
5th–8th floor and higher	129	28.7	16	4.7	
Window orientation					
Facing street	288	64.0	241	71.7	0.020
Not facing street	162	36.0	95	28.3	
Satisfaction with the flat surroundings					
Satisfied	216	48.0	122	36.3	0.004
Partially satisfied	211	46.9	196	58.3	
Not satisfied	23	5.1	18	5.4	
Psychogenic stress					
Yes	169	37.6	133	39.6	0.560
No	281	62.4	203	60.4	
Cumulative GPA	2.80 ± 0.44		2.83 ± 0.48		<0.001

characterize the levels of noise exposure of the participants to objectively assess acoustic interferences on their activities and academic performance.

Questionnaire surveys

A noise annoyance questionnaire adapted from International Commission on the Biological Effects of Noise[26] and previous studies[13,27] was employed for assessing subjective responses. The questionnaire survey was conducted, via face-to-face interview at the university and off-campus accommodation, by trained interviewers. The questionnaire contained questions on personal (gender, age, and study faculty), behavioral (psychogenic stress), and accommodation characteristics (orientation of windows relative to the street, location, and length of stay in accommodation) of students. It also included questions on possible non-traffic and traffic noise effects (noise annoyance from different acoustic sources, interference with various student activities, e.g., reading and mental tasks and disturbance of sleep). Annoyance was estimated using a five-level scale (not at all; slightly; moderately; very; extremely). Individual students were also asked for their current cumulative GPA, representing academic performance. The standard scores for GPA at Silpakorn University range from 0.00 (fail) to 4.00 (excellent). The cumulative GPA values given by the volunteering participants were then crosschecked with the university registration office's database to the extent permitted by privacy regulations.

For statistical purposes, the results of the survey questions were dichotomized (not at all + slightly + moderately; very + extremely) or trichotomized (not at all + slightly; moderately; very + extremely).[13,28] Summary characteristics of the student cohorts, their environments and cumulative GPAs from the questionnaire survey are given in Table 1.

Statistical analysis

Descriptive statistics involve the presentation of numerical variables as mean values ± standard deviation (SD) and categorical variables as percentages (relative numbers). As the IG is regarded as the control group, *t*-tests were applied to determine whether the differences in measured acoustic characteristics experienced by the OG and IG student cohorts were significant.

Bivariate and stratified analyses were used to estimate the extent of community noise interference with the student activities. In stratification analyses where the variables (community noise annoyances) were divided into three categories (not at all + slightly; moderately; very + extremely), results were presented as the Mantel–Haenszel weighted odds ratios (OR_{MH}) with 95% confidence intervals (95% CI).[13] In addition, Mantel–Haenszel chi-square values were calculated. This tests the null hypothesis that all OR_{MH}

Table 2: Measured acoustic characteristics for the environments of the off-campus (OG) and on-campus (IG) student cohorts

Acoustic characteristics (dBA)		Outside group (OG)	Inside group (IG)	*t* value	*P* value
$L_{eq,24h}$	mean ± SD (min–max)	64.7 ± 4.8 (55.2–72.4)	60.3 ± 1.8 (58.3–64.1)	2.721	0.007
L_d	mean ± SD (min–max)	65.1 ± 5.2 (55.2–73.7)	61.4 ± 2.0 (59.2–64.9)	2.070	0.027
L_e	mean ± SD (min–max)	64.6 ± 5.2 (53.7–70.4)	60.7 ± 3.8 (55.0–67.3)	1.908	0.036
L_n	mean ± SD (min–max)	62.0 ± 6.1 (55.1–71.2)	54.8 ± 2.5 (51.0–60.5)	3.474	0.001
L_{den}	mean ± SD (min–max)	69.8 ± 5.2 (61.9–77.4)	64.2 ± 1.8 (62.2–67.5)	3.245	0.002

values are all equal to one versus the alternative hypothesis that at least one differs from unity.

To quantify the association between cumulative GPA and community noise annoyance and student activities, cumulative GPA scores were classified by means of class intervals. This approach divided the scores into low, medium, and high. Low (≤2.39) and high (≥3.18) cumulative GPA groups were employed for analysis (as a dichotomized variable), while those data between 2.39 and 3.18 were excluded. Binary logistic regression was then performed to assess the association between noise disturbed student activities (independent variable) and GPA (dependent variable) and derive odds ratios (ORs). The Statistical Package for the Social Sciences version 13.0 (SPSS Inc., Chicago, IL, USA) software was used for all data analyses.

The original dataset of the current study was not stratified according to gender because previous relevant works[22,23] found no significance difference between male and female participants in reactions to dormitory noise and stratifying the data made no difference to results.

Results

Influence of community noise on student activities

Statistically significant differences ($P < 0.05$) were found for all measured acoustic characteristics between OG and IG sites [Table 2]. The respondents in the OG are thus generally exposed to higher noise levels during the day and especially at night compared with those from the IG. The difference in the magnitude of the mean values of all acoustic characteristics ranged from 3.7 dB for L_d up to 7.2 dB for L_n data that showed the largest disparity.

Interestingly, this difference in measured acoustic characteristics was not reflected in the student perceptions of their environment. For the OG students, the location of accommodation was in fact marginally less often subjectively assessed as "noisy" (50.9% vs. 53.9% in IG), with consequent low statistical power ($P = 0.41$). OG students may have become accustomed to their acoustic environment. This lack of distinction between OG and IG students is also seen with some aspects of building design. The proportion of windows reported to be facing streets were similar (64.0% vs. 71.7%) as therefore were the percentages not facing a street (36.0% vs. 28.3%) [Table 1].

The OG student cohort was, however, more annoyed by all community noise categories (traffic, construction, recreation, and advertising) compared to IG students with significant differences ($P < 0.001$) for all categories except road traffic noise [Figure 1]. Among the different types of community noise investigated, advertising noise (e.g., loudspeakers in vending vehicles driving around the neighborhoods) showed the largest difference in effect on student activity between OG and IG students with OR_{MH} for various activities ranging from 1.396 to 2.228 [Table 3]. Road traffic noise had the least differential impact on the various student activities investigated for OG versus IG cohorts (with OR_{MH} values ranging from 1.000 to 1.768). For specific student activities and their perception of noise annoyance, the largest differences between OG and IG students were consistently found for telephone and personal communication regardless of the type of community noise. Perhaps surprisingly but importantly for the purposes of this work, the smallest differences in community noise impact between OG and IG groups were for listening to radio and television (TV) and reading and mental tasks.

Influence of community noise annoyance and student activities on cumulative grade point average

The relationship between community noise annoyance as perceived by students and their cumulative GPA is shown in Table 4. While values of OR_{MH} were all found to be >1 (the actual values ranged from 1.049 to 1.164), the lower limits of the corresponding 95% CI were all <1 and *P* values were not significant ($P > 0.05$), except for construction noise. These results indicate that there was no significant difference in the perceived annoyance due to these noise types, traffic and non-traffic related, and cumulative GPA in the off-campus group (OG) compared to those for residents in dormitories on campus. This is despite non-traffic community noise being perceived as more annoying to OG students as described above.

To investigate the influence of community noise and academic performance further, associations between student activities and dichotomized cumulative GPA segregated between OG and IG groups were examined using binary logistic regression

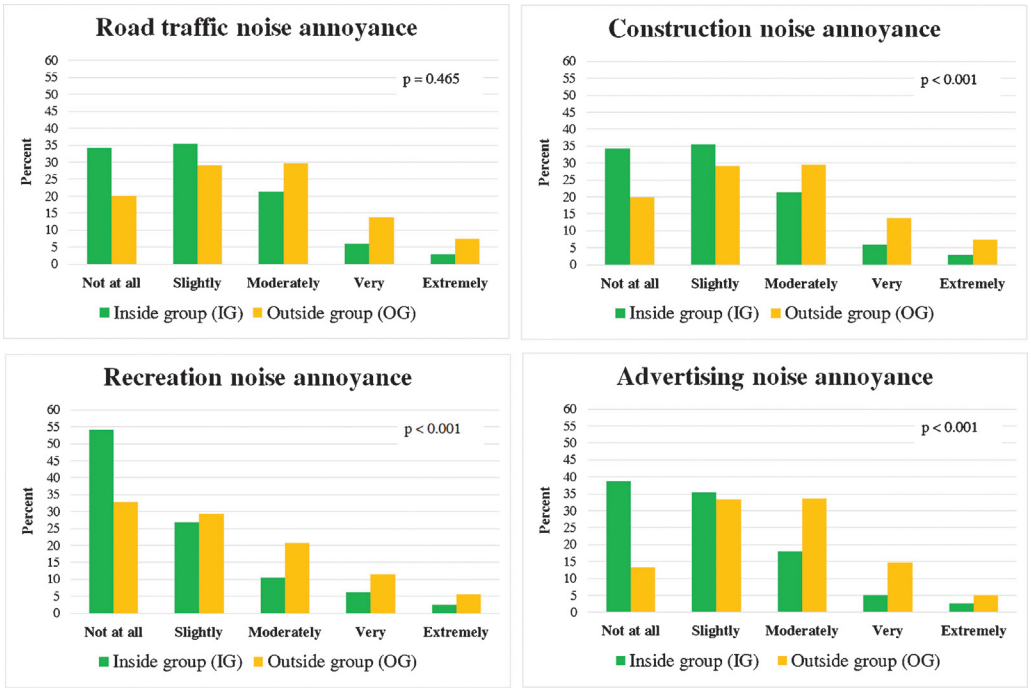

Figure 1: Noise annoyance from the various types of community noise among students residing inside (IG) ($n = 336$) and outside (OG) ($n = 450$) the university

analysis. This yielded ORs as shown in Table 5. These results show the most important noise-influenced activities that affect students' cumulative GPA. For OG students, reading and mental tasks significantly influenced cumulative GPA (OR = 2.801, $P < 0.05$). This means that an increase of the community noise annoyance level for this activity, for example, from moderately to very + extremely increases the odds of a reduction in the cumulative GPA by a factor of 2.8. Paradoxically, rest disturbance was found to have a positive influence on cumulative GPA in IG students (OR = 0.161, $P < 0.05$).

Discussion

This socio-acoustic study showed that student residents off- and on-campus (OG and IG) subjectively perceived their environments to be similarly noisy, despite objective measured sound levels being greater in off-campus areas, particularly at night. Students in the OG were more annoyed and disturbed by non-traffic noise ($P < 0.001$) rather than traffic noise. As compared to primary and secondary school students, university students generally spend more time in dormitories or accommodation for their self-study. Therefore, community noise annoyances might be expected to influence their study patterns and academic performance more. The comparisons of noisy and relatively quiet environments have shown a distinct deleterious effect of community noise on academic-skill descriptors together with a variety of physiological and cognitive factors.[29-31]

The measured mean $L_{eq,24h}$ values of 64.7 ± 4.8 dBA in the OG residential environment and 60.3 ± 1.8 in that of the IG [Table 2] did not exceed Thailand's permissible environmental noise level of 70 dBA. However, this threshold is based on the World Health Organization (WHO)'s Guidelines for Community Noise[32] and aims to prevent hearing damage in most people after a lifetime exposure. It is not a limit below which there is no noise annoyance. In fact, WHO's recommended value to prevent community noise related annoyance or disturbance for daytime living areas is 50–55 dBA ($L_{eq,16h}$) or less, and for nighttime sleep 45 dBA ($L_{eq,8h}$) or less.[32] This suggests a possible influence of community noise on the students' activities in both groups.

The current study indicated that all community noise types had greater detrimental effects on communication activities (personal and telephone) for the sampled university students than any other activity. Adults suffer less than children and even the elderly from the effects of noise on speech perception.[33] Children need higher sound pressure levels than young adults to gain the highest results from word identification tests.[17,34] However, as the participants in the current study were young adults, relatively high ORs would not be expected. OR_{MH} values found were between 1.000 and 2.228 [Table 3] for the various community noise categories.

There was little difference in the annoyance subjectively experienced by OG and IG groups to various types of community noise and cumulative GPA [Table 4]. However, some differences were noted between cohorts in regard to the association of particular noise-impacted student activities and cumulative GPA [Table 5]. A moderate influence of community noise on the sleep quality (awakening from sleep and falling asleep) of the participants in the exposed group (OG) was found [Table 3] for whom the biggest differences in noise levels

Table 3: Noise annoyances and impact on various student activities for students domiciled inside versus outside the university

Type of community noise annoyance	Mantel–Haenszel weighted OR[a] (95% CI)	Chi-square	*P* value
Traffic noise annoyance			
Listening to radio and TV	1.000 (0.723–1.383)	0.007	0.934
Reading and mental tasks	1.080 (0.781–1.493)	0.144	0.704
Personal communication	1.768 (1.307–2.390)	13.258	<0.001
Telephone communication	1.703 (1.252–2.315)	11.031	0.001
Rest disturbance	1.120 (0.822–1.527)	0.408	0.523
Awakening	1.475 (1.092–1.992)	6.029	0.014
Falling asleep	1.279 (0.946–1.729)	2.319	0.128
Construction noise annoyance			
Listening to radio and TV	1.118 (0.820–1.524)	0.394	0.530
Reading and mental tasks	1.217 (0.899–1.646)	1.418	0.234
Personal communication	2.006 (1.475–2.730)	19.241	<0.001
Telephone communication	1.993 (1.460–2.720)	18.430	<0.001
Rest disturbance	1.274 (0.945–1.718)	2.289	0.130
Awakening	1.692 (1.251–2.290)	11.169	0.001
Falling asleep	1.551 (1.136–2.117)	7.238	0.007
Recreation noise annoyance			
Listening to radio and TV	1.240 (0.901–1.706)	1.524	0.217
Reading and mental tasks	1.269 (0.934–1.724)	2.067	0.150
Personal communication	1.997 (1.471–2.711)	19.180	<0.001
Telephone communication	1.972 (1.447–2.689)	17.971	<0.001
Rest disturbance	1.351 (0.996–1.833)	3.437	0.064
Awakening	1.758 (1.294–2.389)	12.473	<0.001
Falling asleep	1.539 (1.128–2.099)	7.013	0.008
Advertising noise annoyance			
Listening to radio and TV	1.396 (1.006–1.937)	3.675	0.055
Reading and mental tasks	1.538 (1.114–2.124)	6.376	0.012
Personal communication	2.228 (1.623–3.058)	24.288	<0.001
Telephone communication	2.151 (1.564–2.958)	21.828	<0.001
Rest disturbance	1.570 (1.144–2.155)	7.355	0.007
Awakening	1.857 (1.360–2.535)	14.803	<0.001
Falling asleep	1.657 (1.206–2.278)	9.275	0.002

[a]Mantel–Haenszel weighted odds ratio was used because of stratification, as the community noise annoyance variable was trichotomized (not at all + slightly; moderately; very + extremely).

Table 4: Influence of community noise annoyance on students' cumulative GPA[a] for students domiciled inside versus outside the university

Type of community noise	Mantel–Haenszel weighted OR[b] (95% CI)	Chi-square	*P* value
Traffic	1.098 (0.827–1.457)	0.325	0.504
Construction	1.164 (0.870–1.557)	0.902	0.022
Recreation	1.056 (0.791–1.410)	0.088	0.190
Advertising	1.049 (0.782–1.407)	0.061	0.478

[a]Cumulative GPA data were dichotomized as "low" (cumulative GPA $\leq$ 2.39) or "high" (cumulative GPA $\geq$ 3.18) according to class interval. [b]Mantel–Haenszel weighted odds ratio was used because of stratification, as the community noise annoyance variable was trichotomized (not at all + slightly; moderately; very + extremely).

as compared to the IG student cohort were for nighttime noise levels (L_n). This finding agreed with that from previous studies indicating noise to be a key element influencing sleep quality at nighttime.[35,36] Noise during sleep may have a significant detrimental effect on academic achievement. It has chronic effects on neural processes related to tasks. However, it is unclear at present based on the literature whether noise was directly responsible for such effects or whether they were caused indirectly by interfering with sleep quality for example.[37]

A prominent association (OR = 2.801) was found between reading and mental tasks and cumulative GPA for the OG group [Table 5]. This possibly relates to the effect of long-term noise exposure on the brain function of attention control,[17] resulting in worse academic achievement. However, it is interesting that more noise-induced rest disturbance in IG students was associated with a better cumulative GPA (OR = 0.161). If not spurious, this result implies that not only noise exposure, but also other factors affect cumulative GPA. Rest disturbance itself is also influenced by a number of factors, for example, indoor air quality, ventilation, and number of cohabitants,[7,8] as well as the psychological status of individuals.[30] Further investigation of this finding is therefore recommended.

As mentioned, clear unequivocal statistical evidence of differential annoyance due to community noise and cumulative GPA between OG and IG students was not obtained in the current study [Table 4]. Inconsistency regarding association between community noise and academic performance has previously been seen in the literature. For example, two recent studies conducted in the same area of Greater London gave conflicting results. The first one found that chronic external noise exposure had a significant negative impact on the performance of primary school students.[16] Another one indicated almost no significant relationships for secondary school students.[20] This apparent inconsistency may be attributed to educational achievement depending not only on the direct effect of environmental factors such as noise annoyance but also other factors such as the student's age and those factors perhaps indirectly affected by

Table 5: Odds ratios (OR) (95% confidence interval) for associations between student activities and dichotomized cumulative GPA segregated between OG and IG groups using multiple logistic regression analysis[a]

Student activity	Outside group (OG) (n = 184)			Inside group (IG) (n = 152)		
	OR	(95% CI)	P value	OR	(95% CI)	P value
Listening to radio and TV	0.745	(0.314–1.767)	0.504	1.603	(0.629–4.086)	0.323
Reading and mental tasks	**2.801**	**(1.157–6.784)**	**0.022**	1.698	(0.627–4.598)	0.298
Personal communication	0.532	(0.207–1.367)	0.190	0.677	(0.234–1.961)	0.473
Telephone communication	1.395	(0.557–3.496)	0.478	0.911	(0.265–3.140)	0.883
Rest disturbance	0.740	(0.296–1.847)	0.519	**0.161**	**(0.047–0.554)**	**0.004**
Awakening	0.541	(0.228–1.282)	0.163	2.939	(0.928–9.313)	0.067
Falling asleep	1.623	(0.682–3.866)	0.274	0.932	(0.306–2.839)	0.901

[a]Cumulative GPA data were dichotomized as "low" (≤2.39) or "high" (≥3.18) according to class interval.

community noise, for example, class attendance[19] as well as general physical and mental health.[37] Class attendance patterns and age are clearly different between secondary school and university students but perhaps health-related factors are influential as well. To emphasize the multifactorial nature of tertiary academic performance, Sheard[38] indicated that gender was less important than commitment among the factors investigated. However, the latter only contributed 3% to the variance of final GPA of University undergraduates and gender only an additional 1%. Other factors such as first-generation status, the educational level of parents, and intelligence quotient of the students have also been reported to influence GPA.[39-41]

This study is among the first to have specifically examined cumulative GPA as a dependent variable in relation to community noise exposure for a sample of young university students. It is difficult to assess the relationship between educational achievement and noise annoyance categories with a relatively small sample size, particularly given the influence of possible confounding factors on GPA identified above. A more powerful sample might give a clearer and more conclusive answer to this question. It is also important to note that while GPA is widely used, it is only one potential measure of academic performance in university. It has some limitations regarding what information it can provide about the academic experience and may not encompass all important aspects of the educational process (e.g., mastery and interest).[16]

Conclusion

Investigation of the influences of various community noise sources on university student activities in accommodation both inside and outside a university precinct showed that measured noise levels were often not in accord with the students' perceptions of how "noisy" their environment was. All measured noise levels were significant higher for off-campus (OG) students. Consistent with this, the OG student cohort was more annoyed by all community noise categories except road traffic noise compared to students resident on campus. Regarding the impact of community noise on student activities, telephone and personal communication showed the largest differences between on- and off-campus groups regardless of the noise source. No significant differences in the relationships between perceived community noise annoyances and cumulative GPA in the off-campus group compared to those for on-campus residents were observed. The most important noise-impacted factors affecting students' cumulative GPA were reading and mental tasks as well as rest disturbance. The latter had a positive influence on cumulative GPA in on-campus students. Limitations identified above notwithstanding, these findings highlight the complex nature of community noise annoyance, interference with various activities, and cumulative GPA among university students. Results do, however, suggest that preventive measures are necessary to reduce community noise in the accommodation of university students both within and external to university precincts.

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Conflicts of interest

There are no conflicts of interest.

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