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Evaluation of sound pressure level and lighting in the dormitories of Golestan University of Medical Sciences in 2022

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Abstract

Background: Sound and lighting have a major effect on residential, office, and welfare environments. Both the lack and excess of these parameters, in addition to causing physical and psychological negative effects, can also adversely impact productivity and efficiency. This research was conducted to determine the level of sound pressure and lighting in the dormitories of Golestan University of Medical Sciences.

Methods: This descriptive and analytical study was conducted cross-sectionally in 2022 in four dormitories of Golestan University of Medical Sciences. At different time intervals, lighting and sound pressure levels were measured.

Results: The results showed that the highest average measured sound level was in the 5th Azar dormitory (59.73 ± 10.54 dB), while the lowest was in the Alamol Hoda dormitory (45.42 ± 7.32 dB). In addition, the lowest and highest sound levels were recorded at 8:00 a.m. (53.97 ± 7.86 dB) and 9:00 p.m. (61.49 ± 9.38 dB), respectively. At 8:00 a.m., no significant difference in lighting was observed between the four dormitories. However, at 4:00 p.m., a significant difference was found between the dormitories ($p < 0.05$).

Conclusion: Since environmental factors such as sound and lighting can play a significant role in providing a peaceful environment for students, it is necessary to pay attention to the modification of these environments based on existing standards.

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Highlights

What is current knowledge?

Sound and lighting, as two primary physical factors, can impact residential, office, and welfare settings by negatively affecting individuals' health, productivity, and efficiency.

What is new here?

Assessing the levels of sound and lighting in student dormitories and comparing them to the allowed limits can assist policymakers and decision-makers in enhancing the conditions of student housing.

Introduction

The first environmental factor necessary for any kind of activity is light and illumination (1). The sense of sight is considered the most important and essential human sense (2). A large portion of the information we receive from the world around us is visual (3). Insufficient or excessive lighting can affect people's health, causing issues such as eye fatigue, headaches, visual impairment, glare, physical fatigue, decreased alertness, changes in body temperature and sleep patterns, and reduced work performance. It can also lead to psychological effects and even accidents (4). Evidence shows that the physical work environment affects job performance and satisfaction (5). The more precise and delicate one's job duties are, the more important it is to ensure proper lighting levels in the work environment (6).

Unfavorable lighting in the work environment can cause the information a person receives to be inaccurate, increasing the possibility of human error (7). Therefore, ensuring adequate lighting for any task and measuring it to prevent visual damage and ensure proper work performance is a fundamental aspect of workplace safety management (8). In educational and residential environments, where visual activities are frequent, attention to the quantity and quality of both natural and artificial lighting is even more important (9). Since 83% of learning occurs through vision, any issues with seeing can lead to a decline in learning (4).

Another physical factor that has received attention in recent years is sound (10). Sound is an integral part of the human living environment (11). There is sufficient scientific evidence that noise can cause hearing problems, high blood pressure, heart disease, noise annoyance, sleep disturbances, and reduced student performance and learning (12). The most well-known adverse effect of noise is hearing loss (13). While noise-induced hearing loss is easily preventable, it is irreversible once it occurs and stabilizes (14). Hearing loss in adults is ranked as the 15th most significant health issue globally, with profound effects such as social isolation and a loss of economic power (15).

Sound also has indirect effects on human performance, such as reducing work efficiency and productivity, and increasing the risk of accidents and errors due to decreased concentration (16). In educational settings, if noise exceeds the threshold level, it can impact not only physical and mental health but also students' learning outcomes. Noise pollution, and particularly noise annoyance (Which often occurs at sound pressure levels lower than those causing noise pollution), can be especially problematic in shared living spaces like student dormitories (17). Dormitories, as residences for students, play a significant role in their educational experience. Different aspects of the environment affect the overall quality of life and the appeal of living conditions in dormitories (18).

According to international standards, the maximum sound level is 40-45 dB for libraries and 45 dB for dormitories (19). In addition, the permissible sound pressure limits in libraries and bedrooms, based on Iran's national residential laws, are between 35-40 dB and 30-35 dB, respectively (20). Since light and sound are significant physical factors that influence both office and educational environments, deviations from standard levels can negatively affect people's health and productivity. Therefore, this study aimed to evaluate the light and sound levels in various sections of Golestan University of Medical Sciences' dormitories and compare them to standard values.

Methods

This descriptive and analytical study was conducted cross-sectionally in 2022 across four dormitories affiliated with Golestan University of Medical Sciences in Gorgan (Two girls' dormitories and two boys' dormitories). The study population included all dormitory rooms, study halls (Libraries), and sports halls. A census sampling method was used to collect data from all rooms. Sound pressure levels and lighting measurements were taken in the Alamol Hoda, Iranmehr, 5th Azar, and Kousar dormitories on different days of the week and at various times of day.

Data collection tools included a lighting evaluation checklist, a sound evaluation checklist, a sound level meter (TES-1150, Taiwan), and a lux meter (TES-1332A, Taiwan).

In selecting the dormitories, their locations were recorded based on traffic conditions and external sound sources. Considering the possibility of differences in student density on different days of the week and varying hours of their presence at the dormitory, sampling was conducted during the week and different times of the day. Samples were taken at the beginning, middle, and end of the week, as well as at three time intervals: 8 to 10 a.m. (Morning), 4 to 6 p.m.

(Evening), and 9 to 11 p.m. (Night). During each time interval, both lighting and sound pressure level measurements were conducted. The recorded sound pressure levels were compared with the national standards for residential and educational spaces.

The level of illumination intensity was also checked using the lux meter during the defined intervals. These intervals ensured adequate coverage to measure natural, artificial, and mixed lighting. During measurements, factors such as the number of people in the room, room size, number and type of lamps, room layout, type of ceiling and floor covering, surface color, and weather conditions (Cloudy, partly cloudy, and sunny) were considered. Illumination measurements were conducted using both general and local methods. Finally, the obtained values were compared with the national standards for lighting in educational spaces.

The collected data were entered into SPSS version 27 software and reported using appropriate statistical indicators. The Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that most variables were non-normally distributed. Consequently, descriptive statistics and non-parametric tests, including Mann-Whitney, Kruskal-Wallis, and Spearman's correlation, were used for analysis, with a significance level set at less than 0.05.

Results

The results of the basic information in this study showed that the minimum and maximum number of students in the Alamol Hoda and Iranmehr dormitories were 4 and 10, respectively (4.42 ± 1.26). The average number of students in the 5th Azar and Kousar dormitories was slightly higher, with a mean of 6.34 ± 2.84.

As shown in Table 1, the pattern of light changes during the day and night differed across the four dormitories. Overall, before 4:00 p.m., the Alamol Hoda dormitory exhibited the highest level of illumination, while at 9:00 p.m., the 5th Azar dormitory had the highest illumination. The Kousar dormitory experienced the most fluctuating lighting levels at 8:00 a.m. and 4:00 p.m.

Table 1. Comparison of average lighting (Natural and artificial) at 8, 16 and 21 hours across different dormitories (Four dormitories, two girls' dormitories and two boys' dormitories)

Time	Dormitory	N	Average lighting (Lux)	
			Mean	SD
8:00	Alamol Hoda	104	115.66	42.1
	Iranmehr	52	120.34	56
	5th Azar	196	113.06	99.64
	Kousar	82	129.20	117.22
	Total	434	117.61	88.70
16:00	Alamol Hoda	104	113.83	40.70
	Iranmehr	52	120.49	55
	5thAzar	196	86.88	79.21
	Kousar	82	121.93	106.96
	Total	434	103.99	77.24
21:00	Alamol Hoda	52	121.13	8.17
	Iranmehr	26	91.42	28.13
	5th Azar	98	142.67	55.83
	Kousar	41	115.41	42.91
	Total	217	126.22	46.31

To compare the lighting between the four dormitories and measurement locations at 8:00, 16:00, and 21:00, the Kruskal-Wallis test and its pairwise comparisons were used, as the conditions for applying the parametric test of repeated measurements were not met. The comparisons were conducted separately for each time point: 8:00, 16:00, and 21:00.

The recent results showed that at 8:00 a.m., no significant difference was observed in terms of lighting among the four dormitories. However, at 4:00 p.m., a significant difference was noted ($p < 0.05$), primarily due to the difference between the 5th Azar and Alamol Hoda dormitories. In addition, at 21:00, a significant difference was observed among the four dormitories, attributed to the differences in illumination between the 5th Azar dormitory and both the Iranmehr and Kousar dormitories, as well as between Alamol Hoda and Iranmehr ($p < 0.05$).

Table 2 shows the trend of lighting changes among the student room, prayer hall, library, and sports hall. In the three locations, student rooms, prayer room, and sports hall, the lighting decreased from 8:00 a.m. to 4:00 p.m. and then increased from 4:00 p.m. to 9:00 p.m. In the library, the lighting level increased from 8:00 a.m. to 4:00 p.m. and then decreased from 4:00 p.m. to 9:00 p.m.

In order to compare the brightness between the measurement locations at 8, 16, and 21 hours, and due to the lack of conditions for using the parametric test of repeated measurements, the comparison between the locations in terms of illumination at 8, 16, and 21 hours was performed separately using the Kruskal-Wallis test and its pairwise comparisons. By comparing the level of illumination between the four places at all three times (8 a.m., 4 p.m., and 9 p.m.), no statistically significant difference was observed between the four places in terms of illumination ($p < 0.05$).

Table 2. Average Comparison of Total Lighting (Natural and Artificial) at 8, 16 and 21 hours based on different student dormitory locations

Time	Place of dormitory	N	Average of total lighting (Lux)	
			Mean	SD
8:00	Student room	402	119.71	89.33
	Library	17	129.96	78
	Prayer hall	6	69.42	46.63
	Sport hall	4	69.54	40.81
	Total	429	118.95	88.33
16:00	Student room	380	111.34	75.51
	Library	16	133.47	64.71
	Prayer hall	6	64.58	45.19
	Sport hall	4	66.37	33.72
	Total	406	111.08	74.81
21:00	Student room	203	128.33	46.31
	Library	9	100.52	40.85
	Prayer hall	3	85.33	30.79
	Sport hall	2	88.41	5.3
	Total	217	126.22	46.31

The average values and standard deviation of sound pressure levels measured in different dormitories are also shown in Table 3. As can be seen, among the evaluated dormitories, only the Alamol Hoda dormitory had a sound pressure level within the recommended and standard values; in the other dormitories, the sound pressure level values were higher than the standard level. Tables 4 to 6 show, respectively, the average and standard deviation of the sound level in the investigated dormitories based on different days of the week, different hours of the day, and different dormitories.

Table 3. Mean and standard deviation of sound pressure levels measured in different dormitories

Dormitory	Number of measured stations	Sound pressure level (dB_A)			
		Min	Max	Mean	SD
Alamol Hoda	468	35.9	88.8	45.42	7.32
Iranmehr	234	42.3	82	55.96	6.56
5th Azar	878	31	88.16	59.73	10.54
Kousar	369	35	86	58.77	9.53

Table 4. Mean and standard deviation of sound pressure levels measured in dormitories based on different days of the week

Days of week	Number of measured stations	Sound pressure level (dB_A)			
		Min	Max	Mean	SD
Saturday	649	31	88.8	57.87	10.30
Monday	651	36.7	88.16	58.56	9.31
Wednesday	649	35.9	85.83	57.75	8.59

Table 5. Mean and standard deviation of sound pressure levels measured in dormitories based on different hours of the day

Hours of day	Number of measured stations	Sound pressure level (dBA)			
		Min	Max	Mean	SD
8:00	649	31	83.5	53.97	7.86
16:00	651	35	87.15	58.71	9.39
21:00	649	35.9	88.8	61.49	9.38

Table 6. Mean and standard deviation of sound pressure levels measured in dormitories based on different locations

Place of dormitory	Number of measured stations	Sound pressure level (dB_A)			
		Min	Max	Mean	SD
Student room	649	31	88.8	57.95	9.38
Library	81	47	73.33	57.47	6.58
Prayer hall	27	47.1	81.33	56.85	10.30
Sport hall	18	52.5	88.16	73.58	10.86

Discussion

The results of this study showed that the incorrect placement of windows, the material and color of the walls, ceiling, and floor, and the condition of the curtains, along with the incorrect arrangement of the lamps, the power of the lamps, and the condition of their maintenance, created a significant difference in the average level of lighting intensity. In addition, due to space limitations in most of the rooms, natural light was blocked by the placement of obstacles such as wardrobes, beds, and other items.

The study halls were not located in suitable positions and did not receive adequate light, and the windows were installed in inappropriate places near the ceiling, which limited the lighting. The arrangement of the lamps in the rooms and study hall was not suitable; some areas were much brighter than the standard (300-500 Lux), while others were completely below the standard, which was annoying for the students. The 5th Azar and Kousar girls' hostels had higher sound levels than the other two dormitories.

In order to control the sound in such environments, engines, pumps, and other equipment must be completely placed and kept in a separate environment. The 5th Azar dormitory, however, was located in a public area, and due to the old

building and equipment, as well as their improper maintenance, there was a lot of noise disturbance outside the standard range.

Also, the speakers of the dormitory paging system were installed in an inappropriate position, and the noise level was significantly higher than the standard, causing audio annoyance.

On the other hand, the 5th Azar and Kousar hostels were located in the city center, and naturally, they had more sources of noise pollution than the Alamol Hoda dormitory, which was located outside the city.

In terms of examining the days of the week and the hours of the day and their effect on the level of sound pressure, during the day, most of the students were outside the university, resulting in lower sound intensity. Conversely, the opposite situation could be observed at night. In addition, the presence of students was higher in public places, such as the dormitory area, prayer hall, TV hall, and sports hall.

In sports halls, due to the sound annoyance from the ventilation device, the proximity to the engine house, and the use of music speakers, there was more noise annoyance.

A study was conducted by Zamanian et al. to investigate the effect of sound level and lighting intensity on students' body condition while studying in three study halls of the boys' dormitories at Shiraz University of Medical Sciences in 2013. The results showed that the lighting intensity was 114.433 ± 83.88 Lux, and the sound pressure level was 49 ± 4.646 dB. In this study, sound and brightness measurements were performed based on the standards of the National Occupational Health Committee of Iran (21). The noise values measured in this study were similar to the findings of the present study, and both were higher than the standard limits, while the illumination values were lower than the standard limits.

In another study conducted by Javan et al. to evaluate the intensity of lighting in 24 study halls of the Isfahan University of Medical Sciences dormitories in 2012, the results showed that the daytime lighting in the studied halls was at the standard level, with an average of 567 lux. However, the lighting at night, due to the removal of natural light sources and the use of artificial lighting, averaged 229 lux, which was not suitable (3).

Conclusion

The results of this study showed that, according to the existing standards in the studied spaces, the level of lighting and sound pressure in many hours and days of the week were not within the permissible limits. Since environmental factors such as sound and lighting can provide a quiet environment, if they have adverse effects on students, such as acoustic annoyance caused by sound above the permissible limit, and visual and musculoskeletal injuries due to the quantity and quality of lighting, it is necessary to pay attention to the modification of these environments based on the existing standards.

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Ethical statement

This research was approved by the Ethics Committee (Approval ethics number: IR.GOUMS.REC.1401.358).

Conflicts of interest

The authors declare that they have no competing interests.

Author contributions

RH and HR conceptualized the study. AYJ, and ZQ collected the data. HRH and NSSQ performed data analysis. HRH and HR reviewed the analysis. HRH and HR authored the manuscript and made edits to it. All authors read and approved the final manuscript.

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