Measurement of Sound Noise Levels and Light Exposure in the Bedroom to Minimize Health Problems

E Purwanto[a], N N Mulyaningsih[a,*], D L Saraswati[a], T A Sari[b], R Ningsih[c], E Wiyanti[d] and Nurizati[e]

[a]*Department of Physics Education, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Indraprasta PGRI Jakarta, Indonesia*
[b]*Department of Biology Education, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Indraprasta PGRI Jakarta, Indonesia*
[c]*Department of Mathematics Education, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Indraprasta PGRI Jakarta, Indonesia*
[d]*Department of Indonesian Language Education, Faculty of Language and Art (FBS), Universitas Indraprasta PGRI Jakarta, Indonesia*
[e]*Department of Teacher Education of Primary School, Subang Institute of Teacher Training and Education, Jawa Barat, Indonesia*

[*] e-mail address: nengnendenmulyaningsih@gmail.com

Abstract

Sleep is an activity to give our body and soul a short break. Sound levels and light exposure can affect sleep quality. Therefore, this study aims to measure the level of sound noise and light exposure in the bedroom, so that it can be a recommendation for sound levels and sound levels that are safe for the bedroom. The research method was used to measure the sound intensity in the bedroom which was generated from two sound sources, namely air conditioner (AC) and from the fan by using the Sound Level Meter application, then the light intensity was also measured from two light sources, namely the main lamp and light sleeper, each light source was measured using the Luxmeter application. The results showed that the noise level from the air conditioner was 37-38 dB and the fan was 68-69 dB, while the value of the light intensity level from the main lamp was 84 lux and from the night light was 0 lux. Following the recommendations of the World Health Organization (WHO), that the noise level in the bedroom should not exceed 40 dB and a maximum light intensity level of 5 lux, then the results of the study can be concluded that if you have to use a bedroom temperature controller, the use of AC is more recommended than a fan and to get safe lighting, you should use a special lamp for sleeping.

Keywords: Sound level; light exposure; bedroom; luxmeter

1. Introduction

Every human being has their own busyness and activities that have a diversity of and differences from one another. However, there is one activity that all humans must do, namely sleep. In the condition of a human being asleep, a comfortable and calm condition is needed to achieve quality sleep, so that if there is the slightest disturbance it will definitely affect the human being himself (Yu, et al., 2021; Savall, et al., 2021).

Among the disturbances that we will discuss in this article are noise and light exposure when someone is sleeping in the bedroom.

Sound noise is one that every human being faces, everywhere. Especially on the road, work and others. Physically, there is no difference between sound and noise. Sound is related to feelings and perceptions while noise is unwanted sound. The sound that is assessed as noise is very relative to what activity is going on (Yu, et al., 2021). For example, when you are in public transportation where the sound of cars and motorbikes is normal and can be tolerated, so it is not noise. When our condition is sleeping, the sound of cars and motorbikes will become a disturbing sound or noise (Murdani, 2016).

The smaller the sound that appears when we fall asleep, the better. According to WHO, the noise level at night should not exceed 40 dB. This means that both from inside and outside the bedroom, it is not recommended that a sound source exceeds 40 dB. Still from the same source, WHO said that if someone sleeps for a long time, they are exposed split infinitive than that, there is a risk of developing insomnia and sleep disorders. Even if it exceeds 55 dB it can result in a heart attack (WHO, 2009).

Another sleep disorder that can cause the quality of human health to be reduced is the level of light exposure (Billings, et al., 2020). Light is an electromagnetic wave of radiation that can be seen by humans. The light that we see, not only consists of white light but there are also wavelengths consisting of various color spectrums, which are then interpreted by the human brain to be colored according to the wavelength range. Visible-light wavelengths range from 340 nanometers (nm) to 700 nanometers (nm), when described this light will consist of several color areas (Austin, et al., 2021; Suha, et al., 2020; Umul, 2021; Wang, et al., 2012).

Light is not just light. It has wavelength, lux, and radiation (lumen). So According to Harvard Medical School, exposure to be light suppresses the secretion of melatonin, a hormone that affects circadian rhythms. Even just 8 lux affect. Light at night is part of why many people don't get enough sleep, and researchers have linked short sleep to an increased risk of depression and diabetes, and cardiovascular problems (Boland, et al., 2020; Petit, et al., 2021). For this reason, it is not recommended to sleep with light exposure exceeding 5 lux.

After we know the various effects on health, we need to know the value of the noise level and light exposure we receive during sleep. Sound noise level can be measured with a Sound Level Meter while for light exposure, we can measure it with a Luxmeter. In today's modern era, we can take advantage of the digitization of these two tools with only an Internet quota and a smartphone. Through the play store/app store application, we can download both. This study aims to measure the level of sound noise and light exposure in the bedroom. So that it can be a recommendation for sound levels and sound levels that are safe for the bedroom.

2. Materials and Methods

2.1. Materials and Tools

This experimental research tries to measure the level of noise and light exposure in the bedroom from the sources of the cause. The sample sources measured were the Fan (Standing Fan Miyako, speed 1st) and Air Conditioner (AC ½ PK, 25 ^{o}C, fan low) for

the noise level, then the main room lights (Main lamp Philips LED 5 Watt) and bed lights (Light sleeper 0.6 Watt) for the level of light exposure.

All samples of the causes of noise levels and light exposure were assumed to be in the bedroom in a house in a residential area. Noise and light exposure from outside factors were assumed to be absent. Measurements using the Sound Level Meter application for noise levels and Luxmeter for light exposure levels. Both applications can be downloaded on the Play Store or App Store for free.

2.2. Research design

In completing this research, researchers used quantitative and qualitative approaches. The data collected is in the form of numerical data, then analyzed by comparing it to controls, namely WHO standard data, both for sound intensity and light intensity, and then described descriptively.

2.3. Sound Level Meter Application

The Sound Level Meter application used was downloaded for free from the Play Store. The Sound Level Meter application was released by Splend Apps with version 2.02. While the Luxmeter application was released by Doggo Apps with version 022, then both applications were installed on the Vivo Y12 android smartphone.

2.4. Data Analysis and Statistical Analysis

Measurements of the noise and light source were each carried out at a distance of 100 cm from the sound or light source and the measurement time were 5 and 10 seconds. Statistical analysis was performed using an independent t-test to compare the measurement results with WHO standards using Microsoft Excel 10. P-value <0.05 deemed to indicate a real/significant difference.

3. Results and Discussion

The results of measurements of sound noise levels during sleep can be seen in Figure 1. Looking at the data in Figure 1, the measurement results on the fan that was 1 meter from the Sound Level Meter application on the gadget, have numbers 68 dB at 5 seconds and 69 dB at 10 seconds. AC with a blowing temperature of 25 ^{o}C has a figure that was almost half, which is between 37 dB at 5 seconds and 38 dB at 10 seconds. It can be seen from Figure 1, that the value of 37 - 38 dB is still below the WHO standard which is calculated as 40 dB. These results indicate that air conditioning that was used within 1 meter is more recommended to accompany our sleep every day. Given that these two samples were air conditioning devices commonly used in tropical regions, we need to be selective in choosing between the two between the fan and the air conditioner. Moreover, there is the potential for health problems, either directly or indirectly.

Quality sleep with sufficient duration (around 7-9 hours for adults) is very important for body and mental health (Razali, et al., 2021; Wang, et al., 2020). The quality of a

person's sleep can be reduced if there is noise around him during his sleep. Sounds above 40 dB at night can trigger the body's natural reactions that can interfere with sleep quality. Having a bad sleep can affect your mood, lead to fatigue, and reduce memory and concentration. Due to frequent exposure to noise pollution, sleep disturbance can cause stress and reduce the quality of life (Liu, et al., 2020; Connelly, et al., 2020). Health research also shows that too frequent exposure to noise pollution in children can affect their ability to learn, concentrate and remember. In infants and toddlers, this can result in speech delays (Denisova, 2019). Therefore, based on the research results that have been done, for the comfort of a bed from disturbing sounds, the use of air conditioning is more recommended than the use of a fan.

Exposure to noise from a fan or air conditioner does not depend on the time of day. The results of measurements at 5 seconds and 10 seconds did not show a significant difference at P <0.05. This shows that the sound emitted from the fan or air conditioner was relatively constant.

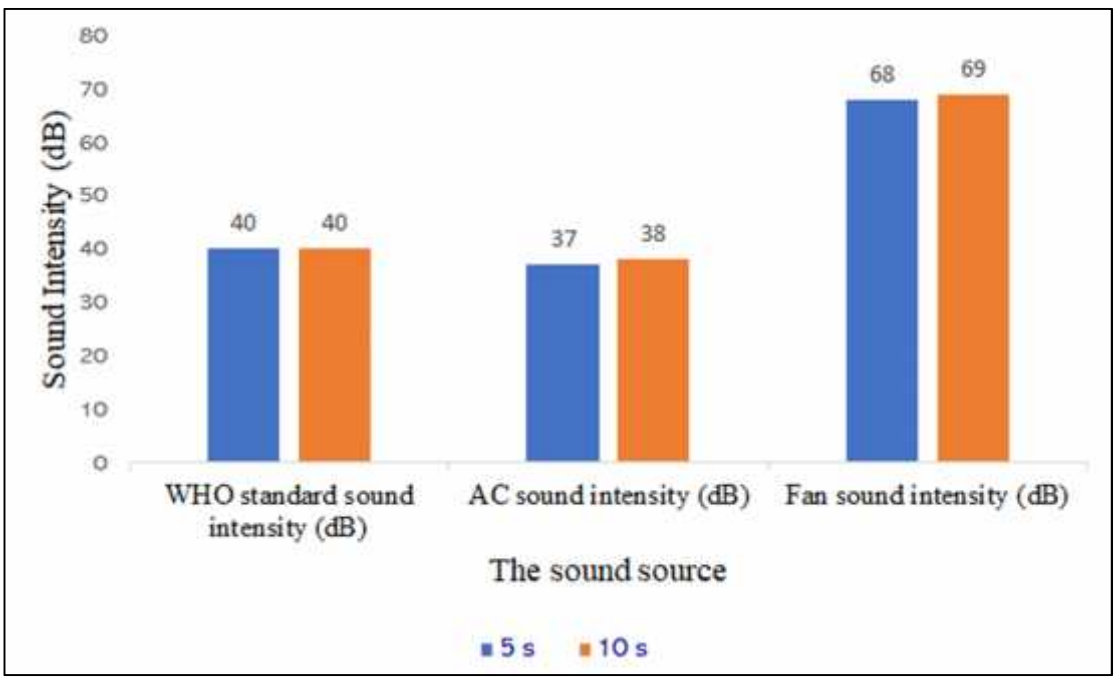

Fig. 1. Noise level measurement results

The next discussion, regarding the exposure to light into the bedroom which comes from the light sleeper and the main lamp. The result is shown in Figure 2. Based on Figure 2, the results of measurements with the Luxmeter application show unequal results. The main lamp has a light exposure intensity of 84 lux compared to 0 lux belonging to a sleep lamp. Of course, during sleep, the less light, the better for health. With a WHO standard of 5 lux (Obayashi, et al., 2020), a light sleeper is highly recommended instead of the main light. According to a sleep researcher from the University of Melbourne, J. L. Rault, light is the reason why many people don't have

enough sleep, which can have the effect of stress on cardiovascular disorders. According to him, 8 lux of light still affect health (Rault, et al., 2017).

As with the results of the measurement of sound intensity, the results of the measurement of light intensity are also not affected by the length of the measurement time. The measurement of light intensity which was carried out for 5 seconds did not show a significant difference with the results of the measurement of light intensity for 10 seconds. This also shows that the light rays from the main lamp and the night lamp emit a relatively constant light beam.

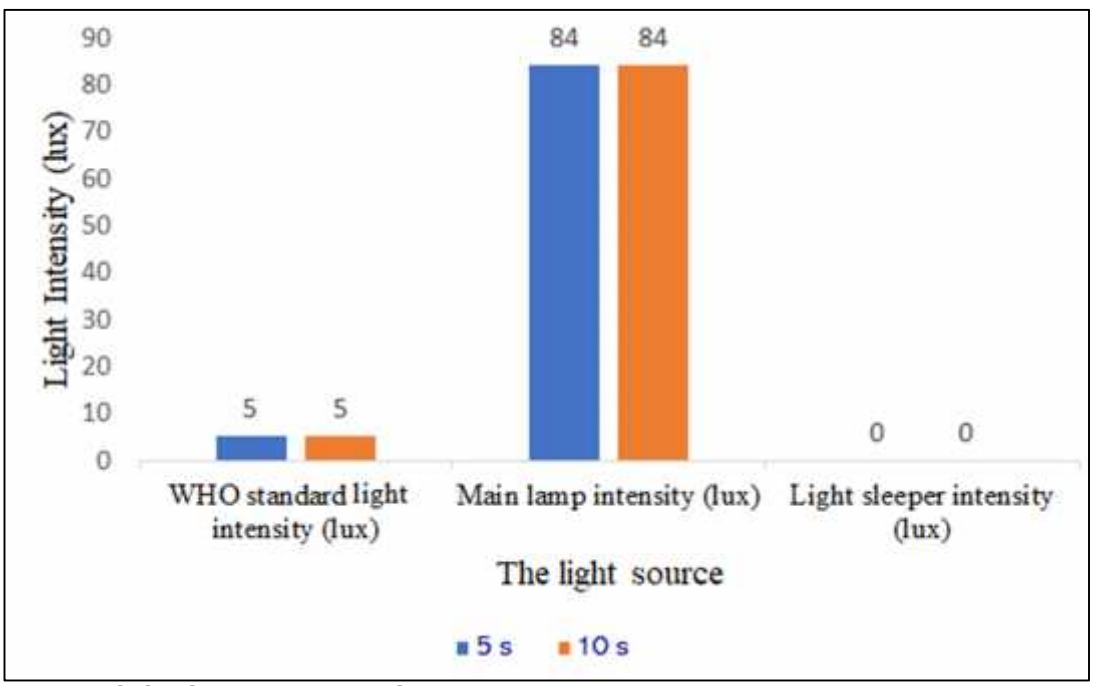

Fig. 2. Light level measurement results

Joanne Stevens, research reveals that exposure to light stimulates nerve pathways from the eye to parts of the brain that control hormones, body temperature, and other functions that play a role in making the eyes feel sleepy or awake. As a result, sleeping with the lights on can make it difficult to sleep well. In addition, sleeping with the light on can bring about various health problems such as depression, obesity, less alertness, and an increased risk of developing critical illness (Stevens, et al., 2019).

Despite the impact on health, most people are more comfortable and can only sleep with the light on. If we are one of the people who have trouble sleeping with the lights off, then the solution is based on the results of the research that has been done, which is to start by using a special night light for sleeping.

4. Conclusion

Following the recommendations of the World Health Organization (WHO), that the noise level in the bedroom should not exceed 40 dB and a maximum light intensity level of 5 lux, then the results of the study can be concluded that if you have to use a bedroom temperature controller, the use of air conditioner (AC) is more recommended than a fan and to get safe lighting, we should use a special lamp (light sleeper) for sleeping.

References

Austin, E., Geisler, A. N., Nguyen, J., Kohli, I., Hamzavi, I., Lim, H. W., Jagdeo, J., 2021. Visible Light Part I. Properties and Cutaneous Effects of Visible Light, J. American Academy of Dermatology.

Billings, M. E., Hale, L., Johnson, D. A., 2020. Physical and social environment relationship with sleep health and disorders, Chest 57, p. 1304.

Boland, E. M., Vittengl, J. R., Clark, L. A., Thase, M. E., Jarrett, R. B., 2020. Is sleep disturbance linked to short- and long-term outcomes following treatments for recurrent depression? J. Affective Disorders 262, p. 323.

Connelly, F., Johnsson, R. D., Aulsebrook, A. E., Mulder, R. A., Hall, V, Vyssotski, A. L., Lesku, J. A., 2020. Urban noise restricts, fragments, and lightens sleep in Australian magpies, Environ. Pollution 267, p. 115484.

Denisova, K., 2019. Age attenuates noise and increases symmetry of head movements during sleep resting-state fMRI in healthy neonates, infants, and toddlers, Infant Behavior Develop 57, p. 101317.

Ju, Y. J., Lee, J. E., Choi, D. W., Han, K. T., Lee, S. Y., 2021. Association between perceived environmental pollution and poor sleep quality: results from nationwide general population sample of 162,797 people, Sleep Med 80, p. 236.

Liu, J., Wu, T., Liu, Q., Wu, S., Chen, J. C., 2020. Air pollution exposure and adverse sleep health across the life course: A systematic review, Environmental Pollution 262, p. 114263.

Murdani, 2016. Pengelolaan polusi udara dan suara di laboratorium otomotif jurusan teknik mesin, J. Penelitian Saintek 21, p. 55.

Obayashi, K., Yamagami, Y., Kurumatani, N., Saeki, K., 2020. Bedroom lighting environment and incident diabetes mellitus: a longitudinal study of the HEIJO-KYO cohort, Sleep Medicine 65, p. 1.

Petit, J. M., Eren-Koçak, E., Karatas, H., Magistretti, P., Dalkara, T., 2021. Brain glycogen metabolism: A possible link between sleep disturbances, headache and depression, Sleep Medicine Reviews 59, p. 101449.

Rault, J. L., Clark, K., Groves, P. J., Cronin, G. M., 2017. Light intensity of 5 or 20 lux on broiler behavior, welfare and productivity, Poultry Sci 96, p. 779.

Razali, R. A. N., Suparto, Perangin-Angin, C. R., 2021. Hubungan antara kualitas tidur dengan kesehatan mental pada mahasiswa kedokteran: tinjauan umum, J. Kedokteran Meditek 7, p. 55.

Savall, A., Marcoux, P., Charles, R., Trombert, B., Roche, F., Berger, M., 2021. Sleep quality and sleep disturbances among volunteer and professional French firefighters: FIRESLEEP study, Sleep Med 80, p. 228.

Stevens, J., Markgraf, C., 2019. Chapter 6 - Sleep and Sleep Disruption, Editor(s): Mary Jeanne Kallman, Michael K. Pugsley, Advanced Issue Resolution in Safety Pharmacology, Academic Press, p.

103.

Suha, A., Mulyaningsih, N. N., Astuti, I. A. D., 2020. Pengembangan modul pembelajran radiasi benda hitam berbasis saintifik terhadap kemampuan berpikir kritis siswa, Schrodinger J. Ilmiah Mahasiswa 1, p. 1.

Umul, Y. Z., 2021. A relativistic electron interacting with electromagnetic waves, Optik 231, p. 166409.

Wang, F., Bíró, É., 2021. Determinants of sleep quality in college students: A literature review, Explore 17, p. 170.

Wang, T., Zhao, D., 2012. Stokes parameters of an electromagnetic light wave on scattering, Optics Communications 285, p. 893.

WHO Regional Office for Europe Night Noise Guidelines for Europe, WHO Regional Office for Europe Publications. Downloadable from www.euro.who.int/en/what-we-do/health-topics/environmental-health/noise/publications/2009/night-noise-guidelines-foreurope, 2009.

Yu, N., Cai, J., Xu, X., Sun, J., 2021. Improvement on perception of welding noise by fountain sound masking: Insights from fMRI, Applied Acoustics 171, p. 107563.