To What Extent Does the Use of Pink LED Lighting Prior to Sleep Impact Adolescent Sleep Patterns and Overall Sleep Quality?

Word Count: 5313

INTRODUCTION

On average, adolescents across the world only gain about 6.5-7.5 hours of sleep each night (Better Health Channel, 2018) with an overwhelming one-third of American adolescents who fail to meet recommended amount of sleep of approximately eight to ten hours a night (NSCH, 2022). This growing problem of adolescent sleep deprivation has been exacerbated by the growing use of blue light emitting technologies prior to going to sleep at night. Blue light technology is a broad term to describe any form of device that emits blue light wavelengths [450 – 495 nanometers (nm)], including smartphones, computers, televisions, light bulbs, and LED lights. The blue light wavelengths emitted from these devices are known to disrupt the body's natural sleep patterns, especially in adolescents as a result of increased time spent on electronic devices and higher sensitivity towards light compared to adults. As researchers have searched to mitigate the effects blue light has on adolescent sleep patterns, they have found that "red light wavelengths stimulate the production of melatonin" (Pietrangelo, 2021) which is the hormone that is released in order to induce sleep. This discovery has led to use of red light as a form of sleep therapy for individuals with sleep disorders such as insomnia, as it works to promote relaxation and stimulate melatonin production, thereby inducing sleep and acting as a solution to the decline in sleep quality among adolescents in America.

During the year of 2020, it became increasingly more common for teenagers to buy LED strip lights, largely impart to their growing ubiquity on social media platforms. In fact, according to the U.S. Energy Information Administration, "The number of U.S. households that reported using LEDs for most of their indoor lighting grew from four percent in 2015 to 47 percent in 2020," (Rachel, 2023) especially in part to the rise of TikTok. Considering the potential positive or negative effects of certain light wavelengths on sleep quality and how LED

strip lights have become a common bedroom decoration among adolescent, it is important to understand how their increase in usage is able to effect adolescent sleep patterns, especially with the growing issue of adolescents lacking adequate sleep.

To understand their implications, this study aims to discover the effects of pink-colored LED strip lights, which contain both red and blue wavelengths, on adolescent sleep patterns and sleep quality. As explained before, blue light can disrupt sleep patterns due to its short wavelengths that stimulate the brain and suppress the production of melatonin. On the other hand, red light promotes sleep and enhances the production of melatonin. When they are emitted together in LED lights, they can create a visual perception of the color pink. Understanding how the combination of these two counteracting wavelengths, emitted together in pink LED strip lights, affects adolescent sleep patterns could potentially provide insight for the decline in sleep quality among adolescents in America if proved to be beneficial. Alternatively, it could reveal that pink light is harmful to adolescent sleep patterns, serving as a warning to adolescents who use pink LED strip lights prior to sleep. Another possibility is that the red and blue wavelengths cancel each other out when produced and be neither harmful nor beneficial, proving that applying pink LED strip lights is acceptable before going to sleep.

These possible implications have led to the research of the rest of this paper, examining the effects of the combination of red and blue wavelengths that create the light color pink on adolescent sleep patterns. This research will involve the participation of adolescents from X County as test subjects to determine if there is a statistical difference between the sleep quality gained among adolescent test subjects having been exposed to no light prior to sleep for one week and pink light prior to sleep the next to determine whether or not pink light is or is not beneficial to adolescent sleep quality.

LITERATURE REVIEW

Adolescent sleep patterns and its role in development:

The quality of an adolescent's sleep plays a crucial role in their development, quality being defined by multiple factors that can improve or worsen sleep such as sleep duration, interruptions to sleep, time it takes to fall asleep, and even an individual's perception of how well rested they felt after wake. According to the U.S. Department of Health and Human Services, a department at the cabinet level of the US federal government, "Adolescents should be getting between eight and ten hours of sleep each night (Department of Health & Human Services, 2018). This recommendation is based on the understanding that adolescents experience rapid physical, intellectual, and emotional growth, sleep being where most of this development occurs and therefore, they need this significant amount of sleep (U.S. National Library of Medicine, 2008, p. 69). Without an adequate amount of sleep, adolescents can struggle in school, have difficulties with regulating their mood and behaviors, and even suffer from negative mental and physical health effects such as depression, anxiety, fatigue, hand tremors, and even substance abuse (Cleveland Clinic, 2024). These implications highlight why sufficient sleep is indispensable during adolescence.

Sleep loss in adolescents can result in a harmful cycle, having "a negative effect on mood and behavior, which leads to subsequent emotional/behavioral difficulties that further interfere with sleep" (Dahl, 1999, p. 355). This vicious cycle of declining mental health and poor sleep quality prevents them from obtaining the sleep they need to properly develop their brain and body. This bidirectional relationship between sleep and mental health – where poor mental health can result in sleep loss, and sleep loss can negatively affect mental health – has

been seen among teenagers across the nation and warrants the exploration of solutions that promote improved sleep quality among adolescents (Master et al., 2019, p. 7732).

Not only can sleep impact the mental health of adolescents, but it can also impact their cognitive function. This includes learning, memory, attention, and emotion processing (Tarokh et al., 2016, p. 182). Considering these factors are fundamental for academic success, it is crucial that adolescents gain a sufficient sleep which includes ensuring their sleep is uninterrupted, gaining a recommended eight to ten hours, and falling asleep within 20 minutes. Unfortunately, as increasing numbers of adolescents are not receiving adequate sleep, these elements of cognitive function are being hindered which can negatively impact their academic performance and daily productivity. Because insufficient sleep is able to significantly impair cognitive function and negatively impact mental health, it is important to address how certain factors, such as pink LED lighting, can impact adolescent sleep quality in order to find solutions to improve sleep quality and mitigate the negative consequences of sleep deprivation.

Definitions and Key Concepts:

In order to understand the possible implications of pink light on this ongoing sleep deprivation among adolescents, it is important to have a clear understanding of certain key terms and concepts. One of the most important terms is the circadian rhythm which has been defined, according to Ashley Abramson who is a writer with experience in health and psychology, as all the physical and mental changes that occurs in an individual's body over a 24-hour period (Abramson, 2024) which involves the brain signaling for the production of the hormone melatonin. Melatonin is the hormone that is released when the brain senses that it is dark out in order to induce sleep for an individual. This process is controlled by the suprachiasmatic nuclei (SCN), a molecular oscillator that is often referred to as the "central-clock" of the body

(Abramson 2024). It regulates the body's behavioral changes throughout the 24-hour cycle in order to partition the bodies alertness and sleepiness (Altimus et. al., 2008, p. 19998).

Factors that can effect circadian rhythm:

Circadian rhythm can be affected by a multitude of factors such as alcohol use, drug use, exercise, and even light exposure (U.S. Department of Health and Human Services, 2022). Exposure to blue light, which the brain associates with daytime, can inhibit melatonin production and disrupt circadian rhythm if encountered at night. On the other hand, red light with longer wavelengths has a more subtle impact on circadian rhythm regulation, highlighting the intricate relationship between light wavelengths and synchronization of the internal clock (Abramson, 2024). Red light has even been proven to be inducive of sleep and to excel the rate of entering a deep sleep by calming the body and enhancing the production of melatonin. With greater melatonin production, and individual's sleep patterns can improve and their sleep cycles balance. On the other hand, when melatonin is suppressed, it disrupts an individual's sleep cycles and circadian rhythm, leading to the negative health effects described in the previous section. This study aims to understand how these opposing light wavelengths can affect adolescent patterns when emitted together in pink LED lights, considering their opposite effects.

Just as light exposure can hold significant effects to circadian rhythm and sleep patterns, so can other factors such as exercise. Exercise has been proven to "improve sleep quality and duration" (Alnawwar, et. al, 2023), making this an important factor to take into account for this study as it has the potential to alter the results of the experiment. Its impact will be later discussed in the limitations section to ensure it is properly addressed as something that should taken into account in subsequent investigations of this research.

LED lighting and sleep research

As of 2020, the use of remote-controlled LED strip lights among adolescents has increased greatly due to the rise of TikTok as specified in the introduction. LED strip lights have the ability to suppress melatonin secretion due to the fact that many of the colors emitted from these color changing lights contain white and blue light which mimics daylight color (Armarthandan, n.d.). These lights are often placed along the walls of the bedrooms of adolescents as a form of room decoration and turned on prior to sleep. While the vibrant colors produced from these lights may be aesthetically pleasing, some of these colors that contain blue and white can be extremely disruptive to adolescent sleep patterns and circadian rhythm. In contrast, when they produce red and amber hues, they can be beneficial for sleep as those wavelengths of light are known to promote relaxation and increase melatonin production. The specific hues of these lights can be altered by a remote control, changing the amount of blue, red, white, or yellow light which allows for the creation of different shades of colors, including pink.

The ability to shift the colors emitted by LED bulbs can have positive effects on sleep patterns, in fact, “Engineers working with LED bulbs are creating technology to manipulate the amount of blue and green light produced at any given time” (U.S. Department of Health and Human Services, 2018). By ensuring that exposure to blue and green light is limited later in the day through this new technology, the manipulation of light wavelengths can potentially prevent disruptions in melatonin production and help individuals maintain a healthier circadian rhythm. This innovation holds promise for improving sleep quality and overall well-being through the strategic use of artificial lighting.

Potential effects of the multiple light wavelengths incorporated in pink light:

As stated previously, pink LED lighting is comprised of a combination of blue and red wavelengths, but it has yet to be discovered how the blend of these two wavelengths of counteracting effects impacts the sleep quality of adolescents prior to falling asleep. There are multiple potential results of this, each having implications that can contribute to the knowledge required to identify solutions for the decline of sleep quality among adolescents. If the pink LED strip lighting is proven to improve sleep quality, the application of pink light can act as potential solution to the increasing loss of sleep quality among adolescents. If it is proven to hinder sleep quality, this research can act as a warning to adolescents to not use pink lights prior to sleep. However, if the application of pink light prior to sleep neither improves nor harms sleep quality, then it can show that the two wavelengths cancel each other out and that it is acceptable for adolescents to use pink light before going to sleep. These possible implications and limited knowledge regarding the effects of the opposing blue and red wavelengths that comprise pink LED light have led to the research question: “To what extent does the use of pink LED lighting prior to sleep influence adolescent sleep patterns and overall sleep quality within X County?”

METHOD

To evaluate the research question, the experimental method should be employed, as it is the most effective way to test the impact of pink LED lighting with concrete results. This method provided a clear consensus on the effects of pink light on the participant’s sleep patterns and quality through quantitative data derived from the manipulation of the light exposure. The scientific method was a vital tool for the conduction of this experiment, as it allowed for a concise structure of the experiment and provided the data needed to come to a conclusion regarding the effects of pink LED strip lighting on adolescent patterns. Additionally, a post-experiment survey was completed by the participants on Google Forms to gather more

quantitative data on how the participants' perceptions of their sleep quality in order to provide more insight into the study's findings.

As stated previously, the scientific method was used in order to carry out the experiment. The first step was creating a research question: "To what extent does the use of pink LED lighting prior to sleep influence adolescent sleep patterns and overall sleep quality within X County?" Next, the researcher conducted background research on the specific topic which has been explained in the introduction/ literature review. After having formulated a research question and gathered background research, the hypothesis was made: if adolescents are exposed to pink LED strip lighting prior to sleep, the lighting will yield a neutral effect on the participant's sleep patterns because the effects of the red and blue light wavelengths that are being simultaneously emitted in pink light will cancel each other out. In other words, the pink lighting will neither improve nor decline the sleep quality of the adolescent participants compared to sleeping without having had light exposure prior to sleep. Once this hypothesis was made, the experiment could be conducted, using adolescent participants between the ages of 14-18 from X County as the dependent variable and light exposure as the independent variable.

This experiment tested the effects of pink LED lighting prior to sleep on adolescent sleep patterns by first gathering a group of 26 previously described participants. Each participant tracked their sleep patterns with and without pink LED lighting over two separate 5-day periods, limited to only school nights (Monday through Friday). Participants were then asked to log some aspects of their sleep patterns such as when they work up and fell asleep, how they felt the morning after wake, and how many times they woke up in the middle of the night on a printed-out sleep log (Appendix B, Table 1), providing quantitative data about their sleep patterns. To account for any external factors that could have influenced their sleep, participants also logged

certain aspects of their daily routine such as how long they exercised for and what time they got off their electronic device. This log not only provided data for the researcher, but it also acted as a guide for the participants to keep certain aspects of their daily and nightly routines consistent each day in order to minimize variables that could have altered the results of the experiment. The participants were consistently remined to stay as consistent as possible with their daily and nightly routines via email, but the log worked as the primary tool for reinforcing participants to stay consistent. The data was later analyzed to answer the research question in the results and analysis section.

The participants were asked to answer question 1 (Appendix B, Table 1) immediately after exercise (if they exercised), question 2 (Appendix B, Table 1) immediately after getting off their electronic device, question 3 (Appendix B, Table 1) directly before attempting to fall asleep, and questions 4-9 (Appendix B, Table 1) immediately after waking up to prevent participants from forgetting these key pieces of information. This log was be printed out for the participants to write their results and hand them back to the researcher at the end of the study. On the back of the paper, they were also asked to write a brief summary of what they did 45 minutes before attempting to fall asleep as another reminder for the participants to stay as consistent with their schedule as possible.

For the first 5 days of the experiment, the participants logged their sleep, answering the questions in the sleep log (Appendix B, Table 1) the way that was explained previously and were required to turn off all light in their area of sleep 15 minutes prior to attempting to falling asleep. This included lamps, electronic devices, or any other form of light that could have potentially impacted the results of the experiment. During the 15 minutes, participants were asked to sit patiently in their given area until the 15 minutes were over. After the 15 minutes,

participants were then asked to write down the time it was (Eastern Time) on the sleep log (Appendix B, Table 1); they were allotted to look at their electronic device for no more than three seconds to check the time which a duration too brief to have influenced the participant's sleep. After writing down the time, the participants then attempted to fall asleep. Since neither the researcher, nor the participants had full control of how consistent their daily and nightly routines were, the logs provided insight into anything that may have contributed to disruptions in their sleep and were considered during data analysis.

The next 5 days, participants repeated the same process but instead of applying no light, the participants turned on their LED strip lights to the color pink for 15 minutes prior to sleep. Each participant was required to have LED strip lights along the walls of their room with a remote control that was able to alter the color of light emitted. To ensure that all participants' LED lights were emitting the same color of pink, they were required to download the "Spectrometer" app which determines the wavelength of light in nanometers (nm) being produced, its frequency in terahertz (THz), and its color saturation percentage. After scanning the light with all other lights turned off, the app should have detected 700 nm, 430 THz, and 97% color saturation. To ensure all the LED's produced a consistent level of brightness, the LEDs were set to the highest level of brightness. The brand of the LED lights did not matter for this experiment since the Spectrometer app acted to ensure that the light being emitted was the same. Since brightness is also a reflection of the saturation of light on the app, controlling these factors helped maintain accuracy of the experiment. Participants then sent their spectrometer results to the researcher via email to ensure that they were applying the correct color and that there was no variation in the ratio of blue and red wavelengths composing the pink light.

After both weeks, the participants handed both their logs back to the researcher and then were asked to answer survey questions seen in Appendix C through a Google Form sent via email. These questions addressed how they personally felt their sleep quality change between the two weeks. This survey provided a more personal aspect of the research, allowing for a broader amount of data that can be used to determine the extent to which pink light effects adolescent sleep patterns.

Once all of the data was collected, a conclusion was able to be drawn about whether pink light is beneficial, harmful, or has more of a neutral effect to adolescent sleep patterns. This was done through an in-depth statistical analysis using the quantitative data collected from the logs and from the survey which is elaborated upon in the results and analysis section. This data was used to determine how each light exposure effected the participants, allowing for a conclusion to have been drawn as to whether or not the pink LED light exposure yields significant results when compared to no light exposure and if so, whether it was beneficial or harmful to adolescent sleep patterns.

Participants who were ages 14-17 were given parental consent forms in order to participate in the experiment, explaining the experiment and its goals and also stressing how no personal information will be released. This required a parental signature, showing that the parent has read through the information described and that they allowed their child to participate. This form can be seen in Appendix A labeled “Research Parental Consent Form.” Participants who were 18 were also given a consent form explaining the same thing as the parental consent form but only requires their own signature because they are legal adults. This can also be found in Appendix A and is labeled as “Research Consent Form.” All participants were also required to consent to participating in the Google Form survey which explained the types of questions they

will be answering, the purpose of the survey, and how all responses will remain anonymous, all in the description of the survey. This can be found in Appendix C. This consent was in the form of a check box indicating that they are either a minor and have parental consent to participate or are 18 years old and consent to participate in the survey. The research question was also sent to the IRB which provided permission for this study to take place and deemed it as safe for participants to take part of.

RESULTS AND ANALYSIS

Sleep Logs

The data from the sleep logs and surveys of each of the 26 participants was transported to an Excel sheet for statistical analysis to determine if there was a significant difference in the average sleep quality among the participants from week one and week two. As predicted in the hypothesis, there was no statistical difference in sleep quality when participants applied pink light prior to sleep when compared to when they applied no light.

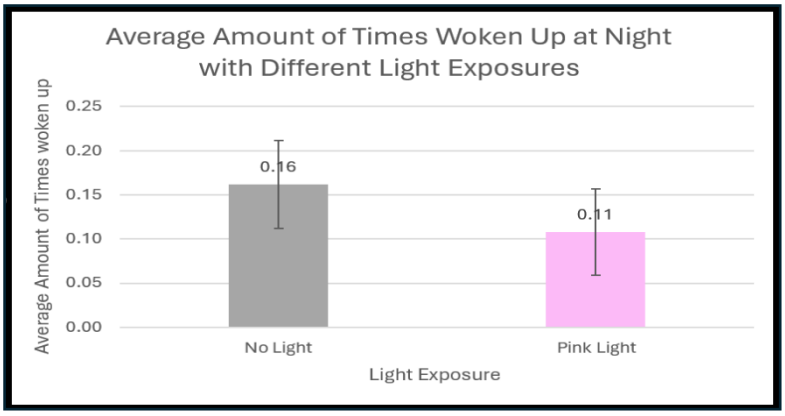

Figure 1 *– Representation of the compared means of the number of times participants woke up in the middle of the night between the two modes of light exposure, using a standard error (SE) of ±2. Researcher created in Excel, 2025*

As seen in Figure 1, there was no statistical difference in the average number of times participants woke up during the night which is an aspect of sleep that can be disturbed by exposure to short wavelengths prior to sleep. The graph shows an overlap in the error bars with a standard error of ±2, showing no statistical difference in the average number of awakenings

between the two light exposures. Even though the average number of times participants woke up at night with no light exposure was slightly higher, the overlap in error bars between the two light exposures suggests that the pink light yielded no measurable effect on the number of times participants awoke at night.

Similarly, there was no significant difference in the average time it took participants to fall asleep which – parallel to the number of times woken up in the middle of the night – can be affected by exposure to short-wavelengths of light prior to sleep. However, as seen in Figure 2, the data suggests that pink LED lighting did not influence the average time it took for participants to fall asleep when compared to having been exposed to no light prior to sleep.

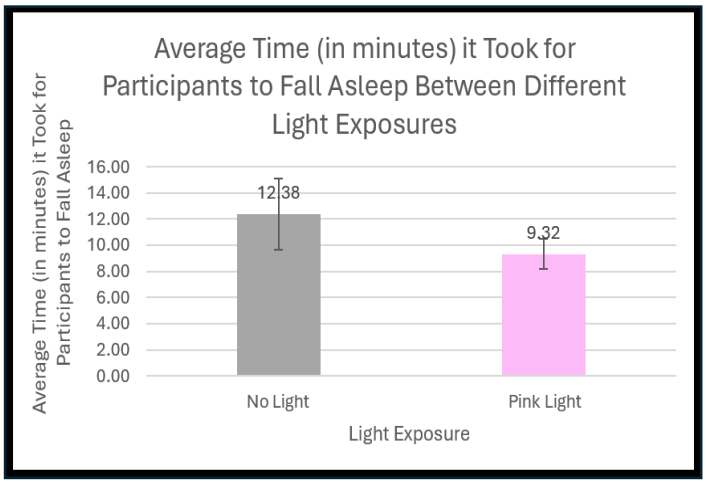

Figure 2 *– Representation of the compared means of the amount of time in minutes it took participants to fall asleep between the two modes of light exposure, using a standard error (SE) of ±2. Researcher created in Excel, 2025*

Similar to the data in Figure 1, the data in Figure 2 had a mean difference of approximately 3.8 minutes, with participants taking slightly longer on average to fall asleep when exposed to no light exposure compared to with pink light. While the mean difference may signal that the pink light is more beneficial than no light, the error bars overlapping signifies that the pink light did not yield a statistically significant effect. This reveals that pink LED lighting did not hold a positive or a negative effect on the sleep quality of the participants, supporting the prediction that pink LED lighting holds a neutral effect on adolescent sleep patterns.

One factor that may have affected the results of this experiment, however, was the amount of exercise participants engaged in. On average, participants exercised approximately 32 minutes more the week with no light than they did the week with pink light. After conducting a paired t-test on the exercise duration data reported by participants between the two weeks, it was found that the p-value was 0.024 which is below the threshold: 0.05. This indicates that there was a significant difference in the amount of exercise participants partook in from each week, potentially effecting the rest of the data from the sleep logs and survey.

Because exercise is known to reduce the time it takes to fall asleep and can improve overall sleep quality, the increased amount of exercise participants partook in may have affected the data in Figure 1 and Figure 2. Since the data showed an average of slightly worse sleeping quality in no-light conditions, the additional exercise during the no-light week could have acted as a slight benefit to sleep and reduced the difference in the data between the two conditions. Had the participants exercised the same amount each week, the data may have shown a more pronounced difference in sleep quality between the two weeks, showing that pink light may be more beneficial rather than no light rather than showing no effect.

Survey

Within the post experiment survey, the similar pattern was reflected between the differences in pink light and no light. As represented in Figure 3, there were slightly more participants who felt as though the pink light was more beneficial to their sleep. This mirrors Figure 2 and Figure 3 where there was a mean difference of participants who had improved sleep quality, but there was no significant difference in the data of Figure 2 and Figure 3 due to the overlap in error bars. Because the data from the sleep logs reflects that the pink LED lighting had a neutral effect on the sleep patterns of the participants, some participants believed

that their sleep quality improved with the pink light, and some believed it improved without pink light. This is likely due to variation of external circumstances unrelated to the pink light that occurred from week 1 and week 2 of the experiment, causing participants to feel noticeable changes in their sleep quality. This concept can also be represented by Figure 6, as all the participants said that they felt a difference in their sleep quality, yet there was almost a 1:1 ratio of those who felt an improvement in sleep quality with the pink light and of those who felt their sleep quality worsened.

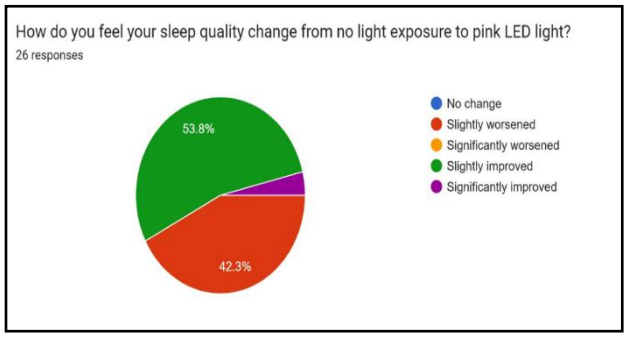

Figure 3 *– Researcher created in Google Forms, 2025*

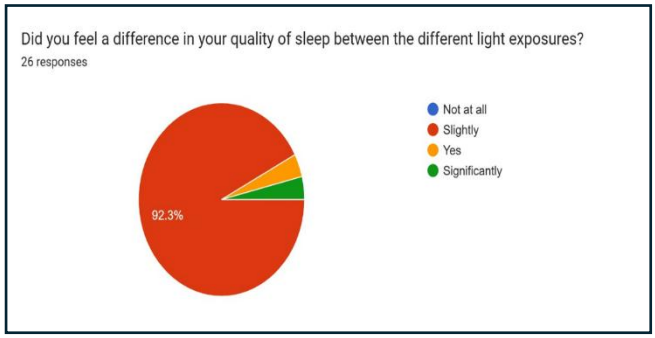

Figure 4 *– Researcher created in Google Forms, 2025*

Again, this same pattern is repeated when the researcher asked the participants which light exposure they would prefer: only slightly more than half of the participants claimed to have preferred the pink light exposure and only slightly less preferred no light as represented in figure 5.

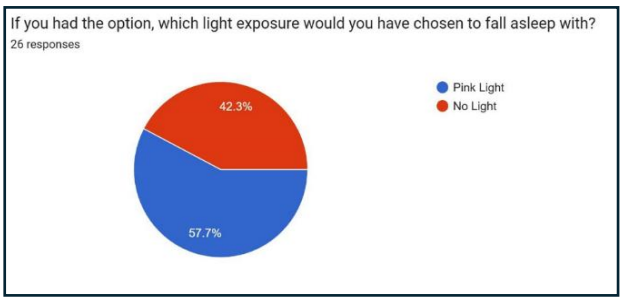

Figure 5 *– Researcher created in Google Forms, 2025*

The data from both the sleep logs and the post-experiment survey support the original prediction that pink LED lighting prior to sleep would lead to no significant difference in the

sleep quality of participants when compared to exposure of no light. This strengthens the idea that the effects of the blue and red wavelengths of light that comprise pink light cancel each other out, therefore leave no lasting effect. While there are limitations and external factors, such as exercise duration, that may have influenced experiment, these findings can act as a basis to discovering more about how counteracting wavelengths of light can interact to effect, or not effect, sleep among adolescents.

CONCLUSIONS

Overall, data indicates no significant difference the participants sleep quality improved when exposed to pink light or not, based on the results seen in their sleep logs and the post-experiment survey. As explained previously in the introduction and literature review, red light and blue light have opposing effects on sleep quality: red light has been proven to improve sleep quality where blue light in can worsen it. As seen in results, the pink light had neither of the two effects even though that it contains both blue and red-light wavelengths. This signifies that there the two light wavelengths canceled each other out and therefore had no measurable effect on the participants.

The data found supports the researcher's hypothesis that there would be no effect on sleep quality when applying pink LED strip lighting prior to sleep due to the red and blue light wavelengths neutralizing each other, therefore neither disrupting nor benefiting sleep. While the data does show averages that reflect pink light may be more beneficial, the overlap in standard error bars with an error of ±2 shows that the pink light had no significant effect on the quality of sleep of participants and the average results were due to extenuating circumstances unrelated to the pink light.

Importantly, these findings suggest that using pink light is a safe option for usage prior to sleep. As highlighted previously in the literature review and introduction, LED lights among gen-z gained increasing popularity during the COVID-19 global pandemic. With their increase in popularity, understanding which modes of light produced by this blue light technology are harmful and beneficial to sleep quality is important to know in order to ensure optimal sleep. Adolescents who continue to use their LED lights from that period can consider applying pink light before going to bed as it is a more neutral alternative than other disruptive colors, such as blue light. Given that sleep is time when adolescents undergo most of their brain reconstruction and development, poor sleep quality with adolescents can lead to various mental and physical health issues. This makes it important to monitor the certain factors that may be affecting their sleep quality, such as light exposure prior to sleep, to ensure optimal sleep quality and proper brain development. Since pink light does have a neutral effect, applying such light exposure before sleep will not negatively affect their sleep and can act as a potential solution to the declining quality of sleep among adolescents.

LIMITATIONS

There were few limitations throughout the course of this experiment. The researcher was unable to fully ensure that participants completely followed instructions. The data also does not account for all the various external factors that could have impacted the study. One of the external factors that was accounted for was the duration of exercise achieved by the participants; there was a statistically significant difference in the amount of exercise participants partook in from week one to week two. Because exercise has the potential to improve sleep patterns, the decrease in the amount of exercise participants gained from week 1 to week 2 could have altered the results of the experiment as described in the results and analysis.

Differences in the participant's daily routines and personal circadian rhythms could have also attributed to potential inaccuracies in the data. Finally, the placebo effect could have altered the perception of the participant's overall rating and personal opinions of how well they slept throughout the week, potentially skewing the data and preventing the researcher from determining the true effectiveness of pink light on adolescent sleep patterns. This research should be replicated having more control over the participant's external circumstances that could have altered the results of the experiment in order to ensure more accurate results.

IMPLICATIONS

Understanding that pink light has no significant effect on adolescent sleep patterns has significant implications on society, especially given the rise in popularity of LED lights among adolescents. These findings have the potential to reassure parents and adolescent users of LED lights that application of the pink color holds no negative impact on their sleep quality or patterns, and it can be continued to be used for aesthetic purposes. Knowing its neutral effect can also work to improve sleep hygiene by persuading adolescents to stray away from blue light and switch to more safer colors such as pink. Thus, this information can act as a foundation to mitigate the decline in sleep quality among adolescents across America.

For the scientific community, these findings can be used to be further studied upon and enhanced with more precise methods or technologies. With advanced technology, scientists can understand how counteracting wavelengths interact with the suprachiasmatic nuclei – the part of the brain that regulates circadian rhythm. This knowledge has the potential to drive significant advancements in the medical field, providing adolescent patients struggling with sleep disorders with safer options of light exposure to be exposed to prior to sleep. By identifying optimal light conditions for adolescents in the evenings, researchers can offer solutions to improve sleep

quality without the need for medication, ultimately improving the sleep quality of adolescents across America.

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Appendix A: Consent Forms

Research Parental Consent Form

Topic: Effect of pink LED lights on adolescent sleep patterns

Name of Investigator: Brianna Bango

Experiment Overview: This is a 2-week experiment intended to determine the effects of LED lighting on adolescent sleep patterns. One week, participants will apply pink light for 15 minutes before sleep and track their sleep patterns with the "Sleep Monitor" app and the next week will do the same thing but with no light instead of pink LED light. They will send their results to Marjory Stoneman Douglas High School student Brianna Bango. Your child has been invited to participate because they are an adolescent between the age of 14-18.

All results will be kept anonymous and only will be used for analysis. No personal information will be collected including your child's name, phone number, email, or address. This is not meant to expose any confidential information and is only used for academic purposes, only to be shared with College Board. Nothing will be used to identify your child.

It is understood that your child is under the age of 18 and require parental consent to participate in the survey. As stated previously, this experiment is completely voluntary and completely anonymous. By signing below, this shows that you AND your child have read through the information above and that you give consent for your child to voluntarily participate in the experiment.

If you have any questions, please contact Brianna Bango at bangobri@gmail.com

Acknowledgment: I have read the Information Sheet provided to me (date, _____) I have asked any necessary questions about the study and have received satisfactory answers to my questions. I know that participation is voluntary, and I that your child is free to withdraw themselves at any given time, without giving any reason, and without any adverse consequences.

I understand the following (check all that apply)

- Who will have access to the personal data provided. I understand how this data will be stored and what will happen to the data at the end of the project.
- How the research will be written up but will remain anonymous and no personal information will be released.
- How to raise concerns or make a complaint.
- The participant is underage, and parental consent is required
- Your child's ability to drop out whenever you feel you need to

Participant signature: _____ Parent signature: _____ Date: _____

Research Consent Form

Topic: Effect of pink LED lights on adolescent sleep patterns

Name of Investigator: Brianna Bango

Experiment Overview: This is a 2-week experiment intended to determine the effects of LED lighting on adolescent sleep patterns. One week, participants will apply pink light for 15 minutes before sleep and track their sleep patterns with a sleep log created by the researcher on Microsoft words and the next week will do the same thing but with no light instead of pink LED light. They will send their results to Marjory Stoneman Douglas High School student Brianna Bango. You have been invited to participate because you are an adolescent between the age of 14-18.

All results will be kept anonymous and only will be used for analysis. No personal information will be collected including your name, phone number, email, or address. This is not meant to expose any confidential information and is only used for academic purposes, only to be shared with College Board. Nothing will be used to identify you.

As stated previously, this experiment is completely voluntary and completely anonymous. By signing below, this shows that you have read through the information above and that you consent to voluntarily participate in the experiment.

If you have any questions, please contact Brianna Bango at bangobri@gmail.com

Acknowledgment: I have read the Information Sheet provided to me (date, _____) I have asked any necessary questions about the study and have received satisfactory answers to my questions. I know that participation is voluntary, and I that you are free to withdraw at any given time, without giving any reason, and without any adverse consequences.

I understand the following (check all that apply)

- Who will have access to the personal data provided. I understand how this data will be stored and what will happen to the data at the end of the project.
- How the research will be written up but will remain anonymous and no personal information will be released.
- How to raise concerns or make a complaint.
- Your ability to drop out whenever you feel you need to

Participant signature: _____ Date: _____

Appendix B: Sleep Log

Table 1 – Sleep Log. Researcher created in Microsoft Word, 2025

Sleep Log Name: _____

Day of the week:	Monday	Tuesday	Wednesday	Thursday	Friday
Date:					
1. Yesterday, how long did you exercise					
2. Yesterday, what time did you get off your electronic device?					
3. Last night, what time did you attempt to fall asleep?					
4. Last night, how long do you think it took you to fall asleep?					
5. Last night, how many times did you wake up?					
6. What time did you wake up?					
7. What time did you get out of bed?					
8. Rate how rested you feel 1-10					
9. Rate how you felt your quality of sleep was 1-10					

Appendix C: Survey Questions/ Consent – Part 2 of The Methods

Survey/ Questionnaire

Topic: Effect of pink LED lights on adolescent sleep patterns

Name of Investigator: Brianna Bango

Experiment Overview: This is a 6-question post-experiment survey that will ask about how you felt about your sleep quality over the course of the experiment regarding the effects of pink light on adolescent sleep patterns. This is part of a research project conducted by Brianna N. Bango at Marjory Stoneman Douglas Highschool. This survey i2s voluntary and if at any time you wish to withdraw your response, you may and will not be penalized.

This survey will take approximately 5 minutes to complete. All responses will be kept anonymous and only the responses will be used for analysis. No personal information will be collected including your name, phone number, email, or address. This is not meant to expose any confidential information and is only used for academic purposes, only to be shared with College Board. Nothing will be used to identify you.

As stated previously, this survey is completely voluntary and completely anonymous. By clicking the next button, this shows that you have read through the information above and that you voluntarily consent to complete the survey

If you do not wish to participate, please close this out of your browser

If you have any questions, please contact Brianna Bango at bangobri@gmail.com

Acknowledgment:
I have read the Information Sheet provided to me I have asked any necessary questions about the study, and have received satisfactory answers to my questions. I know that participation is voluntary, and I am free to withdraw myself or my data at my time, without giving any reason, and without any adverse consequences.

I understand the following:

- Who will have access to the personal data provided. I understand how this data will be stored and what will happen to the data at the end of the project.
- How the research will be written up but will remain anonymous and no personal information will be released.
- How to raise concerns or make a complaint.
- Your ability to drop out whenever you feel you need to

bangobri@gmail.com Switch account

Not shared

* Indicates required question

Click if you have read through the information above and voluntarily agree to complete the survey. *

- [ ] I am under the age of 18 and I have parent consent to participate in this survey
- [ ] I am 18+ and I give consent to participate in this survey

Name *

Your answer

Phone number *

Your answer

Did you feel a difference in your quality of sleep between the different light exposures? *

- ○ Not at all
- ○ Slightly
- ○ Yes
- ○ Significantly

How do you feel your sleep quality change from no light exposure to pink LED light? *

- ○ No change
- ○ Slightly worsened
- ○ Significantly worsened
- ○ Slightly improved
- ○ Significantly improved

Did it feel easier or harder to fall asleep with the pink light than no light exposure? *

- ○ Neither
- ○ Slightly easier
- ○ Substantially easier
- ○ Slightly harder
- ○ Substantially harder

Did it feel easier or harder to fall asleep with the no light exposure than pink light? *

- ○ Neither
- ○ Slightly easier
- ○ Substantially easier
- ○ Slightly harder
- ○ Substantially harder

If you had the option, which light exposure would you have chosen to fall asleep with? *

- ○ Pink Light
- ○ No Light

Rate your overall sleep quality with no light exposure from 1-5 having 1=bad and 5=excellent *

1 2 3 4 5

☆ ☆ ☆ ☆ ☆

Rate your overall sleep quality with pink light from 1-5 having 1=bad and 5=excellent *

1 2 3 4 5

☆ ☆ ☆ ☆ ☆