JOURNAL OF
EMERGING INVESTIGATORS

Article

Blue light blocking glasses: do they do what they promise?

Jason Lee[1], Adita Cho[2]
[1]St. George's Senior School, Vancouver, BC, Canada
[2]No institutional affiliation, Vancouver, BC, Canada

SUMMARY

With increased screen time and exposure to blue light, an increasing number of people have sleep deprivation. Blue light suppresses the release of melatonin and hinders sleep at night. We hypothesized that people could get a greater amount of sleep by controlling the blue light exposure from screen time before bedtime. The purpose of this experiment was to investigate whether blue light blocking glasses (BBG) reduce the impact of blue light on the time taken to fall asleep for teenage and adult groups. Previous work found a 27% reduction in melatonin secretion after exposing subjects to 2-hours of blue light. Hence, we hypothesized that BBG would reduce the duration of time it takes to fall asleep by 25%. Participants had two hours of screen time each night. They spent three nights without BBG and three nights with BBG. Furthermore, we compared the effects of BBG on teenagers and adults to see which group, if any, will be most affected. BBG's effect on reducing time to fall asleep was significant within the teenage group, but not significant in the adult group. This indicated that BBG could improve the time taken to sleep for young teenagers post screen time in the evening.

INTRODUCTION

A CBC Radio podcast, "One Cross Country Checkup on Sleep Crisis", reported that one in three Canadian adults sleep less than the recommended seven to nine hours per night (1). Previous research on sleep duration added that nearly one third of children and adolescents sleep less than the recommended amount (2).

A literature review of adolescent and young adult sleep pattern listed the increased use of technology for work, socializing, and leisure as one of the factors contributing to insufficient sleep (3). The prolonged use (30 or more hours per week) of a computer for leisure (and not work) was associated with sleep problems (4). With the lifestyle change due to the pandemic, screen time has risen for most teenagers and young work adults outside of work and school hours as many activities have moved to virtual platforms.

A reason of why increased screen time is correlated with decreased sleep quality is that most modern screens emit blue light. Working on the computer, chatting on social media, gaming, and reading e-books, all involve looking at screens that emit blue light. Blue light is a range of visible white light with a wavelength 400-495 nm. We get blue light from the sun, electronics, and lights (5). It is a high energy light, which has both benefits and dangers (5). While blue light boosts people's energy, alertness and mood during the daytime, it is linked to difficulties with sleeping and waking up (6, 7) during the night. Blue light suppresses the secretion of melatonin, a hormone responsible for regulating the circadian rhythm that affects people's sleep and wake cycle (8).

Our eyes are ineffective at blocking blue light. Almost all blue light passes through the cornea, (the transparent layer forming the front of the eye) to the lens, (the transparent structure which refracts light) and goes all the way to the retina (the structure that detects light) (9). Blue light blocking glasses (BBG) have multiple layers of special coating that either absorb or reflect light. BBG will note the percentage of blue light blocked. BBG with a higher percent block more blue light. For example, the Uvex Skyper BBG block 98% of blue light, and it has been shown that wearing these glasses during blue light exposure can reduce melatonin suppression and improve sleep (10). Another study suggests that blocking out short wavelength light, which includes blue light, may help in reducing the sleep disruption of rotational shift workers (11). However, it does not examine the correlation between screen usage and the effectiveness of BBG.

We focused our investigation on the effect of blue light on sleep, specifically whether BBG could reduce the impact of blue light from screen time on the time taken to fall asleep. A similar study analyzed the effectiveness of BBG by measuring the salivary melatonin levels of 13 male teenagers exposed to LED screens under strict laboratory conditions (12). The study found that BBG significantly reduced the melatonin suppression and alertness in the evening before bedtime caused by LED screens. Our experiment measured the reduction of time required to fall asleep with the help of BBG during screen time before bed. At the same time, our study allowed the subjects to go about their normal night routines and sleep in a familiar environment to make the conditions more realistic.

In a study by Cajochen et. al with 24 subjects, they found that a 2-hour exposure to blue light in the evening significantly reduced melatonin secretion from 12.0pg/ml to 8.8pg/ml (13). This works out to be about by 27% reduction in melatonin secretion. As melatonin has a direct effect on circadian rhythm and onset of sleep, we hypothesized that BBG will reduce the duration of time it takes to fall asleep by 25%.

RESULTS

The time taken to fall asleep was 7 mins shorter on average with BBG than without BBG and with two hours of prior screen time (**Figure 1**). BBG had a more consistent and beneficial impact on Grade 7 (G7) teenagers than adults. On average, G7 groups fell asleep 14 mins shorter with BBG than without BBG. All but one teenager took longer to sleep

JOURNAL OF
EMERGING INVESTIGATORS

DOI: https://doi.org/10.59720/23-028

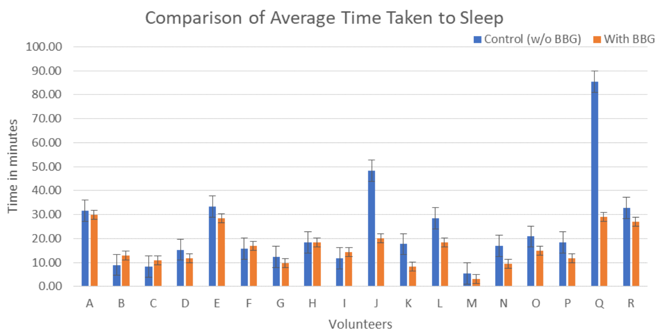

Figure 1: Most participants experienced reduced time taken to sleep with BBG (n= 18). A bar graph showing the average time taken to fall asleep for each volunteer with and without BBG. Participants were exposed to blue light for 2 hours without BBG and measure the time in minutes to fall asleep for 3 nights. They repeated the process again with BBG for another 3 nights. Error bars represent the standard error.

without BBG than with BBG. BBG had less of an impact on adults. The difference in time taken to fall asleep was less than one minute. Wearing BBG does not appear to affect the sleep time of adults.

The average time it took to fall asleep without and with BBG varied across different subsets of volunteers (**Figure 2**). G7 teenagers experienced a decrease of 62% in the time it took to fall asleep (paired T-test; p = 0.0207) while adults observed a 4% reduction in their time taken to fall sleep with BBG (paired T-test; p = 0.2969). The average reduction observed from both groups was 39% (paired T-test; p = 0.0195). The average time to fall asleep with and without BBG was only statistically significantly for the G7 teenage group.

DISCUSSION

Our results show that the BBG's effect on reducing time to fall asleep is statistically significant within the G7 teenage group but not statistically significant in the adult group. Furthermore, our results supported our hypothesis that BBG would reduce time taken to fall asleep, but only in the G7 teenage group. On the contrary, our hypothesis was not true for the adult group. In our interview with an optometrist, Dr. Mini Randhawa, she emphatically stated that children are more susceptible to harmful effects of blue light than adults. Dr. Randhawa is a leading advocate for eye health and has appeared on local and national news media to educate the public on eye health. Our findings support her professional opinion on the topic of the negative effect of blue light on eye health within the younger age group. A full transcript of our interview is available as an appendix.

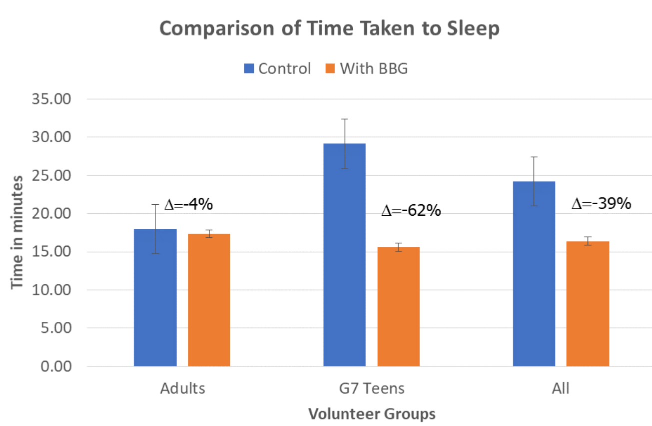

Figure 2: Comparison of the time taken to fall asleep across different subject groups. A bar graph of average time taken to fall asleep for adult group (n = 8), G7 teen group (n = 10) and both groups combined with 5% error bars. The error bars represent the standard error in the data. Blue bar: Control, Orange bar: With BBG

In a recent systematic review by Hester et. al (14), they concluded that BBG are effective for inducing sleep and could be recommended to patients with insomnia or a delayed sleep phase. Our results support this recommendation, especially for a younger age group, to wear BBG when exposed to two or more hours of blue light prior to sleep time. Most teenagers and young adults often spend a significant amount of time exposed to blue light with screen time in the evening, resulting in disruption of circadian sleep rhythm and delayed sleep onset. Our results suggest that wearing BBG during screen time in the evening could alleviate sleep onset delay, thus potentially reducing issues that could result from sleep deprivation.

Our study included some limitations in areas related to the duration of the study, the technology used, and the number of participants. We did not standardize the devices and the content of the screen time since the study environment was to be as realistic as possible. However, since the same participant performed the experiment with and without BBG and we used a paired T-test in our statistical analyses, the lack of standardization should not affect our results. We were limited by the short length of the study and postulate that additional conclusions may be made with a longer study. If we could conduct our experiment over a 7-day period, we would conclude that our results were robust to the variability of pre-bedtime routines throughout the course of the week. At this point in time, there are no non-intrusive, yet accurate tools to measure the duration of time to fall asleep. For the purpose of this study, sleep tracking devices were sufficient to allow for multiple ways for the participants to choose how to track the time taken to fall asleep. The small number of participants in this study also makes it challenging to extend the results to a general population.

There are a few variables that we could not control in the experiment. One important variable is the stress level of the participants. When someone experiences stress prior to taking a test or worries about paying off their bills, they may take longer to sleep. If any of these stressful circumstances were experienced by a participant, BBG may not have had any significant positive impact. Another variable is the load of extracurricular activities after school or work. This variability is especially true for the G7 teenage group. Teenage participants may be very tired after certain classes, therefore, may fall asleep faster irrespective of the use of BBG. In addition, some G7 participants have less than two hours of screen time for the six days of experiment due to lack of time. Both higher activity load after school and less screen time could affect our results since the effect of blue light may be less obvious with less screen time. On the contrary, our findings that BBG works more effectively in the G7 teenage group despite less screen time supports our hypothesis.

Future research in this area can be done by repeating the experiment with a bigger sample size, standardized sleep measuring device and different age groups. Some

DOI: https://doi.org/10.59720/23-028

participants also reported feeling more energized in the morning when they wore BBG the night before. A separate study can be conducted to see whether BBG help increase participant's energy level in the morning when wearing them during screen time.

In conclusion, the results of our study have important implications in our times. The pandemic over the last three years has shifted work and school towards virtual platforms. Consequently, young children, teenagers and adults have been exposed to longer hours of screen time compared to the pre-pandemic period. Our study supports the use of BBG in young people reduces time to fall asleep. This finding suggests that there is potential significance in improving quality of life when the population shifts towards more screen time on virtual platforms. The reason is that sleep is very important in maintaining both mental and physical health. BBG may be one way to improve sleep in our increasingly digitized work and social environments.

MATERIALS AND METHODS

Teenagers (n = 10) between ages 12-13 and adults (n = 8) between ages 21-35 were recruited to the study. Prior to the study, it was determined that these participants had regular sleep pattern. The study lasted six consecutive nights during which participants were exposed to blue light for two hours, the first three nights without BBG and the subsequent three nights with BBG. The initial three nights without BBG were used to measure subjects' usual sensitivity to blue light and how it affects their time to fall sleep.

The participants were given a one-page checklist to help them follow the instructions. The checklist outlined the purpose of the experiment, procedure and how to submit the results. We individually reviewed the checklist with each participant to ensure their comprehension of the experiment's objective and instructions.

We supplied each participant with UVEX BBG because the spectrum control technology in UVEX BBG blocks 98% of blue light (10). The participants used any sleep tracker of their choice that had the capability for recording different stages of sleep throughout the night so they knew when they fell asleep.

The first part of the experiment started without BBG. Participants were instructed to avoid exposure to blue light for an hour before the start of their screen time session. Immediately after that, they began 2 hours of screen time without BBG. Screen time consisted of the use of computers, tablets, cell phones, TV, and e-books. These activities were recorded and performed until bed time. There was no light in the sleeping room after the screen time. The room temperature was set between 20 to 27 degrees Celsius for ideal sleep condition. Before 11:00 pm, the participants lay on the bed and started to sleep. The next day, the sleep data was reviewed to ensure sleep was recorded. The same process was repeated without BBG for two more nights for a total of three nights.

The second part of the experiment was done with BBG. The same process was repeated as per previous three nights, except participants were wearing BBG.

After the six days were completed, participants retrieved the sleep data. Participants submitted their sleep data from the six days. A log of what they did during the two hours of screen time before sleep was also collected. We calculated the time taken to fall asleep by subtracting the time the individual fell asleep from when they activated their device. Their logs indicated a time when the participant fell asleep.

Received: February 13, 2023
Accepted: June 4, 2023
Published: December 13, 2023

REFERENCES

1. *Sleep Crisis*. CBC Radio Canada, 20 Jan. 2019. broadcast.
2. Chaput, Jean-Philippe and Ian Janssen. "Sleep duration estimates of Canadian children and adolescents." *Journal of Sleep Research*, vol. 25, no. 5, 30 Mar. 2016, pp. 541-548, doi: 10.1111/jsr.12410.
3. Wolfson, Amy and Mary Corscadden. "Sleep schedules and daytime functioning in adolescents." *Child Development,* vol. 69, no. 4, Society for Research in Child Development, Aug. 1998, doi: 10.2307/1132351
4. Andersen, Lars Louis and Anne Helene Garde. "Sleep Problems and Computer Use during Work and Leisure: Cross-Sectional Study among 7800 Adults." *Chronobiology International*, vol. 32, no. 10, 5 Nov. 2015, pp. 1367–1372, doi:10.3109/07420528.2015.1095202.
5. "How Blue Light Is Both Bad for You and Good for You! (Huh?)." *All about Vision*, www.allaboutvision.com/cvs/blue-light.htm. Accessed 3 January 2023.
6. "How Blue Light Affects Your Eyes, Sleep, and Health." *Cultivating-Health*, 3 Aug. 2022, health.ucdavis.edu/blog/cultivating-health/blue-light-effects-on-your-eyes-sleep-and-health/2022/08. Accessed 7 January 2023.
7. Newsom, Rob and Abhinav Singh. "Blue Light: What It Is and How It Affects Sleep." *Sleep Foundation*, 4 Nov. 2020, www.sleepfoundation.org/bedroom-environment/blue-light#:~:text=Inversely%2C%20exposure%20to%20blue%20light,we%20are%20trying%20to%20sleep. Accessed 27 August 2023.
8. "Blue Light Has a Dark Side." *Harvard Health*, Harvard Health, 13 Aug. 2020, www.health.harvard.edu/staying-healthy/blue-light-has- a-dark-side. Accessed 7 January 2023.
9. Zhao, Zhi-Chun, et al. "Research Progress about the Effect and Prevention of Blue Light On Eyes." *International Journal of Ophthalmology*, vol. 11, no.12, 18 Dec. 2018, doi: 10.18240/ijo.2018.12.20.
10. "Best Blue-Light Blocking Glasses 2019: Top 5 Picks and Buying Guide." *Tuck Sleep*, 2019,www.tuck.com/best-blue-light-blocking-glasses/. Accessed 5 January 2023.
11. Rahman, Shadab, et al. "Effects of Filtering Visual Short Wavelengths curing Nocturnal Shiftwork on Sleep and Performance." *Chronobiology International*, vol. 30, no. 8, 1 Oct. 2013, pp. 951-692, doi: 10.3109/07420528.2013.789894.
12. Van Der Lely, Stephanie, et al. "Blue Blocker Glasses as a Countermeasure for Alerting Effects of Evening Light-Emitting Diode Screen Exposure in Male Teenagers." *Journal of Adolescent Health*, vol. 56, no. 1, Jan 2014, pp. 113-119, doi: 10.1016/j.jadohealth.2014.08.002.
13. Cajochen, Christian, et al. "Evening exposure to blue light stimulates the expression of the clock gene PER2 in humans". *European Journal of Neuroscience*, vol. 23, no. 4, Feb 2006, pp.1082-1086, doi: 10.1111/j.1460-9568.2006.04613.
14. Hester, Landon, et al. "Evening wear of blue-blocking

DOI: https://doi.org/10.59720/23-028

glasses for sleep and mood disorders: a systematic review". *Chronobiology Internationa*l, vol. 38, no. 10, 24 May 2021, pp. 1375-1383, doi: 10.1080/07420528.2021.1930029.

DOI: https://doi.org/10.59720/23-028

APPENDIX: INTERVIEW TRANSCRIPT

Transcript from Interview with Dr. Randhawa on 26 January 2019

Jason: Hello Dr Randhawa. Thank you for seeing me and letting me interview you for my project. I will be taking notes for this interview if that's okay. I am Jason Lee from St. George's School. I am working on a science project called the Wonder Expo. My topic is about the effectiveness of blue light blocking glasses and whether it reduce the impact of blue light on sleep. It is a pleasure to have you.

Dr. Randhawa: Thank you.

Jason: Have you seen an increase of interest in blue light blocking glasses.

Dr. Randhawa: Yes, a huge increase.

Jason: Does that mean more of your patients are coming in and asking whether they can have a prescription for them?

Dr. Randhawa: Yes exactly, so there is an increase in the demand and in the need. Sometimes there is an increase in demand which is just set by trends, but there is also an increase in the need because the need is feeding the demand.

Jason: So why would people need blue light blocking glasses?

Dr. Randhawa: I am going to tell you the whole story and this is a little bit of a story. So it is good that you are recording so you can go back and watch it. This is what I say to my patients and it really helps them understand it. I always start with a question, do you know why the sky is blue? You might have learned something along that line. When light enters the atmosphere, its white. White light is made out of all the colours. When you look at the spectrum, blue light has the shortest wavelength and the highest energy, so blue light is short wavelengths and really high energy, as oppose to the other end of the spectrum which is red light. Red light has really long wavelengths and really low energy. Long and lazy. So when white light comes to our atmosphere, that long, lazy, red light just goes straight through the atmosphere. That high

1

DOI: https://doi.org/10.59720/23-028

energy, short wavelength blue light scatters, and the sky looks blue. Now when we are looking at a screen, this is light. Light was invented and meant for the time of sunlight to be behind us illuminating what we are doing, brightening our surface. For the first time, we are staring directly into that light. So when we are staring directly into light and that light has all the blue light and the red light, so it has the full spectrum, what happens is that long lazy red light, it kind of goes past your eye a little bit. It doesn't really affect the eyes. That high energy blue light with its short wavelengths, gets all absorbed by the eyeball. So blue light with small wavelengths, is all going to get absorbed. It is that high energy which starts getting absorbed in your eyes as well. So you will see an increase in diseases. So when we are talking about blue light blockers, people often mistake it with if I use screens too long, I'll need glasses. That's a whole different story. If you look at screens too long the muscles in your eyes get tight and eventually you'll need glasses long term. That has nothing to do with blue light. Blue light is much more dangerous, it gets absorbed in your eye and it can cause cataracts, it's going to cause Macular Degeneration and diseases like that. Here is another important tidbit, blue light starts where visible light starts. In visible light, it ends with ultra violet. So UV light is where invisible light ends, and visible light starts with blue light. That means UV and blue light have very similar wavelengths. We have always known how bad UV light is. If UV gets absorbed in your skin it burns your skin. Now guess what blue light is, it is right beside UV light. Therefore it is very similar to blue light, and all this blue light is going into your eye.

Jason: What are your views on whether blue light blocking glasses are effective for reducing the impact on sleep?

Dr. Randhawa: Just like UV glasses block UV light, blue light glasses block blue light. The problem is you can buy sunglasses at dollar stores, but are you getting the same protection as you are getting when buying glasses from the doctors office? Absolutely not! So like anything, when it comes to blue light blockers, quality is important. Are they effective in blocking the blue light, absolutely, but you have to make sure you are getting the good quality ones.

Jason: Is there clinical evidence that blue light affects your sleep?

Dr. Randhawa: Yes. You can do some research on that. It affects your hormones. It increases your awake hormones and decreases your night time hormones.

2

DOI: https://doi.org/10.59720/23-028

Jason: Do you think that optometrists should recommend blue light blocking glasses to people who have lots of exposure to blue light in the evenings?

Dr. Randhawa: I think that optometrists should recommend and do recommend blue light blockers to anyone who has exposure to blue light. When we talk about sleep patterns, yes absolutely. But I am not concerned about it just in the evening, but all day, anytime you are using a screen.

Jason: How much of our eye illnesses is a result of too much screen time?

Dr. Randhawa: There is no stats on that so we can't say that this percentage is because of screen time. We are not gonna get stats on that either because the diseases are multifactorial. For example Macular Degeneration is caused by blue light, but also by malnutrition and genetics. So how do we know if you have Macular Degeneration, how much of it is caused by blue light, by diet or by genetics. So you are not going to get any stats like that. The goal is to decrease the things that are going to increase your chances of disease, and blue light is one of those things.

Jason: Are children more at risk to harmful effects of blue light than adults?

Dr. Randhawa: That's a good question. Absolutely. The reason is that there is a lense behind the colored part of the eyes. The colored part of the eye is called the iris, right behind is the lens. When you are young the lens are crystal clear, and the all that blue light goes to the retina in the back of the eye, which is the film of the eye. Imaging your eye is a camera and the retina is where the picture is taken. As you get older that lense starts to change and the proteins in it start to break down. You start getting a cataract essentially. When that happens the more blue light gets caught in that lense, which when you are older can be removed from your eye and replaced. So the blue light is not hitting your rentna as you get older, less of it I should say.

Jason: What should be the minimum age for children be exposed to using the computer or playing computer games?

Dr. Randhawa: There is no good stats on this. You know computer and screens have exploded, and we are not going to fully understand the impact of this, until a full generation go

3

DOI: https://doi.org/10.59720/23-028

through it. So your generation is going to be the test generation. When you guys grow up and have kids, we are gonna know what happened because of all the screen time and what did to your eyes. I envision that within the next 10-15 years every school will have buckets of blue light blocking glasses. If we are going to sit there and make students stare into light, we will give them the tools that will help protect their eyes. We are not there yet. What age should kids start looking at screens, that is like asking me what age should kids start smoking. This is bad for your eyes, so there is no good to this. Of course you have to weigh the pros and cons, smoking there is no pros. Yes there is pros to using the screen, making the life more effic net. That's why parents should weigh the pros and cons, and make the decision.

Jason: What is your advice to parents about screen time for children?

Dr. Randhawa: Limited as much as possible. Use bigger screens further away, the smaller the screen and the closer it is the more damage is. So limit your screens, and use blue blockers when you can.

Jason: I think that's about it.

Dr. Randhawa: Well good luck with your project and contact me if you have any questions.

4