"A SURVEY ON THE IMPACT OF COVID-19 PANDEMIC ON SLEEP-WAKE CYCLE"

Dissertation submitted to Mahatma Gandhi University

In partial fulfillment of the requirements for the award of the degree of

BACHELOR OF SCIENCE IN ZOOLOGY

DEPARTMENT OF ZOOLOGY

BHARATA MATA COLLEGE

THRIKKAKARA

2020-2021

Date: Submitted by: **NAVYA ROSE BENNY**

Teacher in charge:

Examiner: 1. Reg.no: **180021043819**

2.

DEPARTMENT OF ZOOLOGY BHARATA MATA COLLEGE THRIKKAKARA
DATE: / / 2021

CERTIFICATE

This is to certify that the project work entitled "**A SURVEY ON THE IMPACT OF COVID-19 PANDEMIC ON SLEEP-WAKE CYCLE**" is a bonafide work done by **NAVYA ROSE BENNY** with Reg.no: 180021043819 during 2020-2021 in partial fulfillment of the requirement for the award of the Bachelor Degree of Science in Zoology of Mahatma Gandhi University Kottayam.

Head of the Department

Dr. Priyalakshmi G

Declaration

I, **Navya Rose Benny**, do hereby declare that the work embodied in the dissertation titled "**A SURVEY ON THE IMPACT OF COVID-19 PANDEMIC ON SLEEP-WAKE CYCLE**" submitted to Mahatma Gandhi University, Kottayam, in partial fulfillment for the award of Bachelor of Science in Zoology is record of bonafide dissertation done by me under the guidance of **Dr. Sherin Antony**, Assistant Professor, Department of Zoology, Bharata Mata College, Thrikkakara and **Miss Ancy V.A**, Guest Faculty, Department of Zoology, Bharata Mata College, Thrikkakara and no part of this has been concurrently submitted for the award of any other Degree/Diploma/Associate degree/Fellowship or any other similar title by any candidate of any university.

Place: THRIKKAKARA

Date:

Signature of the Candidate:

Name: Navya Rose Benny

Reg.no: 180021043819

Acknowledgements

Firstly, I would like to praise God Almighty for giving me the opportunity, strength and ability to complete this project.

I would like to thank the following several individuals that made the completion of this project possible.

First, I would like to thank **Dr. Shiny Palatty**, Principal, Bharta Mata College, Thrikkakara, for giving me the platform to carry out this project.

I would like to sincerely thank our Head of the Department, **Dr. Priya Lakshmi G**, Department of Zoology, Bharata Mata College, Thrikkakara, for her guidance and encouragement.

I would like to express my sincere gratitude to our Project guide **Dr. Sherin Antony**, Assistant Professor, Department of Zoology, Bharata Mata College, Thrikkakara, and our co-guide **Miss Ancy V.A**., Guest Faculty, Department of Zoology, Bharata Mata College, Thrikkakara , whose help has been immeasurable over the course of this project. I am sincerely grateful for their patience and insightful comments at all times of this project.

I would also like to express my gratitude to all other faculties of Department of Zoology.

Last but not the least, I am grateful for all the direct and indirect help and support I received from my friends and family.

Table of Contents

Synopsis

Covid-19 pandemic and the lockdown has changed people's normal routines. Changes in sleep-wake cycle which is influenced by the circadian rhythm, is expected, with people being confined to their homes.

An online survey was conducted to evaluate whether the ongoing pandemic has influenced the sleep-wake cycles, screen time, bedtime, waking time and other aspects. Responses from 100 participants aged ≥13 were collected and analyzed.

The results obtained suggested that there was an overall shift in bedtime and waking time .With schools and work shifting online, screen time has also increased ever than before, as expected, mostly in younger individuals. With more time in hand, leisure screen time might have also contributed to this increase.

The shifting of sleep-wake cycle might be linked with the increased scree time that the participants reported. There were several other factors as well, that influenced the quality of sleep, which might have also contributed to such a change. The survey concluded that the sleep-wake cycle of more than half of the participants changed, their screen time as well as sleep duration increased but the sleep quality was reportedly the same. The findings of this survey might help to analyze sleep habits and its associated effects on behavior and health.

Chapter I

Introduction

Our body requires sleep to regulate important bodily functions. Our brain is active during sleep and is crucial for memory consolidation. Memory consolidation is retaining memory for a long time by converting short term memory to long term memory and the hippocampus plays a large role in this. A good night's sleep is essential for such a memory consolidation. Sleep has four stages- stage1, stage 2, slow wave sleep and rapid eye movement, the latter two coming under deep sleep. Deep sleep is during which most important functions are regulated like energizing immune system and brain, memory consolidation, regulating metabolism and blood sugar levels, repair functions, processing and learning, releasing important hormones for growth and development and many more. Electrical impulses are seen to transmit between thalamus, cortex, brainstem and hippocampus during sleep.

Our sleep is influenced by our internal biological clock, known as the Circadian clock and it generates an effect known as the Biological rhythm or the Circadian rhythm. The circadian rhythm generated, is in synchrony with the 24 hour day-night/light-dark periodicity and hence, our biological or circadian clock regulates important vital bodily functions accordingly. Animals following such a rhythm can be either diurnal or nocturnal, human beings being the former. Accordingly, we remain active during the day and rest at night. But following modern day lifestyle habits, can sometimes influence this simple schedule.

Diurnality in animals is influenced by the Suprachiasmatic nucleus (SCN) located in the hypothalamus and they function as the chief circadian pacemaker *(Djik and Archer, 200*9). The SCN is connected to the retina *(Djik and Archer, 2009).* And thus light greatly influences our biological clock *(Waht et al., 2019).* The light with shorter wavelength plays an important role in the synchronization of our circadian rhythm with the light- dark cycle. Hence, blue light, having the shortest wavelength (400-525nm), influences our rhythm the most. Natural blue light and lights of other wavelengths is present everywhere, which received during the day is beneficial, as it boosts our memory and attention, makes us alert and also influences melatonin secretions which increase at night and regulates the circadian rhythm. This secretion can hence be affected when exposed to light in the evening.

Blue light exposure has increased as it is emitted from almost all kinds of electronic devices. With schools and work being online, due to the Covid-19 pandemic, the screen time as increased more than ever for most of the population. This situation has also given people more time to use devices for recreational activities.

Nowadays, blue light blocking glasses and apps are commonly purchased items to limit blue light exposure while using the devices, but their effectiveness needs more study *(Bigalke et al., 2021).* Not only screen time, but other factors like lifestyle, occupation, etc. influences sleep to a great extent.

Sleep affects almost every part of our body, from cognition, immunity, metabolism to motor skills and many more. Poor sleep is associated with many modern day lifestyle disorders as it plays an important role in metabolism. This can be seen in its link with obesity and diabetes and also in neurodegenerative disorders like Alzheimer's *(Ju, Lucey,and Holtzman, 2014*). Poor sleep quality and varying sleep schedule might lead to sleep deprivation with detrimental effects on motor and cognitive skills (*Pilcher and Huffuett, 1996*). Sleep affects almost every part of our body from cognition, immunity, metabolism, motor skill and many more

Exercise plays a significant role in sleep quality *(Singh et al., 1997)*. Being physically active promotes good sleep. With the modern day lifestyle keeping most of us indoors, engaging in physical activity has now become a choice. Increased screen time not only affects sleep but also causes retinal damage, migraines, affects mood etc.*(Tosini, Ferguson and Isubota, 2016).* Poor sleep in also linked with anxiety and depression.

1.1 Background of the study

Covid-19 has affected the world population in many ways. The pandemic imposed lockdown made almost everyone confined to their homes. With work and school being shifted online, the screen time of individuals has increased more than ever. Also, with more time in hand, leisure screen time also has increased. With high speed internet connections, smartphones and electronic devices being more and more common in every household, people turn to such devices for work, leisure, learning, solace, queries and many other things.

Even before the pandemic, such devices were slowly being a part of life. This has accelerated during the pandemic, especially during lockdowns. With nowhere to reach on

time during the pandemic, sleeping and waking late has made the sleep-wake cycle of many, shift. Modern lifestyle habits, occupation, stress, mental, physical and emotional health, all contribute to a change in sleep schedule from the ones our ancestors followed. This could also be due to increased screen time exposure affecting sleep at night, in turn, affecting the time we wake.

Though many used this extra time to engage in activities we couldn't before, it has also limited us in many ways. Busy schedules have made many to compromise on sleep and health, both before and during the pandemic This survey was hence conducted to analyze whether the sleep-wake cycle has changed during the pandemic or not. There were several reports about changing sleep-wake cycles across the world and in several parts of India. This survey was aimed to localize such results, if produced any.

1.2 Need and Significance of the study

Our body repairs itself during sleep. Though our conscious mind is at rest our body and brain is still active and carries out bodily functions to maintain a healthy mind and body. Obesity, diabetes, high blood pressure, high cholesterol and many other disorders are in correlation with sleep. Thus changing sleep patterns, poor quality and quantity of sleep is linked with acquiring these disorders. With the ongoing pandemic many might find it difficult to adhere to their previously followed routine. Sleep is also said to affect mood, emotional intelligence, response to stress *(Bassett et al., 2015)*, mental health etc. Thus studying sleep, its patterns are of immense help to know its association with bodily functions and health. Analyzing changing sleep patterns during the pandemic and its effects might help create awareness among people. It can also promote healthy sleeping habits and can encourage both individuals and organizations to adopt measures limiting screen time. Gaining insight on sleep-wake cycle can immensely help limit screen usage and help people fix a sleep schedule to adhere to. Making people more aware of the cumulative detrimental effects of varying sleep-wake cycle might help in building a stronger, healthy community.

1.3 Scope of the study

One third of our life is spent sleeping. Sleep duration is also said to influence mortality (Patel *et al.,* 2004) and glucose metabolism *(Spiegel et al., 2009).* Poor sleep quality and quantity also increases the risk of metabolic syndrome *(Kang et al., 2010)*, diabetes and obesity.

Diabetes and obesity is prevalent ever more than before with changing lifestyle habits, and it is also linked to the sleep-wake cycle apart from eating habits and genetics. People with poor sleeping habits are more prone to acquiring such diseases. The present survey was carried out to evaluate any changes in the sleep wake cycle, and hence might help to find out if there is any increase in the prevalence of diabetes, obesity or neurodegenerative disorders increasingly than before. The study might also help to link human behavior and cognitive skills in association with sleep.

Aim and Objectives

The present study titled **"A Survey on the Impact of Covid-19 Pandemic on Sleep-Wake Cycle"** was conducted with the following objectives:

- To assess whether the pandemic has influenced the normal bedtime and waking time of individuals
- To analyze whether screen time has increased
- To analyze whether sleep quality and quantity has changed during the pandemic

Chapter II

Review of Literature

Czeisler et al., (1986) conducted a laboratory study of an elderly woman on her output of circadian pacemaker which is a group of nerve cells in the hypothalamus that controls and influences the circadian cycle over the 24 hour light and dark periodicity. They studied her before and after an exposure to 4 hours of bright light for 7 continuous evenings and, before and after in ordinary room light during which her sleep-wake cycle and social contacts were not changed. The studies concluded that there was a 6 hour delay of her circadian pacemaker by analyzing her body temperature and cortisol secretions on exposure to bright light. In another study with similar results, by *Djik and Archer (2009),* suggested that the 24 hour periodicity of day and night influences the biological, physical and behavioral characters as the suprachiasmatic nucleus is connected to the retina and hence light exposure contributes to the synchronization of circadian rhythm with the light-dark cycle.

Studies by *Whal et al., (2019)* suggested the same. They analyzed how visible light synchronizes the biological clock in the suprachiasmatic nucleus (SCN) of humans to the 24 hour light-day periodicity. They suggested that blue light having the shortest wavelength is the strongest synchronizing agent, thus keeping most biological and physiological rhythms synchronized internally and concluded that during the day, blue light increases alertness, cognitive performance etc. But before bed it may affect the sleep quality.

In another survey study conducted by *Sinha, Pande and Sinha (2020),* found out that sleep-wake cycles were more delayed in younger participants during the lockdown in India. They also reported that the younger individuals slept more during the lockdown.

Similar results were obtained by *Gupta et al., (2020)* who concluded that compared to the pre lockdown period, the bedtime and waking time of individuals delayed. A reduction in night time sleep and an increase in day time napping were seen.

Poor sleep quality might lead to sleep deprivation, and its consequences were studied by *Orzel-Gryglewska (2010*) who concluded that sleep deprivation is linked to impaired perception, difficulty in concentrating, slow reaction time, inefficiency in task performance, increased aggressiveness and many more. The risk of obesity, diabetes and cardiovascular

diseases increased. 20-25 hours of sleeplessness is comparable to that of 0.1% blood alcohol content. *Pilcher and Huffuett (1996)* studied three types of sleep deprivation- Partial sleep deprivation (PSD), short term sleep deprivation (SSD), long term sleep deprivation (LSD). PSD had a stronger effect on mood, cognitive function and motor function. PSD affects certain aspects of circadian rhythm. There are many studies on LSD but few on PSD which is a common condition in today's society.

Sleep deprivation also effects emotional intelligence as suggested by *Killgore et al., (2008).* They found out that the subjects showed low scores on their Total EQ after being deprived of sleep. They concluded that sleep deprivation caused changes in cerebral metabolism, emotions, cognition and behavior with mild pre-frontal lobe dysfunction. Similarly, *Knutson and Van Cauter (2008)* investigated the association between short sleep duration and the prevalence of diabetes. Healthy volunteers were sleep restricted for the experiment which resulted in an impact on glucose homeostatis. They found that glucose insensitivity decreased rapidly in the volunteers. There was also reduction on the production of hunger regulating hormone leptin and an increase in hunger promoting hormone ghrelin.

Ju, Lucey, & Holtzman (2014) studied correlation between sleep and Alzheimer's disease. The risk of developing this disease is mainly genetics and age. They used experimental models to demonstrate how sleep deprivation caused an increase in the concentration of beta amyloid proteins which in turn increase the chances of its chronic accumulation. When beta amyloid proteins accumulate, wakefulness and alterations in sleeping pattern is seen to increase. Hence sleep and neurodenegerative diseases are interlinked in many ways. Sleep, circadian rhythm, and physical activity patterns are also linked with depression and anxiety disorders as shown by *Defranscesco et al., (2019).* They conducted actigraphic studies on 359 for 14 days and concluded that people with depression/anxiety showed lower physical activity and larger circadian disturbances.

Sleep duration is another habit affecting quality sleep. Links between sleep duration and mortality was studied by *Patel et al., (2004)* in women. This study lasted for 14 years from 1986 to 2000 on some 82,969 female participants. . They found that mortality risks among women who slept 6-7 hours where lower as opposed to those who slept more than 7 hours of sleep. Furthermore, they showed increased risk of deaths.

In modern day lifestyle, electronic devices play a major role. Increasing screen time in linked to circadian disturbances, poor sleep, depression and many more. This area is being studied

extensively. One such study is a study conducted by *John et al., (2020)* investigating the association of screen time with cognitive delay in preschool children in Kerala. They found that about 84% children had excessive screen time (more than 1 hour a day). Cognitive development was assessed as per Warner David Development Pictorial Scale and according to this scale, those children had deficits in attention, intelligence and social skills compared to those whose screen time was supervised. The former children also showed significant cognitive delays.

Another study again linking screen time with other factors such as physical activity, was conducted by *Schmidt et al., (2020)* in children and adolescents before and during the Covid-19 in Germany and concluded that screen time increased, while physical activities decreased. As per *Demirici et al., (2015),* usage of smartphone affects sleep quality and is linked with depression and anxiety. Participants were university students. They concluded that overusing of smartphone may lead to depression and or anxiety which in turn affects sleep.

Association between screen time and metabolic syndrome (MeTs) was studied by *Kang et al., (2010)* in children and adolescents and concluded that screen time was indeed associated with increased risks of MeTs. Similar results on negative effects of screen time was obtained from the study of *Heuso et al., (2021)* who analyzed the association between screen time and sleep. Children with 120-179 minutes and more than 180 minutes of screen time were found to have short sleep duration. *Xu et al., (2019)* conducted a cross sectional survey of 542 participants aged 16-19 years to investigate the relationship between physical activity, screen time, and sleep quantity and quality in the USA. Participants who did recommended physical activity had 50% chance of having sufficient sleep. Similarly, participants who followed the recommended screen time hours, which is ≤ 2 hours a day had 55% lower chances of having poor sleep quality than those with more screen time than recommended.

Screen time is associated with eye strain, headache and musko-skeleton symptoms as suggested by *Falkenberg et al., (2020).* Symptoms were higher in the case of tablet users than smartphone users. Many with good health showed no symptoms. Children with less physical activity reported neck and shoulder pain. Similarly, *Montagni et al., (2016)* assessed the association between screen time exposure and headaches. They found out that an increase in screen time exposure increased the risk for migraine in young adults. However, they found no significant association with non-migraine headaches. Many think that screen time exposure nowadays can be limited with the use of blue light blocking glasses. A study on the

effectiveness of blue light blocking glasses was studied by *Bigalke et al., (2021).* They found that objective sleep was not significantly impacted while subjective sleep was. They conclude that BLB glasses did not improve objective sleep time or quality and needs more research on its effectiveness.

Sleep quality can be improved by physical exercises. This was demonstrated by *Singh et al., (1997).* There were 32 participant aged 60-84 diagnosed with major and minor depression. They were put to a supervised weight training programme 3 times a week for 10 weeks and they found out that exercise did improve sleep quality, depression, strength and quality of life, but habitual activities were not improved by exercise. *Aguliar et al., (2015)* also investigated the association between physical activity and screen time on sleep pattern and its influence on sleep problems in Chilean girls. They found that when screen time did not exceed the recommended hours (<2 hours), sleep quality was higher .They concluded that screen time should be supervised and physical activity should be encouraged to promote better sleep. A similar study was conducted by *Rubio-Arias et al., (2017)* who investigated the effect of exercise on sleep quality and insomnia. They found and concluded that physical exercise improved sleep quality but no effect on severity of insomnia was seen

In yet another study conducted by *Bassett et al., (2015)* on whether sleep quality affects cortisol responses to acute psychological stress, found that men with good and fairly good sleep quality had less sharp and exaggerated cortisol responses respectively. Women's stress responses were less dependent on the sleep quality. They also found that average sleep duration had no impact on stress response. Participants with blunted stress response had daytime dysfunction. They concluded that low quality sleep caused body to not maintain a normal hypothalamic-pituitary-adrenal functioning during situations of acute stress.

Chapter III

Methodology

3.1 Study Area

All participants of the survey were residents of Kerala, India. The survey was conducted from 2 January 2021 to 6 March 2021

3.2 Study Tool

The study was a questionnaire based survey conducted online. The questionnaire was made and distributed in Google Forms. The URL of the form was sent to participants via social media platforms like Watsaap and Gmail. The questionnaire had a set of 34 questions including comparative questions related to sleep before and during the pandemic, questions about screen time and factors affecting sleep. All the questions were in English. A statement of consent was provided at the beginning of the questionnaire before the individuals partook in the survey. The questionnaire did not require the participants to reveal any personal information to keep their identity anonymous.

3.3 Data Collection

A total of 100 participant responses were collected, aged 13 and above. The responses were saved in Google Form itself. Response summary and data received were analyzed for producing results. Relevant data is represented in tables, graphs and pie charts.

Chapter IV

Results and Observation

4.1 Demographics

There were a total of 100 participants out of which 74% were females and 26% were males. They were divided into the following age groups- 13-17, 18-22, 23-27, 28-32, 33-40 and 50 above (Table 4.1a).

Age group	Male	Female	Total
13-17	1	3	4
18-22	15	57	72
23-27	7	9	16
28-32	0	1	1
33-40	1	0	1
40-50	1	2	3
50+	1	2	3
Total	**26**	**74**	**100**

Table 4.1a-Age and gender wise distribution of survey participants

Out of the 100 participants 79 were students, 12 were working individuals, 7 were both, and 2 were none (Table 4.1b)

Variable	Male	Female	Total
Student	14	65	79
Working	4	8	12
Both	6	1	7
None	2	0	2
Total	**26**	**74**	**100**

Table 4.1b-Gender wise distribution of students and/or working participants

4.2 Use of electronic devices and screen time

All the participants use at least one electronic device daily. About 99% use smartphones and about 26% use smartphones in combination with other devices like TV, laptops, PCs etc. (Table 4.2.1). Only 4% of the participants do not use these devices for study or work and the rest do (Table 4.2.1). And out of these, 80% individuals us these devices all 7 days of the week. Only 3% of the participants use them less than 5 days a week.

Electronic device	**No. of participants**
Only smartphone	63
Smartphone and laptop/PC	11
Smartphone, TV, laptop/PC	10
Only laptop	1
Smartphone and TV	13
Smartphone, TV, laptop/PC, tablet	1
Smartphone, TV, tablet	1
Total	**100**

Table 4.2.1-Different electronic devices used by participants

The screen time of 65% individuals for study or work were more than recommended hours (≥2 hours), the screen time of about 28% individual depended on each day. Only 7% of the individuals had a screen time of ≤ 1 hour. In the case of leisure screen time, 61% individuals exceeded the recommended screen time, screen time of 30% depended each day and only about 9% individual had a screen time of ≤ 1 hour.

29% individuals used their devices a few seconds after waking up apart from checking the time or switching off the alarm, 45% persons used within 10-30 minutes of waking up and 26% used within 1-2 hours of waking up. At night time, 61% used their devices just before

going to bed, 34% used within 10- 15 min and only 5% used 1-2 hours before going to bed, respectively.

Out of the 100 participants 61% is aware of what blue light is from electronic devices and about 59% think that it is harmful while 3% thinks it is not**.** 27% are not aware of electronic devices emitting blue light while 12% are not sure what blue light is. About 70% adopt some or the other measures to reduce blue light. More than half of the participants reduce or adjust the brightness. Some use blue light filter apps and anti- glare glasses while others activate reading mode, eye comfort mode, dark mode etc.

Participants also reported having either head aches and/or along with dryness of eyes, trouble getting sleep, trouble getting up and watery eyes increasingly than before the pandemic. Some participants reported none (Figure 4.2.2).

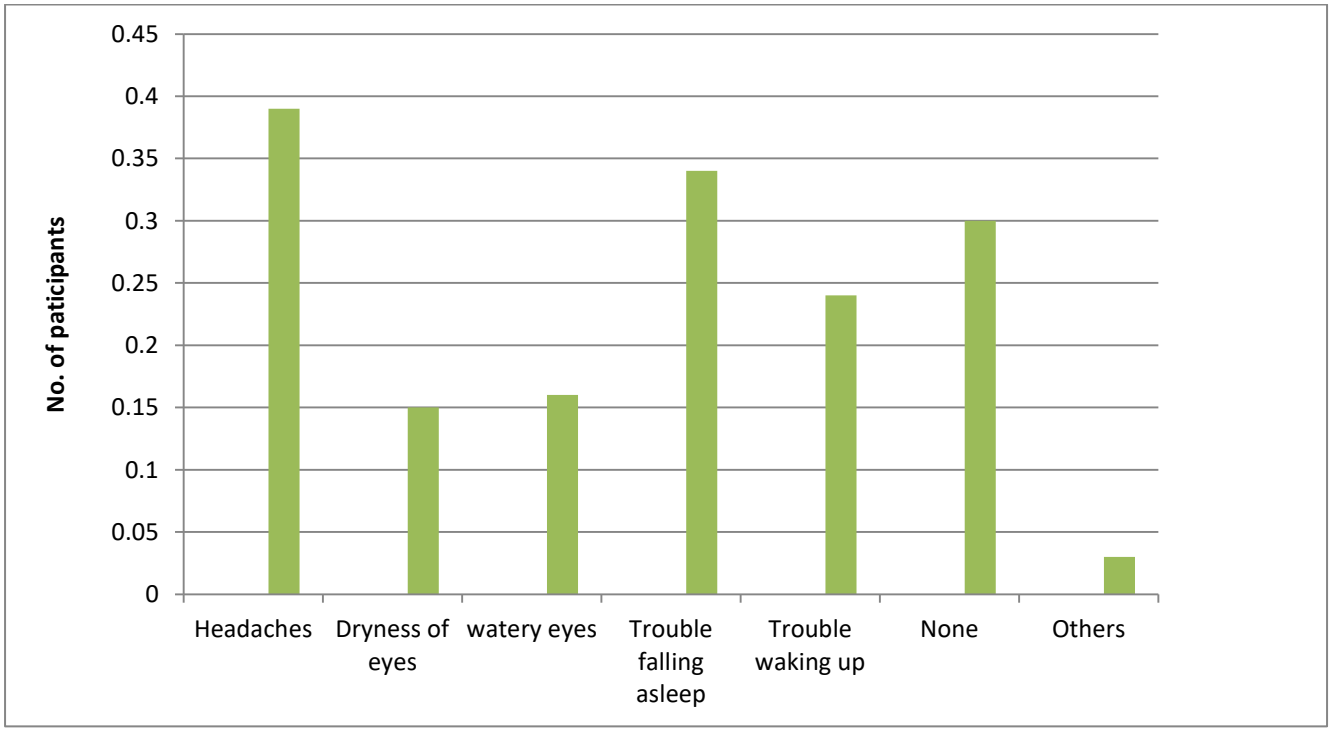


Figure 4.2.2-Variables experienced increasingly during the pandemic

4.3 Sleep schedule and sleep hours of participants

According to the survey data obtained, 10% slept between 8 PM-10 PM, 67% between 10 PM and 12 PM, 19% between 12 AM and 2 AM, 4 % between 2 AM and 4 AM and none above 4AM, before the pandemic.

The bedtime of participants showed a shift during the pandemic (Figure 4.3.1a). Less number of participants slept between 8 PM and 10 PM and slightly more number of individuals slept beyond 12 AM. The exact figures are as follows- only 6% slept between 8 PM and 10 PM, 35% between 10PM and 12 PM, 46% 12 AM and 2 AM, 10% between 2 AM and 4 AM and 3% slept beyond 4AM.

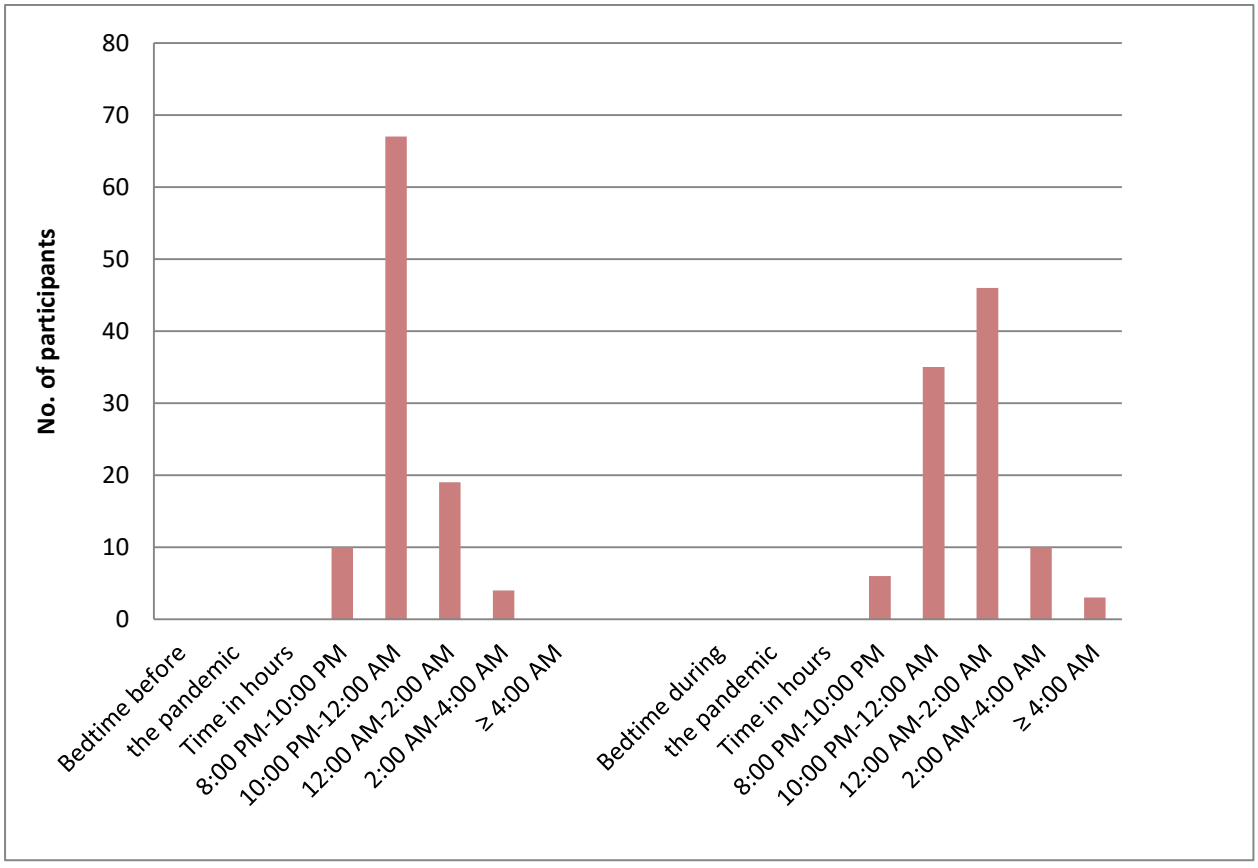


Figure 4.3.1a- Bedtime hours of participants before and during the pandemic

Similarly, a shift in waking time is also seen. Before the pandemic only 2% individuals woke up past 11 AM. But during the pandemic this figure rose to 11% (Figure 4.3.1b). The exact figures for the waking up time before the pandemic are as follows- 55% woke up between 5

AM and 7AM, 41% between 7AM and 9 AM, 2% between 9 AM and 11 AM and 2% beyond 11 AM. None reportedly woke up before 5 AM.

During the pandemic, the shift seen is based on the following figures- 1% woke before 5 AM, 23% between 5 AM and 7 AM, 46% between 7 AM and 9 AM, 19% between 9 AM and 11 AM, and 11% after 11 AM.

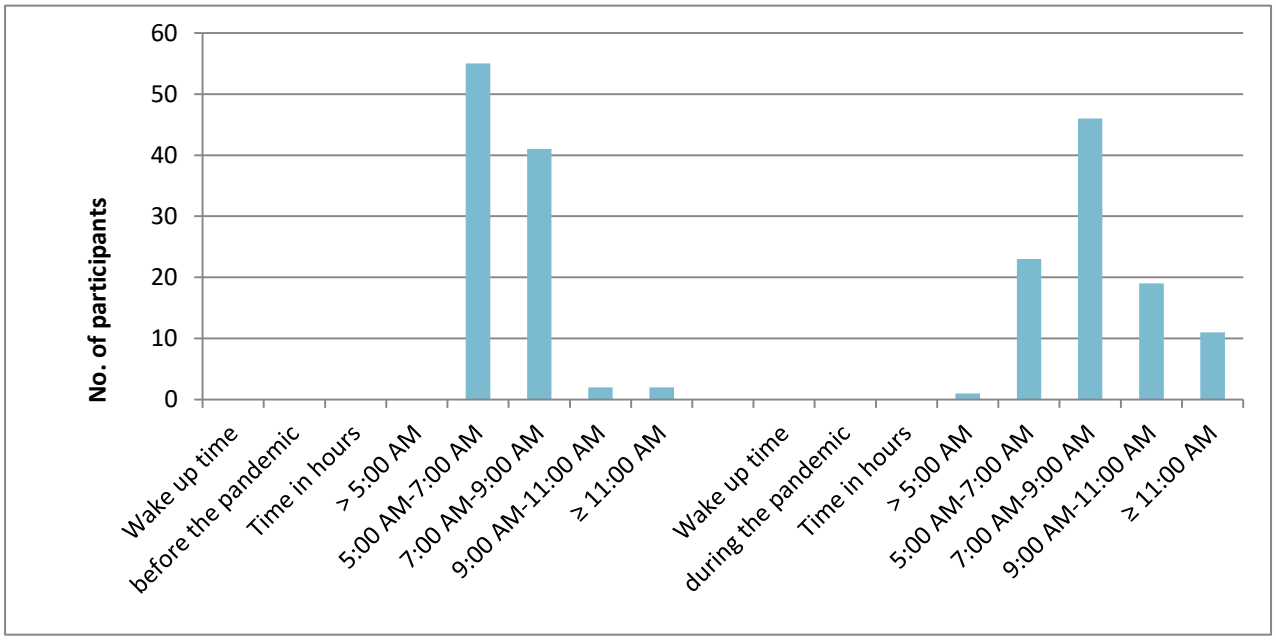
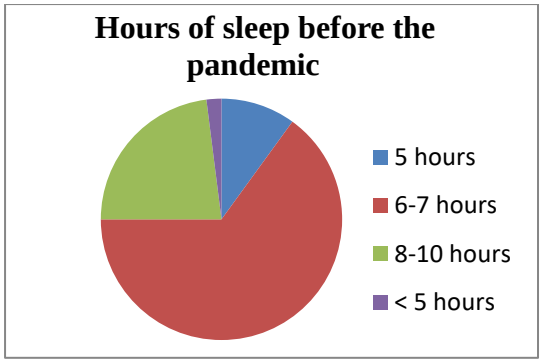


Figure 4.3.1b-Waking time of participants before and during the pandemic

About 65% participants received 6-7 hours of sleep before the pandemic which reduced to 49% during the pandemic. While before the pandemic, 23% received 8-10 hours of sleep, which increased to 38% during the pandemic (Figure 4.3.1c).



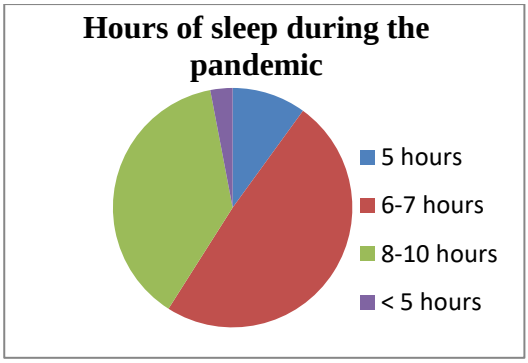


Figure 4.3.1c- Hours of sleep received before and during the pandemic

Participants were asked if they felt sleepier in the day during the pandemic and 30 of them responded they felt sleepier very often and 7 of them responded they felt sleepier always. About 40 of them only felt sleepier sometimes, 16 rarely and 6 never. 48% felt that they felt sleepier before the pandemic than the 34% who felt sleepier during the pandemic

There was a very minor shift by a few percent on how quickly participants fell asleep before and during the pandemic. (Table 4.3.2)

Variable	No. of participants	
	Before pandemic	**After pandemic**
Fell asleep quickly	26	22
Within 10-15 min	28	21
Within 20-30 min	13	18
Within an hour	5	9
Depends on the day	28	30
TOTAL	**100**	**100**

Table 4.3.2-Table showing how quickly the participants fell asleep before and during the pandemic.

4.4 Other variables affecting sleep

48% participants reportedly drank 2-3 cups/servings of caffeinated beverages a day. 31% had them once a day. 17% did not drink any caffeinated beverages throughout the day and 4% drank more than 3 cups/servings a day. In the past 7-8 months, only 17% participants engaged in regular physical activity while 10% each engaged in physical activity 5-6 times and 3-4 times a week respectively. 32% engaged in physical activity once a week while 31% did not at all.

Out of some common factors affecting sleep, more than half (75%) reported experiencing at least one of these and a quarter (25%) did not experience any.

Out of the 100 participants 12% felt that they received good quality sleep before the pandemic as compared to the 21% who felt the opposite. And 67% felt no difference. Poor sleep during the pandemic was experienced by only 3% always, 12% very often, 15% never, 29% sometimes, and 41% rarely.

Other variables	No. of participants		
	Yes	No	Maybe
History of sleep disorder in family	4	91	5
Napping during the day	24	25	51
Memory regarding daily tasks affected during the pandemic	26	45	29
Received 30-40 min of sunlight 2-3 times a week	60	40	-
Screen time increased during the pandemic	87	13	-

Table 4.4-Some factors affecting sleep quality and its effects

About 67% participants felt that their sleep-wake cycle has changed during the pandemic as opposed to the rest 33%.

Chapter V

Discussion

Sleep-wake cycle plays a vital role in regulating important bodily functions and the present survey was conducted to investigate any changes in the sleep wake cycle during the Covid-19 pandemic on a population of 100, residing in Kerala, India. About three quarters of the participants were females in the age group 18-22 and three quarters of both genders combined are students. The survey revealed that bedtime and waking time shifted during the pandemic and there was a delay which is similar to the studies conducted by *Gupta et al., (2020)*. There was an overall shift in bedtime as more participants slept after midnight. Some participants even slept after 3AM during the pandemic which was a trend not reported before the pandemic according to the participants and survey results obtained. Almost all participants used at least one of the modern electronic devices like smartphones, laptops, and T.V for study, work and leisure throughout the week. Almost all used smartphones. The screen time of more than half the individuals were more than the recommended hours ($\leq$2 hours) and as suggested by many like *Heuso et al., 2021* and *Xu et al., 2019*, who in their studies analyzed that increased screen time can be linked with poor quality sleep. The bedtime of participants shifted beyond 12 AM during the pandemic. The waking time also showed a shift beyond 11 AM during the pandemic. The increased screen time may have contributed to such a shift in the sleep-wake cycle which has been assessed by *Aguliar, (2015)* in his studies that associated physical activity, and screen time with sleep pattern.

There were other factors, self-reported by the participants, that they felt, affected their sleep, like mosquitoes, external noise and light, nightmares etc.. Hence, sleep quality could also be affected by any of these factors other than screen exposure. Such factors, that could have been present in both during and before the pandemic might suggest why more than half of the participants claimed that their quality of sleep remained the same during these periods. However, the shift in sleep-wake cycle could be due to increased screen time. Though sleep-wake cycle shifted, sleep duration in many increased. Many participants reported that they felt sleepier during the day in the pandemic than before.

Not many participants reported to have any family history of sleep disorders which also plays a significant role in determining sleep quality, quantity and any sleep disorders in individuals

. Consuming caffeinated drinks is related to poor quality sleep (*Snel and Lorist, 2011*). Almost half of the participants had 2-3 servings of such beverages throughout the day. Napping during the day time is another factor that affects sleep at night. Only a quarter of participants reported to nap in the day during the pandemic. Though napping for 20-30 minutes boosts memory, long time napping might affect sleep at night. As seen in this study, not many people napped and this might be due to an overall increased sleep duration participants received during the pandemic.

Many used their devices just before going to bed and a quarter used their devices just after waking up, being diurnal, this might affect our sleep schedule as suggested by *Whal et al., (2019)*. Light exposure in diurnal animals in the evening can cause an alerting effect as explained by *Djik and Archer (2009)* and this might cause a delay in falling asleep and hence a delay in waking up. Before the pandemic, more than half of the participants reported receiving somewhat around 6-7 hours of sleep. During the pandemic this reduced to almost half. There was a slight increase in the number of participants receiving 8-10 hours of sleep during the pandemic than before it. Though participants receiving < 5 hours of sleep is very less, it has slightly increased during the pandemic.

Getting enough sunlight during the day plays an important role in regulating our circadian rhythm as suggested by *Orzel-Gryglewska (2010)* and in the current study more than half participants received 30-40 minutes of sunlight 2-3 times a week.

More than half of the participants were aware of what blue light is, and adopted some or the other measures to limit the exposure to blue light like using blue light blocking glasses, blue light filter apps, switching on reading mode on their devices, decreasing brightness levels etc. Blue light filter apps might help to filter out short wavelength lights and in some devices switching to reading mode supposedly adds a yellow or reddish tint to the light emitted thus limiting the effects of device emitted blue light. But the effectiveness of blue light blocking glasses are said to be minimal and unclear as seen in the studies of *Bigalke et al., (2021*).

As screen time increased, three quarters of the participants experienced head aches, eye strain, watery eyes etc. which might be linked with the increased screen time.

Studies by *Montagni et al., (2016)* and *Falkenberg et al., (2020)* also linked screen time with headaches and eyestrains respectively.

Exercise is said to promote good quality sleep and overall physical health. This was demonstrated in the studies conducted by *Singh et al., (1997).* Similar results were also seen in the studies of *Rubio-Arias et al., (2017).* In this survey, many participants either did not engage at all in physical activities or engaged in physical activities only once a week. This could also be an additive factory in the changing sleep-wake cycle seen in this study.

Sleep is crucial for memory consolidation. Only a quarter participants reported a decrease in memory regarding daily tasks and this could again be the result of more participants receiving slightly more hours of sleep during the pandemic. In the survey 99% participants did not take any sleeping pills or medication to induce sleep.

With life slowly going back to normal, the sleep schedule of many might change again. It could also change if another lockdown is imposed. Hence healthy sleep habits and fixing a sleep schedule might help to lessen varying sleep-wake cycle.

Chapter VI

Conclusion

With the world being affected by Covid-19 pandemic, there have been reports of its influence on the daily routines and activities of people throughout the world and in India. This survey was hence conducted to evaluate if such a change is seen in the sleep-wake cycles of people residing in Kerala and the factors affecting it. The study showed that the pandemic has brought about a shift or delay in the sleeping and waking time of many individuals, especially in younger participants.

The survey also showed that the screen time of individuals have increased during the past 7-8 months, including months of lockdown, due to work and school being conducted online. Screen time for recreational activities also contributed to this increase. Using electronic devices has become a part of our daily life. This survey hence showed that its usage has increased even more since pandemic.

The study concluded that the sleep schedules of individuals have since changed. Though there has been a delay in the bedtime and waking time, sleep duration reportedly increased. Participants received more hours of sleep than before. But sleep quality was reported to be the same in more than half the participants.

There were several other factors like caffeine consumption, lack of exercise, nightmares, external disturbances and many more, that affected the sleep of many. Conclusions can be drawn that sleep quality being almost reported the same, might be due to these other factors being present before and during the pandemic and changes in the sleep wake cycle can be due to both screen time and these factors combined or any one contributing the most.

However, there were many limitations in the current study, one of which is the survey being a self-reporting one. Another limitation was that it is unclear whether screen time solely brought about the change in sleep schedule or whether the above said factors also played a role in the said change. The survey concluded that the pandemic certainly influenced the sleep -wake cycle, increased both screen time and sleep duration.

Bibliography

1. **Aguilar, M. M., Vergara, F. A., Velásquez, E. J. A., & Garcia-Hermoso, A. (2015).** Physical activity, screen time and sleep patterns in Chilean girls. *Anales de Pediatría (English Edition)*, *83*(5), 304-310.

2. **Bassett, S. M., Lupis, S. B., Gianferante, D., Rohleder, N., & Wolf, J. M. (2015)**. Sleep quality but not sleep quantity effects on cortisol responses to acute psychosocial stress. *Stress*, *18*(6), 638-644.

3. **Bigalke, J. A., Greenlund, I. M., Nicevski, J. R., & Carter, J. R. (2021)**. Effect of evening blue light blocking glasses on subjective and objective sleep in healthy adults: A randomized control trial. *Sleep Health*.

4. **Cartanyà-Hueso, À., Lidón-Moyano, C., Martín-Sánchez, J. C., González-Marrón, A., Matilla-Santander, N., Miró, Q., & Martínez-Sánchez, J. M. (2021).** Association of screen time and sleep duration among Spanish 1-14 years old children. *Paediatric and Perinatal Epidemiology*, *35*(1), 120-129.

5. **Czeisler, C. A., Allan, J. S., Strogatz, S. H., Ronda, J. M., Sanchez, R., Rios, C. D., ... & Kronauer, R. E. (1986)**. Bright light resets the human circadian pacemaker independent of the timing of the sleep-wake cycle. *Science*, *233*(4764), 667-671.

6. **Demirci, K., Akgönül, M., & Akpinar, A. (2015).** Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *Journal of behavioral addictions*, *4*(2), 85-92.

7. **Difrancesco, S., Lamers, F., Riese, H., Merikangas, K. R., Beekman, A. T., van Hemert, A. M., ... & Penninx, B. W. (2019).** Sleep, circadian rhythm, and physical activity patterns in depressive and anxiety disorders: A 2-week ambulatory assessment study. *Depression and anxiety*, *36*(10), 975-986.

8. **Dijk, D. J., & Archer, S. N. (2009).** Light, sleep, and circadian rhythms: together again. *PLoS Biol*, *7*(6), e1000145.

9. **Falkenberg, H. K., Johansen, T. R., & Thorud, H. M. S. (2020).** Headache, eyestrain, and musculoskeletal symptoms in relation to smartphone and tablet use in healthy adolescents.

10. **Gupta, R., Grover, S., Basu, A., Krishnan, V., Tripathi, A., Subramanyam, A., ... & Avasthi, A. (2020).** Changes in sleep pattern and sleep quality during COVID-19 lockdown. *Indian Journal of Psychiatry*, *62*(4), 370.

11. **John, J. J., Joseph, R., David, A., Bejoy, A., George, K. V., & George, L. M. (2020)**. Association of Screentime With Cognitive Delay In Preschool Children of Kerala, India.

12. **Ju, Y. E. S., Lucey, B. P., & Holtzman, D. M. (2014)**. Sleep and Alzheimer disease pathology—a bidirectional relationship. *Nature reviews Neurology*, *10*(2), 115-119.

13. **Kang, H. T., Lee, H. R., Shim, J. Y., Shin, Y. H., Park, B. J., & Lee, Y. J. (2010)**. Association between screen time and metabolic syndrome in children and adolescents in Korea: the 2005 Korean National Health and Nutrition Examination Survey. *Diabetes research and clinical practice*, *89*(1), 72-78.

14. **Killgore, W. D., Kahn-Greene, E. T., Lipizzi, E. L., Newman, R. A., Kamimori, G. H., & Balkin, T. J. (2008).** Sleep deprivation reduces perceived emotional intelligence and constructive thinking skills. *Sleep medicine*, *9*(5), 517-526.

15. **Knutson, K. L., & Van Cauter, E. (2008)**. Associations between sleep loss and increased risk of obesity and diabetes. *Annals of the New York Academy of Sciences*, *1129*, 287.

16. **Montagni, I., Guichard, E., Carpenet, C., Tzourio, C., & Kurth, T. (2016).** Screen time exposure and reporting of headaches in young adults: A cross-sectional study. *Cephalalgia*, *36*(11), 1020-1027.

17. **Orzeł-Gryglewska, J. (2010).** Consequences of sleep deprivation. *International journal of occupational medicine and environmental health*.

18. **Patel, S. R., Ayas, N. T., Malhotra, M. R., White, D. P., Schernhammer, E. S., Speizer, F. E., ... & Hu, F. B. (2004)**. A prospective study of sleep duration and mortality risk in women. *Sleep*, *27*(3), 440-444.

19. **Pilcher, J. J., & Huffcutt, A. I. (1996).** Effects of sleep deprivation on performance: a meta-analysis. *Sleep*, *19*(4), 318-326.

20. **Rubio-Arias, J. Á., Marín-Cascales, E., Ramos-Campo, D. J., Hernandez, A. V., & Pérez-López, F. R. (2017)**. Effect of exercise on sleep quality and insomnia in middle-aged women: a systematic review and meta-analysis of randomized controlled trials. *Maturitas*, *100*, 49-56.

21. **R.Y. Moore, (2001)** Suprachiasmatic Nucleus, Editor(s): Neil J. Smelser, Paul B. Baltes,International Encyclopedia of the Social & Behavioral Sciences ,Pergamon, Pages 15290-15294,

22. **Schmidt, S. C., Anedda, B., Burchartz, A., Eichsteller, A., Kolb, S., Nigg, C., ... & Woll, A. (2020).** Physical activity and screen time of children and adolescents before and during the COVID-19 lockdown in Germany: a natural experiment. *Scientific Reports*, *10*(1), 1-12.

23. **Singh, N. A., Clements, K. M., & Fiatarone, M. A. (1997)**. A randomized controlled trial of the effect of exercise on sleep. *Sleep*, *20*(2), 95-101.

24. **Sinha, M., Pande, B., & Sinha, R. (2020).** Impact of COVID-19 lockdown on sleep-wake schedule and associated lifestyle related behavior: A national survey. *Journal of Public Health Research*, *9*(3).

25. **Snel, J., & Lorist, M. M. (2011)**. Effects of caffeine on sleep and cognition. *Progress in brain research*, *190*, 105-117.

26. Spiegel, K., Tasali, E., Leproult, R., & Van Cauter, E. (2009). Effects of poor and short sleep on glucose metabolism and obesity risk. *Nature Reviews Endocrinology*, *5*(5), 253.

27. **Tosini, G., Ferguson, I., & Tsubota, K. (2016)**. Effects of blue light on the circadian system and eye physiology. *Molecular vision*, *22*, 61.

28. **Wahl, S., Engelhardt, M., Schaupp, P., Lappe, C., & Ivanov, I. V. (2019).** The inner clock—Blue light sets the human rhythm. *Journal of biophotonics*, *12*(12), e201900102.

29. **Xu, F., Adams, S. K., Cohen, S. A., Earp, J. E., & Greaney, M. L. (2019)**. Relationship between physical activity, screen time, and sleep quantity and quality in US adolescents aged 16–19. *International journal of environmental research and public health*, *16*(9), 1524.

30. **Young, M. E., & Bray, M. S. (2007**). Potential role for peripheral circadian clock dys-synchrony in the pathogenesis of cardiovascular dysfunction. *Sleep medicine*, *8*(6), 656-667.

Websites

- https://www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side
- https://www.ted.com/talks/shai_marcu_the_benefits_of_a_good_night_s_sleep?language=en

Appendix

Survey Questionnaire

"**A SURVEY ON THE IMPACT OF COVID-19 PANDEMIC ON SLEEP-WAKE CYCLE**"

Dear Participant,

This is a survey on changes in sleep-wake cycle during acaovid-19 pandemic for my UG projet. By participating in this survey you agree to the following

*Your participation is voluntary

*Your answers are true and accurate to the best of your ability

The information obtained will be used for research purposes only. Kindly co-operate.

Thank you in advance.

Age

- 13-17
- 18-22
- 23-27
- 28-32
- 33-40
- 40-50
- 50+
- Female

Gender

- Female
- Male
- Other

1. Are you a student or a working individual?
   - Working
   - Both
   - Student
   - None of the above

2. Which electronic devices do you use every day? (eg.TV, smartphone, tablet, laptop, computer, etc.). Please type in your answer below.

_____

3. Do you use at least one of the above-mentioned devices for your study/work?
    - Yes
    - No

4. How many hours do you spend a day in front of the screen (TV, phones, computers, etc.) for study/work?
    - 0-1 hour
    - 2-3 hours
    - 4-5 hours
    - More than 5 hours
    - Depends on the day

5. How many hours do you spend a day in front of the screen (TV, phones, computers, etc.) for leisure?
    - 0-1 hour
    - 2-3 hours
    - 4-5 hours
    - More than 5 hours
    - Depends on the day

6. Bedtime before the pandemic
   Time: _____

7. Bedtime during the pandemic
   Time: _____

8. The time you wake up before the pandemic
   Time: _____

9. The time you wake up during the pandemic
   Time: _____

10. How soon do you use your device (apart from checking the time or switching off the alarm) after waking up?
    - Few seconds after waking up
    - within 10-15 min after waking up

- within 30 min after waking up
- after 1-2 hours

11. When is the last time you use a device before going to bed (apart from checking the time)?
    - Few seconds before going to bed
    - 10-15 min before going to bed
    - 30 min before going to bed
    - 1-2 hours before going to bed

12. Are you aware of what blue light is from electronic devices?
    - Yes
    - No
    - Maybe

13. Do you think blue light can be harmful?
    - Yes
    - No
    - Maybe
    - Don't know

14. Do you adopt any extra measures for protecting yourself from the blue light? (eg. using screen filters, reducing brightness, using a blue light protection glass, blue light filter apps, etc.)
    - Yes
    - No

    If 'Yes' please answer briefly what you use.

    _____

15. Do you experience any of the following increasingly than before, during the pandemic? (Multiple options can be selected)
    - Headaches
    - Dryness of eyes
    - Watery eyes
    - Trouble falling asleep
    - Trouble getting up
    - None of the above
    - Other

16. How many hours of sleep did you get before the pandemic?
    - 5 hours

- 6-7 hours
- 8-10 hours
- less than 5 hours

17. How many hours of sleep did you get in the past 7-8 months?
    - 5 hours
    - 6-7 hours
    - 8-10 hours
    - less than 5 hours

18. Has the pandemic affected your memory regarding daily tasks?
    - Yes
    - No
    - Maybe

19. How often do you get sleepy during the daytime in the past 7-8 months?
    - Always
    - Very often
    - Sometimes
    - Rarely
    - Never

20. Have you felt sleepier in the daytime before or during the pandemic?
    - Before the pandemic
    - During the pandemic
    - Not applicable

21. Do you nap during the day?
    - Yes
    - No
    - Sometimes

22. How long did it take for you to fall asleep at night before the pandemic?
    - fall asleep quickly
    - within 10-15 min
    - within 20-30 min
    - within an hour
    - depends each day

23. How long does it take for you to fall asleep at night during the pandemic?
    - fall asleep quickly
    - within 10-15 min
    - within 20-30 min
    - within an hour

- depends each day

24. Does your family have a history of sleep disorders?
    - Yes
    - No
    - Maybe

25. How often do you consume caffeinated beverages during the day? (eg. energy drinks, coffee, tea, etc.)
    - Once a day
    - 2-3 cups/servings a day
    - More than 3 cups/servings
    - None at all

26. How often did you exercise/engage in physical activities in the past 7-8 months?
    - Everyday
    - 5-6 times a week
    - 3-4 times a week
    - once or twice a week
    - None at all

27. Did any of these contribute to you not getting a good night's sleep?
    (Multiple options can be selected)
    - Mosquitoes
    - Snoring
    - Nightmares
    - Sleeping during the day
    - Light from the surroundings
    - Noise from your surroundings
    - Not applicable
    - Other

28. Do you take any sleeping pills or any other medications to help you sleep?
    - Yes
    - No
    - Maybe

29. Did you get good quality sleep before or during the pandemic?
    - Before the pandemic
    - During the pandemic
    - Same before and during the pandemic

30. How often did you have poor sleep in the past 7-8 months?
    - Always

- Very often
- Sometimes
- Rarely
- Never

31. State whether True or False: "I get 30-40 min of sunlight at least 2-3 times a week"
    - True
    - False

32. How many days of the week do you use your devices for study/work/leisure?
    - All 7 days
    - 6 days
    - 5 days
    - Less than 5 days

33. Do you think your screen time has increased in the past 7-8 months?
    - Yes
    - No

34. Do you personally feel like your normal sleep-wake cycle has changed during the pandemic?
    - Yes
    - No

If 'Yes', how would you rate this change on a scale of 1-5

	0	1	2	3	4	5	
Not at all	O	O	O	O	O	O	Has changed drastically