# Screen time, sleep duration and health perception among university students: a cross-sectional study

**Lundstrom, Fritiof Wilhelm**

**UNIVERSITY OF SPLIT**
**SCHOOL OF MEDICINE**

**Fritiof Wilhelm Lundström**

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**Assoc. prof. Ivana Kolčić**

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# TABLE OF CONTENTS

# 1. INTRODUCTION

The recuperative power of sleep is crucial for everyday performance on the physical, cognitive, emotional, and behavioral levels. In addition to the stress that students experience in their daily lives, the pandemic was also contributing significantly to a dramatic rise in screen usage in online instruction. Using a screen can contribute to physical, psychological, and cognitive activation, especially in the evening and at night, which can impair students' ability to sleep (1).

According to the World Health Organization (WHO) research study in children, the findings point to a possible link between excessive screen time exposure, and more frequent ingestion of meals high in fat, free sugar, or salt, whereas longer sleep duration may have a positive impact on kids' dietary decisions. Screen time and sleep duration are both adjustable behaviors that can be targeted in programs to reduce childhood obesity (2).

Even though adolescence (10-24 years of age) is usually regarded as the healthiest phase of life, this population today faces many challenges. Those are linked to poverty causing diseases, injuries and violence, along with mental health problems, substance abuse disorders, and behavioral changes, which are linked to non-communicable diseases (NCDs) occurring later in life, and usually are caused by poor physical activity, alcohol consumption, unhealthy nutrition, and the habit of smoking (3).

### 1.1. Screen time

Screen time is defined as the time a person spends in front of a screen. Smartphones, television or computers are the most popular devices, for people spending time in this manner. The terminology for the description of "screen time" varies, some authors address the subject with "social media use, digital media time, technology use" and many more. This emphasizes the novelty of this topic in science. There are both harmful and helpful effects in the usage of technology devices. Screen time falls into two categories, productive- and leisure-screen-time. Both productive and leisure-time on screen increased significantly during the COVID-19 pandemic, which is associated with an increase in sedentary lifestyle (4).

Leisure time for instance can be subcategorized into 1) TV shows, streaming services and movies, 2) social media, 3) smartphones, and 4) gaming. TV show, streaming

services and movie consumption increased most among of the mentioned services during the COVID-19 pandemic, followed by social media, smartphone and lastly gaming (4). The most reported reason for the increase in usage was boredom, followed by the physical distancing, and trying to stay informed during the active phase of the pandemic (4).

### *1.1.1. Smartphone use*

Smartphones are hand-held computer devices with internet access and advanced computing hardware, that enable handy access to an inbuild camera, navigation, and many other tools (5).

For that, the popularity in smartphone use among medical students today is plausible. Social media, that is accessed via the device, can provide education in care of patients, improvement of medical education, and input from professional partners all around the world. The implementation of these devices in education has great potential. Many of the features provided by smartphones can be of benefit for students, providing greater organization and faster access to accurate data. However, excessive use is linked to development of muscular pain, eye diseases, along with psychological difficulties linked to auditory and tactile sensation (5).

### *1.1.2. Gaming*

The issue of gaming addiction among medical students has been contentious for almost ten years. Around 2 billion individuals worldwide now play video games, making them a very popular kind of entertainment (6). When left unregulated, excessive, and compulsive, an addiction to online games can cause challenges in social and/or emotional functioning (6).

The video game industry is a big business around the world, with products that run on smartphones, computers, and video game consoles. Video games have been shown to be able to improve basic mental functions, including perception, attention, memory, and decision-making. However, using it excessively might result in addiction, namely video game addiction (6).

Stress, which has an adverse effect on social and familial connections, self-control, moderation, and academic success, is frequently present when adolescent gaming addiction prevails (6). However, a systematic review concluded, that video-games can also be of benefit in stress and anxiety reduction, wherein PCs, smartphones, mobile devices and virtual reality gaming devices were tested with positive results (7).

Worth noting in a questionnaire performed on English adolescents found that out of 12,725 participants, 3,970 (31.2%) reported to game at least 3.5 hours per day (8).
A globally conducted meta-analysis performed on medical students found that 6.2% of participants suffered from Internet gaming disorder (IGD), which is double the amount recorded in the population in general (9).

### 1.2. The importance of sleep and sleep duration

Sleep medicine is particularly interested in how sleep serves as a restorative process. Many factors are considered for the evaluation of these restorative processes, but sleep length and sleep quality are among the most crucial ones (4).

In college students, sleep patterns change, due to physiological maturation, resulting in adulthood. Around the age of 12 years, the slow-wave patterns of sleep become shorter, which results in a phase delay of the circadian rhythm by 1 to 3 hours. Spiking of this phenomenon occurs around the age of 15 to 20 years and progresses after (10).

The average duration of sleep in adults is between 7.5 and 8.5 hours, although this varies and individual exceptions are usual (12). Both duration and quality are crucial for the sense of sleep since they convey the individual's subjective contentment with their time spent sleeping. Recent years have seen the development of techniques for evaluating both the objective and subjective aspects of sleep in the fields of sleep medicine and sleep research. Among subjective techniques, getting a thorough medical history that emphasizes the patient's sleep is crucial. Questionnaires that have been validated and are standardized are helpful. Using actigraphy and polygraphy, for instance, to estimate the sleep-wake cycle is an example of an objective method (4).

Polysomnography continues to be the diagnostic tool of choice, particularly for individuals with several morbid conditions (4). However, a major strategy in recent years has been to replace bothersome nightly exams with less upsetting ones that involve performing ambulatory, outpatient exams at the patients' homes, rather than inpatient surveillance in sleep centers (4).

It is well documented that sleep duration and sleep patterns are associated with various health outcomes. A recent study found that maintaining normal daytime working hours, and getting enough sleep lowers one's risk of developing colds and bronchitis (5). Over 60,000 test subjects provided information for the study, including details about their sleeping patterns, shift

work schedules, and frequency of illnesses, like colds and coughs. The control group consisted of people who slept for seven to eight hours every night and had a regular schedule of work hours. It revealed that compared to the control group, those who slept for five hours or less had a 44% increased risk of getting a cold (5). The same study showed that group of people who slept nine or more hours per night demonstrated that getting too much sleep can also have detrimental effects. They had a 20% higher chance of getting the flu than the control group did. Similar to this, a six-hour sleep cycle and a job that required alternating day and night shifts had an impact on the susceptibility to infection (risk of infection increased by 20%). After all disrupting factors were taken into account, regular evening and night employment had no appreciable effect on the risk of colds and bronchitis (5).

In another study performed in women within the Nurses´ Health Education and Health professionals, 67,250 women and 29,114 men were followed from 1986 until 2016 (11). The aim was to examine the lifestyle score, including sleep duration, and the risk of development of a cardiovascular disease. Results of this study showed that 66% of cardiovascular diseases, 67% of coronary heart diseases and 62% of strokes were linked to a lack of adherence to a healthy lifestyle, including sleep (11).

Nearly all living organisms possess circadian clocks, which provide 24-hour patterns of physiology and behavior. These conserved timing systems are believed to help the host species survive by allowing for physiological adaptability to cyclical environmental changes. Endogenous circadian clocks are found in animals in different tissues all across the body, with the suprachiasmatic nucleus (SCN) in the brain serving as the master clock. These clocks regulate daily rhythms of sleep/wake, feeding/fasting, and neuronal, endocrine, immunological, and metabolic processes (12).

However, sleep duration also shows to be impacted by the perceived duration of sleep. In other words, individuals that assumed to have slept less on the time scale, performed worse cognitively, expressed in a slower reaction time in comparison with individuals that thought to have slept longer (12). For instance, individuals who slept for five hours, were told to have slept eight hours. Their cognitive function showed no impact of sleep deprivation, when compared to the other participant group, that actually slept for eight hours, but were told that they slept for five hours (12). This proves that perception of sleep plays a major role in determining a person´s sleep quality.

Sleep is essential for many physiological and biological processes, which include re-charging energy and proper brain functioning. It is true for the opposite, sleep deprivation is

linked to delusion and hallucinating symptoms, that can predispose to the development of systemic diseases. This results in a decrease in the quality of life (13).

### *1.2.1. Neurocircuitory changes in deprivation of quality sleep*

A fundamental mechanism by which inadequate sleep imparts increased vulnerability to emotion-related disorders may be changes in emotion-related neurocircuitry, according to recent neuroimaging studies (14, 15). In fact, compared to a control group that had gotten enough sleep the night before, adults who had been sleep deprived for 35 hours displayed higher amygdala responses and lower functional connectivity (FC) between the amygdala and ventral medial prefrontal cortex (vmPFC) during an emotion processing exercise (15). The filtering and prioritization of information from the environment that is emotionally significant is the responsibility of the amygdala, which is regarded as a key region in emotion regulation circuitry. The vmPFC and the nearby ventral anterior cingulate cortex (vACC) are involved in automatic (or implicit) types of mood regulation and have direct bidirectional connections with the amygdala. Lower amygdala-vmPFC/vACC functional connectivity is believed to reflect loss of "top-down" inhibitory control over emotional responding (i.e., emotion dysregulation), a finding that has been reported across a variety of emotion-related disorders (15). Positive amygdala-vmPFC/vACC FC is observed during active emotion regulation. Two separate studies conducted by Killgore *et al.* and Shao *et al.*, found a similar pattern of reduced FC with shorter sleep in healthy adults, where sleep deprivation or shorter sleep was linked to decreased FC between the amygdala and brain regions implicated in higher-order emotion regulation, including the vmPFC/vACC, and the dorsomedial prefrontal cortex/dorsomedial anterior cingulate cortex (dACC/dmPFC), which is implicated in more effortful (or explicit) forms of emotion regulation (16, 17). It's interesting to note that a recent study performed on young adult men found that sleep recovery the following day reversed the effects of sleep deprivation (i.e., increased FC on amygdala-vmPFC/vACC) (15). An improvement in self-reported mood management was linked to this restoration. All of these results point to the idea that a good night's sleep can help the circuitry for emotion control reconnect functionally. This recovery can enable the person to react correctly to social and emotional situations the following day (15).

## 1.3. Health perception

Perception is defined as the interpretation and understanding of a concept. It is comparable to perspective, but limitations are not in visual, rather intrapersonal interpretations of events (18).

Every individual has an idea of what health is, but errors in their perception can have tremendous impact on health outcomes, with the neglection of hazardous behaviors (18). It has to be mentioned that the focus on the perception of health is based on individual narrative. In other words, how related events influence the individuals state of consciousness in this manner. Understanding is as essential, since it is dictated by the surrounding, one could say, that it demonstrates an external factor in defining one´s state of health perception. This point is affected by the persons surrounding and their belief systems. Included in this issue are media, family and the effect of peer influence, in defining, what it means to be healthy and how to be healthy and how to stay in that state. Perception of health is of tremendous impact on an individual. Assuming one has a poor perception of health, can have tremendous impact on psychological aspects of treatment (18).

Health perception is mostly based on level of physical activity and the individual diet. For instance, a healthy diet was associated with a lower level of perceived stress and depression in university students (18). Sleep, social well-being, alcohol and drug consumption, on the other hand, should be included in assessing this issue.

Putting emphasis on medical students, a study conducted on Romanian medical students found that more than two in five medical students experienced signs of burn-out during online teaching in the COVID-19 pandemic, and more than half of students reported medium- to high-levels of cynicism during this time period (19).

### *1.3.1. Anxiety*

Anxiety affects almost one in three medical students worldwide, a prevalence rate that is significantly greater than that of the general population (20). When students are stressed and concerned, administrators and leaders of medical schools should take the initiative to de-stigmatize mental diseases, and encourage help-seeking behaviors (20).

Despite being as prevalent and potentially as incapacitating as depression, anxiety has received less attention, and is frequently misdiagnosed and untreated in the general population.

Similar to this, anxiety among medical students requires more focus due to its important ramifications (20). These include bodily symptoms like being tired, headaches, dizziness, pain in the abdomen, shortness of breath, palpitations and urinary incontinence along with cognitive impairment, which can be expressed in distractible behaviors, decline in working memory, as well as a drop in eye-muscle coordination (20).

According to the meta-analysis, which included 40,348 medical students from 69 studies, as many as 33.8% of medical students suffered from anxiety globally, which is substantially more prevalent compared to the general population (20). In this study anxiety was most notable in students from Asia and Middle-East, 42,4% and 35,2% respectively. These differences can be attributed to the divergence in cultures, and their stigmatization of mental disorders (20).

### 1.4. Screen time and sleep duration

There was a clear negative relationship between time spent using screen-based devices and both the quantity and quality of sleep, with screen use in bed having more persistently adverse effects (21). Moreover, there were correlations with sleep length, sleep onset latency, and sleep efficiency, as well as increased rates of insomnia among people with higher levels of addiction (21). The amount of evening screen time was higher in those with higher levels of addiction. The results imply that students' usage of screens affects both the quantity and quality of their sleep, with evening screen time having a greater relationship with sleep than total daily screen time (21). The findings also point to a role for social media addiction, and problematic social media use could be the focus of an intervention approach (21).

While screen time varies by age and race, socioeconomic strata show similar patterns, suggesting that cultural influences may influence smartphone use. Sleep problems are linked to screen time. The possibility of the effect-cause still exists: less sleep may result in more screen time. Yet, prolonged use of smartphone screens, especially right before bed, may have a deleterious effect on sleep (22).

### 1.5. Screen time and health perception

The correlation between screen time and health perception demonstrates that these characteristics are having an impact on students. Anxiety seems to be an effect of the increased screen time (3). Linking these points together with the issue of sleep latency, quality of sleep and the effect of decreased physical activity can further contribute to the development of anxiety. It is worth mentioning that the anxiety was provoked by the side effects of worsening quality and quantity of sleep (e.g. sleep latency, sleep duration) (3). This was especially prevalent during online teaching of medical university students, during which students experienced more stress, which was linked to a higher tendency for burn-out (23). However, this was counterbalanced with a supportive environment, which made students more resilient to stressors (23).

Another study among Chinese students found that the negative effect of screen time on mental health can be counterbalanced with regular strenuous exercise (24).
The factor of being in company of friends and children, showed a positive impact on the well-being scores in another study (25).

Worth noting are the positive elements of smart-phone usage in study participants that used their device for studying, listening to music, physical activity, and taking a nap. Furthermore, these effects were identified in individuals in the presence of their loved ones, along with introverts, and people higher in agreeableness (25).

On the other hand, browsing the web, in waiting situations, spending time on the phone, while on vacation, along with social factors of being an extrovert, a neurotic person, low conscientiousness, and being an unagreeable individual, showed negative correlations with usage of smartphones (25).

All in all, the benefits out-rule the disadvantages of utilization of phones (25).

### 1.6. Sleep duration and health perception

The duration of sleep and health perception are two terms that should be discussed in the same context. Observing a decline in sleep duration goes along with a worsened health perception (26).

To give an example, sleep duration declines, along with higher level of stress, were linked to an increase in pro-inflammatory gene expression (24).

Furthermore, short duration of sleep was also linked to the downregulation of antiviral-related genes (24).

Among students sleep deprivation was increasingly prevalent with higher age. Adding with the fact that females showed more pronounced symptoms of sleep deprivation. Sleep deprived individuals showed to have lower sleep duration during weekdays along with issues related to sleep onset (24).

Another study found a correlation between sleep duration and BMI, body weight and fat mass (27). According to the results of this study, an increase in sleep duration by 1.5 h/night, positively impacted weight management in sleep deprived individuals (27).

When energy intake meets the energy balance requirements for an average day and with adequate sleep at baseline, there is an increase in energy expenditure because of the increased wakefulness (28). On the other hand, a negative energy balance was demonstrated during experimental conditions of insufficient sleep in healthy adults; that is, energy expended was greater than energy consumed (28). Due to changes in appetite hormones, hunger will also get worse concurrently. Even though changes in appetite hormones would normally encourage satiety, participants will consume far more calories when sleep is restricted and food is available at all times. If this condition is maintained over time, these extra calories put people into a favorable energy balance and cause weight gain (28). Further encouraging a positive energy balance and weight gain is the fact that the increase in calories occurs primarily in after-dinner snacks, when the energetic response to energy intake is decreased (28).

A cross sectional study performed among medical students in Saudi Arabia found that poor sleeping habits were positively associated with depression, anxiety and stress levels (29). Even though, students that reported to be on the lower end of the sleeping scale were academically more successful students (29).

It is safe to assume that lack of sleep causes many unwanted effects in our body. However, many people in today´s society still lack sleep, many of these individuals for instance work in shifts and have a disbalance in their circadian rhythm. Unfortunately, working environments that force individuals to work in shifts are infrastructural necessities, that must be provided.

### 1.7. Screen time, sleep duration and health perception

It is essential to state the fact, that health perception is declining in individuals with poor quality of sleep. The aspect of physical activity showed a positive influence the quality of sleep in students. The aspect of addiction to mobile phones showed negative impacts on both perceived health and counterbalance the positive effect of physical exercise on sleep quality. In other words, physical strain and screen time showed contrary effects on the quality of sleep (30).

Medical students face tremendous stressors during their studies. These include the issues resulting from possibly living apart from the family for the first time, unknown environment along with social and academic duties. All these factors significantly contribute to the development of sleep related problems. Students in these times are forced to adjust their sleeping routine. This is only emphasized by the fact that students are the most sleep-deprived group in the population, especially in the academic field of medicine, in which students encounter even more factors contributing to stress, which results in decrease in sleep quality (31).

Worth mentioning, poor quality of sleep often co-occurs with mental disorders, among which mood disorders dominate, followed by anxiety related disorders, and substance-abuse disorders (31).

A study conducted on technical students concluded, that long-time mobile device usage was associated with distraction from sleep, as well as decline in mental health (32).

According to research, satisfactory levels of sleep showed a positive impact on the mental and physical state of participants, reducing the risk of developing cardiovascular diseases, diabetes and obesity (33).

In another study performed on students from southern China, there was a proven positive linkage between physical activity and quality of sleep in correlation to body satisfaction. The study also concluded that low body satisfaction levels, were associated with a decline in sleep quality and a drop in physical exercise. It was therefore shown, that depression can be reduced by improving the physical perception (34).

A Chinese study followed 13,494 new undergraduate students before the onset of the pandemic in 2019 for a period of 16 months. The study concluded that most students experienced a stable mental health, although students that reported disturbed sleep and low social support before the outbreak, as well as having parental conflicts during the pandemic, encountering a decline in mental health, together with facing problems with chronic mental health issues (35).

A study conducted on 216 German students during the online teaching phase of the pandemic, found that students were working on average for 6.2 h on week days. There was no statistically significant difference found, however students with lower quality of sleep on average worked more compared to students with sufficient sleep quality. This correlation was associated with the increase in work during hours between 17 – 06 O´clock, which was associated with worse quality of sleep (1).

On days without teaching, students on average worked 3.8 h, here a statistically significant difference between students with good and poor quality of sleep was observed. Students with poor quality of sleep, on average were working one hour more than students with good sleep quality (1).

Concerning the distribution of work times, significant differences were already observed in students working between 14 – 06 O´clock on week days, which was associated with lower quality of sleep. It was concluded, that working on study assignments on teaching-free days in the afternoon impacted the quality of sleep (1).

Furthermore, the study showed the correlation between using screen devices while waking up at night from sleep. It was found that almost half (49.1%) of students with poor quality of sleep regularly used their screen devices, while in the group of students with good quality of sleep, only 26.9% reported to use screen devices during nocturnal wakening (1).

Additionally, the study observed that students with poor sleep quality were more often affected by neck pain, expressed as headaches or stiffness in the neck area, from sitting in front of a computer compared to students that slept well (1).

# 2. OBJECTIVES

## 2.1. Aims

The main aim of this study was to investigate the association between screen time and different types of screens used (TV, computer, and mobile phone), with sleep duration, and the perception of medical students' overall health.

Additional aim was to assess the association between these habits and the quality of life, happiness, optimism, and anxiousness among medical students before and during COVID-19 lockdown.

Finally, the aim was to compare students involved in Croatian and English study medicine program regarding their screen habits, sleep habits, and health perception.

## 2.2. Hypotheses

1. Medical students who spend more time during the day using different devices (TV, computer, and mobile phone) sleep less, and experience worse overall health.
2. Medical students who spend more time during the day using different devices (TV, computer, and mobile phone) have lower quality of life, lower perception of happiness, and optimism, but higher level of anxiousness.
3. Medical students have changed their screen time habits and sleep pattern during the COVID-19 lockdown compared to the period before pandemic.
4. Medical students involved in the Croatian study program have worse screen habits, sleep habits and health perception compared to students involved in the English study program.

# 3. MATERIALS AND METHODS

### 3.1. Study design

This is a cross-sectional study. Data were collected within the project HOLISTic (Habits, Orthorexia Nervosa and Lifestyle in Students), which was registered within ClinicalTrials.gov (NCT04252924). The study was approved by the Ethics Committee of the University of Split School of Medicine (2181-198-03-04-18-0027).

### 3.2. Subjects

This study included two subsamples and two study periods. Both samples were comprised of medical students studying at the University of Split School of Medicine. Study periods included period before COVID-19 pandemic and the period of lockdown due to the COVID-19.

The first sample included medical students who were Croatian citizens, and they were studying Medicine in Croatian language during two consecutive academic years; 2017/2018 and 2018/2019. They were surveyed during their first, fifth and sixth study year. Overall response rate for Croatian medical students was 81.8% in 2018 (n=207), and 86.2% in 2019 (n=206), reaching an overall sample size of 413 students. The second sample included medical students who were most commonly not Croatian citizens, but were coming from countries such as Germany, Scandinavian countries, UK, USA and Australia, and they were studying Medicine in English language during the same two consecutive academic years (2017/2018 and 2018/2019). The response rates for English medical students were 62.8% in 2018 (n=76), and 58.1% in 2019 (n=68).

The second study period was during April and May 2020, at the end of lockdown due to the COVID-19. New generation of students attending the same University of Split and study years were surveyed, when 149 Croatian medical students were included (response rate of 58.4%), and 59 English medical students as well (response rate of 67.0%).

### 3.3. Questionnaire and data collection

Data were collected using a questionnaire. The questionnaire was self-administered and data were collected anonymously. Students were informed about the aim of the study before starting to answer the questions. During the pre-pandemic period, the questionnaire was administered on paper, while during the lockdown period of the study students responded to an online questionnaire via Google Forms.

The questionnaire consisted of several sections. The first section included questions on gender, age, study program (Croatian or English), academic success (expressed as grade point average), body weight, body height, and smoking habits (active smokers, ex-smokers or non-smokers who never smoked).

Body mass index (BMI) was calculated using the formula:

$$\text{BMI} = \frac{weight\ (kg)}{height^2\ (m^2)}$$

The second part of the questionnaire consisted of questions regarding the time spent using different screens during an average day, which was expressed in hours per day. These included TV watching time, computer use time, and mobile use time daily. Additionally, students were asked how many hours per day they usually spend studying.

Sleeping habits section of the questionnaire incorporated a set of three questions, both for working days and non-working days. Questions for non-working days were included only in the study period before the COVID-19 pandemic, while they were excluded for the period of lockdown due to the disruptions in the usual routines. The first question was regarding the time of going to sleep, and the time when students usually wake up. These estimates were used to calculate the sleep duration. The second question asked about usage of alarm clock or waking up on their own. The third question asked about how students feel after waking up, with possible answers being: refreshed, tired and sleepy to a small extent, or extremely tired and sleepy.

Finally, students were asked to rate their overall health perception using a Likert scale, ranging from zero to ten, where a zero represented poor health or being very sick, and 10 was representing best possible health. Additionally, students were asked to answer one Likert type question in order to assess their quality of life (QoL; 0-extremely low, 10-excellent quality of life), one question on how happy they felt during the month prior to the survey (0-not at all, 10-extremely happy), one question on how anxious they have felt during the month prior to the

survey (0-not at all, 10-extremely anxious), and how optimistic they were about their future (0-not optimistic, 10-extremely optimistic).

### 3.4. Statistical analysis

Absolute numbers and percentages were used for description of categorical variables. Ordinal variables were described using median and interquartile range (IQR). Numerical variables were tested for normality of data distribution using Kolmogorov–Smirnov test, where the majority of variables statistically significantly deviated from normal distribution. Consequentially, numerical variables were also described using median and IQR.

Bivariate statistical analysis included the use of chi-square test for categorical variables, and Mann-Whitney U test for ordinal and numerical variables, which deviated from normal distribution.

Correlation between ordinal and numerical variables was tested using the Spearman rank correlation test. Correlation analysis was performed separately for two study periods, and in both periods both sub-samples were included in the analysis jointly.

Statistical analysis was performed using the SPSS statistical program (IBM SPSS Statistics v21). The cut-off point for P value was $<0.05$, when results were considered to be statistically significant.

# 4. RESULTS

This study included 764 medical students from the University of Split School of Medicine. There were two study groups, and two study periods were covered (before and during COVID-19 pandemic). There were 561 students (73.4%) who were studying medicine in Croatian language, and 203 medical students we studying in English program (26.6%) that were included in the analysis (Table 1).

In the overall sample, Croatian and English program students differed in gender composition, with greater share of females among Croatian students (70.9%), compared to English program students (62.1%; P=0.022), study years (P=0.014), and in academic success reported by students (P<0.001; Table 1). These two groups of students did not differ in smoking habits (P=0.598) or BMI (P=0.316; Table 1).

Additionally, within the Croatian program students there was higher percentage of responses from females during the COVID-19 lockdown period, compared to the period before pandemic (P=0.038). This was not recorded in English program students (Table 1).

Table 1. Study participants' characteristics according to study groups and study periods

| | Croatian medical student N=561 | | | English medical students N=203 | | | P value (Croatian vs. English students) |
|---|---|---|---|---|---|---|---|
| | Before COVID-19 N=413 | COVID-19 lockdown N=148 | P value | Before COVID-19 N=144 | COVID-19 lockdown N=59 | P value | |
| Gender; N (%) | | | 0.038 | | | 0.950 | 0.022 |
| Females | 283 (68.7) | 115 (77.7) | | 89 (62.2) | 37 (62.7) | | |
| Males | 129 (31.3) | 33 (22.3) | | 54 (37.8) | 22 (37.3) | | |
| Study year; N (%) | | | <0.001 | | | <0.001 | 0.014 |
| 1st | 157 (38.0) | 43 (29.1) | | 54 (37.5) | 36 (61.0) | | |
| 5th | 122 (29.5) | 80 (54.1) | | 51 (35.4) | 0 (0.0) | | |
| 6th | 134 (32.4) | 25 (16.9) | | 39 (27.1) | 23 (39.0) | | |
| Academic success (grade point average); median (IQR) | 4.0 (1.0) | - | - | 3.6 (1.0) | - | - | <0.001 |
| Smoking; N (%) | | | 0.712 | | | 0.397 | 0.598 |
| Active smoker | 72 (17.5) | 24 (16.2) | | 25 (17.4) | 15 (25.4) | | |
| Ex-smoker | 43 (10.5) | 19 (12.8) | | 19 (13.2) | 6 (10.2) | | |
| Never smoked | 296 (72.0) | 105 (70.9) | | 100 (69.4) | 38 (64.4) | | |
| BMI; median (IQR) | 21.8 (4.0) | 22.0 (4.0) | 0.748 | 22.7 (4.0) | 22.0 (3.0) | 0.027 | 0.316 |

BMI – body mass index; IQR – interquartile range

Croatian students were on average watching TV for twice as long time per day during COVID-19 lockdown, compared to the study period before COVID-19 (1.0 hour/day; IQR 2.0 vs. 0.5 hours/day, IQR 1.0, respectively; P<0.001; Table 2). Similar result was recorded in

students in English program (P=0.028), while there were no differences between two groups of students.

Computer use time has also increased substantially during lockdown in both student groups. On average, it has doubled in Croatian students (P<0.001), while it has tripled in English medical students, increasing from 2.0 h/day to 6.0 h/day on average (P<0.001; Table 2).

Mobile phone use per day has not changed substantially between study periods, but it was on average higher in Croatian medical students than English medical students (P<0.001).

Daily studying time did not differ between study periods in Croatian medical students, while students involved in English program reported studying on average for 6.0 h/day (IQR 5.0) during lockdown, compared to 4.0 h/day (IQR 3.0) before COVID-19 (P<0.001; Table 2).

Table 2. Usage of different screen types among students and studying time (all numbers are expressed as hours per day)

| | Croatian medical student N=561 | | | English medical students N=203 | | | P value (Croatian vs. English students) |
|---|---|---|---|---|---|---|---|
| | Before COVID-19 N=413 | COVID-19 lockdown N=148 | P value | Before COVID-19 N=144 | COVID-19 lockdown N=59 | P value | |
| TV watching time daily; median (IQR) | 0.5 (1.0) | 1.0 (2.0) | <0.001 | 0.5 (2.0) | 1.0 (2.0) | 0.028 | 0.498 |
| Computer use time daily; median (IQR) | 1.0 (2.0) | 2.0 (3.0) | <0.001 | 2.0 (3.0) | 6.0 (7.0) | <0.001 | <0.001 |
| Mobile use time daily; median (IQR) | 3.0 (3.0) | 3.0 (2.0) | 0.046 | 2.0 (2.0) | 2.5 (3.0) | 0.287 | 0.001 |
| Studying time daily; median (IQR) | 4.0 (3.0) | 3.5 (3.0) | 0.929 | 4.0 (3.0) | 6.0 (5.0) | <0.001 | <0.001 |

IQR – interquartile range

Before COVID-19, Croatian medical students had a median sleep duration of 7.0 hours/night (IQR 2.0; Table 3) on working days. During COVID-19 lockdown, Croatian medical students reported a slightly increased median sleep duration of 8.0 hours/night on working days (IQR 1.0), which was statistically significantly different between two study periods (P<0.001; Table 3).

English medical students during COVID-19 lockdown had a higher median sleep duration of 8.0 hours/night (IQR 2.0) on working days, compared to period before COVID-19 (median of 7.8, IQR 1.0; P=0.002). Overall, a higher sleep duration was recorded in English medical students compared to Croatian students (P<0.001, Table 3).

Alarm usage before COVID-19 was reported by 93.6% of Croatian medical students and 85.4% of English medical students during working days, and that percentage decreased during COVID-19 lockdown within both study groups (both P<0.05, Table 3).

Before COVID-19, as many as 20.1% of Croatian students reported feeling extremely tired and sleepy during working days, compared to 6.8% of Croatian students reporting the same feeling during lockdown. The majority of Croatian students reported feeling tired and sleepy to a small extent in both pre-COVID-19 period (66.6%), and lockdown period (55.4%), while only 13.3% of students were refreshed after a night's sleep before COVID-19, a percentage that increased to 37.8% during COVID-19 lockdown (P<0.001; Table 3).

There were no statistically significant differences between two study periods among English students, even though the percentage of students who reported to be feeling refreshed during working days increased to 20.3% during lockdown, compared to 11.8% during period before COVID-19 (P=0.207; Table 3).

Data for non-working days were available only for the period before lockdown, when Croatian medical students reported to be sleeping on average for 9.0 h/night (IQR 1.0), and English students reported average sleep duration of 8.5 h (IQR 1.0), which was not statistically different (P=0.091; Table 3). The use of alarm between study groups was also similar during non-working days before COVID-19, the same as for the reported feeling after waking up. As low as only 3.6% of Croatian students reported to be extremely tired after waking up on free days before COVID-19, which was similar to English students (4.2%; Table 3).

Table 3. Sleep duration and associated characteristics among students

| | Croatian medical student N=561 | | | English medical students N=203 | | | P value (Croatian vs. English students) |
|---|---|---|---|---|---|---|---|
| | Before COVID-19 N=413 | COVID-19 lockdown N=148 | P value | Before COVID-19 N=144 | COVID-19 lockdown N=59 | P value | |
| Working days | | | | | | | |
| Sleep duration (h/night); median (IQR) | 7.0 (2.0) | 8.0 (1.0) | <0.001 | 7.8 (1.0) | 8.0 (2.0) | 0.002 | <0.001 |
| Using alarm for waking up; N (%) | 263 (93.6) | 79 (53.4) | <0.001 | 123 (85.4) | 34 (57.6) | <0.001 | 0.493 |
| Feeling after waking up; N (%) | | | <0.001 | | | 0.207 | 0.219 |
| refreshed | 55 (13.3) | 56 (37.8) | | 17 (11.8) | 12 (20.3) | | |
| tired and sleepy to a small extent | 275 (66.6) | 82 (55.4) | | 98 (68.1) | 39 (66.1) | | |
| extremely tired and sleepy | 83 (20.1) | 10 (6.8) | | 29 (20.1) | 8 (13.6) | | |
| Non-working days | | | | | | | |
| Sleep duration (h/night); median (IQR) | 9.0 (1.0) | - | - | 8.5 (1.0) | - | - | 0.091 |
| Using alarm for waking up; N (%) | 66 (23.6) | - | - | 32 (22.4) | - | - | 0.783 |
| Feeling after waking up; N (%) | | | - | | | - | 0.230 |
| refreshed | 251 (60.9) | - | | 76 (52.8) | - | | |
| tired and sleepy to a small extent | 146 (35.4) | - | | 62 (43.1) | - | | |

| | | | | |
|---|---|---|---|---|
| extremely tired and sleepy | 15 (3.6) | - | 6 (4.2) | - |

IQR – interquartile range

Before COVID-19, Croatian medical students had a median quality of life rating of 8.0 (IQR 2.0, Table 4). During COVID-19 lockdown, this rating decreased to 7.0 (IQR 2.0, P<0.001; Table 4). English medical students reported very similar quality of life rating before and during COVID-19 lockdown (Table 4).

Before COVID-19, Croatian medical students had a median happiness rating of 8.0 (IQR 2.0). During COVID-19 lockdown, this rating decreased to 7.0 (IQR 2.0, P<0.001; Table 4). English medical students during COVID-19 lockdown had the same average happiness rating of 7.0 (IQR 4.0) as during the period before COVID-19, but with higher variability as seen from interquartile range (P=0.007).

Before COVID-19, Croatian medical students reported a median anxiousness rating of 3.0 (IQR 4.0), while it was higher during lock down (median of 4.0, IQR 5.0, P=0.031). English medical students reported on average lower perception of anxiousness during COVID-19 lockdown (median of 4.0, IQR 5.0), compared to the period before COVID-19 (median of 5.0, IQR 5.0), but this result was not statistically significant (P=0.323; Table 4).

Before COVID-19, Croatian medical students had a median optimism rating of 7.0 (IQR 3.0). During COVID-19 lockdown, this rating remained the same at 7.0 (IQR 3.0, Table 4). English medical students during COVID-19 lockdown reported a lower median optimism rating of 8.0 (IQR 2.0), compared to 9.0 (IQR 2.0) during period before COVID-19, but this result was not significant (P=0.082; Table 4).

Before COVID-19, Croatian medical students had a median overall health rating of 9.0 (IQR 2.0, Table 4). During COVID-19 lockdown, this rating remained at 9.0 (IQR: 2.0). English medical students during COVID-19 lockdown had a lower median overall health rating of 8.0 (IQR 2.0), compared to the median of 9.0 (IQR 2.0) during the period before COVID-19 (Table 4).

Comparison between study groups indicated significant differences between Croatian and English medical students in several aspects. The perception of happiness was on average lower in English medical students compared to Croatian students (P=0.002), while their perception of anxiousness was higher (P=0.002), and overall health rating was lower (P=0.009; Table 4).

Table 4. Health perception among students

| | Croatian medical student N=561 | | | English medical students N=203 | | | P value (Croatian vs. English students) |
|---|---|---|---|---|---|---|---|
| | Before COVID-19 N=413 | COVID-19 lockdown N=148 | P value | Before COVID-19 N=144 | COVID-19 lockdown N=59 | P value | |
| Quality of life; median (IQR) | 8.0 (2.0) | 7.0 (2.0) | <0.001 | 8.0 (2.0) | 7.0 (4.0) | <0.001 | 0.273 |
| Happiness; median (IQR) | 8.0 (2.0) | 7.0 (2.0) | <0.001 | 7.0 (2.0) | 7.0 (4.0) | 0.007 | 0.002 |
| Anxiousness; median (IQR) | 3.0 (4.0) | 4.0 (5.0) | 0.031 | 5.0 (5.0) | 4.0 (5.0) | 0.323 | 0.002 |
| Optimism; median (IQR) | 7.0 (3.0) | 7.0 (3.0) | 0.004 | 8.0 (3.0) | 7.0 (3.0) | <0.001 | 0.480 |
| Overall health rating; median (IQR) | 9.0 (2.0) | 9.0 (2.0) | 0.010 | 9.0 (2.0) | 8.0 (2.0) | 0.082 | 0.009 |

In the correlation analysis, several variables were found to be associated in the whole sample of students in the period before COVID-19 pandemic. For example, TV watching time was negatively associated with studying time (r=-0.118, P=0.005; Table 5). Computer use time was negatively associated with academic success (r=-0.115, P=0.023), sleeping during weekends (r=-0.110, P=0.010), and overall health rating (r=-0.101, P=0.019), while it was positively associated with anxiousness (r=0.154, r=0.001; Table 5).

Mobile phone use time was negatively associated with sleeping time during working days (r=-0.134, P=0.014), and quality of life (r=-0.201, P=0.003), and it was positively

associated with anxiousness (r=0.144, P=0.038). Studying time was negatively associated with TV watching time (r=-0.118, P=0.005), sleeping time during working days (r=-0.096, P=0.024), and happiness (r=-0.151, P=0.002), while it was positively associated with anxiousness (r=0.130, P=0.008).

Overall health rating was not associated with sleeping time either during working days or weekends. On the other hand, health perception was associated with quality of life (r=0.423, P<0.001), happiness (r=0.303, P<0.001), and optimism (r=0.245, P<0.001), while it was negatively associated with anxiousness (r=-0.205, P<0.001; Table 5).

In a separate correlation analysis for the period of study during the COVID-19 lockdown, another set of significant correlations was identified in the entire sample of students (Table 6). TV time and computer use time showed to be negatively correlated (r=-0,219, P= 0.001), the same as TV time and studying (r=-0,212, P=0.002; Table 6).

Computer use was negatively associated with sleep duration (r=-0.185, P=0.008), as well as with the perception of the quality of life (r=-0,373, P<0.001), happiness (r=-0,272, P< 0.001), optimism (r=-0.235, P<0.001), and health rating (r=-0,254, P<0.001, Table 6). At the same time, computer use time was positively associated with studying time (r=0.423, P<0.001) and anxiousness (r=0.153, P=0.027; Table 6).

Mobile phone use time was also positively associated with anxiousness, but this was marginally statistically insignificant (r=0.134, P=0.054).

There was no statistically significant correlation between BMI and TV time (r=0.030, P=0.664), computer use (r=-0.038, P=0.584) or mobile phone use (r=-0.058, P=0.286).

Sleep duration showed a significant positive correlation with TV time (r=0.169, P=0.015), quality of life (r=0.182, P=0.009), with happiness (r=0.187, P= 0.007), and overall health rating (r=0.147, P=0.035; Table 6). On the other hand, sleep duration showed a significant negative correlation with studying time (r=-0.224, P=0.001).

Overall health rating showed a negative correlation with computer use (r=-0.254, P<0.001), and studying time (r=-0.144, P=0.038), and a positive correlation with sleep duration (r=0.147, P=0.035), quality of life (r=0.409, P<0.001), happiness (r=0.329, P<0.001), and optimism (r=0.386, P<0.001; Table 6). Additionally, health perception was negatively correlated with anxiousness (r=-0.310, P<0.001; Table 6).

Table 5. Association between screen time, sleep duration and health perception in all medical students before COVID-19 study period; data are shown as Spearman's rho correlation coefficient (P value)

| | Academic success | TV time | Computer use | Mobile use | Studying | Sleeping (working days) | Sleeping (weekends) | QoL | Happiness | Anxiousness | Optimism | Health rating |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BMI | -0.126* (0.013) | -0.001 (0.985) | 0.135** (0.002) | -0.058 (0.286) | -0.136** (0.001) | -0.098* (0.022) | -0.007 (0.878) | -0.032 (0.521) | -0.004 (0.934) | 0.033 (0.505) | 0.027 (0.589) | -0.098* (0.023) |
| Academic success | - | -0.027 (0.600) | -0.115* (0.023) | 0.055 (0.457) | 0.033 (0.516) | -0.030 (0.557) | 0.010 (0.850) | 0.103 (0.091) | 0.094 (0.124) | -0.140* (0.021) | 0.032 (0.598) | 0.120* (0.019) |
| TV time | -0.027 (0.600) | - | -0.056 (0.190) | 0.030 (0.583) | -0.118** (0.005) | 0.055 (0.199) | 0.037 (0.388) | 0.027 (0.584) | 0.001 (0.978) | -0.057 (0.239) | -0.001 (0.985) | 0.008 (0.844) |
| Computer use | -0.115* (0.023) | -0.056 (0.190) | - | -0.053 (0.325) | -0.005 (0.900) | -0.036 (0.395) | -0.110** (0.010) | -0.002 (0.962) | -0.046 (0.351) | 0.154** (0.001) | -0.023 (0.638) | -0.101* (0.019) |
| Mobile phone use | 0.055 (0.457) | 0.030 (0.583) | -0.053 (0.325) | - | 0.079 (0.145) | -0.134* (0.014) | 0.085 (0.119) | -0.201** (0.003) | -0.069 (0.321) | 0.144* (0.038) | -0.043 (0.536) | -0.014 (0.794) |
| Studying | 0.033 (0.516) | -0.118** (0.005) | -0.005 (0.900) | 0.079 (0.145) | - | -0.096* (0.024) | 0.002 (0.971) | -0.071 (0.147) | -0.151** (0.002) | 0.130** (0.008) | 0.034 (0.488) | 0.001 (0.988) |
| Sleep duration on working days | -0.030 (0.557) | 0.055 (0.199) | -0.036 (0.395) | -0.134* (0.014) | -0.096* (0.024) | - | 0.233** (<0.001) | 0.067 (0.171) | 0.049 (0.313) | -0.062 (0.203) | 0.062 (0.208) | 0.033 (0.443) |
| Sleep duration on weekends | 0.010 (0.850) | 0.037 (0.388) | -0.110** (0.010) | 0.085 (0.119) | 0.002 (0.971) | 0.233** (<0.001) | - | 0.027 (0.582) | 0.017 (0.731) | -0.018 (0.711) | 0.051 (0.296) | 0.022 (0.614) |
| QoL | 0.103 (0.091) | 0.027 (0.584) | -0.002 (0.962) | -0.201** (0.003) | -0.071 (0.147) | 0.067 (0.171) | 0.027 (0.582) | - | 0.572** (<0.001) | -0.280** (<0.001) | 0.391** (<0.001) | 0.423** (<0.001) |
| Happiness | 0.094 (0.124) | 0.001 (0.978) | -0.046 (0.351) | -0.069 (0.321) | -0.151** (0.002) | 0.049 (0.313) | 0.017 (0.731) | 0.572** (<0.001) | - | -0.508** (<0.001) | 0.445** (<0.001) | 0.303** (<0.001) |
| Anxiousness | -0.140* (0.021) | -0.057 (0.239) | 0.154** (0.001) | 0.144* (0.038) | 0.130** (0.008) | -0.062 (0.203) | -0.018 (0.711) | -0.280** (<0.001) | -0.508** (<0.001) | - | -0.310** (<0.001) | -0.205** (<0.001) |
| Optimism | 0.032 (0.598) | -0.001 (0.985) | -0.023 (0.638) | -0.043 (0.536) | 0.034 (0.488) | 0.062 (0.208) | 0.051 (0.296) | 0.391** (<0.001) | 0.445** (<0.001) | -0.310** (<0.001) | - | 0.245** (<0.001) |
| Health rating | 0.120* (0.019) | 0.008 (0.844) | -0.101* (0.019) | -0.014 (0.794) | 0.001 (0.988) | 0.033 (0.443) | 0.022 (0.614) | 0.423** (<0.001) | 0.303** (<0.001) | -0.205** (<0.001) | 0.245** (<0.001) | - |

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

Table 6. Association between screen time, sleep duration and health perception in all medical students during COVID-19 lockdown study period; data are shown as Spearman's rho correlation coefficient (P value)

| | TV time | Computer use | Mobile use | Studying | Sleep duration | QoL | Happiness | Anxiousness | Optimism | Health rating |
|---|---|---|---|---|---|---|---|---|---|---|
| BMI | 0.030 (0.664) | -0.038 (0.584) | 0.001 (0.996) | -0.149* (0.032) | -0.003 (0.967) | 0.009 (0.897) | 0.062 (0.378) | -0.079 (0.255) | -0.020 (0.779) | -0.065 (0.352) |
| TV time | - | -0.219** (0.001) | 0.095 (0.171) | -0.212** (0.002) | 0.169* (0.015) | 0.131 (0.059) | 0.038 (0.586) | -0.023 (0.746) | -0.009 (0.896) | -0.039 (0.577) |
| Computer use | -0.219** (0.001) | - | 0.025 (0.720) | 0.423** (<0.001) | -0.185** (0.008) | -0.373** (<0.001) | -0.272** (<0.001) | 0.153* (0.027) | -0.235** (0.001) | -0.254** (<0.001) |
| Mobile phone use | 0.095 (0.171) | 0.025 (0.720) | - | -0.025 (0.718) | 0.004 (0.958) | -0.061 (0.384) | -0.058 (0.404) | 0.134 (0.054) | -0.080 (0.254) | -0.075 (0.284) |
| Studying | -0.212** (0.002) | 0.423** (<0.001) | -0.025 (0.718) | - | -0.224** (0.001) | -0.254** (<0.001) | -0.248** (<0.001) | 0.111 (0.112) | -0.119 (0.088) | -0.144* (0.038) |
| Sleep duration | 0.169* (0.015) | -0.185** (0.008) | 0.004 (0.958) | -0.224** (0.001) | | 0.182** (0.009) | 0.187** (0.007) | -0.131 (0.060) | 0.118 (0.089) | 0.147* (0.035) |
| QoL | 0.131 (0.059) | -0.373** (<0.001) | -0.061 (0.384) | -0.254** (<0.001) | 0.182** (0.009) | - | 0.794** (<0.001) | -0.538** (<0.001) | 0.647** (<0.001) | 0.409** (<0.001) |
| Happiness | 0.038 (0.586) | -0.272** (<0.001) | -0.058 (0.404) | -0.248** (<0.001) | 0.187** (0.007) | 0.794** (<0.001) | - | -0.641** (<0.001) | 0.699** (<0.001) | 0.329** (<0.001) |
| Anxiousness | -0.023 (0.746) | 0.153* (0.027) | 0.134 (0.054) | 0.111 (0.112) | -0.131 (0.060) | -0.538** (<0.001) | -0.641** (<0.001) | - | -0.583** (<0.001) | -0.310** (<0.001) |
| Optimism | -0.009 (0.896) | -0.235** (0.001) | -0.080 (0.254) | -0.119 (0.088) | 0.118 (0.089) | 0.647** (<0.001) | 0.699** (<0.001) | -0.583** (<0.001) | - | 0.386** (<0.001) |
| Health rating | -0.039 (0.577) | -0.254** (<0.001) | -0.075 (0.284) | -0.144* (0.038) | 0.147* (0.035) | 0.409** (<0.001) | 0.329** (<0.001) | -0.310** (<0.001) | 0.386** (<0.001) | - |

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

# 5. DISCUSSION

This study included 764 medical students from the University of Split School of Medicine, divided in two study groups (Croatian medical students and English medical students), and two study periods (before COVID-19 lockdown and during COVID-19 lockdown).

A notable contrast between the Croatian and English programs emerged in terms of gender composition, academic year, and academic achievement. Croatian students had a higher proportion of female candidates, and greater academic success compared to their English counterparts. This disparity could be attributed to the advantage enjoyed by the Croatian students, being in their country of origin, which translated to less time spent on adaptation, particularly during the initial stages of their studies. Conversely, no differences in smoking habits or body mass index (BMI) were detected between the two groups.

In the phase of the COVID-19 lockdown, there was a higher percentage of female respondents in Croatian medical studies, in comparison to the period before lockdown, pointing to greater willingness among women to respond to the survey. None of such differences were seen in students involved in English studies.

Among both Croatian medical students and English medical students, daily TV watching time has on average doubled during the lockdown period, compared to the period of the study before the lockdown. The same result was recorded for computer use, with as much as tripling in usage among English medical students. This is an expected result, given that the teaching was delivered via the online mode during the lockdown period, and students were also trying to stay informed about the pandemic, as well as with the recommendations regarding epidemiological restriction measures. Also, computers might have been used with the aim of staying in touch and connected remotely with their families, especially among English medical students. Additionally, computers could have been used for entertainment purposes, such as gaming or watching Netflix. Contrary to this hypothesis, a study conducted during the COVID-19 pandemic in Japanese students found that leisure screen time was not elevated in medical students, however screen time spent on studying was statistically significantly longer in medical students compared to non-medical students (41). This might also reflect sociocultural differences in the habits related to screen time among students.

Another study found that as many as 78.4% of secondary school students in Croatia reported an increase in computer use during lockdown. The majority of participants further reported increased time spend using mobile phones (33). These findings can be attributed to the higher fear of missing out (FOMO) in younger students, compared to academic students.

On the other side, mobile time use did not change substantially between two study periods in this study, but Croatian medical students tended to use their mobile devices for one extra hour longer compared to English medical students in both study periods. Additionally, Croatian medical students reported less time spent studying compared to English students, especially during lockdown period. These factors might indicate higher academic pressure in Croatian students compared to English students.

Although a study performed in the US in 1500 higher education students found that one quarter of students reported an increase in study time during pandemic, by more than four hours per week, while another quarter reported a decrease in study time, by more than five hours per week (42). This heterogeneity was associated with socioeconomic diversity of students, in a way that students of lower socioeconomic classes were 55% more likely to delay their graduation due to issues faced during the pandemic (42). Considering this, the fact that English students studying at University of Split School of Medicine tend to originate from higher income countries, compared to Croatian students, this factor might have played a role.

When different devices screen time were correlated with students' health perception, only computer screen time was significantly and negatively associated to health perception, both during the COVID-19 study period and before it, while TV time and mobile use did not show this kind of association. However, a study conducted on 400 Indian undergraduate students found no correlation between direct screen time, academic success and quality of sleep, only the academic performance was affected by bed-time screen use (36). Therefore, it is possible to assume, that screen time before bed could result in harm and lower health perception.

On the other hand, a cross sectional survey conducted among 2,116 Chinese medical students found a correlation between low academic success, irregular diet, lack of physical activity, drug use, screen time on mobile phones, and a decline in mental health in form of depression and anxiety (40). In broader terms, this translates to a positive correlation between increase of mobile phone use and mental decline.

Concerning the duration of sleep, Croatian students reported on average one hour increase in sleep duration during the COVID-19 lockdown compared to pre-lockdown. English students on the other hand, had a higher overall sleep duration than Croatian students during pre-lockdown period, which still increased slightly during lockdown period. These factors affected the health of students, which was reported by a different study in which 40% of students reported somatic complaints, sleep disturbances, anxiety and depressive symptoms (36).

Intriguingly a different study found that weekend sleep catch-up in sleep-deprived adolescents in duration of over 120 min was significantly associated with lower well-being, compared to individuals that had catch-up sleep between 0-59 min (37).

Alarm usage decreased in both study groups during the lockdown phase.

Screen time and sleep duration during period before lockdown showed several associations. For example, TV time was not associated with sleep duration either during working days or free days, while computer use was negatively associated with sleep duration on free days, and mobile use was negatively associated with sleep duration on working days. However, during lockdown period TV time was positively associated to sleep duration, meaning that students who were watching TV for longer also slept longer. Computer use time was negatively associated with sleep duration during lockdown, while mobile use did not show an association with sleep duration during this period.

Longer sleep duration during lockdown was associated with better health perception during lockdown period, while this was not the case in the study period before COVID-19 pandemic.

Regarding the quality of life, both Croatian and English program students reported to have a lower quality of life rating during the lockdown, compared to the period before the lockdown. There might be several reasons for that. First of all, home confinement and social isolation could be both strong contributors. It is also important to take the aspect of dissatisfaction with the learning environment into account, when analyzing the active lockdown period. For instance, in a survey conducted in medical students, 66% of participants reported being dissatisfied with online classes, 85% reported lack of clinical skills and 80,6% reported a lack of practical demonstrations (36).

Happiness rating also decreased in both study groups, while anxiousness rating increased during the lockdown for Croatian medical students, and declined in English medical students, although the difference did not prove to be of statistical significance. However, English medical students reported lower optimism during lockdown compared to the period before lockdown. Overall, overall self-perceived health rating maintained stable in Croatian medical students, but it has decreased in English medical students during the lockdown.

Health perception was strongly associated with quality of life, and with happiness perception and optimism too in both study periods. On the other hand, anxiousness was negatively associated with health perception among medical students during both study periods.

In summary, this study revealed significant differences between study groups in various aspects regarding screen time use of different devices, and duration of sleep, and the perception of health.

The COVID-19 pandemic had an impact on several behaviors and perceptions among medical students included in this study. This emphasizes the importance of considering these factors in medical studies and the need for support of students during challenging times. For instance, a study from India reported digital fatigue in 71% of students, as well as lack of motivation to study, which was reported in 73% of participants (36).

However, these effects were not observed in the same extend in the working population. According to the WHO guidelines concerning teleworking, the work-life balance in this population seemed to be positively affected by change of work environment in being balanced with work and life, the possibility of flexibly adjust working hours, lesser time spend in traffic, less pollution exposure and production, which all positively affected physical and psychological aspects of well-being. Several disadvantages were also mentioned in the paper, such as isolation, burnout, depression, domestic violence, musculoskeletal injuries, as well as increase in consumption of alcohol and nicotine, along with a general increase in weight (38).

Even though teleworking and remote university assignments seemed to be relatable, the effects of the lockdown phase of the COVID-19 pandemic might have affected the student population differently. This could be explained with the fact that the working population was married and/or had children, which might have resulted in different obligations and lifestyle habits during lockdown phase.

The main limitation of this study is the cross-sectional study design, which cannot be used to establish the causal relationship between screen time, sleep duration and health perception. Additionally, data collection was via questionnaire, which required from students to estimate and remember about their typical exposures, which might not be very precise, with a possibility of introducing a recall bias into the study. Also, students might have tried to show their screen time as less intensive, given the negative connotation this behavior has, especially in medical community (social acceptability bias).

The advantages of this study include relatively large sample size and high response rates among both study groups and study periods.

Further research should examine the long-term effects of the pandemic on medical students´ well-being, mental health, and academic performance.

# 6. CONCLUSIONS

Based on the conducted study and its results, several conclusions can be drawn:

1. In the study period before COVID-19, higher computer use time was associated with shorter sleep duration during weekends and lower overall health rating, while it was positively associated with anxiousness. Mobile phone use time was negatively associated with sleeping time during working days, and quality of life, and it was positively associated with anxiousness. Overall health rating was not associated with sleeping time either during working days or weekends.
2. In the study period during lockdown, longer computer use time was associated with shorter sleep duration, and lower perception of the quality of life, as well as with lower perception of happiness and optimism, and lower health rating. Longer sleep duration showed a significant association with higher perception of quality of life, as well as higher perception of happiness, and overall health rating.
3. There was no significant difference between Croatian and English medical students in terms of smoking habits or BMI.
4. TV watching time and computer use time per day significantly increased in both study groups during lockdown period compared to the study period before COVID-19 pandemic.
5. Mobile phone use did not differ significantly between two study periods, but it was higher in Croatian students.
6. Daily studying time increased during the COVID-19 lockdown in the English program, but remained unchanged for Croatian students.
7. Croatian medical students reported an increase in median sleep duration by one hour on average during the COVID-19 lockdown, compared to the period before the pandemic, while English students reported a higher overall sleep duration, especially during the period before pandemic.
8. Alarm usage for waking up decreased in both student groups during the lockdown.
9. Croatian students reported feeling less tired and sleepy during the lockdown compared to before COVID-19 lockdown, while English students showed no significant difference.
10. Quality of life and happiness ratings decreased during the lockdown for both groups of students, with Croatian students experiencing a more significant decrease in quality of life.

11. Croatian students reported higher levels of anxiousness during the lockdown, while English students showed a statistically significant decrease.
12. Optimism ratings remained relatively stable for both groups of students.
13. English medical students had a lower happiness perception, higher anxiousness, and lower overall health ratings compared to Croatian medical students.

In conclusion, this study revealed some differences in various aspects between Croatian and English medical students, as well as changes in behaviors and perceptions during the COVID-19 lockdown. The findings highlight the impact of the pandemic on students´ lifestyle, including increased screen time and changes in sleep patterns.

These results contribute to our understanding of the effects of the pandemic on medical students and provide valuable insights for future research and investigations.

# 7. REFERENCES

1. Nestler S, Böckelmann I. Einfluss der Bildschirmzeit auf die Schlafqualität Studierender [Influence of screen time on the sleep quality of students]. Somnologie (Berl). 2023;27(2):124-131.

2. Börnhorst C, Wijnhoven TM, Kunešová M, Yngve A, Rito AI, Lissner L, et al. WHO European Childhood Obesity Surveillance Initiative: associations between sleep duration, screen time and food consumption frequencies. BMC Public Health. 2015;15:442.

3. Cena H, Porri D, De Giuseppe R, Kalmpourtzidou A, Salvatore FP, El Ghoch M,et al.. How Healthy Are Health-Related Behaviors in University Students: The HOLISTic Study. Nutrients. 2021;13(2):675.

4. K. Kaye L, Orben A, A. Ellis D, C. Hunter S, Houghton S. The Conceptual and Methodological Mayhem of "Screen Time." International Journal of Environmental Research and Public Health. 2020;17(10):3661.

5. Lei LY, Ismail MA, Mohammad JA, Yusoff MSB. The relationship of smartphone addiction with psychological distress and neuroticism among university medical students. BMC Psychol. 2020;8(1):97.

6. Almigbal TH, Alrasheed AA, Almutairi ES, Alrehaili RA, Alzahrani AM, Alhassan NA, et al.. Relationship between Medical Students' Perceived Stress and Gaming Behavior at King Saud University. Biomed Res Int. 2022;2022:3220042.

7. Pallavicini F, Pepe A, Mantovani F. Commercial Off-The-Shelf Video Games for Reducing Stress and Anxiety: Systematic Review. JMIR Ment Health. 2021;8(8):28150.

8. Skripkauskaite S, Fazel M. Time Spent Gaming, Device Type, Addiction Scores, and Well-being of Adolescent English Gamers in the 2021 OxWell Survey: Latent Profile Analysis. JMIR Pediatrics and Parenting. 2022;5(4):41480.

9. Chiang CLL, Zhang MWB, Ho RCM. Prevalence of Internet Gaming Disorder in Medical Students: A Meta-Analysis. Front Psychiatry. 2022;12:760911.

10. Adachi M, Nagaura Y, Eto H, Kondo H, Kato C. The impact of sleep-wake problems on health-related quality of life among Japanese nursing college students: a cross sectional survey. Health Qual Life Outcomes. 2022;20(1):150.

11. Guasch-Ferré M, Li Y, Bhupathiraju SN, Huang T, Drouin-Chartier JP, Manson JE, et al. Healthy Lifestyle Score Including Sleep Duration and Cardiovascular Disease Risk. Am J Prev Med. 2022;63(1):33-42.

12. Trott M, Driscoll R, Irlado E, Pardhan S. Changes and correlates of screen time in adults and children during the COVID-19 pandemic: A systematic review and meta-analysis. eClinicalMedicine. 2022;48:101452.

13. Alqudah M, Balousha SAM, Al-Shboul O, Al-Dwairi A, Alfaqih MA, Alzoubi KH. Insomnia among Medical and Paramedical Students in Jordan: Impact on Academic Performance. Biomed Res Int. 2019;2019:7136906.

14. Yoo SS, Gujar N, Hu P, Jolesz FA, Walker MP. The human emotional brain without sleep--a prefrontal amygdala disconnect. Curr Biol. 2007;17(20):877-8.

15. Hehr A, Marusak HA, Huntley ED, Rabinak CA. Effects of Duration and Midpoint of Sleep on Corticolimbic Circuitry in Youth. Chronic Stress. 2019;3:247054701985633.

16. Killgore WDS. Self-Reported Sleep Correlates with Prefrontal-Amygdala Functional Connectivity and Emotional Functioning. Sleep. 2013;36(11):1597–608.

17. Shao Y, Lei Y, Wang L, Zhai T, Jin X, Ni W, et al. Altered Resting-State Amygdala Functional Connectivity after 36 Hours of Total Sleep Deprivation. Bodurka J, editor. PLoS ONE. 2014;9(11):112222.

18. Wagner BE, Folk AL, Hahn SL, Barr-Anderson DJ, Larson N, Neumark-Sztainer D. Recreational Screen Time Behaviors during the COVID-19 Pandemic in the U.S.: A Mixed-Methods Study among a Diverse Population-Based Sample of Emerging Adults. International Journal of Environmental Research and Public Health. 2021;18(9):4613.

19. Silistraru I, Ciureanu AI, Ciubara A, Olariu O. PREVALENCE OF BURNOUTIN MEDICALSTUDENTS IN ROMANIA DURING COVID-19 PANDEMIC RESTRICTIONS (PRELIMINARY DATA). Archiv Euromedica. 2021;11(5):12–5.

20. Quek TT, Tam WW, Tran BX, Zhang M, Zhang Z, Ho CS, et al. The Global Prevalence of Anxiety Among Medical Students: A Meta-Analysis. Int J Environ Res Public Health. 2019;16(15):2735.

21. Hjetland GJ, Skogen JC, Hysing M, Sivertsen B. The Association Between Self-Reported Screen Time, Social Media Addiction, and Sleep Among Norwegian University Students. Front Public Health. 2021;9:794307.

22. Christensen MA, Bettencourt L, Kaye L, Moturu ST, Nguyen KT, Olgin JE, et al. Direct Measurements of Smartphone Screen-Time: Relationships with Demographics and Sleep. Romigi A, editor. PLOS ONE. 2016;11(11):0165331.

23. Liu Y, Cao Z. The impact of social support and stress on academic burnout among medical students in online learning: The mediating role of resilience. Front Public Health. 2022;10:938132.

24. Chen Q, Dai W, Li G, Ma N. The impact of screen time changes on anxiety during the COVID-19 pandemic: sleep and physical activity as mediators. Sleep Biol Rhythms. 2022;20(4):521-531.

25. Teodora Sandra Buda, Khwaja M, Garriga R, Matic A. Two edges of the screen: Unpacking positive and negative associations between phone use in everyday contexts and subjective well-being. 2023;18(4):0284104–4.

26. Carpi M, Vestri A. The Mediating Role of Sleep Quality in the Relationship between Negative Emotional States and Health-Related Quality of Life among Italian Medical Students. International Journal of Environmental Research and Public Health. 2022;20(1):26.

27. St-Onge MP . Sleep-obesity relation: underlying mechanisms and consequences for treatment. Obesity Reviews. 2017:34–9.

28. Chaput JP, McHill AW, Cox RC, Broussard JL, Dutil C, da Costa BGG, et al. The role of insufficient sleep and circadian misalignment in obesity. Nat Rev Endocrinol. 2023;19(2):82-97.

29. Al-Khani AM, Sarhandi MI, Zaghloul MS, Ewid M, Saquib N. A cross-sectional survey on sleep quality, mental health, and academic performance among medical students in Saudi Arabia. BMC Res Notes. 2019;12(1):665.

30. Gao X, Li C, Han B, Xu P, Qu C. The relationship between health belief and sleep quality of Chinese college students: The mediating role of physical activity and moderating effect of mobile phone addiction. Front Public Health. 2023;11:1108911.

31. Wang L, Qin P, Zhao Y, Duan S, Zhang Q, Liu Y, et al. Prevalence and risk factors of poor sleep quality among Inner Mongolia Medical University students: A cross-sectional survey. Psychiatry Research. 2016;244:243–8.

32. Liu S, Wing YK, Hao Y, Li W, Zhang J, Zhang B. The associations of long-time mobile phone use with sleep disturbances and mental distress in technical college students: a prospective cohort study. Sleep. 2018;42(2).

33. Dragun R, Veček NN, Marendić M, Pribisalić A, Đivić G, Cena H, et al. Have Lifestyle Habits and Psychological Well-Being Changed among Adolescents and Medical Students Due to COVID-19 Lockdown in Croatia? Nutrients. 2020;13(1):97.

34. Hao M, Liu X, Wang Y, Wu Q, Yan W, Hao Y. The associations between body dissatisfaction, exercise intensity, sleep quality, and depression in university students in southern China. Front Psychiatry. 2023;14:1118855.

35. Liu L, Chen J, Liang S, Peng X, Yang W, Huang A, et al. An Unusual College Experience: 16-Month Trajectories of Depressive Symptoms and Anxiety among Chinese New Undergraduate Students of 2019 during the COVID-19 Pandemic. Int J Environ Res Public Health. 2023;20(6):5024.

36. Sawant NS, Vinchurkar P, Kolwankar S, Patil T, Rathi K, Urkude J. Online teaching, learning, and health outcomes: Impact on medical undergraduate students. Ind Psychiatry J. 2023;32(1):59-64.

37. Tonetti L, Andreose A, Bacaro V, Grimaldi M, Natale V, Crocetti E. Different Effects of Social Jetlag and Weekend Catch-Up Sleep on Well-Being of Adolescents According to the Actual Sleep Duration. Int J Environ Res Public Health. 2022;20(1):574.

38. World Health Organization. Crucial changes needed to protect workers' health while teleworking [Internet]. 2022 [cited 2023 Mar 23]. Available from: https://www.who.int/news/item/02-02-2022-crucial-changes-needed-to-protect-workers-health-while-teleworking

39. Yeluri K, Hs K, H BG, Bj SC. Electronic Gadget Screen-time, Perceived Sleep Quality & Quantity and Academic Performance in Medical Students. J Assoc Physicians India. 2021;69(11):11-12.

40. Guo Y, Li S, Zhang L, Xuan Q, He L, Ye Q, et al. Depression and anxiety of medical students at Kunming Medical University during COVID-19: A cross-sectional survey. 2022;10:957597.

41. Tashiro T, Maeda N, Tsutsumi S, Komiya M, Arima S, Mizuta R, et al. Association between sedentary behavior and depression among Japanese medical students during the COVID-19 pandemic: a cross-sectional online survey. BMC Psychiatry. 2022;22(1):348.

42. Aucejo EM, French J, Araya MPU, Zafar B. The Impact of COVID-19 on Student Experiences and Expectations: Evidence from a Survey. Journal of Public Economics. 2020;191:104271.

# 8. SUMMARY

**Title:** Screen time, sleep duration and health perception among university students: a cross-sectional study

**Objectives:** To investigate the association between screen time and different types of screens used with sleeping habits and overall health and the quality of life, happiness, optimism and anxiousness in medical students before and during the COVID-19 pandemic, as well as the comparison of Croatian and English medical students concerning their screen habits, sleep habits and health perception.

**Materials and Methods:** The study design was a cross-sectional study, which included two subsamples of medical students from the University of Split School of Medicine: Croatian students and English-speaking international students. Data were collected during two study periods: before the COVID-19 pandemic (2018 and 2019), and during the lockdown period (April - May 2020). The questionnaire was administered on paper before pandemic, and online via Google Forms during lockdown period.
The questionnaire covered various aspects, such as demographics, academic success, smoking habits, body weight and height, as well as screen time usage (TV, computer, and mobile), study hours, and sleeping habits. Students were also asked to rate their overall health perception, quality of life, happiness, anxiousness, and optimism.
Statistical analysis included the use of chi-square test, Mann-Whitney U test, and Spearman rank correlation test.

**Results:** This study included 764 medical students, 561 students studying in Croatian language (73.4%), and 203 students studying in English program (26.6%). Both Croatian and English students have reported to have been watching more TV and to be using computer for longer time during the day during the COVID-19 lockdown period as compared to the period before pandemic. Mobile phone use was higher among Croatian students. Sleep duration increased for both groups during lockdown for working days, with greater increase among Croatian students (increase for one hour per night on average). Croatian students reported feeling less tired and sleepy during lockdown, while English students reported no significant change between two study periods. Quality of life and happiness rating decreased during lockdown for Croatian students, while English students showed no significant changes. English students reported higher levels of anxiousness, and lower overall health perception compared to Croatian students.

In the whole sample of students and during the period before COVID-19 pandemic, computer use time was found to be negatively associated with sleep duration during weekends (r=-0.110, P=0.010), and overall health rating (r=-0.101, P=0.019), while it was positively associated with anxiousness (r=0.154, r=0.001). During the same study period, daily mobile phone use time was also positively associated with anxiousness (r=0.144, P=0.038), while negative association was recorded between mobile use time and sleeping time during working days (r=-0.134, P=0.014), and for quality of life as well (r=-0.201, P=0.003). Overall health perception was not found to be associated with sleeping time either during working days or weekends before pandemic. On the other hand, health perception was associated with quality of life (r=0.423, P<0.001), happiness (r=0.303, P<0.001), and optimism (r=0.245, P<0.001), while it was negatively associated with anxiousness before pandemic (r=-0.205, P<0.001). During the lockdown period in the whole sample of students, it was shown that computer use was negatively associated with sleep duration (r=-0.185, P=0.008), quality of life (r=-0,373, P<0.001), happiness (r=-0,272, P< 0.001), optimism (r=-0.235, P<0.001), and health perception (r=-0,254, P<0.001), while positive association was recorded between computer use and anxiousness (r=0.153, P=0.027). Sleep duration showed a positive correlation with quality of life (r=0.182, P=0.009), happiness (r=0.187, P= 0.007), overall health rating (r=0.147, P=0.035), and TV watching time (r=0.169, P=0.015). Anxiousness was negatively correlated with health perception among students during lockdown (r=-0.310, P<0.001).

**Conclusion:** This study highlighted differences and changes in lifestyle related behaviors and health perceptions between Croatian and English medical students during the COVID-19 lockdown. The findings shed light on the impact of the pandemic on students´ lifestyle, including increased screen time and alterations in sleep patterns. These results contribute to our understanding of the effects of the pandemic on medical students, and provide insights for future research in this area.

# 9. CROATIAN SUMMARY

**Naslov**: Vrijeme provedeno pred ekranima, trajanje sna i percepcija zdravlja među studentima: presječna studija

**Ciljevi**: Istražiti povezanost između vremena provedenog pred ekranima i to različitih tipova ekrana s navikama spavanja, kao i s percepcijom kvalitete života, percepcijom sreće, optimizma i anksioznosti studenata medicine prije i tijekom pandemije COVID-19. Uz to, cilj je bio provesti usporedbu navika korištenja ekrana, spavanja i percepcije zdravlja između studenata koji studiraju medicinu na dva odvojena programa, jedan na hrvatskom i drugi na engleskom jeziku.

**Materijali i metode:** Dizajn studije bio je presječna studija koja je uključivala dva poduzorka studenata medicine Medicinskog fakulteta Sveučilišta u Splitu: hrvatske studente i strane studente koji studiraju prema programu medicine na engleskom jeziku. Podaci su prikupljeni tijekom dva razdoblja istraživanja: prije pandemije COVID-19 (2018. i 2019.) i tijekom razdoblja zatvaranja zbog pandemije (travanj - svibanj 2020.). Prije pandemije podaci su se prikupljali korištenjem upitnika na papiru, a tijekom karantene putem interneta i to putem Google obrazaca.
Upitnik je pokrivao različite aspekte i skupine pitanja, kao što su demografija, akademski uspjeh, navike pušenja, tjelesna masa i visina, kao i korištenje vremena pred ekranom (TV, računalo, mobitel), sati učenja i navike spavanja. Studenti su također zamoljeni da ocijene svoju ukupnu percepciju zdravlja, kvalitetu života, razinu sreće, anksioznosti i optimizma.
Statistička analiza uključivala je korištenje hi-kvadrat testa, Mann-Whitney U testa i Spearman-ova rang korelacijskog testa.

**Rezultati:** Ovo istraživanje obuhvatilo je 764 studenta medicine, 561 studenta na hrvatskom jeziku (73,4%) i 203 studenta na engleskom jeziku (26,6%). Obje skupine ispitanika su izjavile kako su više gledali televiziju i kako su dulje koristili računalo tijekom razdoblja karantene zbog COVID-19 u usporedbi s razdobljem prije pandemije. Korištenje mobitela bilo je u prosjeku u danu duže među hrvatskim studentima. Trajanje spavanja produžilo se za obje skupine studenata tijekom karantene i to radnim danima, s tim da je veći porast zabilježen među studentima koji su studirali na hrvatskom jeziku (povećanje za jedan sat u prosjeku). Hrvatski studenti izjavili su da se osjećaju manje umorno i pospano tijekom karantene, dok među engleskim studentima nije zabilježena značajna promjena između dva istraživana razdoblja. Ocjena kvalitete života i sreće tijekom karantene bila je niža među hrvatskim studentima, dok

među engleskim studentima nije bilo značajnijih promjena. Strani studenti iskazali su višu razinu anksioznosti i nižu ukupnu percepciju zdravlja u usporedbi s hrvatskim studentima.
U cijelom uzorku studenata tijekom razdoblja prije pandemije COVID-19, utvrđeno je da je vrijeme korištenja računala bilo negativno povezano s trajanjem sna tijekom vikenda (r=-0,110, P=0,010), kao i s ukupnom ocjenom zdravlja (r=-0,101 , P=0,019), dok je korištenje računala bilo pozitivno povezano s anksioznošću (r=0,154, r=0,001). Tijekom istog razdoblja istraživanja, dnevno vrijeme korištenja mobilnog telefona također je bilo pozitivno povezano s anksioznošću (r=0,144, P=0,038), dok je negativna povezanost zabilježena između vremena korištenja mobilnog telefona i vremena spavanja tijekom radnih dana (r=-0,134, P=0,014). ), kao i za kvalitetu života (r=-0,201, P=0,003). Cjelokupna percepcija zdravlja nije bila povezana s vremenom spavanja ni tijekom radnih dana ni vikendom prije pandemije. S druge strane, percepcija zdravlja bila je povezana s kvalitetom života (r=0,423, P<0,001), srećom (r=0,303, P<0,001) i optimizmom (r=0,245, P<0,001), dok je negativno bila povezana s anksioznošću u razdoblju prije pandemije (r=-0,205, P<0,001).
Tijekom karantene na cijelom uzorku studenata pokazalo se da je korištenje računala bilo negativno povezano s trajanjem sna (r=-0,185, P=0,008), kvalitetom života (r=-0,373, P<0,001), srećom (r=-0,272, P<0,001), optimizmom (r=-0,235, P<0,001) i percepcija zdravlja (r=-0,254, P<0,001), dok je pozitivna povezanost zabilježena između korištenja računala i anksioznosti (r=0,153 , P=0,027). Trajanje sna pokazalo je pozitivnu korelaciju s kvalitetom života (r=0,182, P=0,009), srećom (r=0,187, P=0,007), ukupnom ocjenom zdravlja (r=0,147, P=0,035) i vremenom gledanja televizije (r=0,169, P=0,015). Anksioznost je bila u negativnoj korelaciji s percepcijom zdravlja među studentima tijekom karantene (r=-0,310, P<0,001).

**Zaključak:** Ovo je istraživanje istaknulo razlike i promjene u ponašanju vezanom uz životni stil i u percepciji zdravlja između hrvatskih i engleskih studenata medicine tijekom karantene COVID-19. Nalazi su rasvijetlili utjecaj pandemije na životni stil studenata, uključujući produženo vrijeme ispred ekrana i promjene u obrascima spavanja. Ovi rezultati doprinose boljem razumijevanju učinaka pandemije na studente medicine i pružaju uvid potreban za buduća istraživanja u ovom području.