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# Influence of length of use of the Information and Communication Technologies on the health of school-age children

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## ABSTRACT

**Introduction:** The use of the internet is becoming increasingly important in enabling children and adults to fully participate in society, whether it is learning new skills or connecting with friends and family. Consequently, children's opportunities are increasingly dependent on the internet. The advance of technological innovations has resulted in more and more Information and communications technology (ICT) devices being available to children, contributing to the deterioration of children and adolescents' health.

**Methods:** The study was designed as an epidemiological, cross-sectional, descriptive-analytical, comparative study. The study was conducted from October 18, 2021, to January 16, 2022, using an online questionnaire accessible through the Microsoft Forms platform. Respondents were able to access the questionnaire through a link or QR code located on the child's consent form for participation in the study, which was previously signed by a parent/guardian.

**Results:** The results of the study showed that school-age children were the most frequent users of smartphones and watches TV, with male respondents spending more time using almost all ICT devices, with the exception of tablets, which were used more frequently by female respondents. The analysis of pain intensity in the use of information and communication technologies revealed that respondents most frequently experienced mild pain, especially in the neck/shoulders and lower extremities. The frequency of eye problems after using ICT devices was found to be occasional, with the most pronounced symptoms being fatigue, tearing, and eyestrain, as well as headaches in one in five respondents.

**Conclusion:** Increasing frequency of ICT device use was associated with higher pain intensity in all anatomic regions. A 1-h increase in weekly ICT device use also increased the likelihood of pain intensity in all anatomic regions, including eye symptoms and headaches. High exposure to ICT is of concern because it leads to adverse health outcomes for children.

**Keywords:** Information and communication technology; children; musculoskeletal pain; eyes; headache

## INTRODUCTION

Information and communications technology (ICT) refers to any technology used to handle telecommunications, electronic media, intelligent surveillance systems, audiovisual processing and transmission systems, and network-based control and monitoring functions. ICT implies the use of computers to store, download, transmit, and process data or information (1).

The widespread use of ICT devices by children, youth, and adults has become an evolutionary phenomenon that significantly permeates the field of education (2). Internet use is becoming increasingly important in enabling children and adults to participate fully in society, whether in learning new skills or in connecting with friends and family. As a result, children's opportunities increasingly depend on the internet (3). The advance of technological innovations has led to more and more ICT devices being available to children. Social networks and the internet are very attractive to today's younger generations (4).

Two-thirds of students in Colombia, the Dominican Republic, Mexico and Peru have access to smartphones at home. Over 80% of students in Australia, Austria, Belgium,

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Denmark, Iceland, Luxembourg, the Netherlands, and Portugal have access to laptops at home, while access is below 40% in Beijing, Shanghai, Jiangsu, Guangdong (China), the Dominican Republic, and Peru (5).

The availability and use of ICT devices have expanded, leading to excessive use, especially among young people with an average daily usage of 7.5 h per day (6).

According to a 2018 study conducted by Limelight Networks, children in the United States play video games for an average of 6.44 h each week, which is longer than the global average of 5.96 h (7).

It was found that the amount of time adolescents spend in front of ICT device screens increases significantly between the ages of 10 and 14, but with significant differences between genders. For boys, it increases by 41.6 minutes per day and for girls by 22.7 minutes per day (8). In America, as many as 89% of adolescents aged 13–17 own a smartphone, more than double the rate of 6 years ago (9).

ICT device use poses a risk for musculoskeletal pain, as an increase in daily use for a single hour increases the likelihood of pain or discomfort from 4% to 7%. The increase in risk can be considered clinically significant because adolescents spend up to several hours a day on a smartphone, computer, or TV (10).

Evidence shows that adolescents adopt non-physiological postures during prolonged smartphone use, with the neck flexed, shoulders hunched, elbows bent, forearms supinated, upper and lower back contorted, and hips, knees, and ankles constantly flexed (11).

Neck and back pain, including headaches, are the leading cause of disability worldwide, with an increasing prevalence in school-aged children (12). The prevalence of thoracic spine pain caused by ICT devices among adolescents is 20.0% in Australia, 13.2% in Portugal, 36% in southern Denmark (13), and 59.0% in Canada (14), while in southern Brazil, in the city of Rio Grande, it is 26.2% and 36.9% in Pelotas (15).

Eye strain is the most common eye problem associated with long-term use of ICT devices, characterized by symptoms such as dry eyes, itching, foreign body sensation, tearing, blurred vision, and headache. Ma et al. (2021) found a rapid increase in myopia (nearsightedness) in students aged 7–12 years in Shanghai during a 4-month isolation at home due to the COVID-19 pandemic, which nearly tripled in just 6 months (16).

It is estimated that the prevalence of eye problems in school-aged children ranges from 25% to 93%. Higher prevalence rates of vision problems have been observed in adolescents who continuously use digital devices for more than 2 h. In a study conducted in private schools in Western India, the prevalence of eye strain was 17.9%. During online classes, 36.9% of children used digital devices for more than 5 h per day, whereas this percentage was 1.8% before school hours (17).

The aim of this work was to determine the duration of daily use of information and communication technologies in school-aged children and to investigate the intensity of pain, eye health, and headaches during use.

## METHODS

The study was designed as an epidemiological, cross-sectional, descriptive-analytic, and comparative study that included all respondents who met the criteria for inclusion in the study. In accordance with the inclusion criteria, the study included 549 respondents of early adolescence, that is, students of sixth, seventh, eighth, and ninth grades of elementary schools in the territory of Republika Srpska (Bosnia and Herzegovina). Of the total number, 266 were male and 283 were female respondents. The survey was conducted in all four geographical regions of Republika Srpska, namely: Banja Luka; Doboj - Bijeljina; Istočno Sarajevo - Zvornik; and Trebinje - Foča.

As provided for in the Ethical Guidelines for Research with Children (Council for Children of Bosnia and Herzegovina - 2006), the research was conducted after receiving the decision of the College Senate on the acceptance of the Commission's report dated September 29, 2021 (number: 01-14-179/21), the approval of the Ministry of Education and Culture of the Government of Republika Srpska dated October 18, 2021 (number: 07.041/059-2318/21), the consent of the administrations of the relevant elementary schools in Republika Srpska and the written consent of the parents/guardians of the children participating in the study. The survey was conducted in the period from October 18, 2021, to January 16, 2022, in the form of an online questionnaire accessible through the Microsoft Forms platform.

The instrument used for the research was the Technology Use Questionnaire, which was adapted to our research. Respondents could access the questionnaire through the link and code QR on the consent form for the child's participation in the study, which was previously signed by a parent/guardian. The link could also be received through the schools' e-mail address provided by the Republika Srpska Pedagogical Institute to provide schools with the consent forms required for participation in the study. After each completion of the questionnaire, the researcher received an e-mail notification of the successful completion of the questionnaire by the respondent, whose identity also remained anonymous to the researcher.

The results of the study are presented in the form of tables, using classical methods of descriptive and analytical statistics, depending on the type of data and measurement scale. Adequate methods of classical descriptive and analytical statistics were used to describe the sample, depending on the type of data: absolute frequency (N) and relative frequency (%).

Results are presented in contingency tables (numbers with two decimal places). The significance level was set at $p = 0.05$.

## RESULTS

The study included 549 respondents of adolescent age. All respondents were between the ages of 10 and 16. Of the total number of respondents, 266 (48.5%) were male and 283 (51.5%) were female.

**TABLE 1.** Average time of using the ICT devices per gender

| ICT devices | X | SD | Min | Max | p-value |
|---|---|---|---|---|---|
| Television (hours/weekly) | | | | | |
| Male | 12.63 | 11.09 | 0.00 | 62.00 | p=0.060 |
| Female | 10.98 | 9.39 | 0.00 | 60.50 | |
| Total | 11.78 | 10.27 | 0.00 | 62.00 | |
| Laptop (hours/weekly) | | | | | |
| Male | 3.48 | 8.82 | 0.00 | 62.00 | p=0.264 |
| Female | 2.75 | 6.45 | 0.00 | 60.50 | |
| Total | 3.10 | 7.69 | 0.00 | 62.00 | |
| Tablet (hours/weekly) | | | | | |
| Male | 1.19 | 4.36 | 0.00 | 55.50 | p=0.127 |
| Female | 1.85 | 5.68 | 0.00 | 60.50 | |
| Total | 1.53 | 5.09 | 0.00 | 60.50 | |
| Smart phone (hours/weekly) | | | | | |
| Male | 24.74 | 16.61 | 0.00 | 62.00 | p=0.307 |
| Female | 23.34 | 15.43 | 0.00 | 62.00 | |
| Total | 24.02 | 16.01 | 0.00 | 62.00 | |
| Total time of the ICT use per week | | | | | |
| Male | 42.04 | 27.62 | 3.00 | 209.00 | p=0.165 |
| Female | 38.92 | 24.86 | 2.00 | 181.50 | |
| Total | 40.43 | 26.25 | 2.00 | 209.00 | |

The statistical analysis in Table 1 shows that male respondents spend more time using ICT devices than female respondents, but with no statistically significant difference.

Using Student t-test, it was found that male respondents spend more time watching TV, on average 12.63 ± 11.09 h per week; on average, they use laptops 3.48 ± 8.82 h per week and smartphones 24.74 ± 16.61 h per week. On the other hand, female respondents spend more time using tablets, with an average usage time of 1.85 ± 5.68 h per week.

Overall, the weekly use of ICT devices was slightly longer for male respondents (with an average use of 42.04 ± 27.62 h) than for female respondents, who used ICT devices for an average of 38.92 ± 24.86 h per week. Weekly use of ICT devices by respondents of both genders ranged from 0 to 62 h.

Table 2 shows a statistically significant difference in neck/shoulder pain intensity according to gender using the Student t-test, which found that pain intensity was higher in female respondents, with an average of 1.97 ± 2.17, than in male respondents, with an average pain intensity of 1.55 ± 2.12 (t = 5.413; $p < 0.020$).

The mean pain intensity in the upper back region was 1.22 ± 2.14 for male respondents and 1.42 ± 2.15 for female respondents.

For the lower back region, the average pain intensity was 1.00 ± 1.97 for male respondents and 1.31 ± 2.20 for female respondents.

For pain in the arms, the average pain intensity was 1.13 ± 2.12 for male respondents and 1.00 ± 1.84 for female respondents.

Of all segments, pain in the wrist/hand was the least severe at 0.83 ± 1.84 for male respondents and 0.95 ± 1.87 for female respondents.

Lower extremity pain had the highest intensity, 1.54 ± 2.29 for male respondents and 1.45 ± 2.19 for female respondents.

**TABLE 2.** Average intensity of pain in different segments of body per gender

| Anatomical regions | X | SD | Min | Max | p-value |
|---|---|---|---|---|---|
| Neck/shoulders | | | | | |
| Male | 1.55 | 2.12 | 0.00 | 10.00 | p=0.020 |
| Female | 1.97 | 2.17 | 0.00 | 10.00 | |
| Total | 1.77 | 2.16 | 0.00 | 10.00 | |
| Upper back | | | | | |
| Male | 1.22 | 2.14 | 0.00 | 10.00 | p=0.261 |
| Female | 1.42 | 2.15 | 0.00 | 10.00 | |
| Total | 1.32 | 2.14 | 0.00 | 10.00 | |
| Lower back | | | | | |
| Male | 1.00 | 1.97 | 0.00 | 10.00 | p=0.086 |
| Female | 1.31 | 2.20 | 0.00 | 10.00 | |
| Total | 1.16 | 2.10 | 0.00 | 10.00 | |
| Arms | | | | | |
| Male | 1.13 | 2.12 | 0.00 | 10.00 | p=0.450 |
| Female | 1.00 | 1.84 | 0.00 | 10.00 | |
| Total | 1.07 | 1.98 | 0.00 | 10.00 | |
| Wrist/hand | | | | | |
| Male | 0.83 | 1.84 | 0.00 | 10.00 | p=0.479 |
| Female | 0.95 | 1.87 | 0.00 | 9.00 | |
| Total | 0.89 | 1.86 | 0.00 | 10.00 | |
| Lower extremities | | | | | |
| Male | 1.54 | 2.29 | 0.00 | 10.00 | p=0.628 |
| Female | 1.45 | 2.19 | 0.00 | 10.00 | |
| Total | 1.49 | 2.24 | 0.00 | 10.00 | |

As per Chart 1, eye fatigue and headache were to some extent more common among respondents from rural areas, while all other symptoms were slightly more common among respondents from urban areas, although the differences were not statistically significant.

Of the total number of respondents, eye fatigue was the most prominent eye symptom during or after ICT use-even among 179 (32.6%) respondents, followed by headache among 105 (19.1%) respondents.

Tears in the eyes occurred in (16.4%) of respondents, while eye discomfort (irritation, heaviness) occurred in 79 (14.4%) of respondents.

The least common eye symptom was dry eye (2.2%).

As per Chart 2, correlation analysis of pain intensity during the last month of the statistically significant variables related to time of ICT device use indicates that a 1-h increase in weekly laptop use increases the probability of upper back pain intensity by 15.1% (rho =0.111; $p < 0.01$), while an increase in weekly smartphone use by 1 h increased the likelihood of pain intensity in the upper back by 23.0% (rho = 0.230; $p < 0.01$), neck/shoulders by 18.2% (rho = 0.182; $p < 0.01$), legs by 17.6% (rho = 0.176; $p < 0.01$), lower back by 10.9% (rho = 0.109; $p < 0.05$), and hands by 8.8% (rho = 0.088; $p < 0.05$).

Regarding tablet use, a 1-h weekly increase in use also increased the odds of wrist/hand pain intensity by 16.2% (rho = 0.162; $p < 0.01$), in the upper back by 10.8% (rho = 0.108; $p < 0.05$) and in the lower back by 9.3% (rho = 0.093; $p < 0.05$). Increasing the total time of weekly ICT device use by 1 h increased the odds of pain intensity in the upper back by 22.2% (rho = 0.222; $p < 0.01$), legs by 13.3% (rho = 0.133; $p < 0.01$), neck/shoulder by

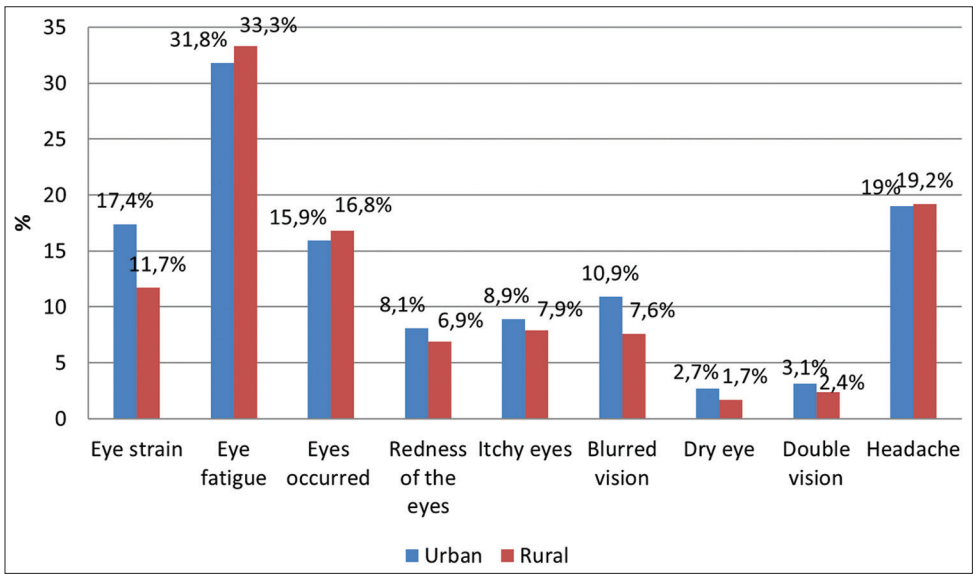


**CHART 1.** Presentation of eye symptoms during or after using the ICT devices per regions.

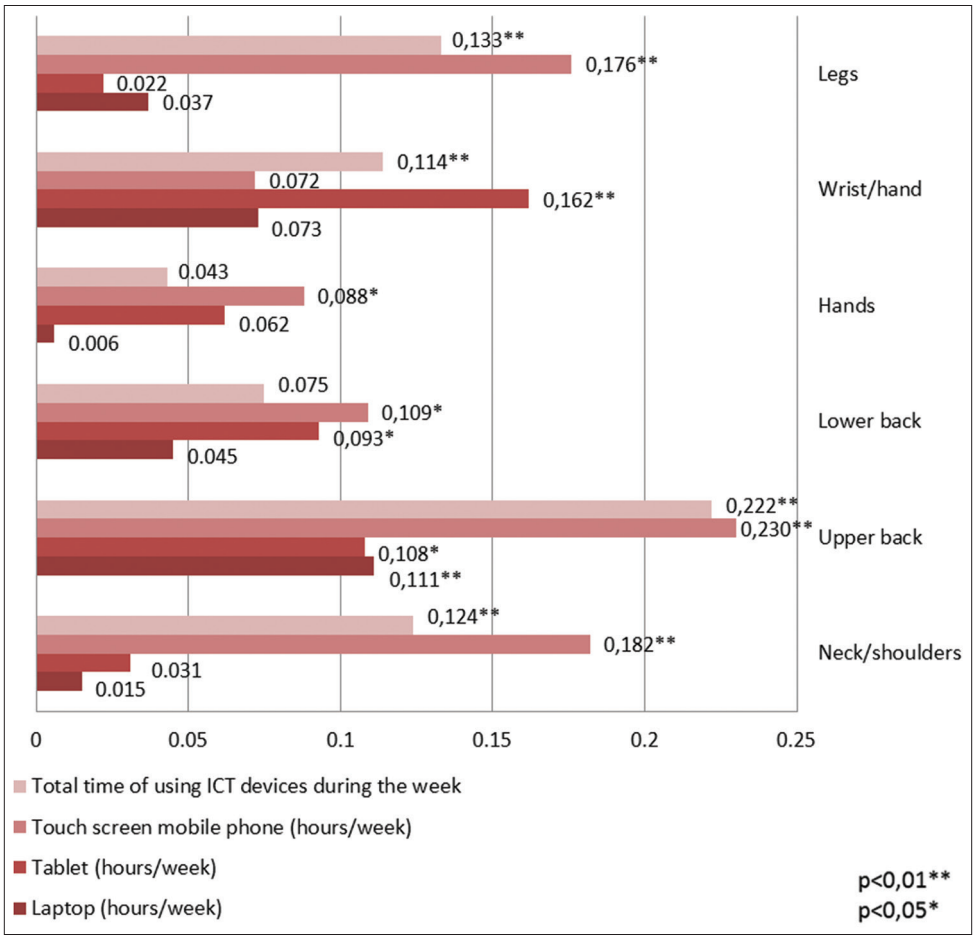


**CHART 2.** Correlation analysis of the pain intensity during the last month of statistically significant variables in relation to the time of used ICT devices.

12.4% (rho = 0.124; $p < 0.01$), and wrist/hand by 11.4% (rho = 0.114; $p < 0.01$).

Correlation analysis of eye symptoms and headache of statistically significant variables related to time of ICT device use, according to Chart 3, shows that increasing the time of weekly tablet use by 1 h increases the likelihood of headache by 8.9% (rho = 0.089; $p < 0.05$). Increasing weekly smartphone use by 1 h increases the odds of headache by 14.2% (rho = 0.142; $p < 0.01$), of visual disturbance by 12.4% (rho = 0.124; $p < 0.01$), for double vision by 12.3% (rho = 0.123; $p < 0.01$), and for itchy eyes by 9.8% (rho = 0.098; $p < 0.05$).

Increasing the total time of weekly ICT device use by 1 h increased the odds of headache by 15.2% (rho = 0.152; $p < 0.01$).

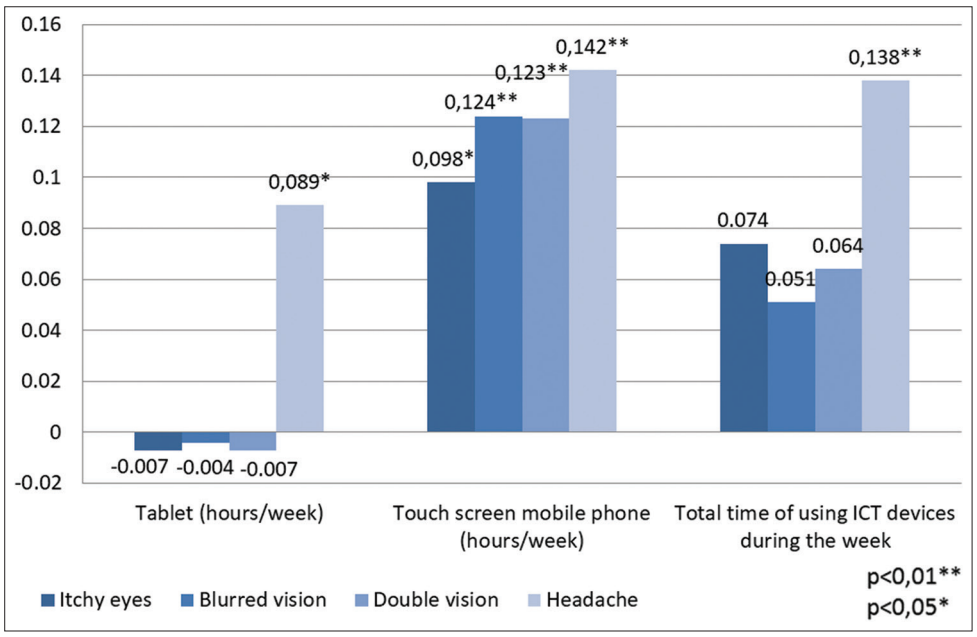


**CHART 3.** Correlation analysis of eye symptoms and headache of statistically significant variables in relation to the time of used ICT devices.

## DISCUSSION

The study included 549 respondents of adolescent age. All respondents were between the ages of 10 and 16. Of the total number of respondents, 266 (48.5%) were male and 283 (51.5%) were female.

A cross-sectional study by Torsheim and associates of 31,022 respondents aged 11–15 years from the Scandinavian countries of Denmark, Sweden, Finland, Norway, Iceland, and Greenland found that average daily computer use was 1.53 h in Denmark (male respondents 1.61 h, female 1.45 h), 1.74 h in Sweden (male 1.75 h, females 1.73 h), in Finland 1.55 h (male respondents 1.54 h, females 1.55 h), in Norway 1.69 h (male respondents 1.58 h, females 1.80 h), in Iceland 1.79 h (male respondents 1.87 h, females 1.72 h), and in Greenland 1.3 h (male respondents 1.17 h, females 1.43 h). The average daily viewing time TV was 2.68 h in Denmark (male respondents 2.61 h, female 2.75 h), 2.23 h in Sweden (male respondents 2.30 h, female 2.17 h), 2.17 h in Finland (male respondents 2.21 h, female 2.13 h), 2.42 h in Norway (male respondents 2.41 h, female 2.42 h), in Iceland 2.39 h (male respondents 2.56 h, female 2.22 h), and in Greenland 2.61 h (male respondents 2.62 h, female 2.60 h) (18), which means that respondents in all Scandinavian countries use computers and watch television more frequently than respondents in our study.

In a cross-sectional study of a sample of 969 respondents aged 13–19 years, Silva et al. examined the association between activities on screens of ICT devices and the presence of pain in the past 7 days. The study authors found that the average pain intensity per body segment ranged from 3.6 ± 1.8 in the neck to 4.4 ± 2.3 in the knee. The results of the study showed that female respondents were significantly more likely to report pain in all body segments (OR ranging from 1.64 to 2.58), except for the region of the ankles and feet (13). This means significantly higher pain intensity in all body regions compared to the results of our study, noting that female respondents in our study had higher pain intensity in almost all body regions except for the regions of the arms and lower extremities, while the results of Silva et al. study showed that female respondents had significantly higher odds of reporting pain in all body segments except for the ankles and feet. The study by Aartun et al. examined pain intensity in adolescents aged 11–13 years and found that the average pain intensity in the neck and upper back was 3.1, whereas it was 2.7 in the lower back (19), suggesting that respondents in their study had higher pain intensity in the aforementioned body regions than was the case in the results of our study, notwithstanding the fact that the results were not exclusive to the gender of the respondents.

Khalaj et al. examined vision problems and their association with computer use in a sample of 642 respondents aged 11 to 18 years. The authors found that eye strain occurred in 81.9% of respondents, eye pain in 50.5% of respondents, eye redness in 43.3% of respondents, headache in 40.2% of respondents, and blurred vision in 37.4% of respondents, while dry eyes were the least common in 7.8% of respondents (20). Review of these results showed that respondents in our study had a significantly lower percentage of headache and eye symptoms.

A cross-sectional study from Pakistan involving 385 adolescents aimed to determine the incidence of eye strain from working on ICT devices and its association with time spent in front of ICT device screens. The research results showed that the most common symptoms were headache (47.3%), tired eyes (33.7%), blurred vision (25%), eye-strain (22.3%), irritated or painful eyes (15%), and dry eyes (9.6%) (21), indicating that eye fatigue was the only symptom consistent with the finding of our study, while all other symptoms were significantly more common among respondents from Pakistan.

A study from Portugal aimed to investigate and compare the association between time spent in ICT device screen activities and the presence of pain in all body regions during the past 7 days. The study included 969 respondents aged 13–19 years. The research results showed that the odds

ratio (OR) for neck pain in the past 7 days was (OR =1.19) among respondents who used a cell phone for <1 h a day and (OR =1.92) among respondents who used a cell phone more than 5 h a day, (OR =1.59) among respondents who used a computer <1 h a day, and (OR =2.16) among respondents who used a computer more than 4 h a day. For upper back pain, this ratio was (OR =1.08) for respondents who used a cell phone <1 h a day and (OR =2.74) for respondents who used a cell phone more than 5 h a day; (OR =0.97) for respondents who used a computer <1 h a day and (OR =1.54) for respondents who used a computer more than 4 h a day. For low back pain, this ratio was (OR =1.25) for respondents who used a cell phone <1 h per day and (OR =3.20) for respondents who used a cell phone more than 5 h per day; (OR =2.34) for respondents who used a computer <1 h per day and (OR =3.02) for respondents who used a computer more than 4 h per day. For pain in the hands, this ratio was (OR =1.36) for respondents who used a cell phone <1 h per day and (OR =2.56) for respondents who used a cell phone more than 5 h per day. For leg pain, this ratio was (OR =1.0) among respondents who used mobile phones <1 h per day and (OR = 2.69) among respondents who used mobile phones more than 5 h per day (13). Respondents who used cell phones and computers more frequently had higher pain intensity in all body regions compared with respondents who used cell phones and computers less frequently, which is consistent with our study in which the likelihood of pain intensity in all body regions increased with an increase in cell phone and computer (laptop) use of 1 h per week.

A study by Falkenberg and associates examined eye discomfort, headaches, and musculoskeletal symptoms associated with tablet and smartphone use by healthy adolescents with normal vision. Fifty-seventh-grade adolescents aged 11–13 years participated in the study. The authors found that headaches had a significant positive correlation with eye strain and associations with neck, shoulder, back, and arm pain with smartphone use. Headaches were also associated with eye strain and neck and shoulder pain when using tablets (22). It is important to emphasize that respondents showed positive correlations of headaches due to smartphone and tablet use, whereas the results of our study showed that the likelihood of various eye symptoms and headaches increased with a 1-h weekly increase in ICT use.

## CONCLUSION

School-age children are most likely to use smartphones and watch TV. Male respondents spend more time using almost all ICT devices, with the exception of tablets, which are used more often by female respondents. The analysis of pain intensity when using information and communication technologies revealed that respondents most often experienced mild pain, especially in the neck/shoulder and lower extremities. The pain that occurred was of a non-specific character, recorded on the basis of the subject's self-assessment. The frequency of eye problems after using ICT devices was found to be occasional, with the most pronounced symptoms being fatigue, tearing, and eyestrain, as well as headaches in one in five respondents. With an increase in the time of ICT use by 1 h per week, the likelihood of pain intensity also increased in all body regions, including eye symptoms and headaches.

### Limitations of the Study

Because the survey was conducted during the COVID 19 pandemic, it was not possible to reach respondents directly. Nevertheless, the entire research was conducted in the form of an online survey on the Microsoft Forms platform.

## CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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