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Original article

Screen time in children and adolescents during the COVID-19 pandemic

Bojana Vuković,
Sanja Živanović,
Bojana Mastilo,
Ivana Zečević

University of East Sarajevo,
Faculty of Medicine Foca,
Republic of Srpska,
Bosnia and Herzegovina

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Corresponding author:
Bojana Vuković, MD
Nemanjina 1, 73300 Foča
bvukovic75@gmail.comm

Summary

Introduction. With the beginning of the pandemic caused by the COVID-19 virus, restrictions on movement, the so-called "lockdown" were applied by many governments. As a result of these actions taken against the transmission of the COVID-19 virus, the use of digital devices has increased, i.e. the time spent in front of screens has increased.

Methods. This paper dealt with a bibliometric analysis of scientific publications on the topic of screen time in children and adolescents during the COVID-19 pandemic. The Dimensions database was chosen as the data source. No time frame is given, but given the topic, publications from 2020-2023 are included in the analysis. The data were analyzed in the VOSviewer program, specified for bibliometric and visual data analysis.

Results. Map of word co-occurrence show that there are three different clusters. In the red cluster, consisting of 53 terms, the most frequent terms are sleep (124), lifestyle (103) and restriction (83), while in the green cluster, consisting of 41 terms, family (126), education (88), relationship (86) are the most represented. The blue cluster consists of significantly fewer terms, 12 of them, of which anxiety (91), symptom (81), depression (58) are the most represented.

Conclusion. Based on the bibliometric analysis, we can conclude that the scientists were mostly concerned with the impact of the screen time phenomenon on the physical health of children and adolescents. In addition, screen time has been linked to mental health, education and socio-emotional relationships.

Keywords: COVID-19, screen time, children, adolescents

Introduction

Since the initial outbreak in China in December 2019, the COVID-19 has spread around the world and on March 11, 2020, the World Health Organization declared the Covid-19 virus a global pandemic. So far, 760,360,956 cases of the disease have been confirmed, of which 6,873,477 cases have resulted in death [1]. However, even though death is the worst consequence of the pandemic, three years after the declaration of the pandemic, the world is also facing other consequences, including those caused by lifestyle changes. After the World Health Organization (WHO) declared a pandemic, governments took different measures to manage

the risk associated with COVID-19, including the closure of educational and cultural institutions, sports facilities and other public places [2]. Since the beginning of the pandemic caused by COVID-19, more than 100 countries have taken measures of isolation or social distancing (known as "lockdown"), all with the aim of reducing the rate of virus transmission. More precisely, with the pandemic restrictions, bans and orders to stay at home came, which were the cause of excessive use of screens among children and adolescents [3]. Thus, while physical distance was the key to reducing virus transmission, prolonged physical constraint reduced opportunities for outdoor activities [4] and increased anxiety and depression [5]. As a result of these actions taken against the transmission of the COVID-19 virus, the use of digital devices, i.e. the time spent in front of screens (screen time) has increased worldwide. The results of a comprehensive study examining changes in the length of screen time during the pandemic speak in favor of this. Namely, a review of 31 studies with data from over 20 countries found an increase in screen time among adolescents during the pandemic compared to the period before the pandemic [6]. These increases ranged from 55 min per day to 2.9 h per day [7]. Screen time refers to the amount of time spent and various activities performed online through digital devices [8]. For example, screen time includes the use of digital devices for work purposes (or educational purposes) as well as for leisure and entertainment. Kanekar and Sharma found that during the COVID-19 pandemic, digital platforms were the only way for people to maintain socioeconomic ties [9]. However, at the same time, prolonged time on the screen has caused various concerns related to its negative impact on the physical and mental health of the individual [10]. Several authors have confirmed that regulated use of digital devices is associated with well-being, excessive use is associated with a whole range of mental problems [11, 12]. Also, some authors believe that excessive use of screens is associated with risks for cardiovascular diseases, such as obesity, high blood pressure and insulin resistance because sedentary behavior is increased, which is associated with "snacking" [3]. Sedentary behavior is defined as any awake behavior characterized by an energy expenditure of ≤1.5 metabolic equivalents (MET) while in a sitting, semi-recumbent, or supine position [13]. Although excessive screen use is associated with potential health risks, including poor sleep and more sedentary time [14], given laws and policies during the pandemic, increased screen time may be inevitable and may even be beneficial for education and socialization [3]. As previously mentioned, sedentary behavior and snacking are usually associated with screen time, although screen time does not have to be sedentary. While in one place, screen time can be used to promote physical activity [15] on various platforms such as online physical activity classes, mobile exercise apps, or video games that have physical activity components [16]. Children and adolescents could also use virtual games and online activities to maintain social connection during the COVID-19 pandemic. Also, during this period social media was used as a platform to play and connect with friends and family. This was some kind of way to maintain social contact. During school closures, many schools as well as universities were forced to switch to virtual or online curricula, which require students to use the screen. Although prolonged screen time may have educational benefits, it may also exacerbate the risk of depression, anxiety, suicide, and attention deficits in children and adolescents [14]. However, during the COVID-19 pandemic, many educational resources and mental health support services were available through online platforms that required the use of screen time [17]. Furthermore, mental health practices offered counseling and therapy sessions exclusively via telehealth, which involved screen time [18]. The

first reports from China, i.e. regions affected by the pandemic, indicate that media entertainment was the most popular tool used by parents to deal with their children's problems and mitigate the consequences [19]. Moreover, it was a striking finding that a record number of people, from all age categories, turned to online video games [20]. When implemented as a coping strategy in the midst of the COVID-19 pandemic, screen time may be associated with certain negative risks, both among children and adolescents. Considering the change in lifestyle reflected in the excessive use of screens, which was imposed during this global problem that we faced, the aim of our work was to examine the trend in the scientific literature dealing with the phenomenon of screen time during the pandemic caused by COVID-19. As we have already mentioned, scientists immediately recognized some advantages and disadvantages of screen use during COVID-19, however some consequences are also long-term, which we as a society are yet to face. Therefore, we believe it is useful to identify topics that researchers have associated with screen time during the COVID-19 pandemic. The main goal of this research is to determine the most relevant sources, countries and research areas, as well as to create a map of keywords in the field of screen time among children and adolescents during COVID-19.

Methods

This paper deals with the bibliometric analysis of scientific publications on the topic of screen time in children and adolescents during the COVID-19 pandemic. PRISMA protocol was applied for dataset extraction (Figure 1). The Dimensions database is chosen as the data source. No time frame is given, but given the topic, publications from 2020-2023 are included in the analysis. The data have been analyzed in the VOSviewer program, which is intended for bibliometric and visual data analysis.

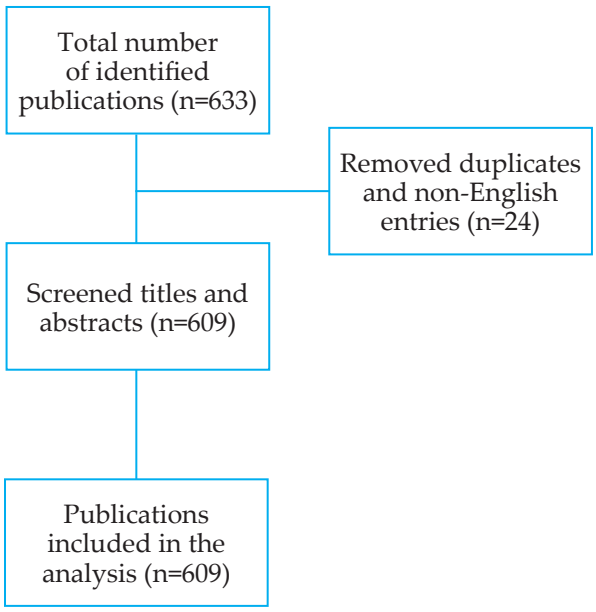

Figure 1. Flowchart according to PRISMA

Bibliometric and visual analyses was used to map the scientific literature in the researched area. The Dimensions database was used for the search. After many attempts to search for different combinations of words, the final search strategy according to the Boolean algorithm included the following: (covid-19 OR Coronavirus) AND ("screen time" OR "digital screen time") AND (children OR adolescent). Raw data was extracted from the Dimensions database in CSV format. The CSV file was processed in the VOSviewer program, in order to determine the national cooperation network, the co-citation network of authors, countries and the network of repeating words. Journal citation reports (JCR) Science Edition 2020 were used to determine the journal's impact factor (IF), JCR, and SCImago journal rank (SJR). The search was conducted in March 2023 and a total of 609 scientific publications were found. Scientific publications with keywords in the title or abstract in all research categories are included. The research included all citation databases, all types of publications and all research categories.

Results

Figure 2 shows the evolution of scientific production on the topic of screen time among children and adolescents during the COVID-19 pandemic. Our search included 609 articles, of which there were the total of 523 scientific articles, 67 preprint versions, 11 chapters and 8 proceedings with the total of 11000 citations and 16.75 citations per document. In 2021, scientific production on this topic had a peak (267 publications), which made up almost half of the scientific literature (43.84%) with a number of 4000 citations. The number of scientific publications in the year 2022 was 235, however with much fewer citations, in total 790.

Figure 3 shows which research categories according to the Australian and New Zealand Standard Research Classification (ANZSRC, 2000) have the most scientific publications on the researched topic. The five most represented research categories are biomedical and clinical sciences, health sciences, psychology, education and human society. It is important to note that one document appears in several research categories.

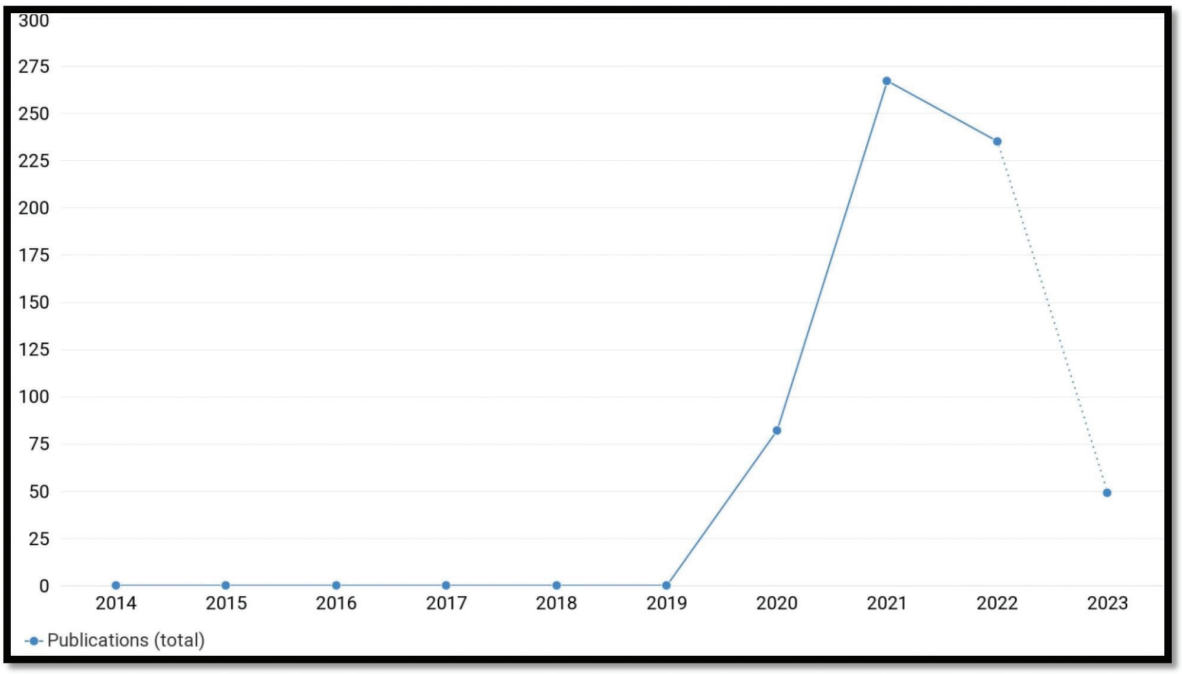

Figure 2. Evolution of scientific production

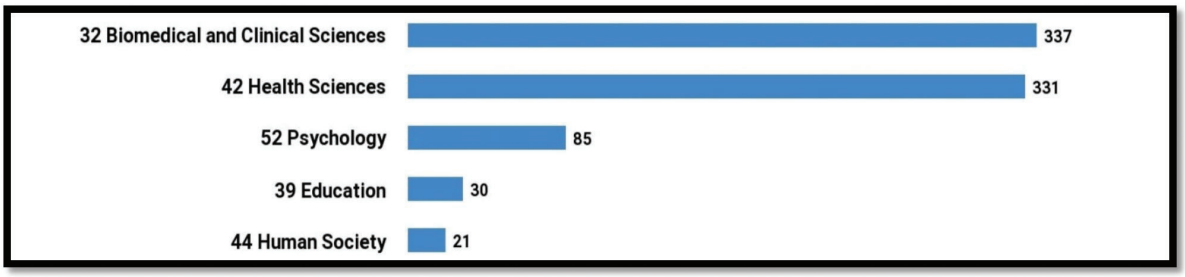

Figure 3. The most represented research categories

Table 1. The most prominent journals

Journals	n	IF	SJR	JCR
International journal of environmental research and public health	41	4.61	0.81	Q1
Children	13	2.83	0.65	Q2
Nutrients	11	5.71	1.29	Q1
Frontiers in psychiatry	11	5.43	1.28	Q1

Table 1 shows the most prominent journals with criteria (obtained by the criterion: minimum 10 documents per journal and minimum 10 citations), in which articles dealing with screen time in children and adolescents during the COVID-19 pandemic were published. The JCR database was searched for impact factors and quartiles. Three of the four top journals are in JCR Q1, which indicates the high quality of the articles they publish in these journals.

In order to determine the potential partnership between the journals, a co-citation analysis was conducted. It is the method used to determine the similarity between two documents. Two articles are said to be co-cited when they both appear in the reference list of a third document. If documents A and B are cited in paper C, they can be said to be related, even though they are not directly cited. If articles A and B are both cited in many other articles, they have a stronger connection. The more articles citing them together, the stronger their connection. Co-citation frequency is defined as the frequency with which two articles are cited together. The minimum number of citations was set to 100, which resulted in the inclusion of 29 articles. The journal co-citation map shown in figure 4 gives us an overview of the structure of the scientific world. Journal clusters can be identified on the map. Clusters that are closer to each other on the map indicate a close connection, and three large clusters can be seen in figure 4. Interpretation of the map is quite simple. The map contains a green, red and blue cluster. Each node represents a magazine and the larger the nodes and the thicker the connection lines, the stronger the collaboration. Thus, we see that the most prominent node in the green cluster is the journal *Pediatrics* with a total of 398 citations, which means that other journals from the green cluster are most often cited together with this journal. In the red cluster, the most prominent node is the journal *International journal of environmental research and public health* with 635 citations, which means that this journal is the most cited journal with the others in the green cluster (most often with journals which nodes are more prominent, see figure 4). The blue cluster consists of one journal, *The Journal of the American Medical Association-JAMA*, which is not particularly related to the journals in the green and red clusters.

Table 2 shows the three most cited scientific articles from the total unit of analysis consisting of a total of 609 articles. All three

Table 2. The most cited articles

Pietrobelli A, Pecoraro L, Ferruzzi A, Heo M, Faith M, Zoller T, et al. Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: a longitudinal study. Obesity 2020;28(8):1382–5.	683
Moore SA, Faulkner G, Rhodes RE, Brussoni M, Chulak-Bozzer T, Ferguson LJ, et al. Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: a national survey. Int J Behav Nutr Phys Act 2020;17(1):85.	600
Xiang M, Zhang Z, Kuwahara K. Impact of COVID-19 pandemic on children and adolescents' lifestyle behavior larger than expected. Prog Cardiovasc Dis 2020;63(4):531–2.	473

articles were published in 2020. The most cited article is by Pietrobelli et al. published in the journal Obesity. The second most cited article is by Moore and colleagues from 2020, which was published in the International journal of behavioral nutrition and physical activity. Xiang et al. was published in Progress in cardiovascular diseases with a total of 473 citations and is the third most cited.

The analysis of the most influential authors included the analysis of the most productive authors. The most productive authors are shown in the table with the number of publications and citations. Australia's Anthony Okely from the University of Wollongong is the most prolific author with a total of 239 citations in the field and an H-index of 87. The H-index is an author-level metric that measures both the productivity and citation impact of publications. Other authors have fewer publications, but they are cited almost three times more (Table 3).

Table 3. The most productive authors

Authors	N	Citations
Okely, Anthony	13	239
Faulkner, Guy	9	857
Tremplay, Mark S	7	876
Moore, Sarah A.	6	842

Figure 5 shows the bibliographic coupling map of the countries (according to criteria: minimum five documents per country and minimum 100 citations). The map shows two larger (green and red) and two smaller clusters (blue and yellow). The most prominent node in the red cluster is the USA, which means that articles from the USA are most often found in the bibliographies of articles from other countries from the red cluster (UK, Brazil, India, Italy, Portugal etc.). In the

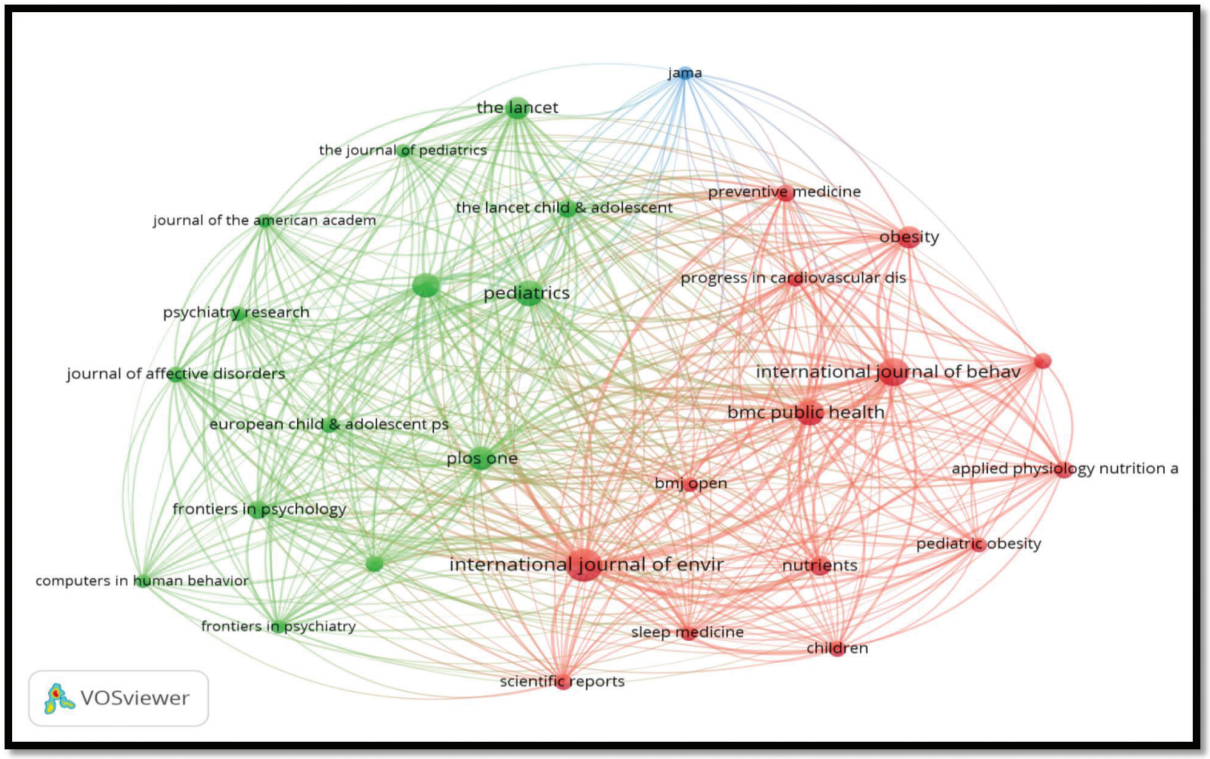

Figure 4. Journal co-citation map

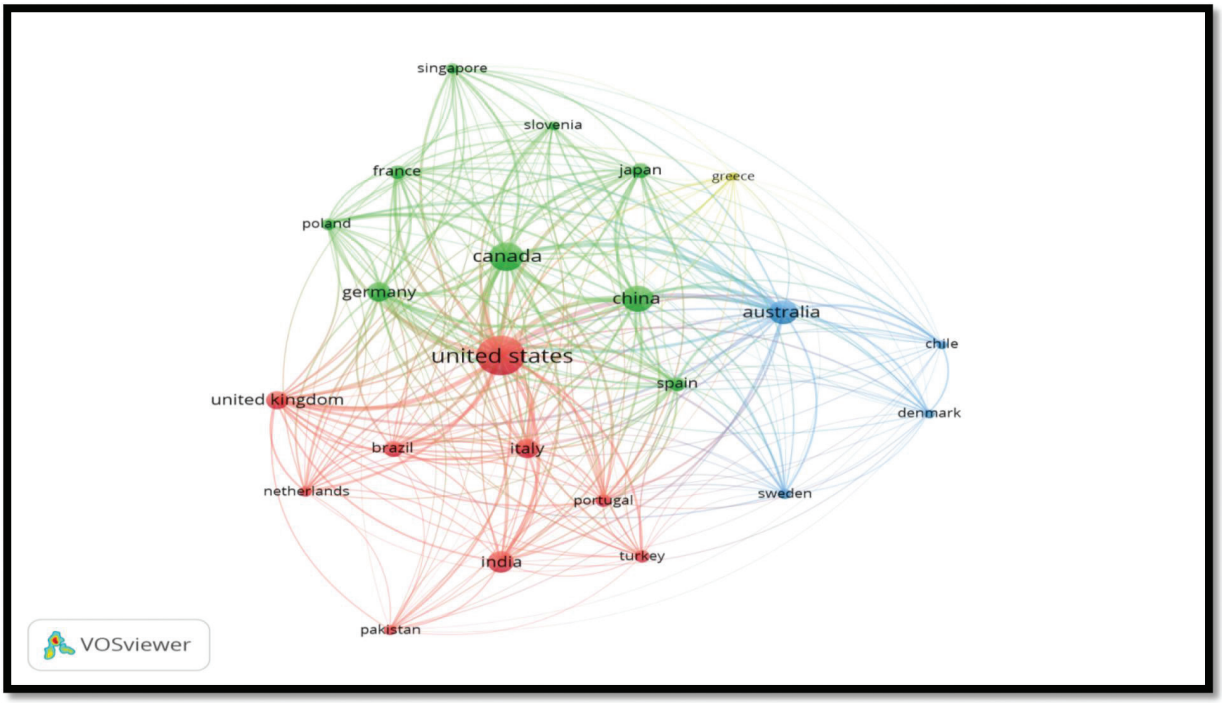

Figure 5. Bibliographic coupling of countries

green cluster, the most prominent nodes are those representing Canada and China, which means that bibliographies of articles from other countries most often cite articles created in these countries (Canada and China). The blue cluster is small and includes four countries Australia, Denmark, Chile and Sweden. The yellow cluster consists only of Greece.

In order to examine current topics covered by scientific publications in the field of screen time in children and adolescents during the COVID-19 pandemic, a map was created based on textual data, i.e. by extracting words from titles and abstracts from a total of 609 scientific publications. Out of a total of 14353 terms, 478 of them were singled out according to the minimum repetition criterion of 20 times. For each of the 212 terms, the program calculated a relevant score based on which the most relevant terms were selected. The default was to select 60% (127) of relevant terms. In figure 6 we see three clusters, red, blue and green. In the red cluster, which consisted of 53 terms, the most frequent terms are sleep (124), lifestyle (103) and restriction (83), while in the green cluster, which consisted of 41 terms, family (126), education (88), relationship (86) were the most represented. The blue cluster consisted of significantly fewer terms, 12 of them, of which anxiety (91), symptom (81), depression (58) were the most represented. By looking at the map, we can see more detailed terms that most often appear together. The larger the nodes the word is repeated more often. Nodes of the same color represent words appearing together most often.

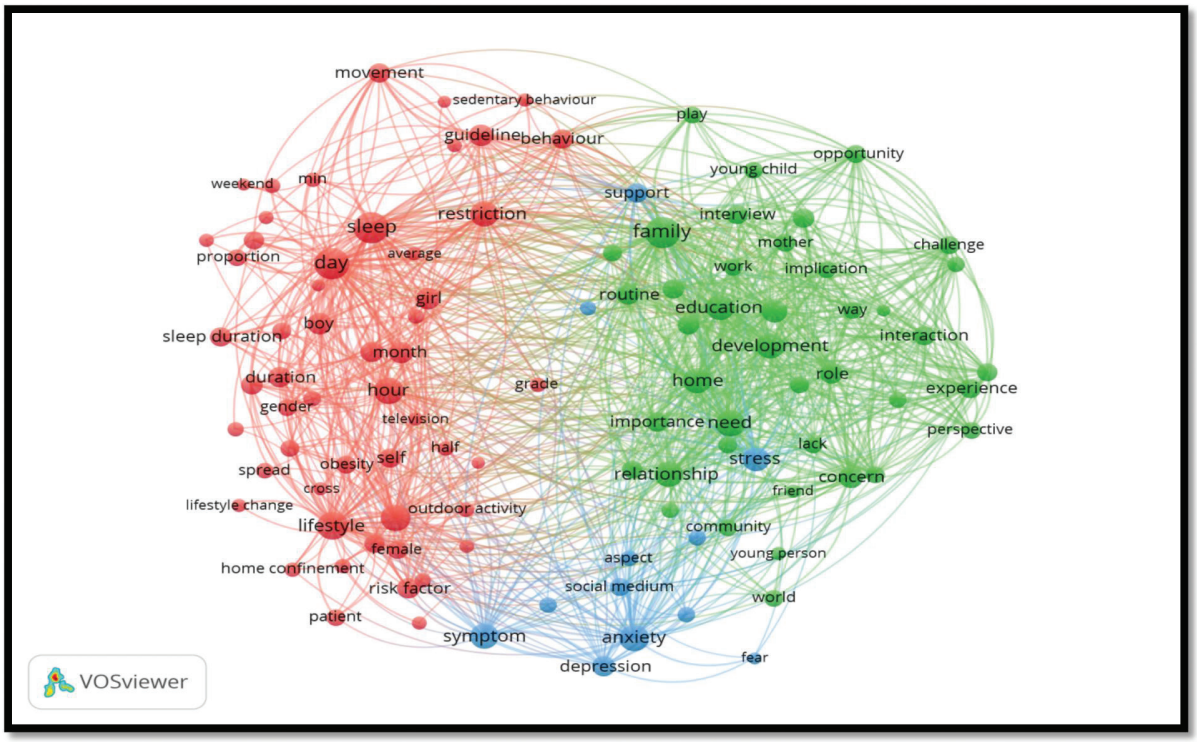

Figure 6. Map of word co-occurrence

Discussion

The main goal of this research was to determine the most relevant sources, countries and research areas, as well as to create the map of key words in the field of screen time among children and adolescents during the pandemic caused by the COVID-19 virus. The phenomenon of "screen time" was the subject of interest to the scientific public even before the pandemic. However, most of the existing studies on screen time were cross-sectional studies and examined screen time among different cohorts of people before and during the pandemic. The few prospective studies to date have been limited to the early phase of the pandemic. Given Hedderson's results that excessive screen use was present, even after many health warnings, it remained unclear what happened during the pandemic and what the impact of screen time was on children and adolescents, as well as what connections the researchers made with screen time during and in the post-covid period [21]. A search of the Dimensions database found a total of 609 scientific publications in the period from 2020-2023, where the most publications were during 2021-2022. Considering the large number of scientific works dealing with this topic in the past three years, we conclude that this topic was recognized by scientific authorities as a current field that requires answers to many questions. By reviewing the research categories dealing with this topic, we see that the majority of publications were created within two research categories: biomedical and clinical sciences, and health sciences. Bearing in mind these results of the bibliometric analysis, we must conclude that science in this period was mostly concerned

with the relationship between screen time and health during COVID-19. One of the best-researched connections between screen time in young people is the connection between the length of screen time and physical activity [22]. Indeed, many studies conducted before the pandemic showed support for the view that excessive screen time led to less physical activity in children and adolescents [14, 23]. Bearing in mind the fact that screen time during COVID-19 is a global phenomenon that the world was faced with and still is facing, it is not surprising that the most prominent journal dealing with this topic is the International journal of environmental research and public health. It covers environmental sciences and engineering, public health, environmental health, occupational hygiene, economic health and global health research. The journal has a high impact factor in JCR Q1 as well, which indicates the high quality of the articles published in this journal.

The most cited article on this topic is Pietrobelli et al. 2020, which dealt with the effects of the pandemic lockdown on the lifestyle of children and adolescents with obesity in Verona. The authors found that screen time increased by 4.85h/day in this examined population during that period [24]. The most productive author exploring this topic is Anthony Okely from the University of Wollongong whose research areas are physical health, sedentary behavior and children's health. Other authors with the largest number of articles are from Canada. It may be surprising that there are no authors from China in the list of the most productive who have dealt with this topic. The analysis of the bibliographic coupling of the countries showed four clusters in which the most prominent nodes were the USA, Australia, and Canada. The term bibliographic coupling refers to a similar linkage as in co-citations only in reverse order. A bibliographic link is considered when two articles refer to the common third article in their bibliographies. The strength of bibliographic coupling increases with the increase in the number of common references. In this case, it means that in the bibliographies of articles from other countries, articles from these three mentioned countries were most often found. Given that these countries adopted the "zero community transmission" model by introducing serious restrictions in terms of movement bans, questions arose about the possible negative effect of excessive screen time that occurred as a consequence of the aforementioned restrictions. Scientists sought to answer questions that arose about the potential negative impact of screen time during COVID-19 on children and adolescents. By creating the map of repeating words, we got three clusters, which means that the words within one cluster most often appear together. In the red cluster we have the words: day, sleep, movement, restriction, outdoor activity, lifestyle, obesity, risk factor, so we conclude that scientists looked at the impact of screen time on the physical health of children and adolescents during COVID-19 pandemics. This cluster is also the largest, which means that this, as previously mentioned, is one of the best-researched connections [22]. In the blue cluster, the most frequently repeated words are: symptom, anxiety, depression, fear, support, stress. Considering the words in this cluster, we can conclude that the subject of interest of the scientific public was also the mental health of children and adolescents. Considering the size of the cluster, this topic is the least researched. The green cluster is also large and the most common words in this cluster are those related to education, family, need, relationship. By reviewing the most frequently recurring key terms in this cluster, we assume that this researched part refers to education and socio-emotional relationships of children and adolescents during COVID-19. Other studies have shown that physical health, sleep and socio-emotional well-being are most often linked to screen time [25].

Conclusion

Despite the mitigating of restrictions in terms of movement, the average screen time in the third quarter of 2021 was still more present than in the third quarter of 2020 by 1.0% [26]. While the debate over whether screen time is always harmful remains, many studies suggest that increased screen time is often positively correlated with other behaviors that are detrimental to overall well-being [27]. Even now, three years after the declaration of the pandemic, the world is facing long-term consequences for the well-being of children and adolescents. Undoubtedly, this topic preoccupied researchers during the pandemic, and it definitely opened up some new questions about the long-term consequences of screen time that still need to be explored. This research can be a good starting point for future researchers as a cross-section of the state of scientific literature in this area.

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Conflicts of interest. The authors declare no conflict of interest.

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"Screen time" kod djece i adolescenata tokom pandemije COVID-19

Bojana Vuković, Sanja Živanović, Bojana Mastilo, Ivana Zečević

Univerzitet u Istočnom Sarajevu, Medicinski fakultet Foča, Republika Srpska, Bosna i Hercegovina

Uvod. Sa početkom pandemije izazvane virusom COVID-19 na snagu su stupila ograničenja kretanja, tzv. "lockdown". Kao rezultat ovih preduzetih akcija protiv transmisije virusa COVID-19 porasla je upotreba digitalnih uređaja, odnosno produženo je vrijeme provedeno pred ekranima ("screen time").

Metode. Ovaj rad se bavio bibliometrijskom analizom naučnih publikacija na temu "screen time" kod djece i adolescenata tokom pandemije COVID-19. Kao izvor podataka birana je Dimensions baza podataka. Nije zadat vremenski okvir, ali s obzirom na temu, publikacije od 2020. do 2023. godine su uključene u analizu. Podaci su analizirani u program VOSviewer, koji je namijenjen bibliometrijskoj i vizuelnoj analizi podataka.

Rezultati. Mapa koincidencije riječi pokazuje da postoje tri različita klastera. U crvenom klasteru, koji se sastojao od 53 pojma, najčešći pojmovi su spavanje (sleep) (124), životni stil (lifestyle) (103) i ograničenje (restriction) (83), dok su u zelenom klasteru, koji se sastojao od 41 termina najzastupljeniji pojmovi porodica (family) (126), obrazovanje (education) (88) i odnosi (relationship) (86). Plavi klaster se sastojao od znatno manje pojmova, njih 12, od kojih su najzastupljeniji anksioznost (anxiety) (91), simptom (symptom) (81), depresija (depression) (58).

Zaključak. Na osnovu bibliometrijske analize možemo da utvrdimo da su se naučnici najviše bavili uticajem "screen time" fenomena na fizičko zdravlje djece i adolescenata. Pored toga, "screen time" je dovođen u vezu sa mentalnim zdravljem, edukacijom i socio-emocionalnim odnosima.

Ključne riječi: Covid-19, "screen time", djeca, adolescenti