

Screen Use and Its Association with ADHD Symptoms among Children: A Systematic Review

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Abstract: Attention Deficit Hyperactivity Disorder (ADHD) is one of the common childhood disorders and a serious public health problem. The influence of screen use on ADHD symptoms has been widely concerned, especially with the improvement of people's living conditions, more and more children have access to screens. Therefore, it is necessary for us to understand whether screen use is related to children's ADHD symptoms and how it affects children with ADHD. This systematic review used thematic analysis to identify common themes and topics in the recent literature on screen use and children with ADHD: screen type, screen time, effects of screen use. The purpose of this study was to conduct a retrospective study to extract, identify, explore and summarize common themes in the recent literature regarding screen use and children with ADHD. By inputting keywords related to the topic, literature search is conducted in Google Scholar. The journal articles used were published between 2019 and 2023 and were edited based on abstracts and content analysis. Screen use increased ADHD symptoms, and children with ADHD showed more screen use. Screen use increases ADHD symptoms, disrupts language development, and affects child's development, life, and family. We also considered the relationship between different types of screens and ADHD symptoms. These results provide a reference source for future research and provide a new idea for research.

1. Introduction

According to DSM-5, the definition of Attention-Deficit/Hyperactivity Disorder (ADHD) is having extreme symptoms of inattentiveness and/or hyperactivity-impulsivity ^[2]. It is also defined as a disorder that could lead a person to be predominantly inattentive and or predominantly hyperactive or impulsive that occurs that lasted more than 6 months period ^[2]. In Malaysia, the statistics for ADHD prevalence are as high as 9% to 12.5% of which is higher than the global statistics of which range from 4% to 8% ^[18]. The high percentage of ADHD prevalence urges researchers to look into topics related to ADHD to address concerns that may take place.

Screen use is referring to the amount of time an individual spends on the behavior of focusing on the screen of electronic gadgets such as smartphones and television ^[29]. The definition of screen use is also agreed by Madigan et al ^[15]. In their study, which defines screen use as the duration of time spent watching television, movies and others on devices such as tablets and television as well as background television shows. Researchers have decided to conduct this research by focusing on screen use and its association with ADHD symptoms among children.

Study conducted by Hill et al ^[10] which was conducted towards 120 subjects that are made up of 36 months of infants who has family history of Autism Spectrum Disorder (ASD) or ADHD which has the aim to examined the relationship between media watching, behavioral outcomes, and language advancement of the infants found that subject with higher ADHD symptoms spent longer duration of time on screen media while compared to the control cluster subjects ^[10]. The study also shared that the highly engagement behavior towards screen time also exists a lot more earlier during the development of the children even before other signs of ADHD starts showing or become visible ^[10]. Another study that was conducted by Beyens et al ^[4] which aims to study transactional relationships between violent media use and ADHD related behaviors among young children which was conducted on 890 children found out that there increase of ADHD related actions would result in higher violent media usage after 1 year. Study by Wu et al ^[32] that was conducted on 42,841 three year old children with the aim to find out the impact of screen exposure and screen time towards children under the age of three years old found that the earlier a child is exposed to screen use, it increase their chances of hyperactive behavior. The study also found that the increase of screen use also increased the association of the children with hyperactive behaviors ^[32]. Although the majority of past studies shows that screen time does have some extent of relationship or association with ADHD symptoms among the subjects, study by Levelink et al ^[14] however states that screen time during early childhood was not associated with ADHD symptoms among children. Study that was conducted on 2,768 mother-child pairs with the aim to study the associations between leisure screen time and sleep in early childhood, and ADHD at age eight to ten years found out that there are no significant relationship between television exposure at a young age and future indications of ADHD ^[14].

There are two theories that are related to screen use and its association with ADHD symptoms among children that the researcher has identified of which are the dopamine hypothesis and delay gratification theory. The first theory will be that the dopamine hypothesis suggests that people with ADHD have an imbalance in dopamine, a neurotransmitter that plays a vital and important role in regulating motivation and attention span of an individual ^[30]. This theory was chosen as screen time usage is viewed as an immediate reward that leads towards boost and release of dopamine which can bring intense sense of happiness and happiness towards people from the ADHD population due to the natural imbalance of dopamine ^[19]. As a result of this, people with ADHD tend to have frequent and screen time on social media, television, games and more as it helps them experience intense feelings of pleasure and satisfaction ^[20]. Overall, the dopamine hypothesis provides an essential framework for understanding the relationship between ADHD and screen time usage, highlighting the importance of moderation and balance in managing ADHD symptoms.

The second related theory will be the delayed gratification theory. Individuals who exhibit ADHD symptoms often have trouble with impulse control and delay gratification as they have trouble needing to wait to feel the rewards from long term efforts ^[25]. Thus, when individuals with ADHD are exposed to immediate entertainment and satisfaction from screen usage, individuals with ADHD will get used to it and as a result reduce their ability to delay gratification, increase screen usage and inhibit impulsive behaviors ^[9]. The two theories that were proposed above will be used as the theoretical guide and framework throughout this research.

Based on existing research, there are limited studies that are conducted in the context of screen use and the association it has towards ADHD symptoms among children and most existing research is scattered and hard to find thus creating the need of this systematic review to provide a more detailed and in depth understanding on the research topic. The aim of this study is to study the association between screen use and its association with ADHD symptoms among children. Papers that will be reviewed are based on the variables decided of which are screen use and ADHD symptoms among children. The papers that will be used for this review will range from year 2019 to

current to ensure the information included in the study is the latest and updated. It is also worth noting that all papers that will be used are peer reviewed that are published in credible sources to ensure that all articles that will be used are quality ensured.

2. Method

One of the main objectives of this study was to review past research on the association between screen use and ADHD symptoms among children. All articles reviewed were selected by searching on certification sites and includes articles on topics such as the association between screen use and ADHD symptoms; the impact of screen use on children with ADHD, as well as the role of problematic Internet use in children with ADHD symptoms. English-language articles published in Google Scholar were used that addressed the topic of the association between screen use and ADHD in children.

The literature search time is from March 1, 2023 to March 20, 2023. In the database search, keywords used included screen use, media use, internet use, digital media use, screen time, video games, ADHD symptoms, ADHD children. Moreover, a time-limited search only identified literature published between 2019 and the date of the search. Abstracts are reviewed in the page order displayed in the results until 20 articles closely matching the current study are selected. Major themes were extracted based on common discussions across multiple articles, while sub-themes were identified as subsections of each major theme, just as shown in Table I.

Table 1: Articles covering different types of screen use

Television	Computer	Mobile	Game	Tablets	Title	Year
✓	✓				Physical Activity, Screen Time, and Sleep in Children With ADHD	2019
✓		✓		✓	Screen Based Media Use among Children with Autism Spectrum Disorder, Attention Deficit Hyperactive	2020
✓	✓	✓		✓	Screen Time exposure in Preschool Children with ADHD: a Cross-Sectional exploratory Study from South India	2021
✓	✓		✓		The Longitudinal Relationship Between Screen Time, Sleep and a Diagnosis of Attention-Deficit/Hyperactivity Disorder in Childhood	2021
	✓		✓		Impact of the COVID-19 lockdown on screen media use in patients referred for ADHD to child and adolescent psychiatry: an introduction	2021
			✓		Video Games in ADHD and Non-ADHD Children: Modalities of Use and Association With ADHD	2021
	✓	✓	✓		Internet, video game and mobile phone addiction in children and adolescents: A case-control study	2022
✓	✓		✓		Physical Health, Media Use, and Mental Health in Children and Adolescents With ADHD During the	2022
			✓		Associations Between Video Game Engagement and ADHD Symptoms in Early Adolescence	2022

3. Discussion

ADHD is a neurodevelopmental disorder that affects between 4 and 12% of school-aged worldwide. Recent research has proposed a link between screen time and ADHD symptoms in children. In this context, a systematic review of the association between screen use and ADHD symptoms in children was conducted. In total 20 studies investigating the relationship between screen use and ADHD symptoms were included in the review. The studies focused on screen time, media use, Internet use and video games, along with outcomes and interventions associated with excessive screen time, just as shown in Figure 1.

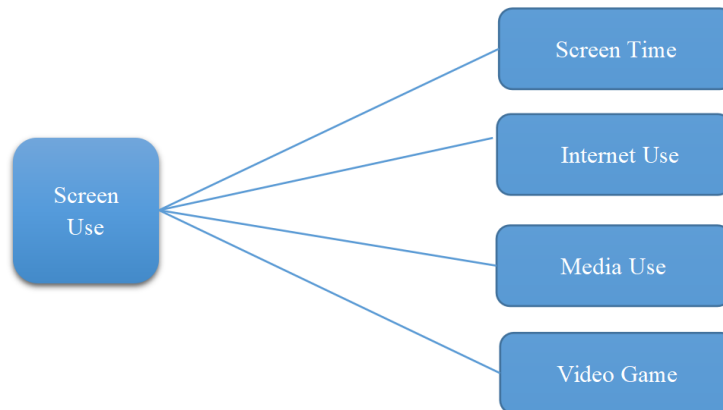


Figure 1: Branches of Screen Use

3.1 Types of Screen Behavior

Screen types are diverse while screen usage is complex as well [21]. According to Ponti et al [22], the term "screen time" refers to the amount of time spent in sedentary activities such as watching television, playing video games, and using computers and mobile devices. Screen-based behavior has been usually measured by the amount of time spent watching television, using a computer, and playing video games [6]. Nevertheless, new types of screen behaviors are emerging among children and adolescents, including movie viewing such as YouTube, social media use such as Facebook, Twitter, and Instagram, as well as online gaming [6]. Shuai et al [24] pointed out that digital media products include television, computers, cell phones, and video games, as well as the Internet, all of which are regarded as screen-based behaviors. Similarly, Cavalli et al [7] divide digital screens into TVs, computers, and mobile devices.

3.2 Correlational Research on Screen Use among ADHD Children

One of the main objectives of this study is to review past findings on the association between screen use and ADHD symptoms among children. Through the Google Scholar database, utilizing keywords such as screen use, media use, internet use, digital media use, screen time, video games, ADHD symptoms, ADHD children, 20 papers were selected during 2019-2023. Abstracts are reviewed in the page order shown in the results until 20 papers are selected that closely match the current study. This review focuses on the main findings related to the association between screen use and ADHD symptoms among children.

The selected papers carried out correlational studies among children with ADHD symptoms to explore screen use and its association with ADHD among children (Attygalle et al [3]; Hill et al [10]; Cavalli [7]; Hong et al [11]; Levelink et al [14]; Vaidyanathan et al [29]; Yang et al. [33]), along with the association between media use and ADHD symptoms (Al-Ansari & Jahrami [1]; Beyens et al [4]; Boer et al [5]; Thoma et al [27]; Shuai et al. [24]; Vaidyanathan et al. [29]; Werling et al. [31]; Sciberras et al. [23]), as well as video games and ADHD symptoms (Masi et al. [16]; Tiraboschi et al. [28]), followed by Internet use and ADHD symptoms (Izmir et al. [13]; Huang et al. [12]; Menendez-García et al. [17]), and video games and ADHD symptoms (Masi et al. [16]; Tiraboschi et al. [28]). Within them, Menendez-García et al [17] have investigated both internet use and video games as variables in research. Participants between the ages of 3 and 18 make up the sample for the studies. Among them, 6 studies used samples of children and adolescents, with participants aged 7-18 years (Izmir

et al. ^[13]; Boer et al. ^[5]; Thoma et al. ^[27]; Werling et al. ^[31]; Menendez-García et al. ^[17]; Tiraboschi et al. ^[28]).

There are 12 studies included a control group of participants without a diagnosis or symptoms of ADHD (Izmir et al. ^[13]; Al-Ansari & Jahrami, ^[1]; Attygalle et al. ^[3]; Beyens et al. ^[4]; Boer et al. ^[5]; Thoma et al. ^[27]; Cavalli et al. ^[7]; Hong et al. ^[11]; Levelink et al. ^[14]; Masi et al. ^[16]; Menendez-García et al. ^[17]; Yang et al. ^[33]), while the remaining studies recruited only participants with a diagnosis or symptoms of ADHD (Tandon et al. ^[26]; Hill et al. ^[10]; Shuai et al. ^[24]; Tiraboschi et al. ^[28]; Vaidyanathan et al. ^[29]; Werling et al. ^[31]; Huang et al. ^[12]; Sciberras et al. ^[23]). In these papers, the main methods used for data collection were through self-reported questionnaires (Izmir et al. ^[13]; Boer et al. ^[5]; Thoma et al. ^[27]; Shuai et al. ^[24]; Tiraboschi et al. ^[28]) and parent/care provider-report questionnaire (Tandon et al. ^[26]; Attygalle et al. ^[3]; Beyens et al. ^[4]; Cavalli et al. ^[7]; Hong et al. ^[11]; Werling et al. ^[31]; Huang et al. ^[12]). Apart from that, instruments in research conducted by Hill et al. ^[10], Masi et al. ^[16], and Yang et al. ^[33] use both self report and parent/care provider-report questionnaires. Beside that, some of researchers utilized semi-structured interview and parent/care provider-report questionnaires to collect data (Al-Ansari & Jahrami ^[1]; Levelink et al. ^[14]; Vaidyanathan et al. ^[29]; Menendez-García et al. ^[17]; Sciberras et al. ^[23]).

3.3 Screen Time and ADHD Symptoms

Study from Tandon et al. ^[26] found that Increased screen time and decreased physical activity in children with ADHD are linked to poorer sleep quality. The study also suggests that reducing screen time and increasing physical activity may improve sleep quality and potentially ease ADHD symptoms. Similar findings from Cavalli et al. ^[7] showed screen exposure was associated with increased sleep disturbance, which in turn was associated with worse ADHD symptoms, followed by suggestions that reducing screen time may improve sleep quality and potentially reduce the severity of ADHD symptoms. However, a longitudinal research conducted by Levelink et al. ^[14] found that there was no longitudinal association between recreational screen time or sleep time in early childhood and ADHD diagnosis at 8 years of age, whereas cross-sectional associations were weaker between TV viewing time, sleep time, and higher behavioral symptom externalization scores at 2 years of age, which is inconsistent with the findings from Tandon et al. ^[26] and Cavalli et al. ^[7]. Besides, Hong et al. ^[11] argued that differences in sleep problems were significantly explained by childhood ADHD when covariates were considered, while diet, screen time, and physical activity may mediate the effects of ADHD on sleep difficulties. Hill et al. ^[10] pointed out that children with ADHD have more screen time, along with a negative relationship has been explored between screen time and language development. The study also found that early intervention with screen time may help reduce the risk of ADHD. A study in Sri Lanka found that children with ADHD who also had migraines spent more time watching TV and using electronic devices than children without migraines ^[3]. Meanwhile, the researcher recommends that reducing screen time may be an effective intervention. Similarly, a study in India found that increased screen time was positively correlated with ADHD severity in children ^[29]. Same as Hill et al. ^[10] and Attygalle et al. ^[3] mentioned, Vaidyanathan et al. ^[29] also believes reducing screen time may be an effective intervention for children with ADHD.

In summary, the above studies suggest that screen time appears to be related to poorer sleep quality, which in turn may exacerbate ADHD symptoms. In this regard, reducing screen time may be an effective intervention for children with ADHD, as it can help prevent ADHD in children at increased risk. In addition, researchers suggest a series of interventions for ADHD children, such as increasing physical activity and reducing screen use in the bedroom, which may be particularly effective in reducing the symptoms of ADHD in children.

3.4 Media Use and ADHD Symptoms

Thoma et al. [27] have investigated the relationship between media use and ADHD symptoms and found that increased media use was associated with worse ADHD symptoms. Besides, research from Al-Ansari and Jahrami [1] investigated screen-based media use among siblings with autism spectrum disorder, attention deficit hyperactivity disorder, and normally developing siblings. The findings found that children with ADHD used media at significantly higher levels than their normally developing siblings. Meanwhile, ADHD children are more distressed if screen-based entertainment is stopped, while violence is a sign. Moreover, a directionality investigative study conducted by Boer et al [5] found that problematic social media use among adolescents increased ADHD symptoms, but not intensity of social media use, which indicated that the effect of social media use on ADHD symptoms is not driven by frequency of use, but rather by the addictive problematic social media use. Furthermore, research conducted by Beyens et al. [4] focused on the transactional relationship between violent media use and ADHD-related behaviors. It was found that violent media use is not a predictor of ADHD-related behavior for the vast majority of children. Also, increases in ADHD-related behaviors predicted increases in violent media use one year later. Studies from Shuai et al. [24], Werling et al. [31], and Sciberras et al. [23] were conducted in the context of COVID-19, investigating the impact of digital media use on children and adolescents with ADHD, including the impact of blocking screen media use and introducing problematic internet use in ADHD individuals. The authors found that the COVID-19 pandemic and lockdown increased digital media use among children with ADHD, which was associated with increased ADHD symptoms. Also, for patients referred to child and adolescent psychiatry for ADHD, the lockdown had a significant impact on their screen media use, leading to an increase in problematic internet use and social media use. In addition, increased media use was associated with poorer physical and mental health outcomes in children and adolescents with ADHD during the pandemic.

In conclusion, a number of studies have explored the relationship between media use and ADHD symptoms in children and adolescents, including the impact of COVID-19 and lockdown on digital media use and related symptoms. The above studies show that increased media use was related to more severe ADHD symptoms, children with ADHD used media at higher levels than their normally developing siblings, and problematic social media use increased ADHD symptoms.

3.5 Internet Use, Video Game, and ADHD Symptoms

The study by Izmir et al. [13] examined the association between internet use and aggression in adolescents with ADHD via a cross-sectional design with recruiting 120 participants and measuring internet use and aggression through self-report questionnaires. Results found that there is a positive association between internet use and aggression in adolescents with ADHD, with ADHD males showing higher aggression tendencies than ADHD females. Three studies were conducted in the case of video games. Firstly, Tandon et al. [26] explores the relationship between internet, video game, and mobile phone addiction in children and adolescents with ADHD. Findings showed children and adolescents diagnosed with ADHD are at higher risk for Internet, video game and mobile phone addictions. Similarly, Masi et al. [16] examined video game use among ADHD and non-ADHD children, as well as their relationship to ADHD symptoms and found that higher levels of video game use were related to severe ADHD symptoms. Similar research from Tiraboschi et al. [28] investigated the relationship between video game engagement and ADHD symptoms in early adolescents and found a bidirectional relationship between variables. Moreover, a study from Huang et al. [12] focused on the impact of excessive smartphone and Internet use on psychopathology in children with ADHD during the COVID-19 pandemic. It was found that ADHD children experienced exacerbated psychopathology during the COVID-19 pandemic due to

excessive smartphone and Internet use.

To sum up, scholars have discussed various aspects of the relationship between Internet and video game use and adolescent aggression and ADHD symptoms. Specifically, there was a positive correlation between Internet use, video game use, and aggression, with males showing higher aggression tendencies than females. In addition, ADHD children and adolescents are at higher risk for Internet, video game and mobile phone addictions. Not only that, high levels of video game use were associated with severe ADHD symptoms, along with a two-way relationship between them. Finally, excessive smartphone and Internet use during the COVID-19 pandemic contributed to exacerbated psychopathology in children with ADHD.

3.6 Outcomes of Excessive Screen Use in ADHD Children

According to the selected articles, the association between screen use and ADHD symptoms among children is complex and multifaceted. To be specific, some scholars have found that excessive screen use, especially social media, could exacerbate ADHD symptoms and lead to increased sleep disturbances (Tandon et al. ^[26]; Thoma et al. ^[27]; Cavalli et al. ^[7]; Hong et al. ^[11]; Levelink et al. ^[14]). Studies have also suggested that screen time may have a bidirectional relationship with ADHD symptoms, with ADHD symptoms increasing screen time and excessive screen time contributing to the development of ADHD symptoms (Beyens et al. ^[4]; Tiraboschi et al. ^[28]). Also, results of studies have also reported links between screen use and negative outcomes, such as aggression (Izmir et al. ^[13]; Boer et al. ^[5]), Internet addiction (Tandon et al. ^[26]), and worsening psychopathology (Huang et al. ^[12]; Menendez-García et al. ^[17])

However, the impact of screen use on ADHD appears to be influenced by various factors, such as age, diagnosis, and type of screen use. For instance, some studies have found that screen use is associated with increased ADHD symptoms in early adolescence and in children diagnosed with ADHD (Izmir et al. ^[13]; Al-Ansari & Jahrami ^[1]; Boer et al. ^[5]; Thoma et al. ^[27]; Masi et al. ^[16]; Shuai et al. ^[24]; Vaidyanathan et al. ^[29]; Werling et al. ^[31]; Sciberras et al. ^[23]), while other studies have shown that screen use is not directly related to ADHD children (Levelink et al. ^[14]).

Overall, most scholars reckon that there is a positive association between screen use and ADHD symptoms. In the other word, the more screen time used, the severe the symptoms of ADHD. However, the underlying relationship has not been fully studied and explored. For this matter, more research is needed to determine the potential impact of screen use on ADHD and how different factors may affect this relationship.

3.7 Interventions for Excessive Screen Use in ADHD Children

Some scholars mentioned various interventions for excessive screen use or problematic screen use in the articles. Researchers suggest that physical activity and good sleep quality are important factors in attenuating the negative effects of screen use on ADHD symptoms among children. Therefore, increasing physical activity can help reduce screen time in children with ADHD (Tandon et al. ^[26]; Hong et al. ^[11]). Parents and care providers can reduce children's reliance on screens by encouraging them to participate in activities such as sports or outdoor play. It is also important to ensure that children get enough sleep, as it might help reduce their dependence on the screen (Thoma et al. ^[27]; Levelink et al. ^[14]). Parents and care providers can establish a regular sleep schedule to control children's screen use in the bedroom. In this meanwhile, parents and care providers should monitor and limit children's screen time to reduce the risk of aggressive behavior and other negative effects ^[5]. Besides, violent media use within screen use also needs to be addressed, as addressing children's exposure to violent media can reduce the risk of ADHD-related behaviors ^[4]. For children with ADHD who have siblings, tailored interventions may be needed. In

this regard, professional practitioners could tailor interventions to the needs of children with ADHD and their siblings that can help reduce excess screen time ^[1].

In conclusion, these interventions focus on promoting healthy habits and reducing excess screen use in children with ADHD. Future research could pay attention to the effectiveness of these interventions, and how to better implement these measures.

4. Conclusion

The purpose of this study was to provide a systematic review of the effects of screen time use on children or adolescents with ADHD. Based on the summary of relevant literature, screen time can increase the ADHD symptoms of ADHD children or adolescents, such as aggression, negative emotions and pressure of life events. It can also hinder language development and damage the family environment of children and adolescents with ADHD. Meanwhile, there may be a positive correlation between ADHD symptoms and screen time, that is, screen time enhances the symptoms of ADHD. Besides, children with ADHD will also show more screen time use, and even produce excessive use of electronic products and smartphones.

Nevertheless, screen use should be dialectically viewed as well. In some cases, such as video games and watching TV, children do increase some abilities, such as hand-eye coordination, enhancing the range of knowledge and so on. There is no connection between early rise screen time in children and ADHD, while it was found to be associated with externalizing symptoms before the age of two. Therefore, the diagnosis of ADHD early rise should be more cautious.

When all screen devices are taken into account, the general situation is as follows: the use time of school-age children with ADHD is almost more than one hour, and even more than two hours for older children, with the older the age, the less restricted. Especially during COVID-19, many countries and regions adopted the form of online courses. Due to the lockdown of the pandemic, children were not able to hangout, instead of more online entertainment, such as electronic games, watching TV, which adds up to screen time for children. However, too much screen time is detrimental to each aspect of children's development. Thus, parents and care providers should avoid screens in children's bedrooms and limit their screen time. Apart from that, reducing screen use can have a positive effect on children, especially those with ADHD. For this matter, providing parents and caregivers with more education and guidance to reduce screen time is beneficial for children's development as well as family development.

5. Contribution

This study makes an important contribution to elucidating the effects of screen time use in children with ADHD. The types of screen behavior, the relationship between each type and ADHD symptoms, the results of relevant studies on screen time use, as well as its impact, all make theoretical contributions to explain the relationship between ADHD children and screen time use. This study helps us to understand some issues related to screen use of ADHD children that have not been deeply explored in previous studies, such as the differences between screen types, how to use screen, and how long should be limited, and so on. Therefore, it helps to better understand the impact of screen use on children. Nevertheless, some aspects of screen use have not been studied much so far. For instance: Is there an optimal time for screen use: morning, afternoon, or evening? Is there a better way to regulate children's screen time than by directly limiting it? These are more likely to need further study at present. This study provides useful information for psychologists, educators and clinicians, as well as new ideas, and makes a great contribution to subsequent research on children with ADHD and their relationship with screen use.

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