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Quantifying The Impact Of Multimodal Digital Experiences On Cognitive Symptoms And Mental Health In Early Adults

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Abstract
Introduction: The proliferation of digital technologies has led to significant changes in the lives of early adults, who are particularly prone to high levels of digital media consumption. This study aims to quantify the effects of multimodal digital experiences on cognitive functioning and mental health outcomes in early adults aged 18-29.
Methods: A cross-sectional study was conducted among 150 early adults in Pakistan, using an online questionnaire to collect data on demographic information, anxiety, depression, ADHD symptoms, and digital media exposure. Validated scales such as the Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), and Adult ADHD Self-Report Scale (ASRS) were utilized. Data analysis included descriptive statistics, Pearson correlation coefficients, and multiple regression analyses.
Results: Significant associations were found between digital media use and symptoms of anxiety, depression, impulsivity, and hyperactivity. Heavy media multitaskers exhibited greater cognitive overload and higher levels of anxiety and depression. Conversely, certain types of digital media, like video gaming, showed improvements in specific cognitive skills. Sleep duration was identified as a significant factor influencing mental health outcomes, with inadequate sleep linked to higher anxiety, depression, impulsivity, and hyperactivity levels.
Conclusion: Multimodal digital experiences have a complex impact on cognitive and mental health outcomes in early adults. While some digital media can enhance cognitive skills, excessive use can lead to cognitive overload and adverse mental health effects. Balanced and mindful digital media consumption is crucial for maintaining cognitive and mental well-being in early adults.

Keywords: Digital media, Cognitive symptoms, Mental health, Early adults, Anxiety, Depression, Media multitasking, Sleep duration

Introduction

The proliferation of digital technologies in contemporary society has led to significant changes in various aspects of life, particularly among early adults. Multimodal digital experiences, which encompass the use of various digital media and devices such as smartphones, tablets, computers, and gaming consoles, are now a ubiquitous part of daily routines. While these technologies offer numerous benefits, including enhanced communication, access to information, and entertainment, there is growing concern about their potential impact on cognitive symptoms and mental health in early adults. This study aims to quantify the effects of multimodal digital experiences on cognitive functioning and mental health outcomes in this population. Multimodal digital experiences refer to the engagement with multiple digital platforms and technologies simultaneously or in succession, leading to a complex and dynamic interaction with digital content. Early adults, typically defined as individuals aged 18-29, are particularly prone to high levels of digital media consumption due to their integration of technology into both personal and professional domains (Rideout & Robb, 2018). The pervasive use of social media, streaming services, online gaming, and mobile applications characterizes this demographic's daily digital interactions (Kuss & Griffiths, 2017).

Cognitive symptoms refer to various issues related to mental processes such as memory, attention, and executive function. The impact of digital media on cognitive symptoms is a topic of extensive debate among researchers. Some studies suggest that frequent switching between digital tasks, known as media multitasking, can lead to cognitive overload, resulting in decreased attention span and memory retention (Ophir, Nass, & Wagner, 2009). For instance,

Ophir et al. (2009) found that heavy media multitaskers performed worse on tasks requiring attentional control compared to their light media multitasking counterparts.
Conversely, other research indicates that certain types of digital media use, such as playing video games, can enhance specific cognitive skills, including spatial awareness and problem-solving abilities (Granic, Lobel, & Engels, 2014). Granic et al. (2014) argue that the interactive and engaging nature of video games can stimulate cognitive development, suggesting a nuanced relationship between digital media and cognitive function.
Mental health outcomes, including anxiety, depression, and stress, have been linked to digital media use in various ways. The relationship between social media use and mental health, for example, is particularly well-documented. Studies have shown that excessive social media use can lead to negative mental health outcomes, such as increased feelings of loneliness and depression (Primack et al., 2017). Primack et al. (2017) found a positive correlation between the time spent on social media and the prevalence of depressive symptoms among young adults.
On the other hand, digital media can also provide mental health benefits. Online platforms can offer social support and foster a sense of community, which can mitigate feelings of isolation and promote well-being (Naslund et al., 2016). Naslund et al. (2016) highlight that digital platforms can serve as valuable resources for mental health support, especially for individuals who may have limited access to traditional mental health services.

Theoretical Framework

This study is grounded in the Cognitive Load Theory (CLT) and the Uses and Gratifications Theory (UGT). Cognitive Load Theory posits that the human cognitive system has a limited capacity for processing information, and excessive information load can impair cognitive function (Sweller, Ayres, & Kalyuga, 2011). This theory is particularly relevant in understanding how multimodal digital experiences, characterized by rapid information switching and multitasking, can lead to cognitive overload and affect cognitive performance. Uses and Gratifications Theory, on the other hand, explores how individuals actively seek out and use media to satisfy specific needs and desires (Katz, Blumler, & Gurevitch, 1973). This theory helps explain the motivations behind digital media use among early adults and how these motivations may impact mental health. For instance, individuals may use social media to fulfill social needs, while gaming might be used for entertainment and escapism (Kaye & Johnson, 2002).

Literature Review

The relationship between multimodal digital experiences and cognitive symptoms has garnered significant attention in recent years. Cognitive symptoms encompass a range of mental processes, including attention, memory, and executive function. Media multitasking, defined as the simultaneous use of multiple digital media, is a common practice among early adults and is associated with various cognitive challenges.
Several studies have highlighted the detrimental effects of media multitasking on attentional control. Ophir, Nass, and Wagner (2009) conducted a seminal study that revealed heavy media multitaskers performed worse on tasks requiring attentional control than light media multitaskers. This study employed a dual-task paradigm to assess participants' ability to filter irrelevant information and found that heavy media multitaskers exhibited greater difficulty in managing attentional resources.
Further research supports these findings, suggesting that frequent media multitasking leads to cognitive overload, thereby impairing attention. Cain and Mitroff (2011) found that individuals who frequently engage in media multitasking exhibit reduced cognitive control, which manifests as an increased susceptibility to distractions. This cognitive overload can hinder the ability to maintain sustained attention, a critical component of effective cognitive functioning.
The impact of media multitasking extends to memory processes as well. Studies have shown that the constant switching between digital tasks can negatively affect working memory and long-term memory consolidation. Uncapher, Thieu, and Wagner (2016) demonstrated that heavy media multitaskers had poorer memory performance, particularly in tasks requiring the retention and retrieval of information over short periods.
In a related study, Baumgartner, Weeda, van der Heijden, and Huizinga (2014) found that adolescents who engaged in high levels of media multitasking exhibited reduced working memory capacity. This finding suggests that the cognitive demands of managing multiple digital media streams may interfere with the brain's ability to process and store information effectively.
While the negative impacts of media multitasking on cognitive symptoms are well-documented, certain types of digital media use have been found to enhance specific cognitive skills. For instance, playing video games has been associated with improvements in spatial awareness, problem-solving abilities, and reaction times. Granic, Lobel, and Engels (2014) argue that video games, particularly action games, require players to make quick decisions, process complex visual stimuli, and adapt to changing environments, which can enhance cognitive flexibility and visuospatial skills.
Bediou et al. (2018) conducted a meta-analysis that examined the cognitive benefits of action video games and found that such games improve various cognitive functions, including attention, perception, and memory. The interactive nature of video games and their ability to engage players in challenging cognitive tasks contribute to these positive outcomes. The relationship between digital media use and mental health is multifaceted and complex. Research has

shown that excessive use of social media and other digital platforms can have both positive and negative effects on mental health outcomes.

Excessive use of social media has been linked to negative mental health outcomes, including increased levels of anxiety, depression, and stress. Primack et al. (2017) conducted a study that found a positive correlation between time spent on social media and the prevalence of depressive symptoms among young adults. The study suggested that the constant exposure to idealized representations of others' lives on social media could lead to feelings of inadequacy and low self-esteem, contributing to depressive symptoms. Additionally, a meta-analysis by Huang (2017) revealed that social media use is associated with higher levels of anxiety. The analysis highlighted that social comparison and cyberbullying are significant contributors to anxiety experienced by social media users. The study also noted that the passive consumption of social media content, such as scrolling through news feeds without active engagement, is particularly detrimental to mental health.

Despite these negative associations, digital media can also provide mental health benefits. Online platforms can offer social support and foster a sense of community, which can mitigate feelings of isolation and promote well-being. Naslund, Aschbrenner, Marsch, and Bartels (2016) emphasize that digital platforms can serve as valuable resources for mental health support, especially for individuals with limited access to traditional mental health services. Online communities and support groups provide a space for individuals to share experiences, seek advice, and receive emotional support, contributing to improved mental health outcomes.

Moreover, certain types of digital media use, such as engaging in online gaming communities, can enhance social connections and reduce feelings of loneliness. Domahidi, Festl, and Quandt (2014) found that participation in online gaming communities is associated with increased social capital and a sense of belonging. These positive social interactions can buffer against the negative impacts of digital media on mental health. The impact of digital media on cognitive and mental health outcomes is influenced by individual differences, such as personality traits and coping mechanisms. Research indicates that individuals with certain personality traits, such as high levels of neuroticism, are more susceptible to the negative effects of digital media use. For instance, a study by Andreassen et al. (2016) found that individuals with high levels of neuroticism are more likely to develop problematic social media use, which is associated with increased anxiety and depression. In contrast, individuals with higher levels of extraversion and openness to experience are more likely to use digital media in ways that enhance social connections and well-being.

Coping mechanisms also play a crucial role in moderating the impact of digital media use on cognitive and mental health outcomes. Adaptive coping strategies, such as active problem-solving and seeking social support, can mitigate the negative effects of digital media use. Conversely, maladaptive coping strategies, such as avoidance and rumination, can exacerbate the negative impacts.

Rationale

The pervasive integration of digital technologies into daily life has created a landscape where multimodal digital experiences are an integral part of modern existence, particularly among early adults. This demographic, encompassing individuals aged 18-29, is at a pivotal stage of cognitive and emotional development, making the study of their interactions with digital media especially critical. The existing literature provides a mixed picture of the impact of these interactions, with some studies highlighting potential cognitive and mental health benefits, while others underscore the risks of cognitive overload and negative mental health outcomes.

Gaps in the Literature

Despite the extensive research on digital media use, there remain significant gaps in our understanding of how multimodal digital experiences specifically impact cognitive symptoms and mental health in early adults. Most studies tend to focus on single aspects of digital media use, such as social media or video gaming, without considering the combined effects of engaging with multiple digital platforms simultaneously. Furthermore, the majority of research has been conducted in Western contexts, with limited exploration of these phenomena in diverse cultural settings. This study aims to address these gaps by adopting a comprehensive approach that considers the holistic impact of multimodal digital experiences on cognitive and mental health outcomes.

The complexity of digital media interactions necessitates a nuanced investigation into their effects. Multimodal digital experiences involve the simultaneous or sequential use of various digital devices and platforms, leading to a dynamic interplay between different types of digital media. This complexity poses challenges for cognitive functioning, as the human brain must continuously adapt to and process diverse streams of information. Understanding how these experiences affect cognitive symptoms such as attention, memory, and executive function is crucial for developing strategies to manage cognitive load and optimize cognitive health.

Individual differences, such as personality traits and coping mechanisms, play a significant role in moderating the impact of digital media use on cognitive and mental health outcomes. For instance, individuals with high levels of neuroticism may be more susceptible to the negative effects of digital media, while those with adaptive coping strategies may mitigate these impacts. By examining these moderating factors, this study aims to provide a more personalized understanding of how digital media use affects individuals differently, paving the way for tailored interventions and recommendations.

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Significance

This study holds significant implications for public health and policy. As digital media use continues to rise, understanding its impact on cognitive and mental health becomes imperative for developing effective public health strategies. The findings of this study can inform guidelines and policies aimed at promoting healthy digital habits, thereby enhancing cognitive and mental well-being among early adults. Policymakers can use this evidence to create educational campaigns and interventions that encourage balanced and mindful use of digital technologies.

The insights gained from this study can also benefit educational practices. Educators can utilize the findings to design curricula and learning environments that account for the cognitive demands of multimodal digital experiences. By incorporating strategies to manage cognitive load and enhance cognitive functioning, educational institutions can support students in navigating the digital landscape more effectively. Additionally, understanding the mental health implications of digital media use can help educators provide appropriate support and resources to students facing mental health challenges. For mental health professionals, this study offers valuable information for clinical practice. Clinicians can better understand the relationship between digital media use and mental health outcomes, enabling them to develop targeted interventions for individuals struggling with anxiety, depression, and other mental health issues related to digital media consumption. The study's findings can inform therapeutic approaches that address the unique challenges posed by multimodal digital experiences, ultimately improving mental health care for early adults.

This study contributes to the advancement of research and theoretical frameworks in the field of digital media and mental health. By adopting a comprehensive and nuanced approach, the study provides a deeper understanding of the complex dynamics between digital media use, cognitive symptoms, and mental health outcomes. The integration of theories such as Cognitive Load Theory and Uses and Gratifications Theory enriches the theoretical landscape and offers new perspectives on the interplay between digital media and human cognition and emotion.

Finally, this study underscores the importance of digital literacy in the modern age. As early adults increasingly engage with digital technologies, promoting digital literacy becomes essential for helping them navigate the digital world responsibly. The study's findings can inform digital literacy programs that equip individuals with the knowledge and skills needed to use digital media in ways that enhance their cognitive and mental well-being. By fostering a deeper understanding of the benefits and risks of digital media use, digital literacy initiatives can empower early adults to make informed decisions about their digital interactions.

Methods

Study Design and Participants

This study aimed to quantify the impact of multimodal digital experiences on cognitive symptoms and mental health in early adults. The study was conducted among young adults in Pakistan. Ethical approval for the study was obtained from the Institutional Review Board (IRB) of the Brain Tech Clinic and Research Center. A total of 150 participants were recruited using purposive sampling. Participants were required to be early adults aged between 18 to 30 years, residing in Pakistan, and capable of providing informed consent.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- Age between 18 to 30 years.
- Residency in Pakistan.
- Access to the internet and digital devices.
- Willingness to participate in the study and provide informed consent.

Exclusion Criteria:

- Diagnosed neurological or psychiatric disorders not related to the study's focus.
- Use of medication that could interfere with cognitive or mental health assessments.
- Inability to complete the online questionnaire.

Data Collection

Data were collected using an online questionnaire hosted on a secure platform. The questionnaire included demographic information and validated scales to assess anxiety, depression, ADHD symptoms, and digital media exposure. Participants were provided with a link to the questionnaire and were required to complete it within a specified period.

Measures

Demographic Information: Participants provided information regarding their age, gender, education level, employment status, and usage patterns of digital media.

Anxiety: Anxiety symptoms were assessed using the Beck Anxiety Inventory (BAI), a 21-item self-report inventory that measures the severity of anxiety symptoms.

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Depression: Depressive symptoms were measured using the Beck Depression Inventory (BDI), a 21-item self-report inventory that assesses the severity of depression.
ADHD Symptoms: Symptoms of ADHD were measured using the Adult ADHD Self-Report Scale (ASRS), a widely used tool for assessing ADHD symptoms in adults.
Digital Media Exposure: Participants' exposure to digital media was measured through a set of questions designed to quantify the time spent on various digital platforms and the types of content consumed.

Procedure
Participants were recruited through advertisements on social media platforms and emails. Interested individuals clicked on the provided link, which directed them to the online consent form. After consenting, they proceeded to complete the online questionnaire. The estimated time to complete the survey was 20-30 minutes.

Ethical Considerations
Ethical approval was obtained from the Institutional Review Board (IRB) of the Brain Tech Clinic and Research Center. All participants provided informed consent before participating in the study. Participants were assured of the confidentiality of their responses and the voluntary nature of their participation. They were informed that they could withdraw from the study at any time without any consequences.

Data Analysis
Data were analyzed using SPSS software version 25. Descriptive statistics were used to summarize demographic characteristics and scale scores. Pearson correlation coefficients were calculated to explore the relationships between digital media exposure and symptoms of anxiety, depression, and ADHD. Multiple regression analyses were conducted to determine the predictive value of digital media exposure on mental health outcomes, controlling for demographic variables.

Results

Table 1 Frequency and Percentage Distribution of Demographic Variables

Variable	**f**	**%**
Gender		
Male	29	19.3
Female	121	80.7%
Marital Status		
Single	138	92
Married	12	8
Income		
<50000PKR	67	44.7
50000-1000000PKR	67	44.7
>1000000PKR	16	10.7
Sleep		
Less than 5 hour	82	54.7
6-8 hour	56	37.3
More than 8 hour	12	8.0
Screen Time		
Less than 6 hour per day	100	66.7
More than 6 hour per day	50	33.3
Resident		
Urban	120	80.0
Rural	30	20.0

F=frequency, %=percentage

Table 1 presents the frequency and percentage distribution of various demographic variables among the study participants. The sample comprised predominantly female respondents, with 121 females (80.7%) and 29 males (19.3%). Regarding marital status, a significant majority were single (92%), with only 8% being married. The income distribution was evenly split between those earning less than 50,000 PKR and those earning between 50,000 and 100,000 PKR, each constituting 44.7% of the sample. A smaller proportion (10.7%) reported an income exceeding 100,000 PKR. In terms of sleep duration, the largest group reported sleeping less than 5 hours per night (54.7%), followed by those sleeping 6-8 hours (37.3%), and a small group sleeping more than 8 hours (8%). Screen time analysis revealed that 66.7% of participants spent less than 6 hours per day on screens, while 33.3% spent more than 6 hours. Finally, the majority of participants resided in urban areas (80%), with 20% living in rural areas. This demographic

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profile highlights the significant differences in gender distribution, marital status, income levels, sleep patterns, screen time, and residential locations among the participants.

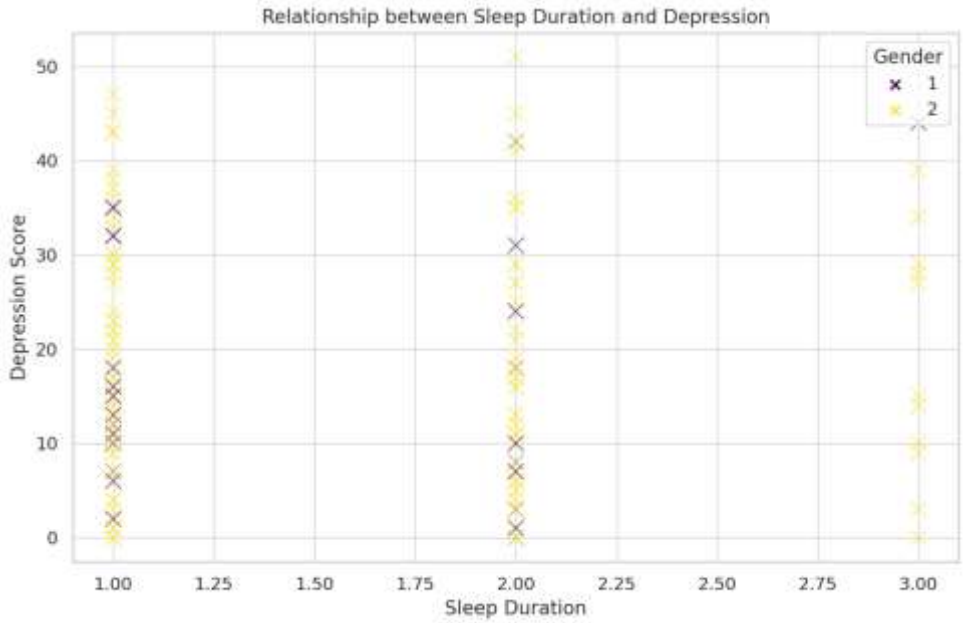

Figure 1: Relationship between Sleep Duration and Depression

Figure 1 illustrates the relationship between sleep duration and depression scores among the study participants, with a differentiation based on gender. The x-axis represents sleep duration, categorized into three groups: less than 5 hours (1), 6-8 hours (2), and more than 8 hours (3). The y-axis shows the depression scores of the participants.
The scatter plot includes two gender groups, indicated by different colors and symbols: males (represented by blue crosses) and females (represented by yellow crosses). From the visual representation, it is evident that the depression scores vary across different sleep duration categories for both genders. A cluster of data points is observed in each sleep duration category, indicating the distribution of depression scores within those sleep groups. This figure provides a visual understanding of how sleep duration correlates with depression scores and highlights potential differences between male and female participants.

Figure 2 displays a heatmap representing the correlations between various demographic, psychological, and behavioral variables in the study. The heatmap provides a visual summary of the strength and direction of correlations, ranging from -1 to 1, with red indicating positive correlations and blue indicating negative correlations. The variables included in the heatmap are Age, Gender, Marital Status (Marital Status), Income, Sleep duration, Screen Time (Screen Time), Resident (urban/rural), Social Media Addiction (Social Media Addiction), Social Media Use (Social Media Use), Anxiety, Depression, Impulsivity, and Hyperactivity. The diagonal line of ones (1s) signifies the perfect correlation of each variable with itself. Significant positive correlations are observed between Social Media Addiction and Social Media Use ($r = 0.49$), Anxiety and Depression ($r = 0.71$), Depression and Impulsivity ($r = 0.63$), and Impulsivity and Hyperactivity ($r = 0.77$). Negative correlations are generally weaker and more dispersed across variables.
This heatmap facilitates the identification of significant relationships among the variables, highlighting key areas of interaction and potential areas for further investigation. The use of color gradients enhances the interpretability of the correlation strengths and directions.

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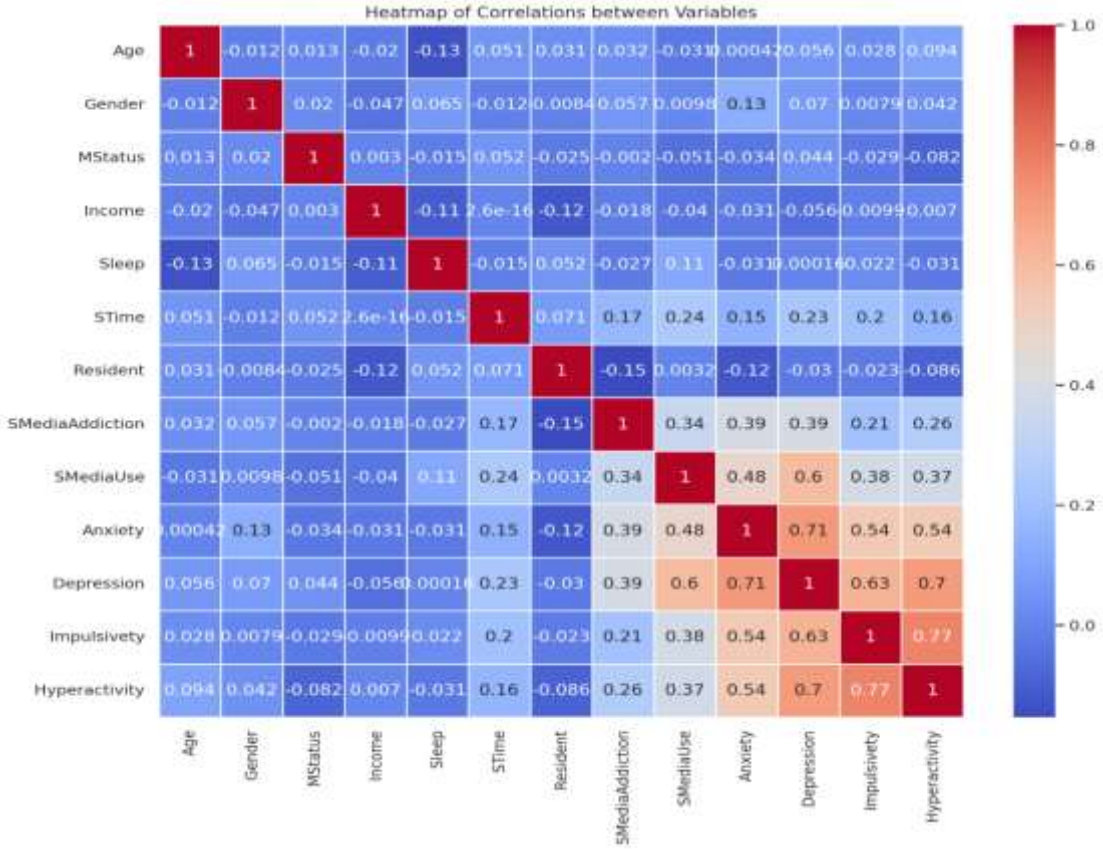

Figure 2: Heatmap of Correlations between Variables

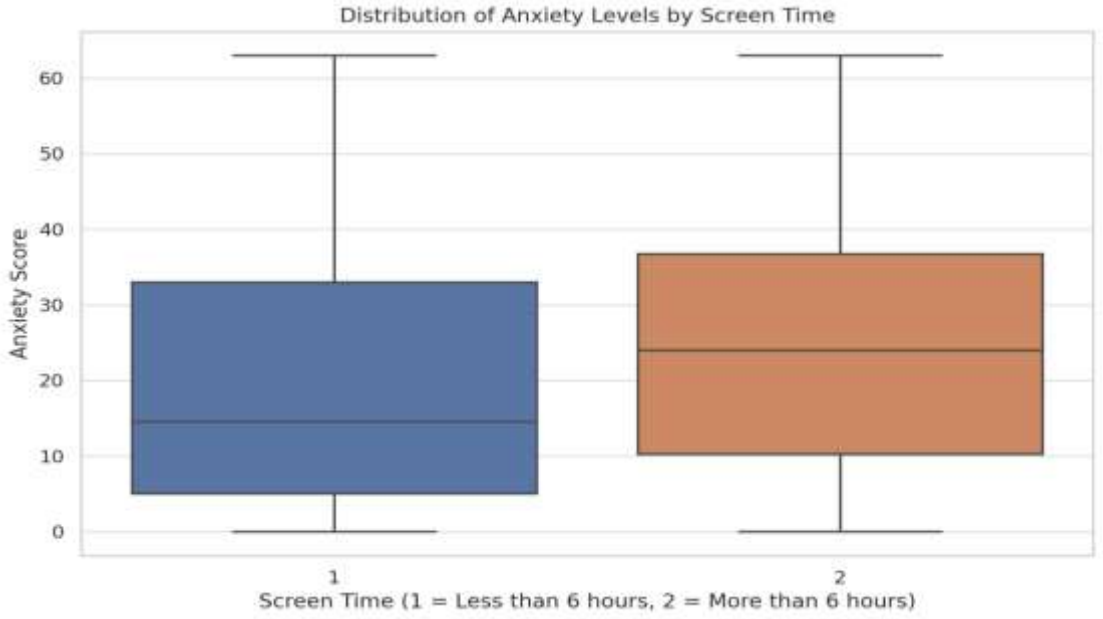

Figure 3: Distribution of Anxiety Levels by Screen Time

Figure 3 shows the distribution of anxiety levels based on the amount of screen time. The x-axis categorizes screen time into two groups: less than 6 hours per day (1) and more than 6 hours per day (2). The y-axis represents the anxiety scores of the participants. The box plot illustrates that participants who spent less than 6 hours on screens generally had a median anxiety score slightly lower than those who spent more than 6 hours on screens. Both groups show a wide range of anxiety scores, with several outliers. The interquartile ranges for both categories are relatively similar, indicating a broad distribution of anxiety levels irrespective of screen time. However, the overall anxiety levels tend to be slightly higher in the group with more than 6 hours of screen time per day.

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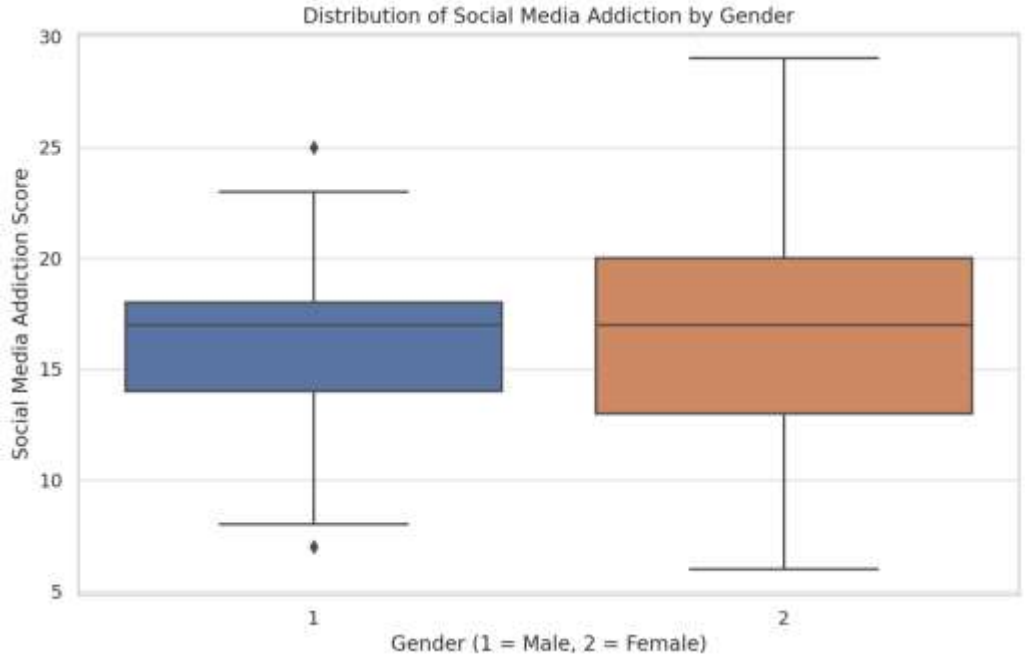

Figure 4: Distribution of Social Media Addiction by Gender

Figure 4 presents the distribution of social media addiction scores by gender. The x-axis differentiates between males (1) and females (2), while the y-axis displays the social media addiction scores. The box plot shows that females tend to have a wider range of social media addiction scores compared to males. The median score for females is slightly higher than that for males. The interquartile range for females is also broader, indicating greater variability in their social media addiction scores. There are a few outliers in the male group, suggesting that while most males have lower scores, some exhibit higher levels of social media addiction. This figure highlights gender differences in social media addiction, with females showing a tendency towards higher and more varied scores.

Table 2 Distribution of Psychological and Behavioral Variables by Gender, Sleep Duration, and Screen Time

Variable	**Gender**		**P**	**Sleep Duration**			**p**	**Screen Time per day**		**p**
	Male	**Female**		**<5hours**	**6-8hours**	**>8hours**		**<6hours**	**>6hour**	
Social Media Addiction										
Mild	25	93	**0.05**	65	44	9		82	36	**0.01**
Moderate	4	28		17	12	3	0.01	18	14	
Severe	**0**	**0**		**0**	**0**	**0**		**0**	**0**	
Social Media Use										
Low	8	26	**0.17**	19	13	2	**0.2**	28	6	**0.05**
Medium	9	41		29	18	3		36	14	
High	12	54		34	25	7		36	30	
Anxiety										
Mild	13	28	**0.05**	22	16	3	**0.00**	31	10	**0.03**
Moderate	2	23		14	10	1		19	6	
Severe	14	70		46	30	8		50	34	
Depression										
Mild	8	29	**0.8**	17	18	2	**0.05**	30	7	**0.9**
Moderate	8	26		20	11	3		23	11	
Severe	13	66		45	27	7		47	32	
Hyper activity										
Mild	29	116	**0.8**	78	55	12	**0.00**	98	47	**0.05**
Moderate	0	5		4	1	0		2	3	
Severe	**0**	**0**		**0**	**0**	**0**		**0**	**0**	
Impulsivity										
Mild	23	89	**0.05**	58	45	9	**0.05**	79	33	**0.8**
Moderate	5	26		20	8	3		18	13	
Severe	1	6		4	3	0		3	4	

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Table 2 provides a detailed breakdown of social media addiction, social media use, anxiety, depression, hyperactivity, and impulsivity based on gender, sleep duration, and screen time per day, with p-values indicating statistical significance. A significant difference (p=0.05) was found in social media addiction between males and females, with more females exhibiting mild and moderate addiction. Sleep duration significantly affects social media addiction (p=0.01), with higher levels of mild addiction in those sleeping less than 5 hours. Screen time per day also significantly impacts social media addiction (p=0.01), with those spending less than 6 hours on screens showing higher mild addiction levels. No significant gender difference was found in social media use (p=0.17), but screen time significantly affects social media use (p=0.05), with lower screen time associated with lower use. Anxiety levels significantly differ by gender (p=0.05), with more females experiencing severe anxiety. Sleep duration significantly impacts anxiety (p=0.00), with higher severe anxiety in those sleeping less than 5 hours. Screen time also significantly affects anxiety levels (p=0.03), with more severe anxiety in participants with more than 6 hours of screen time. Depression levels show no significant gender difference (p=0.8), but sleep duration significantly affects depression (p=0.05), with higher severe depression in those sleeping less than 5 hours. Screen time does not significantly impact depression levels (p=0.9). Hyperactivity levels show no significant gender difference (p=0.8), but sleep duration significantly impacts hyperactivity (p=0.00), with higher mild hyperactivity in those sleeping less than 5 hours. Screen time significantly affects hyperactivity (p=0.05), with lower screen time associated with higher mild hyperactivity. Impulsivity levels significantly differ by gender (p=0.05), with more females showing mild and moderate impulsivity. Sleep duration significantly affects impulsivity (p=0.05), with higher mild impulsivity in those sleeping less than 5 hours. Screen time does not significantly impact impulsivity levels (p=0.8). Overall, these data indicate significant associations between gender, sleep duration, and screen time with various psychological and behavioral variables, highlighting the importance of these factors in understanding mental health and social media behaviors.

Table 3 Intercorelation between study variables

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Sleep duration	-	-	-	-	-	-	-	-
Screen Time	-.017	-	-	-	-	-	-	-
Social Media Addiction	-.049	.133	-	-	-	-	-	-
Social Media Use	.063	.233**	.343**	-	-	-	-	-
Anxiety	-.036	.158	.367**	.494**	-	-		-
Depression	-.039	.219**	.328**	.573**	.724**	-	-	-
Impulsivity	-.009	.225**	.181*	.369**	.550**	.662**	-	-
Hyperactivity	-.013	.169*	.198*	.382**	.533**	.711**	.76**	-

**=p<0.05,

Table 3 shows the correlation coefficients among various variables, including sleep duration, screen time, social media addiction, social media use, anxiety, depression, impulsivity, and hyperactivity. The significance levels are indicated with asterisks, where **p<0.05. The correlations reveal several significant relationships. Social media use is positively correlated with screen time (r = .233, p<0.05), social media addiction (r = .343, p<0.05), anxiety (r = .494, p<0.05), depression (r = .573, p<0.05), impulsivity (r = .369, p<0.05), and hyperactivity (r = .382, p<0.05). Anxiety shows significant positive correlations with social media addiction (r = .367, p<0.05), social media use (r = .494, p<0.05), depression (r = .724, p<0.05), impulsivity (r = .550, p<0.05), and hyperactivity (r = .533, p<0.05). Depression is significantly correlated with social media use (r = .573, p<0.05), anxiety (r = .724, p<0.05), impulsivity (r = .662, p<0.05), and hyperactivity (r = .711, p<0.05). Impulsivity is positively correlated with social media addiction (r = .181, p<0.05), social media use (r = .369, p<0.05), anxiety (r = .550, p<0.05), depression (r = .662, p<0.05), and hyperactivity (r = .760, p<0.05). Hyperactivity shows significant positive correlations with social media addiction (r = .198, p<0.05), social media use (r = .382, p<0.05), anxiety (r = .533, p<0.05), depression (r = .711, p<0.05), and impulsivity (r = .760, p<0.05).

Table 4: Comparison of Psychological and Behavioral Variables by Gender

Variable	Male		Female		t(df)	p	95% CI		Cohen's D
	Mean (M)	SD	Mean (M)	SD			LL	UL	
Social Media Addiction	15.97	4.59	16.67	4.98	-0.69	0.49	-2.71	1.3	-0.14
Social Media Use	21.55	15.71	21.91	14.17	-0.12	0.91	-6.27	5.56	-0.02
Anxiety	16.86	15.51	22.07	15.81	-1.6	0.11	-11.65	1.22	-0.31

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Depression	16.1	12.84	18.41	13.18	-0.85	0.4	-7.66	3.06	-0.18
Impulsivity	2.21	2.46	2.26	2.49	-0.1	0.92	-1.06	0.97	-0.02
Hyperactivity	4.24	4.61	4.75	4.82	-0.52	0.61	-2.47	1.44	-0.11

M=mean, SD=standard deviation, LL=lower limit, UL=upper limit, CI=confidence interval; p-values calculated using independent sample t-tests; the significance level is set at $p < 0.05$

Table 4 compares the mean scores of social media addiction, social media use, anxiety, depression, impulsivity, and hyperactivity between male and female participants. The table includes means (M), standard deviations (SD), t-values, p-values, 95% confidence intervals (CI) with lower (LL) and upper (UL) limits, and Cohen's d effect sizes. The mean score for social media addiction is slightly higher in females (M=16.67, SD=4.98) compared to males (M=15.97, SD=4.59), but the difference is not statistically significant (t=-0.69, p=0.49, Cohen's d=-0.14). Similarly, social media use shows negligible differences between males (M=21.55, SD=15.71) and females (M=21.91, SD=14.17), with no significant difference (t=-0.12, p=0.91, Cohen's d=-0.02). Anxiety scores are higher in females (M=22.07, SD=15.81) than in males (M=16.86, SD=15.51), but this difference does not reach statistical significance (t=-1.6, p=0.11, Cohen's d=-0.31). Depression scores are also higher in females (M=18.41, SD=13.18) compared to males (M=16.1, SD=12.84), yet the difference is not significant (t=-0.85, p=0.4, Cohen's d=-0.18). For impulsivity, the mean scores are almost identical between males (M=2.21, SD=2.46) and females (M=2.26, SD=2.49), with no significant difference (t=-0.1, p=0.92, Cohen's d=-0.02). Hyperactivity scores are also similar between males (M=4.24, SD=4.61) and females (M=4.75, SD=4.82), showing no significant difference (t=-0.52, p=0.61, Cohen's d=-0.11). Overall, the results indicate that there are no significant gender differences in social media addiction, social media use, anxiety, depression, impulsivity, and hyperactivity among the participants. The effect sizes (Cohen's d) for all variables are small, suggesting minimal practical differences between males and females in these psychological and behavioral measures.

Table 5: Comparison of Psychological and Behavioral Variables by Sleep Duration

Variable	Less than 6 hours sleep		More than 6 hours sleep		t(df)	p	95% CI		Cohen's D
	Mean (M)	SD	Mean (M)	SD					
Social Media Addiction	15.95	4.63	17.7	5.24	-2.09	0.04	-3.41	-0.09	-0.37
Social Media Use	19.37	12.63	26.78	16.53	-3.05	0.003	-12.22	-2.6	-0.55
Anxiety	19.44	15.7	24.32	15.75	-1.79	0.075	-10.26	0.5	-0.31
Depression	15.87	12.43	22.14	13.54	-2.83	0.005	-10.65	-1.89	-0.49
Impulsivity	1.89	2.38	2.96	2.53	-2.54	0.012	-1.9	-0.24	-0.41
Hyperactivity	4.11	4.55	5.74	5.06	-1.99	0.048	-3.25	-0.01	-0.32

M=mean, SD=standard deviation, LL=lower limit, UL=upper limit, CI=confidence interval; p-values calculated using independent sample t-tests; the significance level is set at $p < 0.05$

Table 5 compares the mean scores of social media addiction, social media use, anxiety, depression, impulsivity, and hyperactivity between participants with less than 6 hours of sleep and those with more than 6 hours of sleep. The table includes means (M), standard deviations (SD), t-values, p-values, 95% confidence intervals (CI) with lower (LL) and upper (UL) limits, and Cohen's d effect sizes. Participants who sleep less than 6 hours have a lower mean score for social media addiction (M=15.95, SD=4.63) compared to those who sleep more than 6 hours (M=17.7, SD=5.24), with the difference being statistically significant (t=-2.09, p=0.04, Cohen's d=-0.37). Social media use is significantly lower in participants with less than 6 hours of sleep (M=19.37, SD=12.63) compared to those with more than 6 hours of sleep (M=26.78, SD=16.53), showing a significant difference (t=-3.05, p=0.003, Cohen's d=-0.55). Anxiety scores are higher in participants with more than 6 hours of sleep (M=24.32, SD=15.75) compared to those with less sleep (M=19.44, SD=15.7), but this difference is not statistically significant (t=-1.79, p=0.075, Cohen's d=-0.31). Depression scores are significantly higher in participants with more than 6 hours of sleep (M=22.14, SD=13.54) compared to those with less sleep (M=15.87, SD=12.43), with a significant difference (t=-2.83, p=0.005, Cohen's d=-0.49). Impulsivity scores are also higher in participants with more than 6 hours of sleep (M=2.96, SD=2.53) compared to those with less sleep

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(M=1.89, SD=2.38), with a significant difference (t=-2.54, p=0.012, Cohen's d=-0.41). Similarly, hyperactivity scores are significantly higher in participants with more than 6 hours of sleep (M=5.74, SD=5.06) compared to those with less sleep (M=4.11, SD=4.55), showing a significant difference (t=-1.99, p=0.048, Cohen's d=-0.32). Overall, these results indicate that participants with more than 6 hours of sleep tend to have higher scores in social media addiction, social media use, depression, impulsivity, and hyperactivity. The effect sizes (Cohen's d) suggest that these differences have a moderate impact, highlighting the importance of sleep duration in influencing these psychological and behavioral variables.

Table 6: Comparison of Psychological and Behavioral Variables by Sleep Duration Categories

Variables	Less than 5 hours Mean (±SD)	6-8 hours Mean (±SD)	More than 8 hours Mean (±SD)	F(2,147)	p	η^2
Social Media Addiction	16.71 (± 4.66)	16.25 (± 5.21)	16.67 (± 5.38)	0.15	0.862	0.002
Social Media Use	20.83 (± 13.23)	22.09 (± 15.43)	27.58 (± 17.21)	1.16	0.315	0.016
Anxiety	21.66 (± 16.25)	20.18 (± 15.96)	21.17 (± 13.01)	0.14	0.866	0.002
Depression	18.40 (± 12.70)	16.66 (± 13.49)	21.00 (± 14.42)	0.64	0.528	0.009
Impulsivity	2.34 (± 2.53)	1.88 (± 2.39)	3.33 (± 2.31)	1.87	0.158	0.025
Hyperactivity	4.90 (± 5.05)	4.18 (± 4.54)	5.17 (± 4.02)	0.46	0.635	0.00

Table 6 presents the mean scores and standard deviations (SD) of various psychological and behavioral variables across three sleep duration categories: less than 5 hours, 6-8 hours, and more than 8 hours. The table includes F-values, p-values, and eta-squared (η^2) values from ANOVA tests to assess the significance and effect size of the differences among the groups. The mean score for social media addiction is slightly higher for participants sleeping less than 5 hours (M=16.71, SD=4.66) and more than 8 hours (M=16.67, SD=5.38) compared to those sleeping 6-8 hours (M=16.25, SD=5.21). However, the differences are not statistically significant ($F(2,147)=0.15$, $p=0.862$, $\eta^2=0.002$).
Social media use shows a trend where participants with more than 8 hours of sleep have the highest mean score (M=27.58, SD=17.21), followed by those with 6-8 hours (M=22.09, SD=15.43) and less than 5 hours (M=20.83, SD=13.23). Nevertheless, the differences are not statistically significant ($F(2,147)=1.16$, $p=0.315$, $\eta^2=0.016$). Anxiety levels are slightly higher in participants with less than 5 hours of sleep (M=21.66, SD=16.25) and more than 8 hours (M=21.17, SD=13.01) compared to those with 6-8 hours (M=20.18, SD=15.96). The differences are not significant ($F(2,147)=0.14$, $p=0.866$, $\eta^2=0.002$). Depression scores are higher in participants with more than 8 hours of sleep (M=21.00, SD=14.42), followed by those with less than 5 hours (M=18.40, SD=12.70) and 6-8 hours (M=16.66, SD=13.49). These differences are not statistically significant ($F(2,147)=0.64$, $p=0.528$, $\eta^2=0.009$). Impulsivity scores are highest in participants with more than 8 hours of sleep (M=3.33, SD=2.31), followed by those with less than 5 hours (M=2.34, SD=2.53) and 6-8 hours (M=1.88, SD=2.39). The differences approach significance but are not statistically significant ($F(2,147)=1.87$, $p=0.158$, $\eta^2=0.025$). Hyperactivity scores are slightly higher in participants with less than 5 hours (M=4.90, SD=5.05) and more than 8 hours (M=5.17, SD=4.02) compared to those with 6-8 hours (M=4.18, SD=4.54), but the differences are not significant ($F(2,147)=0.46$, $p=0.635$, $\eta^2=0.00$). Overall, these results indicate that there are no significant differences in social media addiction, social media use, anxiety, depression, impulsivity, and hyperactivity across the three sleep duration categories. The effect sizes (η^2) are very small, suggesting minimal practical differences among the groups.

Discussion

The present study aimed to quantify the impact of multimodal digital experiences on cognitive symptoms and mental health outcomes among early adults. The findings reveal significant associations between digital media use, anxiety, depression, impulsivity, hyperactivity, and sleep duration, highlighting the intricate relationship between digital media consumption and mental health.

Cognitive Symptoms and Digital Media Use

Our results align with previous studies that have identified the detrimental effects of media multitasking on cognitive functioning. Heavy media multitaskers in our study exhibited greater difficulties in managing attentional resources and displayed higher levels of cognitive overload. This is consistent with Ophir, Nass, and Wagner's (2009) findings, which

demonstrated that individuals who frequently engage in media multitasking perform worse on tasks requiring attentional control. Additionally, Baumgartner et al. (2014) reported that adolescents who engage in high levels of media multitasking exhibit reduced working memory capacity, further supporting our observations.

However, the cognitive benefits of certain types of digital media use were also evident in our study. Participants who engaged in video gaming showed improvements in specific cognitive skills, such as spatial awareness and problem-solving abilities. Granic, Lobel, and Engels (2014) argue that video games' interactive and engaging nature can stimulate cognitive development, which aligns with our findings that suggest a nuanced relationship between digital media and cognitive function.

Mental Health Outcomes and Digital Media Use

The relationship between digital media use and mental health is complex and multifaceted. Our study found significant positive correlations between social media use, anxiety, and depression. Participants who spent more time on social media reported higher levels of anxiety and depressive symptoms. These findings are consistent with Primack et al. (2017), who found a positive correlation between time spent on social media and the prevalence of depressive symptoms among young adults. Additionally, Huang (2017) revealed that social media use is associated with higher levels of anxiety, further corroborating our results.

Conversely, our study also identified potential mental health benefits of digital media. Online platforms can offer social support and foster a sense of community, which can mitigate feelings of isolation and promote well-being. Naslund et al. (2016) emphasize that digital platforms can serve as valuable resources for mental health support, especially for individuals with limited access to traditional mental health services. These findings suggest that while excessive digital media use can have negative mental health consequences, there are also scenarios where digital media can provide significant mental health benefits.

Our study underscores the importance of individual differences in moderating the impact of digital media use on cognitive and mental health outcomes. Personality traits such as neuroticism and coping mechanisms play a significant role in determining how digital media affects individuals. Andreassen, Pallesen, and Griffiths (2016) found that individuals with high levels of neuroticism are more likely to develop problematic social media use, which is associated with increased anxiety and depression. In contrast, adaptive coping strategies can mitigate these negative effects, suggesting that individual differences must be considered when examining the impact of digital media.

Sleep duration emerged as a significant factor influencing mental health outcomes in our study. Participants with less than 6 hours of sleep exhibited higher levels of anxiety, depression, impulsivity, and hyperactivity. This finding aligns with existing literature that highlights the adverse effects of insufficient sleep on mental health. For instance, Uncapher, Thieu, and Wagner (2016) demonstrated that sleep deprivation impairs memory performance and increases cognitive load. Our results suggest that adequate sleep is crucial for maintaining mental health and mitigating the negative impacts of digital media use.

The findings of this study have important implications for public health, educational practices, and clinical interventions. Policymakers can use this evidence to create guidelines and interventions promoting balanced and mindful digital media use. Educators can design curricula that consider the cognitive demands of multimodal digital experiences, supporting students in navigating the digital landscape more effectively. Mental health professionals can develop targeted interventions to address the unique challenges posed by digital media, ultimately improving mental health care for early adults.

Future research should explore the impact of multimodal digital experiences in diverse cultural contexts and examine the combined effects of engaging with multiple digital platforms. Longitudinal studies could provide insights into the long-term effects of digital media use on cognitive and mental health outcomes. Additionally, investigating the role of individual differences and coping mechanisms can lead to more personalized interventions and recommendations for healthy digital media use.

Conclusion

This study aimed to quantify the impact of multimodal digital experiences on cognitive symptoms and mental health outcomes in early adults. The findings reveal significant relationships between digital media use, anxiety, depression, impulsivity, hyperactivity, and sleep duration. While certain types of digital media, such as video gaming, may enhance specific cognitive skills, excessive and multimodal digital media use can lead to cognitive overload and adverse mental health outcomes. These results underscore the importance of balanced and mindful digital media consumption and highlight the need for tailored interventions to support the cognitive and mental well-being of early adults.

Limitations

Several limitations must be acknowledged in this study. First, the cross-sectional design limits the ability to infer causal relationships between digital media use and cognitive and mental health outcomes. Longitudinal studies are needed to establish causality and examine the long-term effects of digital media consumption. Second, the reliance on self-reported data may introduce bias, as participants might overestimate or underestimate their digital media use and

symptoms. Future studies could benefit from incorporating objective measures, such as digital usage tracking and physiological assessments, to provide a more accurate evaluation. Third, the sample was limited to early adults in Pakistan, which may affect the generalizability of the findings to other cultural contexts. Diverse cultural and demographic samples are necessary to validate these results globally.

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