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Smartphone Overuse Is Negatively Associated with Episodic Future Thinking and Mental Health in School-Aged Children

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Abstract

This study examines the developmental impact of excessive smartphone use on cognitive functioning and externalizing behaviors in elementary school children. Specifically, it examines the relationship between smartphone overuse and cognitive skills related to future thinking, as well as related mental health outcomes. A descriptive cross-sectional design was utilized. Data were collected from 200 Iranian parent-child pairs (139 boys and 61 girls) aged between 6–13 years. Parents completed the Children's Future Thinking Questionnaire (CFTQ) to assess related cognitive functions to future thinking and the Child Behavior Checklist (CBCL) to evaluate mental health outcomes. Additionally, Smartphone overuse was measured through Child Smartphone Addiction Questioner (CSAQ). The results revealed significant negative correlations between smartphone addiction and key cognitive functions such as episodic foresight, prospective memory, and planning. Notably, smartphone addiction was strongly correlated with increased externalizing behaviors, including aggression and rule-breaking, and other mental health problems, such as anxiety and depression. Regression analysis showed that smartphone addiction accounted for 25% of the variance in these negative outcomes, highlighting its

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significant impact on child development. These findings highlight the need for interventions that address smartphone addiction and focus on strengthening future-oriented cognitive skills, which are essential for the improvement or prevention of mental health and behavioral outcomes in children.

Keywords: Smartphone Overuse, Mental Health, Cognitive Development, Executive Functions, Future-Oriented Cognition, Future Thinking

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1. Introduction

Addiction encompasses a wide range of compulsive behaviors, including excessive reliance on rewarding stimuli such as gambling, watching television, and using smartphones (Griffiths, 2005; Volkow et al., 2016). Smartphones provide conveniences such as checking the weather, shopping, socializing, and entertaining, but overuse can impair mental, emotional, and social functioning. Excessive use has been linked to anxiety, depression, and poor sleep quality, negatively impacting emotional well-being (Sohn et al., 2019; Wacks & Weinstein, 2021). It also causes cognitive problems, impulsiveness, and social networking dependency. (Muhammed & Taha, 2024). Long-term use can be a source of loneliness, anxiety, and isolation, especially for adolescents (Volungis et al., 2020). Additionally, smartphone addiction reduces real-life social interactions and harms mental health (Alwi et al., 2022; Ihm, 2018). Johansson et al. (2016) found that approximately 47% of teens surveyed used three or four devices before bed, with 97% using some form of technology in the hour before bed. It is noteworthy that nearly 74% of these respondents were using a cell phone during this period.

A significant number of children engage in compulsive smartphone use before bed and after waking, with evidence linking these habits to negative sleep outcomes such as reduced total sleep time and delayed bedtime. For example, research has shown that nighttime smartphone use reduces sleep by an average of 21 to 45 minutes, underscoring the far-reaching impact of this behavior on overall sleep health (Arora et al., 2014; Arora et al., 2013). These habits, which were once functional, now reflect the characteristic features of a behavioral addiction. As a form of behavioral dependence, overuse of smartphones meets the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), which defines dependence as a chronic, relapsed disorder that involves loss of control, preoccupation, compulsion, and persistent engagement despite negative consequences (Körmendi et al., 2016).

While smartphones serve an important function, their excessive and compulsive use can have a significant impact on mental health, cognitive functioning, and social interactions (Körmendi et al., 2016; Lin et al., 2016). Incentive-sensitization theories suggest that repeated exposure to rewarding stimuli, such as social approval or emotional gratification, hypersensitizes neural pathways associated with reward-seeking behavior. (Robinson & Berridge, 2001). This framework aligns with findings by Pérez de Albéniz Garrote et al. (2021), These studies show that compulsive smartphone use, based on impulsivity and sensation seeking, may be due to an increased

sensitivity to smartphone-related cues and rewards. Collectively, these perspectives emphasize how behavioral dependencies, such as phone overuse, arise from neurobiological adjustments to repeated rewarding stimulation.

Smartphone use is growing rapidly among children and teens around the world. Studies show that many children own smartphones by the age of 10, with ownership rates as high as 37% in Europe and 45% in the UK for pre-adolescents (Davie et al., 2004; Mascheroni et al., 2013). In the United States, smartphone use among younger children is similarly widespread, with 75% of 4-year-olds owning a mobile device (Kabali et al., 2015). This trend highlights the growing prevalence of smartphone adoption at increasingly younger ages globally. Smartphone use among elementary school students in Iran is a growing concern. A study conducted in Shiraz found that 31.42% of elementary school students owned smartphones, with boys reporting higher ownership and usage rates compared to girls. There was a significant association between smartphone use and symptoms, with an average of 7.08 minutes in talk mode reported daily (Mortazavi et al., 2011). In addition, this addiction can have an effect on the brain's reward system, which in turn affects cognitive functions such as working memory, inhibition, and planning (Horvath et al., 2020; Liebherr et al., 2020). The consequences of excessive smartphone use extend to cognitive dysfunction, particularly in forward-looking cognitive abilities such as prospective memory, episodic forethought, and planning. Research shows that these abilities, which are critical for decision making and goal setting, are disrupted by smartphone addiction. Evidence highlights reduced prospective memory performance and structural brain changes in regions associated with executive function and planning (Chiang et al., 2019; Horvath et al., 2020).

The purpose of the present study is to examine the relationships among excessive smartphone use, future-oriented cognitive skills, and mental health outcomes in a sample of elementary school students. This research explores the novel intersection of smartphone addiction, episodic future thinking, and mental health-factors that, to our knowledge, have not been extensively studied in the context of younger children. By focusing on primary school children, this study will provide new insights into the developmental implications of excessive phone use during a crucial period of cognitive development.

2. Material and Methods

Participants

The study used a descriptive cross-sectional design. Participants were 200 Iranian parent child pairs selected using a convenience sampling. Parents were between the ages of 25 and 59 years old (M = 39 SD = 5.4) and typical developing children (139 boys and 61 girls) aged between 6–13 years old (M = 9.06 SD = 1.79). participation was voluntary. Participant's demographical information is included in Table 1. Participants were studying in the academic year 2020-2021 and the online (Google Form) questionnaire along with the demographic checklist was provided to their parents. Inclusion criteria included study in primary school for children, no psychological and neurological disorders in the child (as reported by parents), no severe sensory problems in the child and parent (blindness and deafness), and also parents' familiarity with Internet and having smartphone or tablet. Exclusion criteria included the failure to complete questioners and

random answers to the questions.

Table 1. Description of participants (age)

Variable		*M*	*SD*	*Min*	*Max*
Age of children	Year	9.06	1.79	6.92	13
Age of mothers		36.66	4.95	25	50
Age of fathers		40.98	5.26	31	59

Abbreviations: *M*, Mean: *SD*, Standard deviation: *Min*, Minimum: *Max*, Maximum

3. Data Collection

Child Smartphone Addiction Questioner (CSAQ)

Smartphone addiction questionnaire - parent version in elementary school students, was inspired by the (Young, 1998) and created by (Sadeghi et al., 2021), was used to measure the level of addictive/excessive use of mobile/smartphone and tablet. It consists of 20 items, examinees responded to each statement with a number from 1 to 5 on a Likert scale continuum, indicating the extent to which they engage in a particular behavior. Cronbach's alpha coefficient indicated high internal consistency for the total scale 0.92 also Guttman Split-half coefficient indicated high reliability coefficient 0.88.

Child Behavior Checklist (CBCL)

The Child Behavior Checklist, developed by Achenbach (1991) is used to assess emotional and behavioral problems in children. It consists of 113 items, with responses given on a 3-point Likert scale (0 = not true, 1 = somewhat true, 2 = very true). The questionnaire is designed to identify internalizing and externalizing behaviors. Based on report by Minaee (2006), The range of internal consistency coefficient of the scales using Cronbach's alpha formula has been reported to be from 0.63 to 0.95.

Children's Future Thinking Questionnaire (CFTQ)

The Children's Future Thinking Questionnaire, based on the theoretical framework by Mazachowsky and Mahy (2020), was employed in a study involving Iranian elementary school students. The questionnaire, which was administered by parents, includes 44 items divided into

five dimensions: saving behavior, prospective memory, episodic foresight, planning, and delay of gratification. Each item is scored on a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The instrument has demonstrated excellent reliability and validity, with a Cronbach's alpha of 0.89 and a Guttman Split-half coefficient of 0.85 (Sadeghi et al., 2022).

4. Results

The relationship between Children's Future Thinking abilities and Behavior problems and he analysis revealed that CFTQ Total Score showed significant negative correlations with CBCL Anxious/Depressed ($r = -0.21$, $P \leq 0.05$), CBCL Withdraw/Depressed ($r = -0.23$, $P \leq 0.01$), CBCL Somatic Complaints ($r = -0.21$, $P \leq 0.05$), CBCL Social Problems ($r = -0.23$, $P \leq 0.01$), CBCL Thought Problems ($r = -0.26$, $P \leq 0.01$), CBCL Attention Problems ($r = -0.28$, $P \leq 0.01$), CBCL Rule Breaking Behavior ($r = -0.29$, $P \leq 0.01$), CBCL Aggressive Behavior ($r = -0.40$, $P \leq 0.01$), CBCL Internalizing ($r = -0.29$, $P \leq 0.01$), CBCL Externalizing ($r = -0.38$, $P \leq 0.01$), and CSAQ Total Score ($r = -0.37$, $P \leq 0.01$). The CFTQ Saving subscale demonstrated significant negative correlations with CBCL Anxious/Depressed ($r = -0.19$, $P \leq 0.05$), CBCL Thought Problems ($r = -0.17$, $P \leq 0.05$). The CFTQ Prospective Memory subscale demonstrated significant negative correlations with several CBCL subscales, including Withdraw/Depressed ($r = -0.21$, $P \leq 0.01$), CBCL Somatic Complaints ($r = -0.13$, $P \leq 0.05$), Social Problems ($r = -0.18$, $P \leq 0.01$), Thought Problems ($r = -0.19$, $P \leq 0.01$), Attention Problems ($r = -0.21$, $P \leq 0.01$), Rule Breaking Behavior ($r = -0.20$, $P \leq 0.01$), Aggressive Behavior ($r = -0.28$, $P \leq 0.01$), and Externalizing ($r = -0.27$, $P \leq 0.01$). It also showed a significant negative correlation with the CSAQ Total Score ($r = -0.23$, $P \leq 0.01$). The CFTQ Episodic Foresight subscale had significant negative correlations with CBCL Anxious/Depressed ($r = -0.26$, $P \leq 0.01$), Withdraw/Depressed ($r = -0.27$, $P \leq 0.01$), Somatic Complaints ($r = -0.24$, $P \leq 0.01$), Social Problems ($r = -0.30$, $P \leq 0.01$), Thought Problems ($r = -0.32$, $P \leq 0.01$), Attention Problems ($r = -0.36$, $P \leq 0.01$), Rule Breaking Behavior ($r = -0.31$, $P \leq 0.01$), Aggressive Behavior ($r = -0.35$, $P \leq 0.01$), Internalizing ($r = -0.34$, $P \leq 0.01$), Externalizing ($r = -0.36$, $P \leq 0.01$), and CSAQ Total Score ($r = -0.37$, $P \leq 0.01$). The CFTQ Planning subscale demonstrated significant negative correlations with CBCL Anxious/Depressed ($r = -0.29$, $P \leq 0.01$), Withdraw/Depressed ($r = -0.31$, $P \leq 0.01$), Somatic Complaints ($r = -0.27$, $P \leq 0.01$), Social Problems ($r = -0.32$, $P \leq 0.01$), Thought Problems ($r = -0.35$, $P \leq 0.01$), Attention Problems ($r = -0.32$, $P \leq 0.01$), Aggressive Behavior ($r = -0.38$, $P \leq 0.01$), Rule Breaking Behavior ($r = -0.36$, $P \leq 0.01$), Internalizing ($r = -0.37$, $P \leq 0.01$), Externalizing ($r = -0.40$, $P \leq 0.01$), and CSAQ Total Score ($r = -0.30$, $P \leq 0.01$). The CFTQ Delay of Gratification subscale demonstrated significant negative correlations with CBCL Anxious/Depressed ($r = -0.31$, $P \leq 0.01$), Withdraw/Depressed ($r = -0.29$, $P \leq 0.01$), Somatic Complaints ($r = -0.24$, $P \leq 0.01$), Social Problems ($r = -0.32$, $P \leq 0.01$), Thought Problems ($r = -0.36$, $P \leq 0.01$), Attention Problems ($r = -0.32$, $P \leq 0.01$), Rule Breaking Behavior ($r = -0.26$, $P \leq 0.01$), Aggressive Behavior ($r = -0.39$, $P \leq 0.01$), Internalizing ($r = -0.36$, $P \leq 0.01$), Externalizing ($r = -0.36$, $P \leq 0.01$), and CSAQ Total Score ($r = -0.29$, $P \leq 0.01$). The CBCL Anxious/Depressed subscale demonstrated significant negative correlations with CFTQ Saving ($r = -0.19$, $P \leq 0.05$), Episodic Foresight ($r = -0.26$, $P \leq 0.01$), Planning ($r = -0.29$, $P \leq 0.01$), Delay of Gratification ($r = -0.31$, $P \leq 0.01$), and Total Score ($r = -0.21$, $P \leq 0.05$). Additionally, a significant positive correlation was observed with the CSAQ Total Score ($r = 0.15$, $P \leq 0.05$), The CBCL Withdraw/Depressed subscale demonstrated significant negative correlations with CFTQ Prospective Memory ($r = -0.21$, $P \leq 0.01$), Episodic Foresight ($r = -0.27$, P

≤ 0.01), Planning (r = -0.31, P ≤ 0.01), Delay of Gratification (r = -0.29, P ≤ 0.01), and Total Score (r = -0.23, P ≤ 0.01). The CBCL Somatic Complaints subscale demonstrated significant negative correlations with CFTQ Episodic Foresight (r = -0.24, P ≤ 0.01), Prospective Memory (r = -0.13, P ≤ 0.05) Planning (r = -0.27, P ≤ 0.01), Delay of Gratification (r = -0.24, P ≤ 0.01), and Total Score (r = -0.21, P ≤ 0.05). The CBCL Social Problems subscale demonstrated significant negative correlations with CFTQ Prospective Memory (r = -0.18, P ≤ 0.01), Episodic Foresight (r = -0.30, P ≤ 0.01), Planning (r = -0.32, P ≤ 0.01), Delay of Gratification (r = -0.32, P ≤ 0.01), and Total Score (r = -0.23, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.17, P ≤ 0.05). The CBCL Thought Problems subscale demonstrated significant negative correlations with CFTQ Saving (r = -0.17, P ≤ 0.05), Prospective Memory (r = -0.19, P ≤ 0.01), Episodic Foresight (r = -0.32, P ≤ 0.01), Planning (r = -0.35, P ≤ 0.01), Delay of Gratification (r = -0.36, P ≤ 0.01), and Total Score (r = -0.26, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.16, P ≤ 0.05). The CBCL Attention Problems subscale demonstrated significant negative correlations with CFTQ Prospective Memory (r = -0.21, P ≤ 0.01), Episodic Foresight (r = -0.36, P ≤ 0.01), Planning (r = -0.32, P ≤ 0.01), Delay of Gratification (r = -0.32, P ≤ 0.01), and Total Score (r = -0.28, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.17, P ≤ 0.05). The CBCL Rule Breaking Behavior subscale demonstrated significant negative correlations with CFTQ Prospective Memory (r = -0.20, P ≤ 0.01), Episodic Foresight (r = -0.31, P ≤ 0.01), Planning (r = -0.36, P ≤ 0.01), Delay of Gratification (r = -0.26, P ≤ 0.01), and Total Score (r = -0.29, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.24, P ≤ 0.01). The CBCL Aggressive Behavior subscale demonstrated significant negative correlations with CFTQ Prospective Memory (r = -0.28, P ≤ 0.01), Episodic Foresight (r = -0.35, P ≤ 0.01), Planning (r = -0.38, P ≤ 0.01), Delay of Gratification (r = -0.39, P ≤ 0.01), and Total Score (r = -0.40, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.31, P ≤ 0.01). The CBCL Internalizing subscale demonstrated significant negative correlations with CFTQ Episodic Foresight (r = -0.34, P ≤ 0.01), Planning (r = -0.37, P ≤ 0.01), Delay of Gratification (r = -0.36, P ≤ 0.01), and Total Score (r = -0.29, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.17, P ≤ 0.05). The CBCL Externalizing subscale demonstrated significant negative correlations with CFTQ Prospective Memory (r = -0.27, P ≤ 0.01), Episodic Foresight (r = -0.36, P ≤ 0.01), Planning (r = -0.40, P ≤ 0.01), Delay of Gratification (r = -0.36, P ≤ 0.01), and Total Score (r = -0.38, P ≤ 0.01). Additionally, a significant positive correlation was observed with the CSAQ Total Score (r = 0.30, P ≤ 0.01), The CSAQ Total score demonstrated significant negative correlations with CFTQ Prospective Memory (r = -0.23, P ≤ 0.01), Episodic Foresight (r = -0.37, P ≤ 0.01), Planning (r = -0.30, P ≤ 0.01), Delay of Gratification (r = -0.29, P ≤ 0.01), and Total Score (r = -0.37, P ≤ 0.01).

Additionally, the CSAQ Total score exhibited significant positive correlations with multiple CBCL subscales. These include Anxious/Depressed (r = 0.15, P ≤ 0.05), Social Problems (r = 0.17, P ≤ 0.05), Thought Problems (r = 0.16, P ≤ 0.05), Attention Problems (r = 0.17, P ≤ 0.05), Rule Breaking Behavior (r = 0.24, P ≤ 0.01), Aggressive Behavior (r = 0.31, P ≤ 0.01), Internalizing (r = 0.17, P ≤ 0.01), and Externalizing (r = 0.30, P ≤ 0.01).

To better understand children's future thinking abilities, mental health problems and, a multiple regression analysis was conducted with Smartphone Addiction (CSAQ) as predictors. As

shown in table 2, Using the enter method, the model was found to be significant (F (13, 98) = 2.56, P < 0.005), with an R^2 of 0.25. This model explains 25% of the variance in the dependent variable.

Table 2. Linear Regression Analysis Predicting CSAQ Total Score Using CBCL and CFTQ Subscales

Variables				
Independent	*Dependent*	B	SE B	B
CFTQ_Saving		-.42	.23	-.16
CFTQ_Prospective_Memory		-.10	.25	-.04
CFTQ_Episodic_Foresight		-.32	.23	-.15
CFTQ_Planning	CSAQ_Total	.04	.24	.02
CFTQ_Delay_of_Gratification		-.34	.21	-.16
CBCL_Anxious_Depressed		.06	.54	.01
CBCL_Withdraw_Depressed		-.75	.82	-.11
CBCL_Somatic_Complaints		-.18	.54	-.04
CBCL_Social_Problems		.40	.60	.09
CBCL_Thought_Problems		-1.05	.53	-.31
CBCL_Attention_Problems		-.69	.67	-.13
CBCL_Rule_Breaking_Behavior		-1.49	.87	-.42
CBCL_Externalizing		**1.43**	**.48**	**.85****

* $p \leq 0.05$, ** $p < 0.01$

SE: Standard error.

5. Discussion

The purpose of this study was to examine the relationships among excessive smartphone use, future-oriented cognitive skills, and mental health outcomes in elementary school students. We found that several significant patterns emerged, which help us to understand these constructs in a younger population.

First, we found a significant negative relationship between excessive phone use and several components of future perception, including episodic anticipation, future memory, and planning. These findings are consistent with previous research suggesting that excessive smartphone use disrupts cognitive processes critical for future thinking. (Li et al., 2024; Peng et al., 2022). Specifically, children with higher smartphone addiction scores exhibited poorer performance on measures of planning and delay of gratification, underscoring the potential cognitive costs of excessive device use (Potash, 2016). Secondly, consistent with previous studies, the findings demonstrated that excessive smartphone use was associated with increased symptoms of anxiety, depression, and behavioral issues (Chang et al., 2022). The observed positive correlation between smartphone addiction scores and CBCL subscales, including Aggressive Behavior and Anxious/Depressed, highlights the psychological toll of smartphone overuse. These associations may be due to the impact of screen time on emotional regulation and social interactions (Chang et al., 2022; Doo & Kim, 2022; Kim & Ha, 2018; Poulain et al., 2023; Robinson & Berridge, 2001). Interestingly, the negative correlations between future-oriented cognition subscales and internalizing and externalizing behaviors suggest a protective role for future-oriented skills. For example, children who scored higher on episodic foresight and planning had fewer conduct problems and lower levels of anxiety and depression. This finding is consistent with theories suggesting that strong cognitive skills enable better emotional and behavioral regulation (Al-Amri et al., 2023; Atance & Mahy, 2016; Marks et al., 2023).

Despite these valuable findings, the study has several limitations that need to be considered. The cross-sectional design precludes conclusions about causality. There is a need for future longitudinal research to examine the impact of smartphone addiction on the trajectory of cognitive and mental health outcomes over time. In addition, the reliance on parent-reported measures introduces potential biases and limits the generalizability of the findings. The inclusion of objective cognitive assessments and diverse participant samples could strengthen the validity of future studies. These findings underscore the importance of addressing smartphone overuse in children to safeguard their cognitive and emotional development. Interventions aimed at enhancing future-oriented cognitive abilities, such as episodic foresight and planning, may serve as effective strategies for mitigating the negative consequences of excessive device use. Moreover, these results highlight the need for educational and policy initiatives to promote healthy technology habits among children and their families.

In conclusion, the current study contributes to a growing body of evidence that links the

overuse of smartphones to negative outcomes in children's cognitive and mental health. By identifying the critical role of future-oriented cognition, these findings provide a basis for developing targeted interventions to enhance children's well-being and resilience in an increasingly digital world.

Disclosure statement

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