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No funding was received for this study. The authors declare no conflict of interest. The study received ethical approval. All participants provided informed consent.

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Screen-Time Exposure and Behavioral Problems in Early Childhood: A Cross-Sectional Survey of School Children

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ABSTRACT

Background: Children's screen exposure has increased substantially and may affect behavioral regulation during early school years, yet context-specific evidence in low- and middle-income settings remains limited. Objective: To evaluate the association between total daily screen time and behavioral difficulties among children aged 4–10 years in Lahore, Pakistan. Methods: A cross-sectional observational survey was conducted from January to August 2025 among 420 school-going children selected via multistage probability sampling. Parents reported average daily screen exposure and completed a standardized behavioral difficulties instrument generating total and domain scores. Group comparisons across <2, 2–4, and >4 hours/day were assessed using one-way ANOVA with post hoc testing, and associations were examined using correlation and adjusted regression controlling for prespecified sociodemographic covariates. Results: Mean age was 7.1 ± 1.8 years and mean screen time 3.2 ± 1.5 hours/day. Mean total behavioral difficulties increased across exposure categories: 10.2 ± 3.1 (<2 hours/day), 14.6 ± 4.5 (2–4 hours/day), and 18.7 ± 5.2 (>4 hours/day) ($p<0.001$). Screen time correlated positively with total difficulties ($r=0.62$, $p<0.001$) and remained independently associated after adjustment ($\beta=0.42$, $p<0.001$). Conclusion: Higher daily screen exposure was associated with substantially greater behavioral difficulties and less favorable domain profiles, supporting early family-centered guidance emphasizing moderated and purposeful screen use.

Keywords

Behavioral Problems; Child Development; Cross-Sectional Studies; Early Childhood; Pakistan; Screen Time; Social Behavior; Television; Video Display Terminals.

INTRODUCTION

Children's daily environments have been reshaped by the rapid normalization of televisions, smartphones, tablets, and computers, resulting in screen exposure becoming a routine feature of childhood rather than an occasional leisure activity (1). Contemporary cohort data indicate that substantial proportions of children in late childhood already accumulate multiple hours of daily screen use across devices and modalities, suggesting that exposure patterns are established early and may intensify as children progress through school and gain greater autonomy (1). This trend is clinically relevant because the ages of 4–10 years represent a period of active development in attention control, emotion regulation, and peer-directed social functioning, domains that are plausibly sensitive to lifestyle factors that alter sleep, activity patterns, and family interaction. Within this developmental window, screen time may operate as both an exposure and a behavioral context, varying by duration, timing, supervision, and competing opportunities for sleep and play.

An expanding literature links longer screen exposure with adverse behavioral and emotional profiles, although reported effects vary by age group, measurement approach, and contextual factors. In preschool populations, actigraphy-informed work has shown that screen time and sleep patterns are interrelated and jointly associated with behavioral problems, underscoring sleep as a plausible pathway through which screen habits may translate into daytime dysregulation (2). Recent evidence further suggests that sleep duration can moderate the association between screen time and emotional-behavioral problems, implying that the same exposure level may have different behavioral correlates depending on sleep sufficiency and related routines (3). Among school-aged children, cross-sectional findings have associated higher screen exposure with poorer academic performance and higher anxiety and behavioral problem indicators, reinforcing that screen time correlates with multi-domain functioning beyond purely leisure outcomes (4). Large-scale studies of 9–10-year-old children also report associations between screen exposure and mental health, social, and academic outcomes, supporting the importance of studying this age band with attention to functional and behavioral endpoints (5).

The relationship between screen exposure and behavioral outcomes is likely shaped by family context and home routines, which can influence both children's access to screens and the ways screens are used. Family-context analyses have demonstrated that associations between screen time and child behavior or health-related quality of life can vary depending on household characteristics, suggesting that sociodemographic and parenting-related factors may confound or modify observed relationships (6). Mechanistic observational research has also proposed circadian rhythm disruption as a mediating pathway linking screen use to internalizing and externalizing problems in young children, adding biologic plausibility to behavioral associations and emphasizing timing and routine, not only total exposure duration (7). In older youth, work on problematic patterns of social media use and mental health characteristics reinforces that digital engagement may become maladaptive in certain

contexts, though extrapolation to younger ages requires caution given developmental differences and the heterogeneous nature of "screen time" as an umbrella construct (8).

Despite this growing evidence base, two practical gaps remain salient for early school-age populations in low- and middle-income settings. First, many studies focus on preschoolers or adolescents, whereas the 4–10-year age range encompasses the transition into structured schooling, expanding peer exposure, and increasing independent media use, which may create distinct risk profiles and dose–response patterns. Second, culturally and contextually anchored data are limited in settings where household structures, schooling schedules, device-sharing norms, and parental mediation practices may differ from the environments in which much of the literature has been generated. Additionally, screen exposure is correlated with other lifestyle behaviors and household characteristics—including dietary patterns and sedentary time—that may track with broader developmental and health risks and therefore require explicit consideration as potential confounders when interpreting associations with behavior (9,10). Given the policy relevance of pediatric guidance on healthy media habits, there is a need for school-based data that quantify dose–response gradients and evaluate whether higher exposure levels are associated with clinically interpretable increases in behavioral difficulties within routine community settings.

Accordingly, this study examined school-going children aged 4–10 years in Lahore, Pakistan, to evaluate whether total daily screen exposure is associated with behavioral difficulties measured using a standardized behavioral screening framework. Using a priori exposure categories (<2 hours/day, 2–4 hours/day, and >4 hours/day) and complementary continuous analyses, the study tested the hypothesis that greater daily screen exposure is associated with higher total behavioral difficulty scores and less favorable subdomain profiles after adjustment for key child and household covariates.

MATERIAL AND METHODS

This cross-sectional observational study was conducted in Lahore, Pakistan, between January and August 2025 to evaluate the association between children's daily screen exposure and behavioral difficulties among school-going children aged 4–10 years. The sampling frame comprised primary schools across urban and semi-urban localities, selected to provide socioeconomic variation through inclusion of both public and private institutions. A multistage probability approach was applied in which schools were selected first, followed by proportional sampling of eligible children within grades to ensure representation across the target age range. Children were eligible if they were 4–10 years of age, enrolled in a participating school, and residing in the district for at least one year. Children were excluded if parents reported a prior clinical diagnosis of a neurodevelopmental or psychiatric disorder or a chronic medical condition likely to independently influence behavior or daily activity patterns, and only one child per household was enrolled to reduce within-family correlation.

The target sample size was estimated for a cross-sectional association study using a single-proportion approach based on an anticipated prevalence of behavioral difficulties of 30% among children with higher screen exposure, a 95% confidence level, and a 5% absolute precision, with inflation for non-response to reach a final target of 420 participants. Parents or primary caregivers were approached through the schools and provided written informed consent; assent was also obtained from older children in an age-appropriate manner. Data were collected via a structured parent-completed questionnaire that captured the child's sociodemographic characteristics and daily screen exposure across common devices. Screen exposure was operationalized as the average total daily hours spent on screens, calculated by combining parent-reported weekday and weekend exposure into a single daily estimate. For inferential comparisons, screen time was categorized a priori as <2 hours/day, 2–4 hours/day, and >4 hours/day to align with commonly applied thresholds in pediatric screen-time research and to facilitate dose–response interpretation across clinically meaningful exposure bands (11,12). Behavioral outcomes were assessed using a standardized behavioral difficulties framework that yields a total difficulties score and subdomain scores reflecting emotional symptoms, conduct problems, hyperactivity/inattention, peer problems, and prosocial behaviors; higher total difficulties scores indicate greater behavioral burden, while prosocial behavior is interpreted directionally as a protective social functioning indicator. Questionnaires were reviewed at the point of collection for completeness and internal consistency, and records with materially incomplete outcome data were excluded from inferential analyses to preserve scoring integrity.

The primary exposure was total daily screen time (hours/day) examined both continuously and categorically, and the primary outcome was the total behavioral difficulties score. Secondary outcomes were the behavioral subdomain scores to characterize which domains most strongly tracked with exposure gradients. Potential confounders were prespecified based on the literature on correlates and determinants of screen exposure and child behavior and included age, gender, parental education, and household income (1,6,13,14). These covariates were selected to reduce confounding by socioeconomic position and home environment factors known to correlate with both screen exposure opportunities and behavioral outcomes (1,6,13,14). To mitigate selection and information bias, standardized written instructions were provided to caregivers, data collectors were trained to ensure uniform administration and collection procedures, and questionnaires were completed privately to minimize social desirability pressure. Data were de-identified using numeric codes prior to entry, and double-entry verification with random checks was applied to reduce transcription error and maintain data integrity.

Statistical analysis was performed using IBM SPSS Statistics (version 26.0). Continuous variables were summarized as mean ± standard deviation and categorical variables as counts and percentages. Distributional assumptions were evaluated using the Shapiro–Wilk test alongside visual inspection of histograms and Q–Q plots. The association between screen time (hours/day) and total behavioral difficulties score was quantified using Pearson's correlation coefficient with two-sided significance testing. Group differences in total and subscale scores across the three screen-time categories were assessed using one-way analysis of variance with Tukey post hoc comparisons to identify pairwise differences while controlling the familywise error rate. A multiple linear regression model was specified a priori with the total difficulties score as the dependent variable and screen time as the primary independent variable, adjusted for age, gender, parental education, and household income. Regression diagnostics included evaluation of linearity, homoscedasticity, residual normality, and influential observations, and multicollinearity was assessed using variance inflation factors. Because participants were sampled within schools, model inference accounted for potential within-school clustering by applying robust (cluster-adjusted) standard errors at the school level where feasible within the analytic workflow. Statistical significance was set at $p < 0.05$ for primary analyses, and subdomain analyses were interpreted as secondary with emphasis on effect sizes and confidence intervals rather than sole reliance on p-values.

Ethical safeguards included voluntary participation, confidentiality protections, and storage of de-identified data. All analyses were conducted on aggregate data, and no individual-level identifiers were included in any reports or outputs.

RESULTS

A total of 420 children aged 4–10 years were included (mean age 7.1 ± 1.8 years). Males constituted 51.9% (n=218) and females 48.1% (n=202). Most caregivers reported graduate-level education (63.1%, n=265). Mean household monthly income was PKR 82,400 ± 25,600, and mean daily screen exposure was 3.2 ± 1.5 hours/day. Screen-time distribution showed 28.1% (n=118) with <2 hours/day, 45.9% (n=193) with 2–4 hours/day, and 26.0% (n=109) with >4 hours/day (Table 1).

Behavioral difficulty increased in a clear exposure gradient. Mean SDQ total difficulties rose from 10.2 ± 3.1 in children exposed to <2 hours/day to 14.6 ± 4.5 in the 2–4 hours/day group and 18.7 ± 5.2 in those with >4 hours/day, representing an absolute increase of 8.5 points between the highest and lowest exposure groups (95% CI 7.37 to 9.63). Overall group differences were statistically significant (one-way ANOVA F=29.4, p<0.001), with a moderate-to-large variance explanation (η^2=0.124) (Table 2). Pairwise comparisons indicated statistically significant separation between all screen-time categories, with large standardized effects: 2–4 vs <2 hours/day (Hedges g=1.09), >4 vs <2 hours/day (g=2.00), and >4 vs 2–4 hours/day (g=0.86) (Table 4).

Subscale analyses demonstrated that increasing screen exposure tracked consistently with higher emotional symptoms, conduct problems, hyperactivity/inattention, and peer problems, alongside lower prosocial behavior. For example, hyperactivity/inattention increased from 3.0 ± 1.2 (<2 hours/day) to 4.2 ± 1.5 (2–4 hours/day) and 5.1 ± 1.6 (>4 hours/day), with a strong overall group effect (F=60.32, p<0.001; η^2=0.224). Prosocial behavior declined from 7.4 ± 1.3 (<2 hours/day) to 6.9 ± 1.5 (2–4 hours/day) and 6.2 ± 1.4 (>4 hours/day), also significant overall (F=20.37, p<0.001; η^2=0.089). Pairwise effects for >4 vs <2 hours/day were largest for total difficulties (g=2.00), followed by hyperactivity/inattention (g=1.49) and conduct problems (g=1.38), while prosocial behavior showed a negative effect (g=-0.89), indicating clinically unfavorable social-functioning shifts with heavier exposure (Tables 3–4).

Table 1. Demographic Characteristics of Participants (n=420)

Variable	Value
Age (years), mean ± SD	7.1 ± 1.8
Gender, n (%)	
• Male	218 (51.9)
• Female	202 (48.1)
Parental education, n (%)	
• Graduate	265 (63.1)
• Non-graduate	155 (36.9)
Monthly household income (PKR), mean ± SD	82,400 ± 25,600
Screen time (hours/day), mean ± SD	3.2 ± 1.5

Table 2. Screen-Time Categories and SDQ Total Difficulties (n=420)

Screen time category	n (%)	Mean SDQ total ± SD	95% CI of mean
<2 hours/day	118 (28.1)	10.2 ± 3.1	9.63 to 10.77
2–4 hours/day	193 (45.9)	14.6 ± 4.5	13.96 to 15.24
>4 hours/day	109 (26.0)	18.7 ± 5.2	17.71 to 19.69
One-way ANOVA	—	F=29.4; p<0.001	η^2=0.124

Table 3. Mean SDQ Subscale Scores by Screen-Time Category, With Overall Group Tests

SDQ domain	<2 hours/day (n=118) mean ± SD	2–4 hours/day (n=193) mean ± SD	>4 hours/day (n=109) mean ± SD	One-way ANOVA (F, p)	η^2
Emotional symptoms	2.1 ± 1.3	2.8 ± 1.5	3.7 ± 1.6	33.49, p<0.001	0.138
Conduct problems	1.5 ± 1.0	2.4 ± 1.1	3.1 ± 1.3	57.57, p<0.001	0.216
Hyperactivity/inattention	3.0 ± 1.2	4.2 ± 1.5	5.1 ± 1.6	60.32, p<0.001	0.224
Peer problems	1.8 ± 0.9	2.5 ± 1.1	3.2 ± 1.4	43.01, p<0.001	0.171
Prosocial behavior	7.4 ± 1.3	6.9 ± 1.5	6.2 ± 1.4	20.37, p<0.001	0.089

Table 4. Pairwise Comparisons Across Screen-Time Categories (Mean Difference, 95% CI, p-value, Effect Size)

Mean difference is Group A − Group B; positive values indicate higher scores in Group A.

Outcome	Group A vs Group B	Mean difference	95% CI	p-value	Hedges g
SDQ total	<2 h vs 2–4 h	-4.4	-5.25 to -3.55	<0.001	-1.09
	<2 h vs >4 h	-8.5	-9.63 to -7.37	<0.001	-2.00
	2–4 h vs >4 h	-4.1	-5.27 to -2.93	<0.001	-0.86
Emotional symptoms	<2 h vs 2–4 h	-0.7	-1.02 to -0.38	<0.001	-0.50
	<2 h vs >4 h	-1.6	-1.96 to -1.24	<0.001	-1.10
	2–4 h vs >4 h	-0.9	-1.26 to -0.54	<0.001	-0.59
Conduct problems	<2 h vs 2–4 h	-0.9	-1.13 to -0.67	<0.001	-0.83
	<2 h vs >4 h	-1.6	-1.90 to -1.30	<0.001	-1.38
	2–4 h vs >4 h	-0.7	-1.00 to -0.40	<0.001	-0.55
Hyperactivity/inattention	<2 h vs 2–4 h	-1.2	-1.53 to -0.87	<0.001	-0.87
	<2 h vs >4 h	-2.1	-2.48 to -1.72	<0.001	-1.49

Outcome	Group A vs Group B	Mean difference	95% CI	p-value	Hedges g
	2–4 h vs >4 h	-0.9	-1.28 to -0.52	<0.001	-0.57
Peer problems	<2 h vs 2–4 h	-0.7	-0.93 to -0.47	<0.001	-0.71
	<2 h vs >4 h	-1.4	-1.71 to -1.09	<0.001	-1.20
	2–4 h vs >4 h	-0.7	-1.02 to -0.38	<0.001	-0.52
Prosocial behavior	<2 h vs 2–4 h	0.5	0.18 to 0.82	0.002	0.35
	<2 h vs >4 h	1.2	0.85 to 1.55	<0.001	0.89
	2–4 h vs >4 h	0.7	0.33 to 1.07	<0.001	0.48

Table 5. Multiple Linear Regression for Predictors of SDQ Total Difficulties (Adjusted Model)

Predictor	β coefficient	95% CI	SE (derived from CI)	p-value
Total screen time (hours/day)	0.42	0.35 to 0.49	0.036	<0.001
Age (years)	0.11	0.03 to 0.18	0.038	0.006
Gender (male)	0.08	-0.02 to 0.19	0.054	0.140
Parental education (graduate)	-0.15	-0.25 to -0.05	0.051	0.003

Correlation analysis showed a strong positive association between total screen exposure and SDQ total difficulties (r=0.62, p<0.001). In the adjusted model, screen time remained independently associated with higher behavioral difficulties (β=0.42, 95% CI 0.35 to 0.49, p<0.001), while parental graduate education showed an inverse association (β=-0.15, 95% CI -0.25 to -0.05, p=0.003). Age was positively associated with total difficulties (β=0.11, 95% CI 0.03 to 0.18, p=0.006), whereas male gender was not statistically significant (β=0.08, 95% CI -0.02 to 0.19, p=0.140) (Table 5).

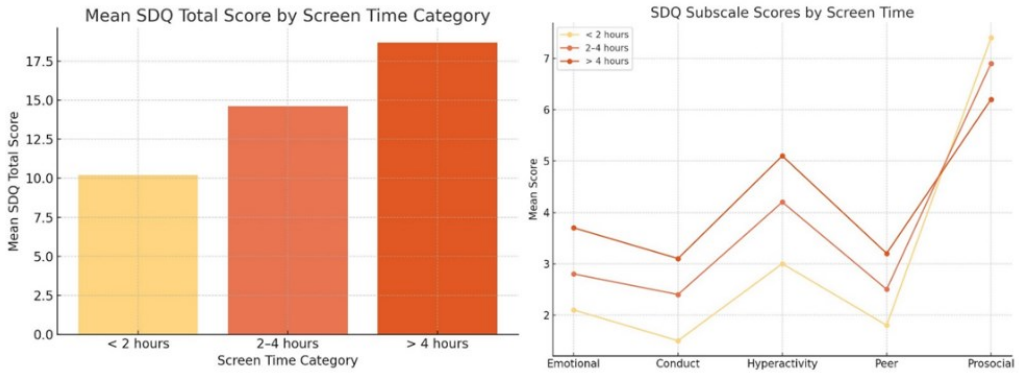

Figure 2. Mean SDQ Total and Subscale Scores by Screen-Time Category

The left panel shows a progressive increase in mean SDQ total difficulties scores across screen-time categories (<2 hours/day, 2–4 hours/day, and >4 hours/day). The right panel displays parallel domain-wise trends, with higher screen exposure associated with increased emotional symptoms, conduct problems, hyperactivity/inattention, and peer problems, alongside reduced prosocial behavior. Mean SDQ total difficulties increased in a clear dose–response pattern from 10.2 in children exposed to <2 hours/day to 14.6 in those exposed to 2–4 hours/day and 18.7 among children with >4 hours/day. Subscale patterns showed consistent worsening with longer exposure, particularly for hyperactivity/inattention and conduct problems, while prosocial behavior declined progressively as screen time increased.

DISCUSSION

The present findings demonstrate a consistent, exposure-graded association between higher daily screen time and greater behavioral difficulties among children aged 4–10 years, with a stepwise increase in SDQ total difficulties across <2 hours/day, 2–4 hours/day, and >4 hours/day categories. The magnitude of differences was clinically notable, including very large standardized effects for total difficulties and for domains that directly influence classroom functioning and peer interactions, particularly hyperactivity/inattention and conduct problems. This pattern is concordant with prospective and cross-sectional evidence indicating that higher screen exposure is associated with more disruptive-behavior profiles and broader mental health and functional challenges in school-aged children, even when accounting for key sociodemographic correlates (15). It also aligns with observations from large pediatric datasets showing that screen-related exposures co-occur with less favorable social and academic outcomes during the 9–10-year developmental period, supporting the relevance of this age band for targeted prevention and family guidance (5).

Several pathways may plausibly explain the observed gradient without implying causality. Screen time may displace developmentally protective activities such as physically active play, reading, family conversation, and peer engagement, thereby reducing opportunities to practice emotional regulation and social problem-solving. Sleep disruption remains a particularly plausible mediator; actigraphy-based work in young children has linked screen exposure and sleep patterns to behavioral problems, and emerging evidence indicates that sleep duration can modify the strength of associations between screen time and emotional-behavioral difficulties (2,3). Circadian and routine disruption may further contribute, as suggested by research proposing circadian rhythm effects as intermediate mechanisms between screen use and internalizing/externalizing symptoms in early childhood (7). In this context, the observed decline in prosocial behavior at higher exposure levels may be clinically meaningful, because prosociality reflects cooperative and empathic behaviors that are reinforced through face-to-face play and adult-guided interaction, both of which can be reduced by prolonged or unsupervised screen engagement.

The family environment likely shapes both exposure and outcome, and the inverse association observed for parental graduate education is consistent with work indicating that family context and home routines can influence the relationship between screen time and child behavioral and

quality-of-life outcomes (6). Parental education may serve as a proxy for several protective factors, including structured routines, media co-viewing, content selection, and consistent behavioral boundaries around device use. At the same time, screen exposure is not a unitary construct; passive viewing and algorithm-driven short-form content may have different correlates than supervised educational programming or interactive learning. This heterogeneity is important because some evidence suggests that broader lifestyle patterns—diet quality, sedentary time, and home media availability—cluster with screen exposure and may contribute to confounding if not measured directly (9,10). Accordingly, the current findings should be interpreted as robust associations that warrant preventive attention, while recognizing that duration alone does not capture timing, content, interactivity, or the social context of use.

These results have practical implications for child health promotion in Pakistan, where rapid growth in smartphone availability and changing household media norms may expose younger children to extended unsupervised screen use, particularly in urban and semi-urban settings. The clear dose–response gradient across exposure categories suggests that counseling messages framed around achievable thresholds and structured routines may be useful. Given that the strongest domain effects were observed in behavioral self-regulation and conduct, integrating brief screen-time screening into school health programs and pediatric visits could help identify at-risk children and facilitate early family-centered guidance. However, the findings also underscore the need to distinguish "total exposure" from "problematic exposure," as problematic patterns of screen engagement have been linked with adverse mental health characteristics in youth, and intervention strategies should prioritize the context and function of screen use, not solely duration (8). Future studies in this setting should incorporate longitudinal designs, objective or device-logged exposure metrics, and key mediators such as sleep duration/quality, physical activity, and parental mediation practices, allowing stronger causal inference and more actionable intervention targets.

Important limitations should be acknowledged. The cross-sectional design precludes determination of directionality; children with pre-existing behavioral vulnerabilities may be more likely to engage in prolonged screen use, creating potential reverse causality. Exposure and outcomes were parent-reported, introducing potential recall and social desirability bias. Although adjustment was performed for several covariates, residual confounding is likely given that sleep parameters, content type, parental monitoring, and physical activity were not directly modeled. Additionally, sampling within schools can introduce clustering effects that may narrow standard errors if not accounted for analytically. Despite these limitations, the consistent monotonic gradient across exposure categories and across multiple SDQ domains supports the internal coherence of the observed association and highlights the clinical relevance of screen-time moderation during early school years.

CONCLUSION

In children aged 4–10 years, higher daily screen exposure was associated with progressively higher behavioral difficulty scores and less favorable SDQ domain profiles, with the largest differences observed in hyperactivity/inattention and conduct problems and a concurrent decline in prosocial behavior; these findings support the clinical value of early, family-centered screen-time guidance that emphasizes moderated duration, structured routines, and purposeful use, while reinforcing the need for longitudinal and context-sensitive research to clarify causal pathways and intervention targets.

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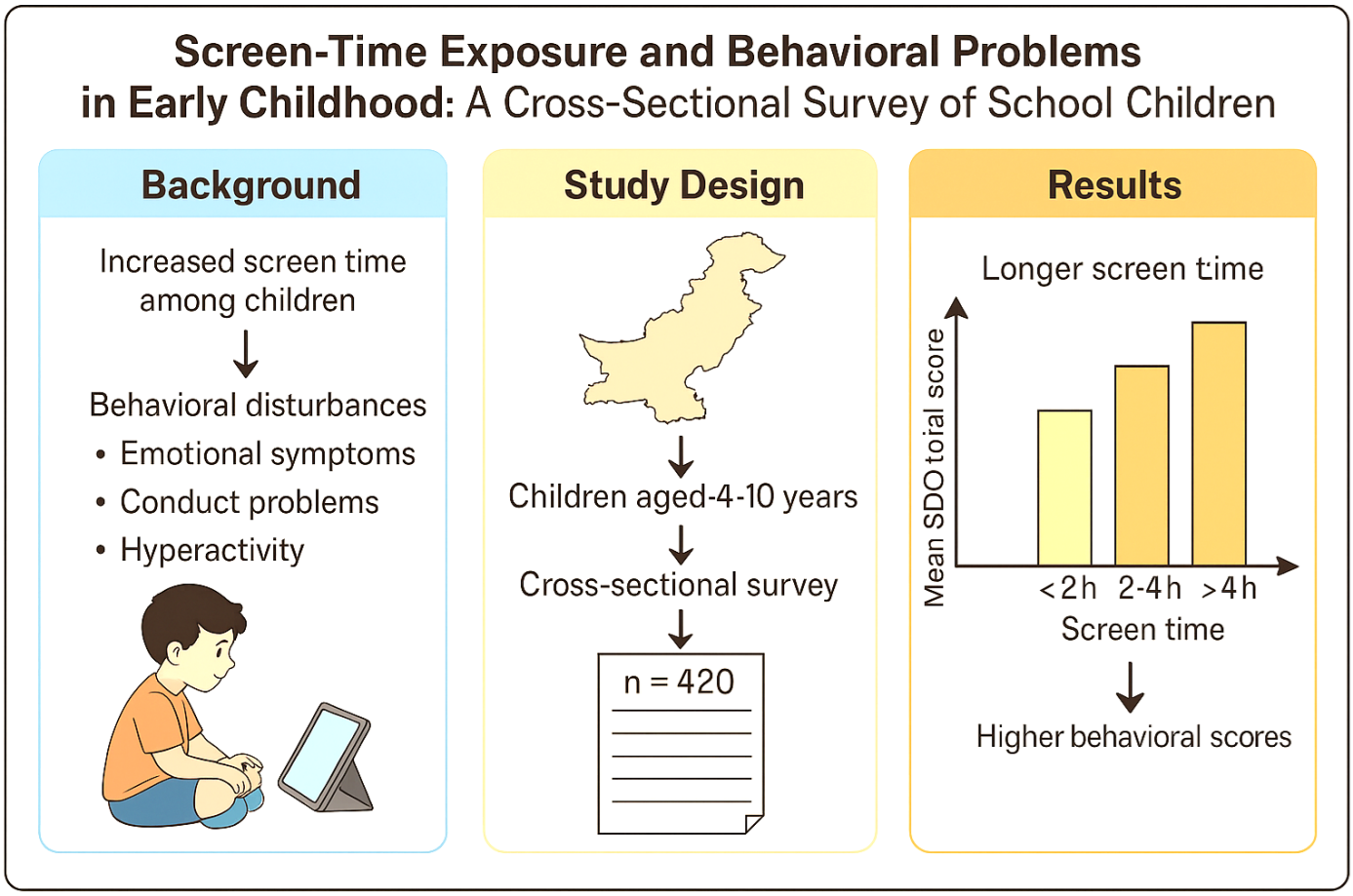

Figure 1 Graphical Abstract