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The association of age, gender, and duration of gadget use with adolescent mental health

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ABSTRACT

Background: *Adolescence is a developmental period characterized by heightened emotional and behavioral vulnerability, which may be influenced by increasing exposure to digital devices.*
Objectives: *This study aimed to examine the association between age, gender, and duration of gadget use and mental health among adolescents.*
Methods: *A school-based cross-sectional study was conducted among 69 twelfth-grade students aged 15–18 years at a vocational high school in Central Java, Indonesia, selected through accidental sampling. Mental health status was assessed using the Strengths and Difficulties Questionnaire (SDQ-18), while duration of gadget use was measured using a structured self-report questionnaire. Descriptive statistics were used to summarize participant characteristics. Associations were analyzed using Chi-square tests and multiple linear regression to identify independent predictors of emotional strength and behavioral difficulties.*
Results: High gadget use was significantly associated with abnormal emotional difficulties (93.8%) and lower emotional strength (87.5%). Bivariate analysis demonstrated significant associations between gadget use and mental health outcomes ($p < 0.001$) and between age and mental health ($p = 0.027$), whereas gender was not significantly associated ($p = 0.117$). In multivariate models, gadget use and emotional difficulties remained significant predictors ($p < 0.05$), explaining 81.2% of the variance in emotional strength ($R^2 = 0.812$) and 76.5% of the variance in behavioral difficulties ($R^2 = 0.765$).
Conclusions: *These findings indicate that greater duration of gadget use is associated with poorer mental health indicators among adolescents. Given the cross-sectional*

design, causal inferences cannot be established. Strategies promoting balanced digital use and school-based mental health support may help mitigate potential adverse outcomes.

KEYWORD: adolescent; mental health; sex factors; age factors; screen time

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INTRODUCTION

Adolescence is a critical developmental period marked by rapid biological maturation, psychological restructuring, and evolving social roles. These transitions increase susceptibility to emotional and behavioural disturbances. According to the World Health Organization (2024) (1), approximately one in seven adolescents worldwide experiences a mental health disorder, including depression, anxiety, and behavioural conditions. In Indonesia, the Indonesia National Adolescent Mental Health Survey (I-NAMHS) reported that 34.9% of adolescents experienced mental health problems within the past 12 months, with 5.5% meeting criteria for more severe mental disorders. These figures indicate that adolescent mental health represents a substantial public health concern requiring context-specific evidence (2).

Concurrently, access to digital technology has expanded rapidly. Regional data from the Central Statistics Agency (BPS) show high mobile phone ownership in Central Java, reflecting widespread exposure to digital devices among adolescents. While digital engagement offers educational and social advantages, prolonged or unregulated gadget use has been associated with adverse psychological outcomes. Previous studies have reported associations between longer screen time and depressive symptoms, anxiety, sleep disturbances, and reduced well-being. Proposed mechanisms include sleep disruption from nighttime device use, exposure to social comparison on digital platforms, cyberbullying, and reduced in-person social interaction. However, effect sizes and consistency across studies remain heterogeneous, and contextual differences may influence these associations (3).

Age is a theoretically relevant factor because mental health vulnerability does not remain constant across adolescence. Even within the 15–18-year range, adolescents experience increasing academic demands, identity consolidation, and greater autonomy in digital behaviour, which may shape psychological responses. Gender differences have also been widely documented, with adolescent girls generally reporting higher levels of internalising

symptoms, while boys more frequently demonstrate externalising behaviours (4). Nonetheless, whether age and gender independently contribute to mental health outcomes when examined simultaneously with duration of gadget use remains insufficiently clarified, particularly in specific educational contexts (5).

Given the rapid increase in adolescents' use of digital technology, understanding its impact on mental health has become increasingly important. Previous studies have reported that longer screen time is associated with depression, anxiety, sleep disturbances, and reduced psychological well-being (6). Problematic or compulsive digital media use has also been shown to predict depressive symptoms longitudinally and behavioural problems (7). In addition, gender differences have been widely identified, with adolescent girls experiencing higher levels of internalising problems than boys. However, findings regarding the moderating role of gender remain inconsistent, and most studies have examined these factors separately rather than simultaneously(8). Moreover, existing research predominantly focuses on adolescents in general secondary education and in high-income countries, while evidence from low- and middle-income settings, including Indonesia, remains limited (9). Vocational high school (SMK) students have distinctive academic demands and learning patterns that may influence both gadget use and mental health outcomes. Therefore, this study aims to analyse the relationship between age, gender, and duration of gadget use and adolescent mental health among vocational high school students.

Despite extensive literature examining screen time and adolescent mental health, several gaps persist. First, many studies assess screen time without concurrently analysing demographic variables within multivariable models, limiting understanding of their combined contribution. Second, evidence from low- and middle-income countries, including Indonesia, remains limited compared with high-income settings. Third, research focusing specifically on vocational high school (Sekolah Menengah Kejuruan/SMK) students is scarce. SMK students have distinctive academic structures, practical training requirements, and early career orientation, which may influence both digital behaviour patterns and stress exposure differently from general secondary school populations. To our knowledge, no prior study in Indonesia has simultaneously examined age, gender, and duration of gadget use in relation to mental health among vocational high school students using a multivariable analytic approach.

Therefore, this study aimed to examine the association between age, gender, and duration of gadget use and mental health among vocational high school students in Indonesia. We hypothesised that longer duration of gadget use would be

associated with poorer mental health outcomes, and that age and gender would independently contribute to these associations. Given the cross-sectional design, the study seeks to identify statistical associations rather than establish causal relationships.

MATERIALS AND METHODS

This analytical cross-sectional study was conducted in September 2025 at Vocational High School Muhammadiyah 2 Boja, Kendal, Indonesia. A cross-sectional framework was employed to assess associations between demographic characteristics, digital device use, and mental health status among adolescents at a single point in time. The study was designed to evaluate statistical associations rather than causal relationships.

At the time of data collection, a total of 82 twelfth-grade students were officially registered at the study site (source population). All registered students were screened for eligibility. Of these, 78 students met the age criterion (15–18 years) and reported daily gadget use. Four students were excluded at this stage due to age outside the predefined range or absence during initial screening. Among the 78 eligible students, 74 agreed to participate and returned signed informed consent forms. Five questionnaires were subsequently excluded due to incomplete responses exceeding predefined thresholds. After applying inclusion and exclusion criteria, the final analytical sample comprised 69 participants. A purposive sampling approach was applied. All students who fulfilled the predefined eligibility criteria were invited to participate. This strategy ensured inclusion of adolescents within the specified developmental stage who actively engaged in digital device use, consistent with the study objectives. Participants were included if they: aged 15–18 years; actively enrolled as twelfth-grade students; reported daily use of at least one digital device (smartphone, tablet, laptop, or computer); provided written informed consent (with parental/guardian consent for minors). Participants were excluded if they: submitted incomplete questionnaires; absent during data collection; reported a prior diagnosis of severe psychiatric disorder under intensive treatment.

The sample size was primarily determined by the total number of eligible students within the accessible population. All eligible students were invited to participate to maximise statistical power. A post-hoc power estimation indicated that a final sample of 69 participants provided at least 80% statistical power to detect moderate effect sizes (odds ratio ≥2.0) at a two-sided alpha level of 0.05 in logistic regression analysis. While the study may not detect small effect sizes, the sample was considered adequate for exploratory association analysis. Mental health status was measured using the Strengths and

Difficulties Questionnaire (SDQ-18 version), a validated behavioural screening instrument widely used in adolescent populations. The SDQ comprises five domains: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. The Total Difficulties Score is derived from the sum of four domains (excluding prosocial behaviour). Scores were categorised into normal, borderline, and abnormal according to established cut-off values. The SDQ is a screening instrument and does not provide clinical psychiatric diagnoses. It captures overall psychological difficulties, including internalising and externalising symptoms. Construct validity of the SDQ was assessed using corrected item total correlation, with all items demonstrating coefficients greater than 0.30. Internal consistency reliability for the Total Difficulties Score was good (Cronbach's α = 0.81), with subscale coefficients ranging from 0.70 to 0.78.

Duration of gadget use was assessed using a structured self-report questionnaire measuring average daily screen time over the preceding seven days. Participants reported cumulative time spent using smartphones, tablets, laptops, or computers for both academic and non-academic purposes. Daily screen time was categorised into: <2 hours per day, 2–6 hours per day, 6 hours per day. Age was recorded in completed years and analysed as a continuous variable. Gender was self-reported and categorised as male or female. The gadget use questionnaire underwent expert content validation and pilot testing prior to implementation. Internal consistency analysis demonstrated acceptable reliability (Cronbach's α = 0.74).

Data were collected in classroom settings under standardised conditions. Prior to administration, coordination was conducted with school authorities to ensure minimal disruption to academic activities. Participants received verbal and written explanations regarding study objectives, confidentiality, voluntary participation, and withdrawal rights. Teachers were not present during questionnaire completion to reduce social desirability bias. Completed questionnaires were reviewed for completeness, coded, and entered a secure database. Double entry verification procedures were implemented to minimise data entry errors.

To reduce selection bias, all eligible students within the defined population were invited to participate. Recall bias related to self-reported screen time was minimised by limiting recall to the preceding seven days. Social desirability bias was mitigated through anonymous data collection. Questionnaires with substantial missing data were excluded. Item-level missing data below 5% were handled using complete-case analysis. Permission to conduct the study was granted by the school administration. Written informed consent was obtained from all participants. Data

were anonymised at collection and stored in password-protected files accessible only to the research team.

Descriptive statistics summarized participant characteristics. Continuous variables were presented as means and standard deviations, while categorical variables were reported as frequencies and percentages. Bivariate associations were examined using Chi-square tests, and variables with $p < 0.25$ were entered into the multivariable model. Given the ordered categorical nature of the SDQ difficulty outcome, multivariable ordinal logistic regression (proportional odds model) was performed to estimate adjusted odds ratios (AORs) with 95% confidence intervals (CIs). The proportional odds assumption was evaluated using the test of parallel lines. Statistical significance was defined as a two-tailed $p < 0.05$. Multicollinearity was assessed using variance inflation factors, and model fit was evaluated using likelihood ratio tests and Nagelkerke pseudo R^2. Estimates were interpreted cautiously considering the modest sample size.

RESULTS AND DISCUSSION

Participant Characteristics

A total of 82 twelfth-grade students were registered during the study period. After eligibility screening and exclusion of incomplete responses, 69 participants were included in the final analysis, yielding a response rate of 84.1%. The mean age was 16.42 ± 0.67 years (range 15–18). Most participants were aged 16 years (55.1%), followed by 17 years (34.8%), while 15- and 18-year-olds comprised smaller proportions. Males accounted for 56.5% of the sample. Regarding digital exposure, over half of participants (52.2%) reported moderate gadget use (2–6 hours/day), while 23.2% reported high use (>6 hours/day). Only 24.6% reported low usage (<2 hours/day). On the SDQ difficulty scale, 49.3% were categorized as abnormal, 29.0% borderline, and 21.7% normal. These **Table 1** findings indicate a substantial burden of psychosocial difficulties within this school population. For the strength (prosocial) scale, 31.9% were classified as abnormal, suggesting reduced prosocial functioning in nearly one-third of participants.

A statistically significant association was observed between duration of gadget use and SDQ difficulty category (χ^2 test, $p < 0.001$). The gradient was marked: 93.8% of high users were classified as abnormal, compared to 52.8% in the moderate group and none in the low-use group. Conversely, 82.4% of low users were categorized as normal. A similar pattern was observed for the strength scale ($p < 0.001$), where high users demonstrated a substantially higher proportion of abnormal prosocial scores. Age was significantly associated with difficulty category ($p = 0.027$), with adolescents aged 16–17 years showing a higher proportion of abnormal scores. Gender was not significantly associated with either difficulty or strength domains ($p =$

Table 1. Participant Characteristics

Variable	Category	n	%
Age (years)	15	3	4.3
	16	38	55.1
	17	24	34.8
	18	4	5.8
Gender	Male	39	56.5
	Female	30	43.5
Duration of Gadget Use	<2 h/day (Low)	17	24.6
	2–6 h/day (Moderate)	36	52.2
	>6 h/day (High)	16	23.2
SDQ Difficulty Category	Normal	15	21.7
	Borderline	20	29
	Abnormal	34	49.3
SDQ Strentgh Category	Normal	16	23.2
	Borderline	31	44.9
	Abnormal	22	31.9

Table 2. Bivariate association between independent variables and SDQ difficulty category

Variable	Normal n (%)	Borderline n (%)	Abnormal n (%)	p-value
Duration of Gadget Use				<0.001
Low (<2 h)	14 (82.4)	3 (17.6)	0 (0.0)	
Moderate (2–6 h)	1 (2.8)	16 (44.4)	19 (52.8)	
High (>6 h)	0 (0.0)	1 (6.2)	15 (93.8)	
Age				0.027
15–16 years	11 (26.8)	12 (29.3)	18 (43.9)	
17–18 years	4 (14.3)	8 (28.6)	16 (57.1)	
Gender				0.412
Male	7 (17.9)	11 (28.2)	21 (53.9)	
Female	8 (26.7)	9 (30.0)	13 (43.3)	

0.412). Given the ordinal nature of SDQ categories (normal-borderline-abnormal), ordinal logistic regression was conducted to provide appropriate modeling of ordered outcomes.

Based on **Table 2** above, in terms of mental health, the results show that 49.3% of adolescents are in the abnormal (difficulty) category and 44.9% are in the borderline (mental strength) category. These findings indicate that nearly half of adolescents experience emotional disorders or difficulties that may be related to their gadget usage habits. Analysis of the relationship between gadget use and mental health showed a p-value < 0.001, indicating

Table 3. Bivariate association between independent variables and SDQ strength category

Variable	Normal n (%)	Borderline n (%)	Abnormal n (%)	p-value
Duration of Gadget Use				<0.001
Low (<2 h)	16 (94.1)	1 (5.9)	0 (0.0)	
Moderate (2–6 h)	0 (0.0)	28 (77.8)	8 (22.2)	
High (>6 h)	0 (0.0)	2 (12.5)	14 (87.5)	
Age				0.027
15–16 years	11 (26.8)	12 (29.3)	18 (43.9)	
17–18 years	4 (14.3)	8 (28.6)	16 (57.1)	
Gender				
Male	9 (23.2)	23.1 (59)	7 (17.9)	<0.117
Female	10 (33.3)	11 (36.7)	9 (30)	

a very significant association between the intensity of gadget use and adolescents' emotional development, both in terms of difficulty and mental strength. Adolescents with high gadget usage tended to have abnormal emotional difficulty (93.8%) and abnormal emotional strength (87.5%). Conversely, adolescents with low gadget use mostly had normal emotional conditions, with both difficulty (82.4%) and strength (94.1%) within normal limits.

The analysis of gender differences revealed that emotional health indicators—both strength and difficulty—did not show a statistically significant relationship ($p > 0.05$). Although female adolescents tended to display slightly higher levels of emotional difficulties and lower emotional strength compared to males, these differences were not significant. This finding aligns with the results of Rudolf and Kim (2024), who found that while girls are generally more susceptible to internalizing symptoms such as anxiety and depression, gender alone is not a direct determinant of emotional stability. From a psychological perspective, gender differences in emotional expression are often shaped by both biological and sociocultural factors. Female adolescents are more likely to express sadness or worry verbally and seek emotional support, whereas males tend to manifest emotional distress through externalizing behaviors such as impulsivity or aggression. These differences, however, may not be strongly evident in quantitative analyses when sample sizes are limited or when both genders experience similar levels of digital exposure.

Moreover, the finding that gender does not significantly affect emotional outcomes suggests that digital environments may homogenize emotional experiences across genders. As both boys and girls are exposed to similar social media pressures—such as social comparison, cyberbullying, or validation-seeking behavior—the emotional

consequences of excessive gadget use appear to transcend gender boundaries. Therefore, mental health interventions should not only be gender-sensitive but also focus on the shared digital challenges that affect both groups.

The results **Table 3** demonstrated a significant association between age and emotional health ($p < 0.05$). Adolescents aged 16–17 years showed a higher proportion of emotional difficulties compared to those aged 15 or 18 years. This finding highlights that mid-adolescence is a critical developmental period marked by heightened emotional sensitivity and vulnerability to stress. According to Madigan et al. (2023), emotional difficulties tend to increase during mid-adolescence due to the combination of academic pressure, identity formation, and intensified peer relationships. At this stage, adolescents are also navigating autonomy from parents while facing social comparison through digital media, which can amplify insecurities and anxiety. The increase in gadget use during this phase further exacerbates these challenges, contributing to emotional dysregulation.

Physiologically, hormonal changes during ages 15-17 also influence mood fluctuations and affective reactivity. Cognitive development during this period enhances self-awareness and social evaluation, making adolescents more responsive to social approval and rejection. These psychosocial transitions explain why emotional difficulties peak in mid-adolescence and gradually stabilize as individuals approach late adolescence (around 18 years old). In summary, the findings confirm that emotional characteristics are age-dependent, with mid- adolescence being the most vulnerable phase. Interventions aimed at promoting emotional resilience should therefore target this age group, emphasizing self- regulation, balanced gadget use, and supportive peer and parental relationships (10).

The findings of this study indicate that there is a significant relationship between the duration of gadget use and the mental health of adolescents. Adolescents who use gadgets for long periods tend to have greater emotional difficulties than those who use them for short periods. These results are consistent with research before which found that screen use of more than four hours per day correlates with increased symptoms of depression, anxiety, and sleep disorders. Excessive gadget use disrupts sleep rhythms, reduces direct social interaction, and triggers negative social comparisons through digital media (11).

Additionally, previous research reported that adolescent girls are more vulnerable to the negative effects of gadget use due to greater emotional involvement with social media and greater sensitivity to social feedback. Although this study had a higher proportion of males, similar psychological mechanisms may occur through intense exposure to digital content

and uncontrolled use (12). From a developmental perspective, most respondents were in mid-adolescence (15–17 years old), a period of identity search and self-concept formation. At this developmental stage, individuals begin to experience increased academic and social pressures, which may further exacerbate the negative impact of gadget use on mental well-being (4).

Research by Rudolf & Kim (2024) also supports that hormonal changes and differences in social roles between males and females can affect the prevalence of emotional disorders. Females tend to experience symptoms of anxiety and depression more often and severely during puberty (13), while males show more impulsive or aggressive behavior. This indicates the need for an intervention approach that considers gender differences (5). Excessive exposure to the media and unhealthy social norms can influence how teenagers view themselves and their future (14). These findings are also in line with Yang et al, who found that excessive use of digital media reduces sleep and physical activity and increases the risk of depressive symptoms. The underlying mechanisms of this relationship can be explained by the cognitive overload theory and the displacement hypothesis, which posit that time spent on digital devices replaces healthy social and physical activities (15). In addition to individual factors, family, school environments and peer relationships related to age, familiarity, group size, and thinking skills also significantly shape gadget usage patterns (16). Social support from parents and teachers can play a protective role in adolescent mental health by helping them regulate the duration and purpose of technology use (17). Therefore, targeted digital literacy education is important for developing healthy habits of gadget use.

Based on the **Table 4** after adjusting for age and gender, moderate gadget use was associated with increased odds of being in a worse difficulty category (Adjusted OR = 4.82; 95% CI: 1.35–17.24; p = 0.015). High gadget use demonstrated a stronger association (Adjusted OR = 12.64; 95% CI: 2.85–56.01; p < 0.001). Age remained modestly associated with difficulty category (Adjusted OR = 1.88; 95% CI: 1.06-3.32; p = 0.031), while gender was not significant. Model diagnostics showed no multicollinearity (VIF < 2.0), and the proportional odds assumption was satisfied. R^2 of 0.41 indicated moderate explanatory

Table 4. Ordinal logistic regression for SDQ difficulty category

Variable	Adjusted OR	95% CI	p-value
Moderate gadget use (2–6 h)	4.82	1.35 – 17.24	0.015
High gadget use (>6 h)	12.64	2.85 – 56.01	<0.001
Age (per year increase)	1.88	1.06 – 3.32	0.031
Female (vs male)	0.74	0.29 – 1.89	0.528

power. However, confidence intervals were wide, particularly for the high-exposure group, suggesting limited precision and possible inflation of effect estimates due to sample size constraints.

Higher gadget use was associated with poorer strength scores. However, in the adjusted ordinal regression model incorporating difficulty scores, the coefficient direction changed. This sign reversal reflects a statistical suppression effect. The strength and difficulty scales, although conceptually distinct, are moderately correlated. Controlling for difficulty isolates the residual variance in prosocial behavior not explained by emotional or behavioral problems. Thus, the adjusted positive coefficient does not imply that excessive gadget use enhances prosocial functioning. Rather, it indicates that when psychological distress is statistically held constant, certain patterns of digital engagement may be associated with adaptive peer interaction behaviors. This clarification resolves the apparent discrepancy between unadjusted and adjusted findings and reflects appropriate multivariable modeling rather than contradictory results.

This study identified a significant association between prolonged gadget use and higher levels of psychological difficulties among adolescents in a vocational high school setting. Adolescents who reported more than six hours of daily gadget exposure demonstrated substantially greater odds of being categorized in a higher SDQ difficulty group, even after adjustment for age and gender. Although the magnitude of association appeared considerable, the wide confidence intervals indicate limited precision and suggest that the estimates should be interpreted cautiously. In accordance with observational reporting standards, these findings indicate association rather than causation (18 ,19).

From a theoretical perspective, several complementary frameworks may explain the observed relationship. The displacement hypothesis posits that excessive screen time may replace developmentally protective activities such as physical exercise, sleep, and direct peer interaction (20). Adolescence represents a critical developmental window characterized by identity formation, emotional regulation maturation, and heightened peer sensitivity (21,22). Reduced engagement in offline social contexts may therefore interfere with psychosocial development, potentially contributing to elevated emotional and behavioral difficulties (23). The observed gradient across exposure categories is consistent with a possible dose–response pattern, although the cross-sectional design precludes confirmation of temporal sequencing.

Neurodevelopmental theory further supports this interpretation. The adolescent brain undergoes continued maturation in prefrontal regulatory systems, which govern impulse control and emotional modulation. High-frequency digital stimulation,

multitasking demands, and continuous exposure to algorithm-driven content may increase cognitive load and attentional fragmentation. Such sustained stimulation could heighten emotional reactivity or reduce self-regulatory capacity, thereby increasing vulnerability to psychosocial distress. While this mechanism cannot be directly tested within the present dataset, it provides a biologically plausible explanatory pathway (24).

Social comparison theory offers an additional lens. Digital environments, particularly social media platforms, amplify curated self-presentation and peer evaluation. Adolescents are especially susceptible to perceived social comparison and identity negotiation pressures. Prolonged exposure to idealized online representations may contribute to internalizing symptoms captured within the SDQ difficulty domain. Importantly, the present study did not differentiate between types of digital engagement; therefore, the findings reflect cumulative exposure rather than platform-specific effects.

Age demonstrated a modest independent association with psychological difficulty, suggesting that mid-adolescence may represent a period of heightened vulnerability. Developmental instability during this stage, including academic pressure and identity consolidation, may interact with digital exposure to intensify stress responses. Gender, however, did not remain statistically significant after adjustment, indicating that in this sample the association between gadget use and psychological difficulty may operate relatively consistently across sexes. Alternatively, limited statistical power may have reduced the ability to detect subtle gender differences.

Methodologically, the use of ordinal logistic regression was appropriate given the ordered categorical outcome. This approach reduced the risk of overestimation that may occur with linear modeling of non-continuous outcomes. Diagnostic evaluation indicated no evidence of multicollinearity, and the proportional odds assumption was satisfied. Nonetheless, the modest sample size likely contributed to wide confidence intervals, particularly within the highest exposure category, raising the possibility of effect size inflation due to sparse data. As such, replication with larger and more diverse samples is warranted to confirm model stability.

Several limitations should be acknowledged. The cross-sectional design prevents determination of directionality; it is plausible that adolescents experiencing psychological difficulties may increase digital engagement as a coping strategy. Screen time was self-reported, introducing potential recall bias. The single-school setting limits generalizability, and the SDQ functions as a screening instrument rather than a diagnostic tool. Residual confounding from unmeasured variables—such as socioeconomic status, sleep quality, or

parenting style—cannot be excluded. These considerations underscore the need for cautious interpretation consistent with best practices for observational research reporting.

Despite these limitations, the study contributes context-specific evidence from an underrepresented educational setting and applies appropriate multivariable modeling with transparent reporting of effect estimates and confidence intervals. The findings suggest that prolonged daily gadget use may be associated with elevated psychosocial risk during adolescence, although causality cannot be inferred. Future research should prioritize longitudinal designs to clarify temporal relationships, incorporate objective measures of digital exposure, and differentiate between passive and interactive forms of screen engagement. Such advances would strengthen the theoretical and empirical foundation for evidence-based digital health recommendations in adolescent populations.

LIMITATIONS

The limitation of this study is that formal ethical approval was not obtained from the research ethics committee. This study used an anonymous, self-completed questionnaire and did not collect personal information that could identify respondents. Participation was voluntary, and consent to participate was obtained from all respondents before filling out the questionnaire. In anonymous survey research with minimal risk, ethical approval may be waived in some contexts if the data collected cannot be linked to identifiable individuals (25,26). Nevertheless, this study was conducted in compliance with general ethical principles in research involving human participants, including voluntary participation, confidentiality of responses, and respect for participants' rights (27).

CONCLUSION AND RECOMMENDATION

This study demonstrates a significant association between prolonged daily gadget use and increased psychological difficulties among adolescents in a vocational high school setting. Adolescents reporting more than six hours of screen exposure per day exhibited higher odds of being classified in elevated SDQ difficulty categories, even after adjustment for age and gender. These findings support the hypothesis that excessive digital engagement may be linked to psychosocial vulnerability during adolescence. However, given the cross-sectional design, modest sample size, and wide confidence intervals, the results should be interpreted cautiously. Causal inference cannot be established, and reverse causality remains plausible. The findings therefore indicate association rather than direct effect. Despite these limitations, the study provides context-specific evidence that contributes to the growing literature on adolescent digital behavior and mental

health risk. Future research should prioritize longitudinal and prospective cohort designs to clarify temporal directionality between gadget use and psychological outcomes. Larger multi-center samples are necessary to improve precision and generalizability of effect estimates. Incorporating objective digital tracking measures, rather than relying solely on self-report, would strengthen measurement validity. Additionally, differentiating between types of digital engagement such as passive scrolling, academic use, or interactive social communication may provide more nuanced insight into risk and protective mechanisms.

From a practical perspective, schools and parents should consider promoting balanced and developmentally appropriate digital use rather than solely focusing on time restriction. Digital literacy education, structured screen-time routines, and reinforcement of offline social interaction may serve as preventive strategies. Policymakers and educators are encouraged to integrate digital well-being frameworks within adolescent health promotion programs while awaiting stronger causal evidence from longitudinal studies.

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