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Multidimensional predictors of adolescents' nonacademic digital media use in the United States: Insights from a bioecological perspective

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ABSTRACT

Using the revised bioecological model, we examined whether three broad factors predict adolescents' nonacademic media use, with the exception of TV: (a) process factors that highlight a child's fundamental and proximal interactional activities (e.g., eating meals together); (b) person factors (e.g., age, sex, ethnicity); and (c) contextual factors that delineate a child's immediate physical and social environments (such as family, school, and community). By analyzing a nationally representative cohort ($N = 22,454$) of U.S. parents/primary caregivers who completed surveys regarding their children, we identified specific process-person-contextual factors that predict adolescents' nonacademic screen time. Factors that positively predict screen time include, e.g., age, sex, ethnicity, BMI, anxiety. Those that negatively predict screen time include, e.g., sleep, physical activity, father's physical health, mother's mental health, eating meals together, sharing ideas with parents, the child's active participation in school activities and community service, school safety, and emotional support for parents. Further, we found one age-related developmental process; the beneficial impact of meal sharing on media use was more pronounced in younger adolescents. This underscores the importance of exploring not only individual characteristics but also the broader process and contextual factors that shape adolescents' nonacademic media use.

IMPACT SUMMARY

Prior state of knowledge: Prior research on adolescents' screen time primarily examined risk or protective factors at the individual level. In contrast, understanding the nuanced interplay among individual, familial, and broader contextual factors in shaping nonacademic media consumption is limited.

Novel contributions: We identified a comprehensive but understudied group of process, personal, and contextual factors and their intricate interactions that are pivotal in adolescents' media use. We

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also made critical theoretical contributions regarding family functioning in the promotion of healthy media practices.
Practical implications: Our results have important implications for effective and holistic interventions that support healthy media-use practices in adolescents. These include the promotion of adolescents' self-regulatory skills, healthy family lifestyles at home, and diverse activities at school and within the community.

Because of the rapid uptake of highly versatile new media devices, including computers, laptops, smartphones, iPads, and other mobile devices – excluding traditional platforms such as TV – the landscape of adolescents' media use (hereafter, new media) has shifted dramatically in recent years. Specifically, old media use is declining; 8th graders in 2016 reported spending 1 hour less per day watching TV than their counterparts did in the early 1990s (Twenge, Martin, et al., 2018). New media use, in contrast, has sharply increased: 45% of teenagers reported being online "almost constantly" in 2018 compared with 24% in 2015 (M. Anderson & Jiang, 2018; Lenhart, 2015). Relative to traditional media platforms, new media offer significant benefits, such as rapid social connection, real-time communication and interaction, and easy access to a vast array of information and entertainment. However, new media's capabilities can sometimes compromise academic progress and mental and physical health. Time spent on media for nonacademic purposes likely displaces time that could be devoted to other activities (D. R. Anderson & Kirkorian, 2015). Studies suggest that individuals who excessively engage in nonacademic screen activities, such as using screens to pass time or for entertainment purposes, are prone to spend less time on positive activities, such as physical exercise, social interactions, reading, or engaging in hobbies that yield beneficial outcomes (e.g., Busch et al., 2013). These findings highlight the distinction between academic and nonacademic media use, because nonacademic screen time (e.g., gaming, social networking, web browsing, content streaming, etc.) is more likely to evolve into problematic media use (Mathers et al., 2009). Specifically, using a longitudinal design, Gentile et al. (2011) found that more gaming by youths was associated with depression, anxiety, social phobias, and lower school performance. In analyzing data from two nationally representative surveys of U.S. adolescents ($N = 506{,}820$), Twenge, Martin, et al. (2018) found that adolescents with longer screen time on social media and smartphones reported more frequent mental health issues, such as depression and suicidal ideation. In considering potentially negative outcomes (see also Yang et al., 2020), it is crucial that we identify both the protective and risk predictors of nonacademic media use by adolescents. Further, in the context of rapidly changing societal environments, an essential research question emerges: How do various individual familial and broader contextual predictors not only uniquely but also interactively influence adolescents' nonacademic media consumption?

To this end, we drew on Bronfenbrenner's bioecological (i.e., process-person-context-time) framework (1977; 2005) to achieve two research objectives. First, our primary goal was to identify a range of pertinent ecological factors that may influence adolescents' nonacademic media consumption. These include not only demographic (i.e., age, sex, ethnicity) and unique individual/biological characteristics (i.e., sleep, physical activity, self-regulation, BMI, anxiety, and depression), but also contextual/environmental (family,

school, and community) factors. Second, because increasing media consumption is a developmental phenomenon tied to both age and dispositional characteristics in media content selection and screen time (Yang et al., 2020), we aimed to examine how age, sex, and ethnicity would interact with multifaceted bioecological factors to influence adolescents' media use.

The theoretical framework

Bronfenbrenner's (1977) ecological systems theory postulates that child development is affected not only by the child's unique individual characteristics (e.g., age, sex, ethnicity), but also by the quality and contexts of multiple layers of ecological systems. The first layer of ecological systems, the *microsystem*, is the child's immediate physical and social environments (i.e., family, peers, school, community) that directly shape their development. This layer continues to interact with the *mesosystem*, in which different parts of the microsystem interact and work together and have both positive and negative impacts on the child. The *exosystem* encompasses social, political, or economic settings that do not directly implicate the child but have a profound effect on their development. Lastly, the *macrosystem* is the most distal to the child, but impacts their development through culture or attitudes at a societal level.

Bronfenbrenner's (1977) ecological systems theory has been modified to stress person-context interrelatedness (Tudge et al., 2009). The essence of Bronfenbrenner's revised bioecological theory (2005) lies in the core concepts of the process, person, context, and time (the PPCT model). *Process* refers to the complex reciprocal interactions between personal characteristics (e.g., age, sex) and contextual aspects (e.g., family, school) that influence developmental outcomes. Here, we refer to such an enduring interaction between children and people (especially their caregivers – parents, teachers, grandparents, etc.) as a proximal process. *Person* refers to personal characteristics; these are divided into (a) demand characteristics, which pertain to an immediate stimulus (age, sex, ethnicity, etc.) that influences an individual's initial interaction with others; (b) resources, which refer to past experiences, skills, opportunities, or emotional and material resources (e.g., housing); and (c) force characteristics, which are related to differences in temperament, motivation, and persistence. *Context* refers to an environment or context (e.g., home, school, community) in which an individual spends a substantial amount of time in activities or interactions. Lastly, *time* refers to the course of some specific activity or interaction (i.e., micro time). Because of the cross-sectional nature of our study, we did not consider the element of time.

This theoretical framework has proven to be valuable in studying the complex psychological and broader ecological factors that contribute to child development. For example, Swearer et al. (2012) reviewed individual (e.g., depression, sexual orientation); peer group (e.g., peer alcohol use, delinquency); school (e.g., school climate); family (e.g., positive parenting); and community (e.g., neighborhood safety and connection) factors with respect to bullying and victimization in adolescents. Their findings shed light on a wide range of multiple levels of individual and environmental factors involved in bullying. Use of the PPCT is empirically important because of the model's holistic and ecological emphasis on vital and complex interactions between individual characteristics and environmental systems. Therefore, we used Bronfenbrenner's PPCT model as a major

framework to identify an extensive range of critical but less explored processes – the person- and context-related predictors that play tangible roles in aspects of adolescents' use of new media.

However, the PPCT model has limitations in terms of justifying the specific relations between a wide range of bioecological factors and adolescents' new media use. In light of this, Valkenburg and Peter's (2013) differential susceptibility to media effects model (DSMM) theorizes how dispositional, developmental, and social factors would influence individuals' media use. Dispositional factors are related to the individual, such as gender, personality, values, attitudes, beliefs, moods, motivations, and trait aggression. Developmental factors are the individual's developmental responsiveness due to cognitive, emotional, and social maturity and developmental stages. Lastly, social factors are the socio-contextual factors (e.g., family, friends, peers, school, community) that surround an individual. An individual's developmental response states are further theorized to mediate the relationship between media use and subsequent media effects. In this way, the DSMM framework complements the PPCT model and provides support for the relations between process-, person-, and contextual-level factors and media use.

Process factors

The process component of Bronfenbrenner's PPCT model stresses the enduring interactions between the person (a child's personal characteristics) and contextual (e.g., family, school) factors that are instrumental to a child's development. Under this conceptualization, quality parent-child interactions, such as sharing ideas/thoughts or co-viewing media, can be understood as crucial, family-related core process factors. In a similar way, adolescents' participation in school activities and community service can be conceptualized as process factors associated with school and community, respectively. The DSMM also posits that parents, school, and community can either restrict or stimulate a child's exposure to media via norms or values communicated to the child.

In support of this model, the importance of quality parent-child interactions for children's screen time has been well documented. Specifically, research highlights the mediating role of parent-child interaction on the effect of excessive screen time on children's psychosocial well-being (Zhao et al., 2018). Wong et al. (2020) similarly found that distracted parenting due to technology use during parent – child interactions mediated the association between parents' problematic digital media use and a child's screen time. These studies suggest that process factors that capture high-quality parent-child interaction may serve as a protective factor against excessive media use by adolescents.

In the same vein, process factors associated with school and community likely mitigate or aggravate adolescents' media use. Participation in extracurricular activities, such as clubs and sports teams, has been related to positive adjustment (e.g., higher grades and lower risky behavior; Fredricks & Eccles, 2008). By extension, adolescents' participation in community service should decrease their media use, because it provides opportunities to channel energy toward altruistic goals and promotes social interactions with others (Yates & Youniss, 1996). Thus, the influence of these process factors on adolescents' nonacademic media use merits further investigation.

Person factors

As person factors, Bronfenbrenner's PPCT model identifies three individual characteristics that seem pertinent to media use in adolescents: (a) demand characteristics that are immediately apparent, such as age, sex, ethnicity, and physical appearance; (b) resource characteristics that are pertinent to an individual's mental, emotional, and material condition, such as skills, intelligence, knowledge, and wealth; and (c) force characteristics that characterize the internal forces that motivate or drive an individual to act in a certain way.

Previous studies have yielded limited and inconsistent findings regarding the association between demand characteristics and media use. For example, in terms of sex, male adolescents spend more time playing computer and video games, whereas females spend more time on social networks (Rideout et al., 2010). Conversely, other studies found a cohort effect in the gender gap, whereby that younger males and females spend approximately the same time on the internet (Gross, 2004). Ethnicity also plays a role in media consumption: Roberts and Foehr (2008) found that the highest use occurs among Black adolescents, followed by Hispanics and those of European decent. Nevertheless, it remains unclear whether there are specific reasons for these ethnic disparities. In the context of age, Csibi et al. (2019) suggest that different age groups show varying sensitivity to various components of problematic smartphone use, such as tolerance, withdrawal symptoms, or mood modification.

Whereas the DSMM is silent about the relations between resource characteristics and media use, the PPCT model elucidates their positive associations with developmental outcomes. For example, previous studies have highlighted the beneficial impacts of sleep quality (Wang et al., 2019) and adequate physical activity (Kim, 2013) on smartphone use. Another key resource factor, self-regulation – which enables individuals to regulate their behaviors, emotions, thoughts, and desires (Maranges & Baumeister, 2016) – likely protects adolescents from overusing new media. This is consistent with previous studies, which have found that individuals with poor impulse control and depleted self-control, which reflects aspects of self-regulation, are more likely to overuse media (LaRose et al., 2003; Yang et al., 2022). Hence, it is conceivable that adolescents who are well equipped with physical, emotional, and psychological resources could regulate themselves more effectively and refrain from excessive media use.

Lastly, the PPCT model suggests that force factors trigger changes in an individual's development by affecting their drive and desire. Although the PPCT model does not specify mental health conditions as such, they can influence a person's motivation or drive to engage with their environment. In favor of this, previous studies suggest that anxiety and depression are linked to problematic media use, such as video gaming (Hartanto & Yang, 2016; Mathers et al., 2009; Yang et al., 2022) and internet use (Caplan, 2007). Nesi and Prinstein (2015) also found that adolescents with mental health issues engage in prolonged use of social media to seek social support online and attempt to alleviate emotional difficulties. Given these findings, mental health conditions as force characteristics likely predict greater use of nonacademic media consumption by adolescents.

Contextual factors

The PPCT model identifies three primary contexts (family, school, and community) that may be pertinent to adolescents' media use. When considering parents' media mediation style as a viable family-context factor, Gentile et al. (2014) found that parents' monitoring of children's media use led to positive developmental outcomes. These outcomes included sleep quality, school performance, and prosocial behavior through reduced screen time and lower exposure to media violence. Although more research is needed to fully understand the array of family-context factors that influence the nonacademic media use of adolescents, evidence suggests that family environments that provide psychological support to adolescents tend to have a positive impact on their media use.

Despite their presumed empirical importance, the contextual factors of school, neighborhood, and community in relation to adolescents' new media use have rarely been examined. For example, school safety, which is a facet of school climate, characterizes a child's experiences related to harm, theft, or violence. Previous studies suggest that school safety has an impact on students' adjustment (Brand et al., 2003) and is associated with an adolescent's TV viewing, video gaming, and computer use on weekdays (Garcia-Continente et al., 2014). Living in a safe neighborhood also likely affects adolescent development by increasing opportunities for community engagement. Timperio et al. (2017) proposed adolescents' neighborhood environment as a lifestyle-based intervention to counteract media overuse. Therefore, it is reasonable to posit that school- and community-related variables could attenuate nonacademic media use in adolescents.

The present study

In light of the integral role new media play in an adolescent's life, identifying the risk and preventive factors associated with adolescents' screen time is vital. Therefore, using the PPCT and DSMM models as the primary theoretical framework, we set out to holistically examine the predictive roles of various factors in relation to media use in adolescents.

With respect to *process* factors, our aim was to examine five variables that capture interrelations between a child and their family, school, and community: (a) eating meals together; (b) sharing ideas or thoughts with parents; (c) child's participation in school activities; (d) child's participation in community service; and (e) parents' participation in child's events or activities. We hypothesized that adolescents' involvement with their family, school, and community – which is expected to nurture more robust interpersonal connections – would be inversely related to their nonacademic media use.

In terms of unique person factors that could influence adolescents' media use, we focused on three facets: (a) demand characteristics (i.e., age, sex, ethnicity, and BMI); (b) resource characteristics (i.e., sleep quality, physical activity, and self-regulation); and (c) force characteristics (i.e., previous history and current anxiety and depression conditions). Considering the substantial empirical evidence that highlights the significance of person factors, we hypothesized a significant relationship with adolescents' new media use. Specifically, force characteristics are expected to positively correlate with new media consumption, whereas resource characteristics are anticipated to inversely predict it.

Among demand characteristics, BMI is predicted to have a positive association with new media use.

Lastly, we examined five family-context factors (socioeconomic status (SES) and maternal and paternal physical and mental health); one school-context factor (perceived school safety); and three community-context factors (neighborhood safety, living in a supportive neighborhood and parents having someone in the community to whom they can turn for emotional support). Given the scant or inconsistent empirical evidence for these factors, we aimed to explore their relationships with adolescents' new media use, instead of generating hypotheses.

To achieve our goals, we analyzed data from the 2016 National Survey of Children's Health (NSCH), which is a large, nationally representative, and comprehensive survey administered in the United States. The NSCH dataset encompasses a broad spectrum of individual, family, school, and community measures and offers a unique opportunity to apply the PPCT and DSMM frameworks to explore the impacts of multiple layers of person, process, and contextual influences. Furthermore, to elucidate developmental and dispositional processes, in accordance with the DSMM, we examined how some crucial factors, such as age, sex, and ethnicity, would interact with adolescents' media use.

Method

The 2016 NSCH was conducted between June 2016 and February 2017. We chose this dataset because: (a) it had the largest sample size of all NSCH datasets available in 2018; (b) the 2016 NSCH was redesigned to move from a telephone-based to an address-based sampling method because of low response rates to previous surveys; and (c) the 2016 NSCH employed new internet-based and mailed survey instruments instead of telephone interviews. Data were collected and weighted to reflect the demographic composition of children and youth to create a nationally representative sample. The study was approved by the Census Disclosure Review Board.

Participants

A sample of 364,150 U.S. household addresses was selected from the Census Master Address File. Of these, households with children under 18 were oversampled at a 5:1 ratio relative to households without children, and 139,923 households were screened for age-eligible children. Of these 68,961 households reported age-eligible children. A nationally representative cohort of 50,212 households completed topical surveys about their noninstitutionalized children aged 0 to 17 years; 80.6% of these ($n = 40{,}493$) completed the survey using the online instrument, and 19.45% ($n = 9{,}714$) used the paper instrument. We focused on a subset of 23,453 parents who had an adolescent child aged 11 to 17 years (see Table 1 for details; mean age = 14.26 years, $SD = 1.989$; 49.2% female; 71.5% White). All surveys were completed by an adult who was familiar with the child and provided appropriate informed consent. Most respondents were biological or adoptive parents (90.8%).

Table 1. Descriptive statistics for media use and person factors.

	Mean (SD)
Media use[1]	4.2 (1.3)
None (%)	1.6
Less than 1 hour (%)	8.7
1 hour (%)	20.3
2 hours (%)	29.9
3 hours (%)	17.2
4 or more hours (%)	21.5
Person factors	
Demand characteristics	
Age	14.3 (2.0)
Sex (% female)	49.2
Ethnicity	
White (%)	71.5
Hispanic (%)	10.6
Black (%)	6.0
Other	11.9
BMI[2] (%)	
Underweight	5.7
Healthy weight	67.8
Overweight	13.9
Obese	12.5
Resource characteristics	
Sleep[3]	4.2 (1.0)
Physical activity[4]	2.6 (.9)
Self-regulation[5]	2.5 (.4)
Force characteristics	
Anxiety (%)	
Do not have condition	86.1
Ever told, but do not currently have condition	1.9
Currently have condition	12.0
Depression (%)	
Do not have condition	91.8
Ever told, but do not currently have condition	1.9
Currently have condition	6.3

Note: SDs are shown in parentheses.

[a]Average weekday time spent on nonacademic use on new media (computers, cell phones, handheld video games, and other devices) was rated on a 6-point scale: 1 = none, 2 = less than one hour, 3 = one hour, 4 = two hours, 5 = three hours, 6 = four or more hours.

[b]Body mass index was classified in 4 categories: 1 = underweight (5^{th} percentile or below); 2 = healthy weight (5^{th} to 84^{th} percentile); 3 = overweight (85^{th} to 94^{th} percentile); 4 = obese (95^{th} percentile or above).

[c]Amount of sleep on an average weekday was rated on a 7-point scale: 1 = less than six hours, 2 = six hours, 3 = seven hours, 4 = eight hours, 5 = nine hours, 6 = ten hours, 7 = eleven or more hours.

[d]Number of days spent exercising, playing a sport, or engaging in physical activity for at least 60 minutes in the past week was rated on a 4-point scale: 1 = zero days, 2 = one to three days, 3 = four to six days, 4 = every day.

[e]Self-regulation was assessed using three positive health items to assess self-regulation of behaviors, emotions, and learning. Parents rated each item on a 3-point scale (1 = not true, 2 = somewhat true, 3 = definitely true).

Measures

Nonacademic media use

One survey item assessed the average nonacademic weekday screen time on various new media devices, such as computers, cell phones, handheld video games, and other electronic devices, excluding TV. A 6-point scale was used (1 = *none*, 2 = *less than one hour*, 3 = *one hour*, 4 = *two hours*, 5 = *three hours*, 6 = *four or more hours*). Using parent or caregiver reports for assessing an adolescent's nonacademic new media use may raise validity concerns. However, Barry et al. (2017) found that parent-reported data on a child's social media use largely aligned with the adolescent's self-reports. Validity concerns are further addressed in the discussion section.

Process factors

In line with the PPCT model, five process factors that reflect interactions between person and contextual factors were assessed. Interactions between child and parents were assessed by two items that asked about the number of days per week the family ate meals together using a 4-point scale (1 = *not at all* to 4 = *very often*) and how well parents and children shared ideas or talked about things that really matter (1 = *not at all* to 4 = *very well*). Parent participation (an interaction between parent and child) was assessed by how often they attended events or activities in which the child participated using a 5-point scale (1 = *never* to 5 = *always*). The child's participation in school activities was assessed by a single item regarding the number of activities the child participated in after school or on weekends (e.g., sports teams, clubs, or other activities such as music and other arts). A child's participation in community service or volunteer work (i.e., interactions between the child and the community) was also assessed by a single item that asked about the child's participation in any type of community service or voluntary work at school, in church, or in the community during the past 12 months.

Person factors

Several demand factors (the child's age, sex, ethnicity, and BMI) were measured. Because of the unique growth patterns of adolescents, their BMI (weight in kg/height^2 in meters) for age (in years) categories were defined with underweight (below the 5th percentile); healthy weight (from the 5th percentile to less than the 85th percentile); overweight (from the 85th to less than the 95th percentile); and obese (equal to or above the 95th percentile). BMI was dummy coded with underweight as the reference. Ethnicity (Hispanic, Black, and Other) was also dummy coded, with White as the reference group.

Resource factors were the average amount of sleep on weeknights for the past week, physical activity, and self-regulatory abilities. Physical activity was assessed by the number of days the child engaged in exercise, a sport, or any physical activity for at least 60 minutes in the past week. Self-regulation was assessed on a 3-point scale by three items that characterize different domains of the regulation of behaviors, emotions, and learning (1 = *not true*, 2 = *somewhat true*, 3 = *definitely true*). Using principal axis factoring extraction, all items (behaviors = 0.81, emotions = 0.64, learning = 0.62) loaded highly on a single factor with acceptable internal consistency (Cronbach's alpha = 0.72). Because of the conceptual similarity in regulatory characteristics across all three items, their mean

score was used to index an adolescent's self-regulatory ability. Lastly, anxiety and depression as force factors were assessed on a 3-point scale (1 = *do not have condition*, 2 = *ever told, but do not currently have condition*, 3 = *currently have condition*) and dummy coded with "do not have condition" as the reference group.

Contextual factors

Family-related (SES and parents' physical and mental health); school-related (perception of school safety); and community-related (neighborhood safety, supportive neighborhood, and parents' emotional support from the neighborhood) variables were assessed as contextual factors. SES was measured by the family poverty level (FPL), also known as the family poverty ratio, which was calculated as the ratio of total family income to the family poverty threshold (based on household size). Maternal and paternal physical and mental health were assessed by two questions ("In general, how is your physical health?" and "In general, how is your mental or emotional health?") on a 5-point scale (1 = *poor* to 5 = *excellent*). The school-related factor was assessed with a single item on a 4-point scale to evaluate the child's sense of safety at school. A single item measured parents' perception of neighborhood safety using a 3-point scale. Next, a supportive neighborhood (an interaction between family and community) was assessed using three items: (a) "People in my neighborhood help each other out;" (b) "We watch out for each other's children in this neighborhood;" and (c) "When we encounter difficulties, we know where to go for help in our community," based on a 3-point scale. Using factor analysis, all items significantly loaded on a single factor (item a = 0.85, item b = 0.83, item c = 0.57), with acceptable internal consistency ($\alpha = 0.79$). The mean of these items was used to index living in a supportive neighborhood. Lastly, parent's emotional support, reflecting family-community interaction, was measured by asking whether, in the past year, the parent had access to someone for daily emotional support with parenting or childrearing.

Analytic plan

All analyses were conducted using survey weights provided in the NSCH dataset, which incorporated a base sampling weight, adjustments for both screener and nonresponse, an adjustment for the selection of a single child within the sample household, and demographic population control adjustments. These weights ensured nationally representative population-based estimates for noninstitutionalized children.

Using the PPCT framework, a series of ordinary least squares (OLS) hierarchical regression analyses were conducted in SPSS to identify factors that predict adolescents' nonacademic new media use. Adolescents' nonacademic media use was regressed on process factors (i.e., proximal processes; Model 1); person factors (Model 2); contextual factors (Model 3); and all factors (Model 4; see Table 2). Further, we used the Process macro (model 1; Hayes, 2018) to examine whether age modulated the influence of bioecological factors that emerged as significant in Model 4.

Results

Table 1 shows descriptive statistics for new media use and individual factor variables. The data did not reveal multicollinearity issues (tolerance = 0.408 to 0.966; VIF = 1.018 to

Table 2. Regression coefficients for media use (computers, cell phones, handheld video games, etc.) in adolescents (11–17 years).

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β	*B* (SE)	β	*B* (SE)	β	*B* (SE)	β
Process factors								
Having meals together	−.229 (.010)	−.152***					−.126 (.012)	−.083***
Sharing ideas with parents	−.177 (.015)	−.082***					−.084 (.018)	−.038***
Participation in school activities	−.145 (.009)	−.113***					−.060 (.011)	−.046***
Participation in community service	−.096 (.019)	−.036***					−.216 (.022)	−.081***
Parent participation in child's events	−.058 (.009)	−.043***					.005 (.011)	.003
Person factors								
Age			.139 (.004)	.212***			.141 (.005)	.217***
Sex (*1* = male, *2* = female)			.046 (.017)	.018**			.110 (.020)	.043***
Ethnicity[1]								
Hispanic			.101 (.027)	.024***			.062 (.034)	.014
Black			.251 (.035)	.045***			.171 (.052)	.025***
Other			−.004 (.026)	−.001			.003 (.030)	.001
BMI[2]								
Normal weight			−.009 (.027)	−.003			−.005 (.033)	−.002
Overweight			.106 (.033)	.028**			.090 (.040)	.024***
Obese			.152 (.034)	.038***			.078 (.043)	.018
Sleep			−.098 (.008)	−.080***			−.072 (.009)	−.061***
Physical activity			−.180 (.010)	−.115***			−.133 (.012)	−.090***
Self-regulation			−.173 (.015)	−.080***			.077 (.029)	.035**
Anxiety[3]								
Ever told, but do not currently have			.194 (.062)	.020***			.158 (.074)	.016*
Currently have condition			.021 (.031)	.005			−.034 (.037)	−.008
Depression[3]								
Ever told, but do not currently have			.136 (.063)	.014*			.077 (.079)	.007
Currently have condition			.164 (.040)	.031***			.066 (.051)	.011
Context factors								
SES					.000 (.000)	.016*	.000 (.000)	−.013
Mother's physical health					−.037 (.015)	−.025*	−.019 (.015)	−.013
Father's physical health					−.098 (.015)	−.066***	−.062 (.015)	−.042***
Mother's mental health					−.033 (.016)	−.022*	−.032 (.016)	−.021*
Father's mental health					−.032 (.016)	−.021	−.012 (.016)	−.008

(*Continued*)

Table 2. (Continued).

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β	*B* (SE)	β	*B* (SE)	β	*B* (SE)	β
School safety					−.142 (.015)	−.054***	−.047 (.022)	−.018*
Neighborhood safety					.019 (.021)	.007	−.016 (.022)	−.006
Supportive neighborhood					−.071 (.025)	−.022**	.005 (.025)	.002
Parent emotional support					−.336 (.026)	−.105***	−.255 (.044)	−.080***
R^2	.164		.109		.036		.140	
ΔF	303.239***		183.679***		68.810***		14.647***	

Note: *$p < .05$, **$p < .01$, ***$p < .001$.
[a]Ethnicity was dummy coded with White as reference.
[b]BMI was dummy coded with underweight as reference.
[c]Anxiety and depression were dummy coded with "do not have condition" as reference.

2.453). Zero-order correlations among all variables are reported in the appendix (Table S1). We found that the distribution of our dependent variable (new media use) did not meet the normality assumption, Kolmogorov-Smirnov statistic = .165, $p < .001$. However, its skewness (−0.154) and kurtosis (−0.778) are within acceptable ranges, and previous studies suggest that violations of the normality assumption minimally impact results in large samples. Furthermore, any arbitrary transformations to satisfy the normality assumption of a linear regression model might bias model estimates (Schmidt & Finan, 2018). Thus, we did not transform our dependent variable.

Process factors (Model 1)

When OLS hierarchical linear regression analysis was performed, Model 1 explained a significant amount of variance in adolescents' media use, $R^2 = .064$, $F = 303.238$, $p < .001$. Consistent with our hypothesis, the process factors that elucidate interactions between a child and parents – eating meals together as a family and sharing ideas with parents – predicted adolescents' lower media use, all *p*s <.001 (see Table 2). Factors that reflect child-school, child-community, and parent-child interactions—i.e., the number of organized activities a child participates in, a child's participation in community service, and parents' participation in a child's events/activities, respectively – significantly predicted a child's media use in Model 1, all *p*s <.001. However, in Model 4, which included all process predictors, parents' participation in a child's events/activities did not reach significance.

Person factors (Model 2)

Model 2 alone explained a significant amount of variance in adolescents' media use, $R^2 = .109$, $F = 183.679$, $p < .001$. Of the demand factors, both age and sex (female) were significant predictors, all *p*s <.001. In terms of ethnicity, being Black ($p < .001$) significantly predicted adolescents' greater media use compared

with those of White ethnicity. Further, being overweight significantly predicted greater media use compared with underweight individuals, $p = .001$. These demand factors remained significant in Model 4, in which all ecological factors were considered.

Regarding resource factors, sleep, physical activity, and self-regulation significantly predicted reduced screen time, all $ps < .001$ (Model 2). However, in Model 4, only sleep and physical activity remained significant. Lastly, as force factors, adolescents' history of anxiety and depression and current depressive symptoms were associated with longer media screen time, while no such association was found with anxiety symptoms (Model 2). However, in Model 4, only a previous history of anxiety remained significant, $p < .05$. These results provide partial support for our hypothesis.

Contextual factors (Model 3)

Model 3 alone explained significant variance in predicting adolescents' media use, $R^2 = .036$, $F = 111.124$, $p < .001$. Of the family-context factors, father's physical health and mother's mental health significantly predicted lower media use by adolescents, all $ps < .05$. With respect to environmental safety factors, a safe school significantly predicted adolescents' media use, but a safe neighborhood did not. Similarly, parents' perception of neighborhood supportiveness and emotional support significantly predicted adolescents' lower media use, all $ps < .01$. In Model 4, however, only mother's mental health, father's physical health, and parents' emotional support remained robust predictors.

Developmental and sociocultural interactions

It is notable that age emerged as a significant predictor of adolescents' social media use: the older the child, the longer the screen time (see Models 1 and 4). Considering the wide age range (11–17 years) of adolescent children in the study, certain age-related developmental processes could potentially modulate the relations between media use and process, person, and contextual factors. Thus, we examined whether developmental processes specifically interact with the operation of the bioecological (PPCT) model for adolescents' media use: (a) process factors (eating meals together, sharing ideas with parents, and child's participation in school activities and community services); (b) person factors (sleep, physical activity, self-regulation, history of anxiety and depression, and current depressive symptoms); and (c) contextual factors (father's physical and mother's mental health, school safety, and parental emotional support).

Using the Process macro (model 1; Hayes, 2018), we found that age did not interact with any of the person factors, all $ps > .08$. Of the process factors, only one significant interaction emerged, which indicates that the negative association between eating meals together and adolescents' new media use was more pronounced at a younger age, $B = .12$, $F = 5.11$ $p = .03$. Other interactions between age and process factors did not reach significance, all $ps > .34$.

In accordance with the DSMM, which suggests that dispositional or individual-level factors influence media use and subsequently determine media effects, we examined sex

and ethnicity as potential individual-level, social-cultural moderators. After applying Bonferroni correction, none of the process or contextual factors significantly interacted with sex. Of the person factors, however, we found that the protective effect of self-regulation against media use was more pronounced in females, $F = 18.03$, $p < .001$. Similarly, the rise in media use associated with current anxiety, $F = 22.88$, $p < .001$, and depressive symptoms $F = 12.11$, $p = .005$, was more apparent in female adolescents.

Regarding ethnicity, we focused on potential interaction effects with Black ethnicity, using White as the reference. Of the process factors, participation in community service, $F = 8.404$, $p = .004$, and school activities, $F = 9.898$, $p = .002$, significantly decreased media use in White adolescents. Of the person factors, the protective effect of physical activity against media use was more evident in Whites, $F = 15.42$, $p = .0001$. No process or context factors significantly interacted with Black ethnicity. These results, in part, lend support to the postulates of the DSMM.

General discussion

Using Bronfenbrenner's bioecological (PPCT) framework (1977; 2005) and a large, nationally representative sample of adolescents in the United States, we identified important process, person, and contextual factors that predicted adolescents' non-academic screen time on new media devices. Specifically, of the process factors, family activities (i.e., sharing meals and ideas) and adolescents' participation in organized school activities and community service emerged as important proximal processes that predicted adolescents' lower media use when controlling for other factors. Of the person (demand) factors, we found significant associations of heavier consumption of new media use with older age, female sex, being Black, having a history of anxiety, and being overweight. Of the person (resource) factors, adolescents' sleep, physical activity, and self-regulation predicted adolescents' reduced media use. In terms of family-contextual factors, parents' physical and mental health were important for adolescents' new media use. Similarly, parents' receiving emotional support from the neighborhood was associated with adolescents' reduced reliance on new media. Our study supports the ecological and DSMM models and reveals an exhaustive range of previously unexplored process (proximal process), person, and contextual factors that play a major role in adolescents' new media use.

Several findings are noteworthy. First, despite scant attention to the influence of developmental contexts on adolescents' new media use, our results underscore that multifaceted, complex, and contextual factors play a vital role in safeguarding adolescents from prolonged media use. This highlights the critical theoretical contribution of family dynamics to promoting healthy media habits in adolescents. Second, we demonstrate that when Bronfenbrenner's bioecological factors are considered together (see Model 4), person and process factors outweigh contextual factors, such as living in a safe and supportive neighborhood. This suggests that process and person factors are more fundamental than contextual factors in explaining adolescents' nonacademic media use. This finding is in line with the theoretical implication that both person factors and their interactions (i.e., proximal processes) with immediate contexts (family, school, and community) are the core building blocks of a child's development. Together, our findings

provide practical guidance for parents, educators, and communities striving to improve adolescents' media practices.

Given these findings, longitudinal studies are necessary to elucidate causal relationships between these bioecological factors and adolescents' media use. The results can inform effective interventions that foster healthy media practices in adolescents by emphasizing healthy lifestyles, diverse family activities, and, notably, adolescents' self-regulatory skills. Indeed, a general psychological framework suggests that individual skills, such as self-regulation, can alleviate problematic or addictive behavioral patterns. Empirical evidence also supports this, and suggests that a lack of self-control can potentially lead to a range of problematic addictive behaviors (LaRose et al., 2003). Although interventions for adolescents' media use are still scarce, promising evidence underscores the value of self-regulatory skills. As part of the School Wellness Integration Targeting Child Health initiative, McLoughlin et al. (2019) evaluated the effectiveness of a self-regulation wellness program on screen time behavior in elementary school students. They found that interventions that focused on improving self-regulation skills correlated with significant reductions in sedentary screen time use.

Our study is not without limitations. First, given the correlational nature of our study, bidirectional effects likely exist between the various predictors and adolescents' nonacademic media use. For example, individuals who effectively control their media use may exercise better self-regulation and engage in more physical activities. Given the central role of new media in most adolescents' lives, more comprehensive longitudinal studies using more sophisticated measures are warranted to explore the causal effects of potential risk and protective factors, as well as to identify specific mediating factors that influence adolescents' media use.

Second, although we identified a multitude of predictors of adolescents' media use, the majority had small effect sizes; this indicates that the observed relationships are not robust. However, given the extensive array of variables in place to predict adolescents' media use, the effect size could indeed have been impacted. Further, the study's large sample size enhances the precision of our effect size estimates due to increased statistical power, and thereby bolsters the reliability of our findings. Nonetheless, these small effect sizes may still reflect considerable individual variability or other contextual/environmental factors that could modulate adolescents' nonacademic screen time.

Third, we used single-item, parent-report measures for several constructs. Although single-item measures may not capture specific dimensions of a construct, they are widely used to represent global constructs, especially when the construct is unambiguous (Wanous & Reichers, 1996) and a holistic impression is more informative (Youngblut & Casper, 1993). Because most of our single-item, self-report measures ask about factual and frequency information or gauge parents' overall perceptions, relying on such measures is practical. Nevertheless, future research should incorporate multi-item measurements for relevant predictors to better elucidate the influence of different facets of the constructs of interest.

Fourth, our reliance on parents' (or other primary caregivers') self-reports of adolescent's nonacademic new media use raises validity concerns. Although most self-reported measures can be subject to recall bias and social desirability, they are considered reasonably accurate, especially when respondents' anonymity is ensured and there is minimal fear of reprisal, as in this study (Brener et al., 2003). Supporting this method, Dahlgren

et al. (2021) used an objective measure to assess adolescents' (aged 10–15 years) screen time. They found that the average smartphone screen time for adolescents was 161 minutes (2.68 hours) per day, which aligns closely with the mean screen time reported by parents in our study. In contrast, Paulich et al. (2021) collected screen time reports from both young adolescents and their parents. They found that, although it was not the primary objective of their research, parents underestimated their child's screen time compared with the self-reports provided by the children. Therefore, these findings underscore the need for a cautious interpretation of our results, which are based on parent-reported measures of their child's new media use. However, the measures may not be entirely invalid.

Another related limitation is that our assessment of media use did not specify screen time durations beyond 4 hours, which potentially limits its ability to differentiate heavy users with even more extensive media use. However, it is noteworthy that the measure still provides a reasonable indication of typical media use and facilitates comparisons across a large and diverse sample of adolescents. In many contexts, media use that exceeded 4 hours for nonacademic purposes in 2016 was often considered excessive, especially given that social media was less popular than it is today. Nevertheless, we acknowledge that our measure cannot precisely quantify media use beyond 4 hours.

Fifth, although we employed the PPCT model as our primary framework, our analyses may not fully reflect the intricacies of Bronfenbrenner's model. This limitation arises from factors such as the cross-sectional design and the constraint of variables. In view of the multilayered ecological aspects inherent in Bronfenbrenner's theory, employing a more sophisticated multilevel model to align our analysis with the theory would be ideal. However, our nationwide sample lacked the variables (e.g., school or neighborhood) needed for hierarchical grouping in multilevel modeling. Therefore, future studies should consider multilevel variables to better align with Bronfenbrenner's ecological systems.

Lastly, considering the emphasis on media content over screentime in recent theories and studies, the study raises questions about the use of screen time as a primary metric instead of specific content details (e.g., physical appearance). Despite these notable limitations, however, there are several advantages to studying screen time. First, screen time serves as a general metric that is applied across a wide variety of media types and devices, including computers, cell phones, handheld video games, and other electronic devices. Second, screen time is a relatively easier and more straightforward measure; in contrast, it is more challenging to measure content accurately, because it is highly variable and more subjective. Third, a substantial body of empirical evidence still suggests that screen time, regardless of specific content, can have significant implications for psychological functioning and health (Toh et al., 2022). For example, numerous studies have demonstrated associations between excessive screen time and obesity in children (e.g., Hacox et al., 2004); sleep disruption (Hale & Guan, 2015); depression and anxiety in adolescents (Stiglic & Viner, 2019); and well-being (Twenge, Martin, et al., 2018). Lastly, studying screen time can provide valuable insights into usage patterns or habits that serve as an important basis for intervention. Given these strengths, screen time remains a valuable proxy measure for media use.

Nevertheless, future studies should incorporate more comprehensive assessment of media use that encompasses both screen time and content in large panel surveys.

In conclusion, drawing on the process-person-context-time framework, our study enhances understanding of the multifaceted factors and core processes that influence adolescents' media use. Despite several shortcomings of the dataset, our use of a large and representative sample and diverse variables that span child, parent, school, and community – as well as parent-child and child-school – interactions contributes to the literature by elucidating holistic and ecological facets of adolescents' new media use. Because both individual and socioecological factors are vital for adolescents' media consumption, our study highlights the need to extend beyond unidimensional predictors. Further, the study provides comprehensive insights into effective and practical family-, school-, and community-based interventions for promoting healthy media habits in adolescents. The study also offers context-based strategies for addressing problematic media use and enhancing social competence.

Disclosure statement

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