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Substance use patterns and in-hospital care of adolescents and young adults attending music concerts

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The negative relationship between digital media exposure and childhood flourishing

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By
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BS, Emmanuel College, 2006
MD, University of Massachusetts Medical School, 2011

Thesis

Submitted in partial fulfillment of the requirements for the
Degree of Master of Public Health in the Brown University School of Public Health

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This thesis by *Stephanie Ruest, MD* is accepted in its present form by the Brown University School of Public Health as satisfying the thesis requirements for the degree of Master of Public Health.

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Vita

Stephanie Ruest was born in Massachusetts to Samuel and Cynthia Ruest. After attending Apponequet Regional High School in Lakeville, Massachusetts, she went on to college at Emmanuel College in Boston, Massachusetts on a full academic scholarship. During her time in college, she was a research assistant at Joslin Diabetes Center and was a contributing author on an original research article evaluating low birthweight-associated glucose intolerance. She also spent a year as a research assistant in the Department of Neurology at Boston Children's Hospital, studying mechanisms of excitatory neurotoxicity. Her research at Boston Children's Hospital culminated in her thesis paper and presentation, leading to graduation from Emmanuel College with a Bachelor of Science Degree in Biology with distinction in the field. She also completed a minor in Psychology and graduated Magna Cum Laude as a member of the Kappa Gamma Pi National Catholic Honor Society, Psi Chi Psychology Honor Society, Sigma Xi Research Honor Society, and Beta Beta Beta Biology Honor Society. The year following her college graduation, Stephanie spent a summer abroad volunteering in a Romanian orphanage, returning to be a practice coordinator for three surgeons in the Division of Plastic Surgery at Brigham and Women's Hospital in Boston, Massachusetts. In the summer of 2007, Stephanie began medical school at the University of Massachusetts Medical School, where she was a member of multiple student lead organizations and the recipient of the New England Pediatric Society Award, the Massachusetts Medical Society Scholars Award, and the University of Massachusetts Department of Pediatrics Achievement Award. She graduated from UMass Medical in 2011 as a member of the Alpha Omega Alpha Medical Honor society. After graduating from medical school, Stephanie entered a pediatrics residency at Massachusetts General Hospital. During her three year residency, she was chosen to be one of two Pediatric Chief Residents, a position in which she served for the year following completion of her residency program. During this year, she was a practicing part-time primary care physician and hospitalist, a Clinical Fellow in Pediatrics at Harvard Medical School, and was actively involved in the development and organization of the residency program, medical teaching, and quality and safety. She was then accepted into the pediatric emergency medicine fellowship at Brown University/Hasbro Children's Hospital and entered the Brown University School of Public Health the same year. Stephanie's research interests include injury prevention, including injuries and illnesses related to adolescent substance use, as well as child maltreatment and abuse. Her current research projects span the range of pediatric age groups and focus on substance-use related outcomes in adolescents who attend music concerts, childhood flourishing outcomes, and sentinel injuries in child abuse.

Preface and Acknowledgements

The work produced for part one of this thesis was carried out at Hasbro Children's Hospital in collaboration with mentors and colleagues at Massachusetts General Hospital between July 2015 and January 2017. The work produced for part two of this thesis was carried out at the Brown University School of Public Health between September 2015 and July 2016. The active guidance, and encouragement of my mentors at the School of Public Health, HCH, and MGH were integral to the completion of these two projects, and I am extremely grateful for the time and dedication of my mentors.

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Part 1 – Original Manuscript: Substance use patterns and in-hospital care of adolescents and young adults attending music concerts

Stephanie M Ruest, MD, Alexander M Stephan, MD, Peter T Masiakos, MS, MD, Paul D Biddinger, MD, Carlos A Camargo, Jr., MD, DrPH, and Sigmund Kharasch, MD

ABSTRACT

Introduction: There are few studies that describe medical complaints and substance use patterns related to attending music concerts. As such, the objective of this study is to describe patient demographics, substance use and intoxication patterns, and medical interventions provided to adolescents and young adults assessed in an emergency department (ED) for complaints directly related to concert attendance.

Methods: A retrospective chart review of patients 13-30 years old who were transported to the ED directly from music concerts between January 2011 and December 2015 was conducted. Descriptive statistics and logistic regression were used to analyze patient demographic, intervention, and substance use data.

Results: There were 115 concerts identified, of which 48 (42%) were linked to 142 relevant ED visits. Patient mean age was 19.5 with 72% < 21; 71% were female and 96% of visits were substance-use related. Mean blood alcohol level was 242 mg/dL (range 104-412, SD 70). Glasgow Coma Scale (GCS) scores ranged from 3-15. Two patients required intubation and 61% of patients required interventions, including medications (47%), intravenous fluids (46%), specialty consultation (20%), restraints (14%), imaging (6%), and laceration repair (3%). Attendance at pop and EDM concerts was associated with the widest ranges of GCS scores, mass casualty incident declarations, and among the highest mean blood alcohol levels.

Conclusions: Substance use was nearly ubiquitous among patients presenting to the ED from music concerts. Such patients may have serious illnesses and require multiple medical interventions. These data demonstrate the need for additional large-scale studies to confirm trends and increase awareness of this important public health problem.

INTRODUCTION

Mass gathering events, such as sporting and political events, music concert events, visits by dignitaries, and others, have been defined as the presence of >1,000 people gathered at a specific location for a defined period of time.[1] Prior research has identified several attributes of mass gatherings that result in morbidity and mortality, including weather and environmental factors,[2-6] alcohol and drug use,[5-7] crowd attendance and density,[8-10] and event type.[6,9-10] While previous publications on mass gatherings have helped to advance our understanding of event characteristics,[9,11-12] only a handful of studies have uniquely addressed complaints directly related to music concert attendance, the majority of which have been cross-sectional event reports rather than longitudinal series and are from outside of the United States.[5-7,13-18] This may be because there is currently no universally standardized approach to data collection or large patient registries for reporting adverse outcomes at concerts or other mass gathering events.[19]

Despite the limited number of publications on issues related to substance use patterns, levels of intoxication, and the need for medical care at concerts, in recent years there has been frequent lay press media attention describing deaths and significant morbidity and mortality related to substance use at music concerts. Additionally, there have been multiple formal declarations of “mass casualty incidents” (MCIs) across the country when emergency medical services (EMS) and medical providers have been faced

with large surges of patients with significant levels of intoxication, dehydration, injuries, and other issues arising secondary to substance use at both indoor and outdoor concerts.[20-30] A 2015 publication cited at least 68 concert-associated deaths that were reported in the lay press over 15 years.[16] In 2013-2014 alone, journalists reported at least 10 deaths of individuals under the age of 25 and >650 hospital transports related to drug and alcohol use at concerts in cities throughout the United States, the vast majority of which occurred at electronic dance music (EDM) concerts or festivals.[21,26-29]

Although there is growing interest in these issues, there are no publications known to these authors that document in-hospital care, including patient demographics, substance use patterns, levels of intoxication, and toxicology results, provided to adolescents and young adults who attended shows across multiple music genres over a multi-year study period. The objective of this study was to identify adolescents and young adults evaluated in a large urban emergency department (ED) for complaints directly related to concert attendance over the course of five years and to describe these factors listed above based on the music genre of the concert attended.

METHODS

Design, setting, and population

A retrospective chart review was performed on the identified case series of patients between the ages of 13 and 30 years old seen in the Massachusetts General Hospital (MGH) ED on nights coinciding with concerts at a large nearby event venue between January 2011 and December 2015. This age range was chosen as prior publications have found that concert-goers below the age of 30 are more likely to present

for medical evaluation.[5-6,18] The study was reviewed and approved by the MGH institutional review board.

The studied concert venue has a maximum patron capacity of over 19,000 people. Although the venue has on-site EMS, it does not have an on-site physician to evaluate and treat concert patrons. The total number of concert attendees and the number of patients treated and released at on-site first aid stations at each event are unknown to the authors. In part based on its geographic location, MGH is the primary hospital for transport of patients from this concert venue. All patients requiring medical evaluation, with the exception of those rerouted in MCI declarations based on EMS protocol, were directly transported from the venue to MGH (personal communication, December 12, 2014).

Concert dates were identified via publically available schedules and the performer and music genre for each concert were recorded. Music genre was designated based on the performer's official website or the Billboard™ music charts (e.g. pop, rock, electronic dance music, jazz, etc.). Patients seen on the day of the concert through 2AM the following morning who had a chief complaint or discharge diagnosis related to ingestion, intoxication, alcohol or drug use, altered mental status, agitation, loss of consciousness, syncope, near syncope, dizziness, chest pain, shortness of breath, injury, trauma, wound, abrasion, or laceration, based on the diagnosis listed in the ED log, underwent further chart review. The time frame up until 2AM the following morning was chosen in an attempt to capture all concert-related patients, as concerts generally ended by 11PM. Patients were included in the study if they met the above criteria and their medical record included specific documented reference to concert attendance at the venue of interest.

Patients were excluded if there was no mention of attending a concert at this venue or if it was not clearly specified based on the available documentation.

Data collection and analysis

Age, sex, time of presentation, verbal report of drug or alcohol use, Glasgow Coma Scale (GCS) score by a triage nurse or first-contact physician on arrival and the lowest documented GCS score during the ED visit, need for medical intervention (e.g. airway support, imaging, intravenous fluids, laceration repair, medications, restraints, etc.), serum and urine toxicology results, length of stay, final diagnosis, and disposition were abstracted by two physicians (AS and SR). AS performed the primary review of all charts (n=698) and SR independently reviewed 25% of charts; 95% of re-reviewed charts yielded identical data.

The study was mainly descriptive in nature. Data were transcribed into Microsoft Excel 2010 (Microsoft Corporation, Redmond, WA) and then exported into STATA 14.0 (StataCorp LP, College Station, TX) for analysis. Continuous variables were summarized using mean (standard deviation, SD) and median (interquartile range, IQR), while categorical variables were summarized using frequency and percentage. Multivariable logistic regression analysis was performed to obtain odds ratios and 95% confidence intervals (CI). Odds ratios were adjusted for age and sex, consistent with a prior publication that controlled for the same covariates.[5]

RESULTS

Between January 2011 and December 2015, 115 concerts were identified via review of publically available schedules. Based on date and time of presentation, age, and

chief complaint or discharge diagnoses, 698 patients met inclusion criteria for chart review. After more detailed chart review, 142 patients were eligible for data analysis. Five hundred and forty five patients' charts were reviewed and excluded because there was no specific reference to concert attendance, and an additional 11 patients were excluded because they came from concerts at venues that were not the main venue of interest (Figure 1).

Patients ranged in age from 13 to 30 years old with a mean age of 19.5 years (SD 3.3); 72% (n=102) of patients were under the age of 21 and 33% were under age 18 (Table 1). When controlling for sex, individuals who attended rock concerts had 2.4 times the odds (95% CI 1.1-5.3, p=0.027) of being aged 21 or older as compared with those who attended concerts of all other genres. There were no other statistically significant relationships found between age and the genre of the concert attended. Overall, 71% (n=101) of patients were female. When controlling for age, individuals who attended pop concerts had 3.5 times the odds (95% CI 1.33-9.17, p=0.01) of being female as compared with those who attended concerts of all other genres. There were no other statistically significant relationships found between sex and the genre of the concert attended.

Forty-eight (42%) of 115 concerts accounted for all identified ED concert-related patient visits (Table 2). Seven music genres were represented among these 48 concerts: country, EDM, heavy metal, pop, punk, rap/hip hop, and rock. Overall, 31% of patients attended pop concerts, 29% rock, 19% rap/hip hop, 18% EDM, 2% punk, 1% country and 1% heavy metal (Figure 2). There were no patients from jazz concerts.

Two specific concerts in the study period, one pop and one EDM, resulted in large volumes of patients requiring EMS transport, leading to a formal declaration of an MCI

and distribution of patients to MGH and other local area hospitals according to the established Boston EMS MCI plan. The total number of patients transported from the pop concert is unknown to these authors, however, per lay press reports of the EDM concert, there were 50 patients who were treated and released on scene and an additional 36 patients transported to area hospitals, 13 of whom were seen at MGH.[23]

Overall, 96% (n=137) of all patient presentations involved alcohol or drug use based on patient report and/or clinician documentation (Table 3). The five presentations not related to substance use included two complaints of chest pain, two lacerations, and one complaint of dizziness/pre-syncope.

Substance use was nearly ubiquitous among patients evaluated in the MGH emergency department (Table 3). All 142 patients were asked about alcohol use. Of those, 87% (n=124) of patients reported using alcohol on the day of the ED visit. Of the 38 individuals who were specifically asked about whether or not they had consumed alcohol prior to entering the concert venue, 71% (n=27) answered affirmatively, 21% (n=8) denied this, and 8% (n=3) refused to answer the question. Forty-two percent of individuals (n=60) had serum toxicology screening sent at the discretion of the evaluating clinician to assist with medical decision-making and/or management and 98% of those screens were positive for alcohol, with an overall mean blood alcohol level of 242mg/dL (SD 70), which is equivalent to a blood alcohol content of 0.24% (SD 0.07%).

Overall, 123 out of 142 individuals had documentation that they were asked about drug use. Of those, 16% (n=22) reported drug use, 70% (n=100) denied drug use, and 1% (n=1) refused to answer the question (Table 3). Only 20 individuals had urine toxicology screening sent at the discretion of the clinician; screens were not necessarily sent on

individuals who endorsed drug use. Of these, 50% were positive for one or more drugs, including opioids, marijuana, and amphetamines. Of note, one of the tested patients reported chronic opiate use for pain, one patient reported recreational ecstasy use, one reported prescribed methylphenidate use, and one reported recreational methylphenidate use.

Glasgow Coma Scale (GCS) scores were obtained via nursing or physician documentation. The median GCS score on arrival for all patients was 15 with a range of 6-15 (IQR 8-15). Patients from EDM and pop concerts presented with the widest range of GCS scores, 6-14 (median 14) and 8-15 (median 15), respectively. The lowest documented GCS score for all patients was 3, which was recorded in a patient who attended an EDM show and required intubation. The overall median lowest documented GCS score was 13, with one EDM and one rap/hip hop concert having the lowest documented GCS scores of 3 and 6, respectively. Although 80% of patients did not have a difference between their arrival GCS and their lowest documented GCS score, 10% dropped 1-2 points, 5% dropped 3-4 points, and nearly 5% dropped ≥5 points. Of those with a decrease of ≥5 points, four were female and one was male, with ages ranging from 17-24 years, initial GCS scores of 12-15, and blood alcohol levels ranging 194-310mg/dL.

While some patients only required clinical monitoring, 61% (n=86) required interventions beyond clinical observation (Table 4). Two individuals required intubation for airway protection (1%), 1 required a nasopharyngeal airway (1%), 67 received medications (47%), 65 received intravenous fluids (46%), 19 required either physical restraints, chemical restraints, or both (13%), 8 had imaging performed (6%), and 4 had

laceration repairs (3%). There were 29 individuals (20%) who had specialty consultations, which included social work, plastic surgery, psychiatry, and pediatric intensive care.

The median length of stay across all music genres was 3.6 hours (IQR 0.5-14.4) and mean of 4.3 hours (SD 3.4), with a range of 0.4 to 18.6 hours. The shortest median length of stay was for individuals attending heavy metal concerts (2.9 hours), and the longest median length of stay was for those who attended punk concerts (6.5 hours). Overall, 90% of patients were treated and released with an admission rate of less than 2%. The remainder of patients left without being seen or left without completing treatment.

DISCUSSION

Although prior studies have broadly evaluated the public health implications of mass gatherings, most of the concert-related literature to date has described the on-site care of single specific concerts or festivals and is based on non-US populations. The lay-press reports of at least 10 deaths and over 650 hospital transports related to drug and alcohol use at concerts throughout the U.S. in 2013-2014 highlight the gap in our understanding of this important public health issue. Previous to this study, Chan et al is the only study known to the authors that has addressed the in-hospital experience of patients who attended concerts (pop and rock only in their series) over an extended period of time; however, this study included patrons from events other than concerts and only 31% of their patients had alcohol or drug related complaints. Additionally, as their data was from over 15 years ago, it likely does not reflect the scope of substance use patterns and need for medical care by today's concert-going youth.[18]

Prior studies have reported a sex disparity for patients who present for medical attention, with a published range of 57-69% females comprising the patient population.[5-6,16,31] In this study population, there was also a female predominance, with females comprising 71% of patients. It has been hypothesized that this sex disparity may be related to a disproportionate number of young females attending some of the high patient-volume concerts, an increased likelihood of females becoming ill from substance use, and/or females presenting for care more often.[5-6] Because the authors do not know the sex breakdown of concert attendees at each of the shows in the current sample, it is not possible to speak further to the possible causes of the female predominance in this study population.

Alcohol and drug use were a common reason for EMS transport from the concert venue to the MGH ED. While prior studies have reported a range of 11-48% of patients presenting from music concerts with substance use-related complaints, 87% of all patients in this study explicitly reported alcohol use and 98% of those tested had a positive serum toxicology screen, with a mean blood alcohol level over three times the legal limit for operation of a motor vehicle (80mg/dL or 0.08%).[7,18,31] Co-ingestions were also present in this series, identified by positive toxicology screens and/or patient verbal reports of tetrahydrocannabinol (THC) and amphetamine use (including methylenedioxy-methamphetamine, otherwise known as MDMA, “molly”, or ecstasy). The proportion of substance-use related presentations in this series was more consistent with that of Lund et al’s more recent population of EDM concert-goers, in which 79% of presentations involved substance use.[16] Over 70% of the patients in this series that were asked about when they consumed alcohol reported that they had used alcohol prior to entering the

concert venue. A study by Chapman et al highlighted the fact that many concertgoers will consume a large portion or all of their alcohol or drug supply before entering a venue to avoid confiscation, which is likely the case among this study population as well. [32] The mean blood alcohol levels were quite high in this patient population, possibly because patrons are often consuming large volumes of alcohol within a short period before entering the venues.

In this series, EDM, pop, rap/hip hop and rock concerts represented the genres with the highest patient volumes. Similar to prior studies, this data supports that rock and EDM are associated with higher rates of presentation, and EDM shows may result in higher acuity of presentations.[16-17,33] EDM represented only 6% of concerts in this series, yet resulted in 18% of the patient volume, an MCI declaration, one of the highest mean blood alcohol levels measured, and the lowest median GCS of patients presenting to the MGH ED. Congruent with the New York City Department of Health and Mental Hygiene's publication investigating adverse health events from a local EDM festival in 2013, this series demonstrates that some patients who have attended concerts may arrive with significantly altered mental status and in need of close monitoring and more serious medical interventions.[34]

The current publication adds a missing piece to the full spectrum of concert-related patient presentations by describing the in-hospital experience at a large Boston teaching hospital over 5 years and across multiple music genres. Lay-press articles and pre-hospital publications have demonstrated that attendance at music concerts may be associated with significant morbidity and mortality and that there is a need for on-site evaluation and treatment of patients by medical providers. When patrons present with

higher acuity complaints, nearby hospitals must be prepared to care for these patients with significant intoxications and poly-substance ingestions. This and other publications suggest that patrons attending EDM, pop and rock concerts and patrons who are female and under the age of 21 may be at greatest risk factors for needing medical assessment and care. Local hospitals may consider increasing staffing on nights that could have higher patient volumes. Furthermore, medical providers should keep the various types of substances used at these concerts in mind, including timing to peak effects, when creating a treatment and disposition plan for patients.

In Canada, harm reduction strategies, including free water, cool down stations, female-only break areas, pill/drug-checking stations, and on-site drug education programs and medical services have all been employed at EDM festivals with success. With these strategies in place at a 2014 seven day EDM festival with over 67,000 cumulative attendees, less than 1% of patrons who presented for care required transport to hospitals, there were no intubations, and no fatalities.[17] The acceptance and implementation of similar health and harm reduction strategies at large U.S. venues for concert-going patrons should be considered by venue owners as a means of decreasing the severity of substance related outcomes. Furthermore, increasing education and awareness for the patrons through public service announcements and on site education tables may also have a positive impact on outcomes. Adopting standardized data collection strategies at venues, including collecting patron demographics, presenting complaints, pertinent exam findings, and disposition plans may increase knowledge of substance use trends and lead to improved preparedness, both at the venue itself and by local EMS providers and hospitals.

LIMITATIONS

This study has some important limitations. The retrospective nature makes it dependent on publicly available information for concert date listings as well as on specific ED documentation of the patients' concert attendance. All patients without specific reference to concert attendance were excluded, so additional patients who were present at a concert and lacked this documentation may have been missed. Although the authors included a number of medical complaints and diagnoses in the initial medical chart retrieval, an exhaustive search of medical diagnoses was not done and, therefore, may have missed additional patients. If true, these data likely under-represents the number of patients associated with concert attendance; the extent of the problem may well be greater.

Furthermore, while concert date listings are public record and allowed for the targeted search of patients' hospital records analyzed in this study, both the total number of attendees present at each concert and the number who were evaluated and released by on-site first aid stations are proprietary data that were not made available by the operators of the private concert venue studied despite repeated attempts to obtain this information. Thus, the authors are unable to comment on the relative prevalence of concert-related morbidity between specific music genres. Additionally, data obtained from the hospital records of those concert attendees who required transport to an ED by EMS is likely skewed towards younger patrons and those with greater levels of intoxication or more serious medical complaints.

While almost all toxicology testing obtained was positive, not all patients were screened; as such, all patients who used alcohol or other drugs prior to or during the

concert may not have been identified. However, 87% of patients had laboratory-confirmed or verbal report of alcohol use. It is important to note that some drugs, including synthetic marijuana and inhalants, are not detectable on routine toxicology screening, possibly resulting in false-negative screens. It should also be mentioned that individuals who used marijuana in the preceding days to weeks may test positive for THC even if marijuana was not used on the day of the attended concert; however, the majority of patients either verbally endorsed use that day or showed signs of intoxication at the time of their ED visit, suggesting that positive screens in this study likely represented current use.

Lastly, this single-venue study does not allow for larger scale predictions of substance use trends and in-hospital interventions and outcomes across all music genres at a variety of indoor and outdoor venues. The venue included was an indoor venue and did not host concerts of all genres. Outdoor country music concerts, for example, have been associated with large patient volumes in the lay press and were not represented in this series.[28] The authors encourage the design and implementation of multi-center, multi-venue studies that include venue-provided data on the total number of concert patrons and data from patrons treated and released by on-site medical providers combined with data on patrons transported to local hospitals.

CONCLUSIONS

The data from this study demonstrate that music concerts can result in the transport of adolescent and young adult patients to emergency departments, many of whom require a high level of medical care and significant interventions. In this retrospective case series, the preponderance of female patients, the frequency of alcohol

intoxication and other drug use, the considerable number of patients with altered mental status, and the large number of interventions required by this population, speaks to the substance use behavior among adolescents and young adults attending concerts. Although the sample size of this study limits the ability to predict large-scale trends, specific genres such as pop, EDM, and rock, as shown in this series, may be associated with higher risk as compared with other genres.

The present study provides in-hospital data, including toxicology, GCS, and medical intervention data, that has not previously been reported in the mass casualty medicine literature. It supports the need for additional large-scale collaborative studies as well as universally standardized patient registries to identify patient volume and substance use trends at a national level, along with morbidity and mortality at music concerts. Such efforts may improve venue and local ED planning and preparedness on the days of these events and raise public awareness regarding the scope of adverse outcomes associated with substance use at concerts. Furthermore, the development of collaborative relationships among venues hosting concerts, EMS officials, police, lawmakers, and local hospitals may allow for improved interventions targeted around the well-known relationship between concert attendance and substance use.

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Figure 1. Analytic Sample

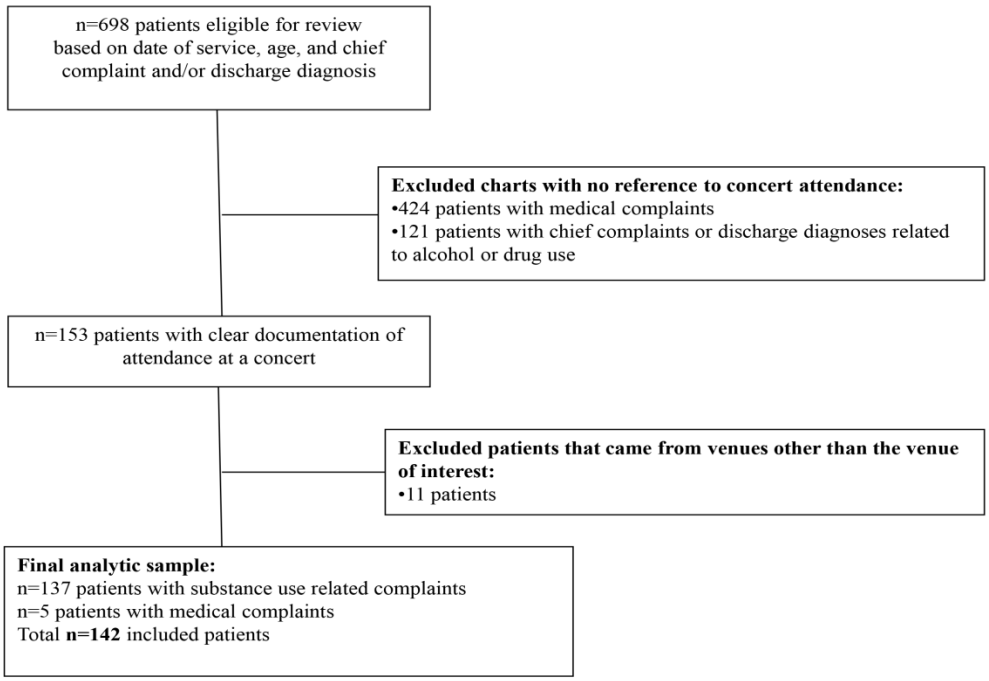


Table 1. Patient Characteristics Overall, and by Music Genre

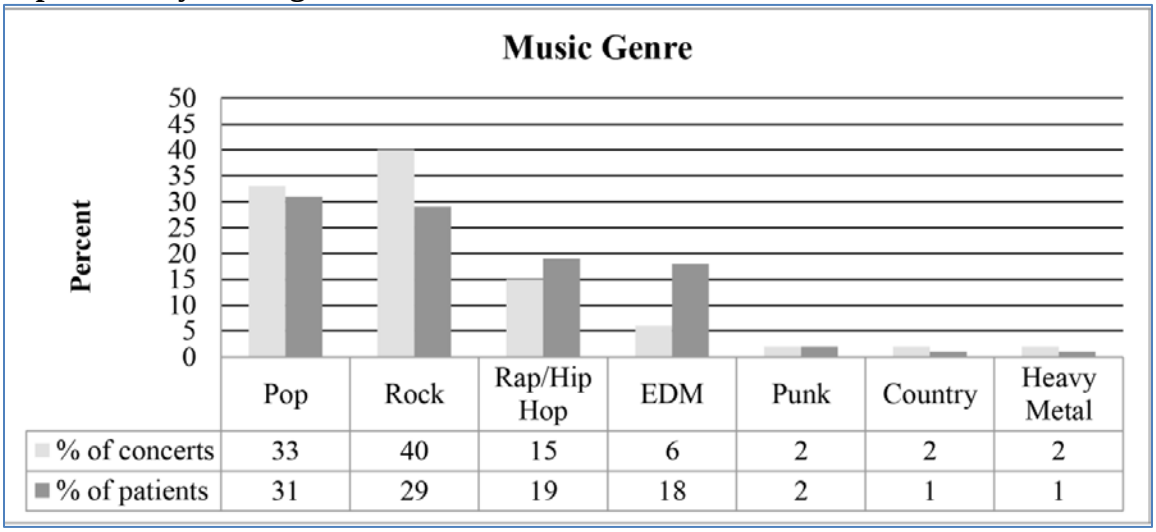
	Mean	**(SD)**
Age (in years)	19.5	(3.3)
Min-Max: 13-30		
Mean age (in years) by music genre		
Country (n=1)	18	(-)
EDM (n=25)	17.5	(1.8)
Heavy Metal (n=1)	23	(-)
Pop (n=44)	20.2	(4.0)
Punk (n=3)	20.7	(1.5)
Rap/Hip Hop (n=27)	18.6	(2.6)
Rock (n=41)	20.4	(3.3)
	N	**(%)**
Age < 21 years	102	(72)
Age < 18	47	(33)
	N	**(%)**
Sex (overall)		
Males	41	(29)
Females	101	(71)
Sex (by age)		
Females < 21	82	(73)
Females < 18	92	(70)
Distribution of females (by attended music genre)		
Country (n=1)	0	(0)
EDM (n=25)	18	(72)
Heavy Metal (n=1)	0	(0)
Pop (n=44)	38	(86)
Punk (n=3)	2	(67)
Rap/Hip Hop (n=27)	18	(67)
Rock (n=41)	25	(61)

Table 2. Concerts that resulted in ED visits

Genre[a]	Performer
Country	Lady Antebellum
Electronic Dance Music	Avicii,[bc] Pretty Lights
Heavy Metal	Avenged Sevenfold
Pop	Beyonce,[cd] Britney Spears, Jingle Ball,[ce] Justin Beiber,[c] Justin Timberlake, Lady Gaga, Madonna, Marc Anthony (Latin Pop), Miley Cyrus,[b] New Kids on the Block, Rhianna,[cd] Stevie Wonder[d]
Punk	Dropkick Murphys
Rap/Hip Hop	Drake, Jay-Z, Kanye West, Mackelmore and Ryan Lewis, Monster Jam,[cg] The Throne Tour with Kanye West and Jay-Z
Rock	Avett Brothers, Black Keys, Bon Jovi, Boston Strong,[f] Coldplay, Dispatch,[h] Foo Fighters, Imagine Dragons, Kings of Leon, Mumford and Sons, Red Hot Chili Peppers, Tool, U2,[h] Van Halen

a. As per the artist's official website or Billboard™ music charts.
b. Concert resulted in an emergency medical services mass casualty incident (MCI) declaration.
c. Two separate concerts by the same performer resulted in ED visits.
d. Beyoncé, Rhianna, and Stevie Wonder are identified as both pop and rhythm and blues (R&B). For the purposes of this study, they were categorized as pop.
e. Multiple performer show, mostly pop performers.
f. Multiple performer show, mostly rock performers.
g. Multiple performer show, mostly rap/hip hop performers.
h. Three separate concerts by the same performer resulted in ED visits.

Figure 2. Proportion of concerts resulting in ED visits compared to the proportion of patients, by music genre



	Pop	Rock	Rap/Hip Hop	EDM	Punk	Country	Heavy Metal
% of concerts	33	40	15	6	2	2	2
% of patients	31	29	19	18	2	1	1

Table 3. Substance use and toxicology lab data

	N (%)		Mean (SD)	
Was the ED visit substance use related? (n=142)[a]				
Yes	137	(97)		
Reported alcohol use (n=142)				
Yes	124	(87)		
Reported of alcohol use BEFORE entering the concert, when asked (n=38)				
Yes	27	(71)		
No	8	(21)		
Patient asked but refused to answer	3	(8)		
Serum toxicology screen sent[b] (n=142)				
Yes	60	(42)		
Serum toxicology screen positive (n=60)				
Yes	59	(98)		
Mean serum ethanol level, mg/dL (n=59)			242.3	(70)
Min-Max: 104.3-412.0				
Mean serum ethanol level for females, mg/dL (n=43)[c]			247.5	(65)
Min-Max: 104.3-412.0				
Mean serum ethanol level for males, mg/dL (n=16)			243.8	(60)
Min-Max: 142.2-358.0				
Mean serum ethanol levels (by music genre), mg/dL				
Country (n=0)			-	
EDM (n=13)			244	(48)
Heavy Metal (n=0)			-	
Pop (n=20)			246	(92)
Punk (n=1)			311	(0)
Rap/Hip Hop (n=12)			229	(65)
Rock (n=14)			243	(62)
Reported of drug use (n=142)				
Yes	22	(16)		
No	100	(70)		
Patient was asked but refused to answer	1	(<1)		
Patient was not asked	19	(13)		
Verbal report of drug use BEFORE entering concert (n=22)				
Yes	6	(27)		
No	1	(5)		
Patient was not asked	15	(68)		
Urine toxicology screen sent[d]				
Yes	20	(14)		
Serum toxicology screen positive[e]				
Opioids	1	(5)		
Marijuana	6	(30)		
Amphetamines	3	(15)		

a. As indicated by the patient's chief complaint or physician or nurse documentation.
b. Serum toxicology panel: ethanol, isopropanol, methanol, acetaminophen and salicylates.
c. One female with serum toxicology testing had a level of 0. This patient was excluded from the analysis of mean blood alcohol level for females.
d. Urine toxicology panel: phencyclidine, barbiturates, cannabinoids, amphetamines, benzodiazepines, opiates, cocaine metabolites. Standard toxicology screens do not test for most synthetic substances, such as synthetic marijuana.
e. One patient reported chronic opioid use, 1 patient endorsed ecstasy use, 1 patient endorsed recreational methylphenidate use, 1 patient reported prescribed methylphenidate use.

Table 4. Interventions, length of stay, and disposition of individuals seen in the ED. Total patient n=142.

	N (%)	
Was any intervention needed beyond clinical observation[a]		
Yes	86	(61)
Airway support		
Nasopharyngeal airway	1	(<1)
Intubation	2	(1)
Imaging	8	(6)
Intravenous fluids	65	(46)
Laceration Repair	4	(3)
Medications		
Antiemetics	49	(35)
Other[b]	30	(21)
Restraints		
Physical	17	(12)
Chemical	14	(10)
Both	12	(9)
Specialty consultations		
Any consult	29	(20)
Social Work	22	(16)
Plastic Surgery	2	(1)
Pediatric ICU	2	(1)
Psychiatry	3	(2)
	Mean	**(SD)**
Overall mean length of stay, in hours		
Min-Max: 0.4-18.6	4.3	(3)
Mean ED length of stay, by musical genre		
Country (n=1)	3.7	-
EDM (n=25)	5.1	(3.0)
Heavy Metal (n=1)	2.9	-
Pop (n=44)	4.0	(3.4)
Punk (n=3)	6.2	(4.0)
Rap/Hip-Hop (n=27)	5.4	(4.7)
Rock (n=41)	3.4	(2.2)
	N (%)	
Patient Disposition		
Treated and released	128	(90)
Left without being seen/without completing treatment	11	(8)
Admitted	2	(1)
Discharged to another care facility/hospital	1	(<1)

a. Interventions: airway support (nasopharyngeal airway or intubation), imaging, intravenous fluid administration, laceration repair, medication administration, restraints (chemical, physical, or both), and specialty consultation.
b. Other medications given: pain medications, antibiotics, anxiolytics, rapid sequence intubation medications, and electrolyte repletion

Part 2 – Original Manuscript: The negative relationship between digital media exposure and childhood flourishing

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ABSTRACT

Introduction: Digital media exposure (DME) is linked with negative physical, behavioral and neurocognitive effects in children. This study describes the relationship between DME and parental perception of childhood flourishing, or overall positive well-being. It is hypothesized that there is a negative association between measures of childhood flourishing and increasing daily DME.

Methods: Parental responses for children ages 6-17 years (N=64,464) from 2011-2012 National Survey of Children's Health were analyzed. Average weekday DME that was not school work related was categorized in two hour intervals: 0 to < 2, 2 to < 4, 4 to < 6, and ≥6 hours. The relationship between DME and parent-reported frequency of five childhood flourishing markers was examined. The markers were: completing homework, caring about academics, finishing tasks, staying calm when challenged, and showing interest in learning.

Results: Only 31% reported less than 2 hours of weekday DME. For the remaining children, daily DME was 36% (2 to <4 hours), 17% (4 to <6 hours), and 17% (≥6 hours). In a model adjusted for age, sex, and poverty level, there was a dose-dependent decrease in the odds of demonstrating all 5 markers of flourishing as weekday DME increased; test for trend for each outcome $P < 0.001$. In stratified analyses, this relationship held true regardless of the child's age group, sex, or poverty level.

Conclusions: This study provides new evidence that, among school aged children, increasing weekday DME has a negative dose-dependent impact on multiple childhood flourishing markers.

Introduction and Background:

With the introduction of laptops, smart phones, and tablets, patterns of digital media exposure (DME) have evolved significantly over recent decades.[1] The change in media landscape has made DME ubiquitous in the lives of children. Although digital media use has conferred benefits such as enhanced communication, connectivity, and knowledge,[1] physicians and other childhood specialists have become increasingly concerned about the physical, behavioral, and neurocognitive effects of DME on children. Studies have demonstrated negative associations between DME and obesity and poorer fitness,[2-5] attention and cognitive deficits,[6,7] violence and bullying behavior,[8,9] poor sleep,[10,11]and risky behaviors, such as substance use.[12] In 1999, the American Academy of Pediatrics (AAP) and Bright Futures Guidelines made their first set of recommendations discouraging TV use for children <2 years old and limiting viewing time to < 2 hours daily for children over age two.[13] In the wake of newer studies examining the effects of DME, the AAP released an updated policy statement in 2016, including recommendations to discourage DME for children < 18 months, allow selective exposure for children 18-24 months and <1 hour of daily exposure for children 2-5 years.[14] For school-aged children, the use of digital media while doing homework is discouraged, creation of daily "media-free" time is recommended, and parents are encouraged to set time and content limits and to create personalized media plans with their children.[1]

Although numerous studies have evaluated the relationship between DME and health outcomes as well as specific markers of academic performance, an area in need of further exploration is the impact of DME on childhood flourishing. Existing

conceptualizations of "flourishing" include components of social and emotional well-being, psychological regulation, sense of purpose, diligence, initiative, and indicators of academic performance, including homework and task completion and showing interest in learning new things.[17-19] Although publications evaluating childhood flourishing have not used one universal set of constructs, flourishing has been categorized into indicators of physical health as well as cognitive, psychological, emotional, and social development and behavior. Also, flourishing has been evaluated in the context of developmental stages, generally broken down into 6 years increments (0-5, 6-11, and 12-17 years).[20]

Despite academic interest in childhood flourishing, to date there are no studies known to the authors specifically addressing its relationship with DME. As such, the objective of this study is to evaluate the impact of weekday DME on childhood flourishing. It is hypothesized that there is a negative association between measures of flourishing and increasing daily DME.

Methods

Study Population and Design

For this study, data from the 2011-2012 National Survey of Children's Health (NSCH) was utilized. This is a cross-sectional telephone survey conducted over 16 months (February 2011-June 2012) by the National Center of Health Statistics at the Centers for Disease Control under the sponsorship of the federal Maternal and Child Health Bureau and is designed to obtain a nationally representative sample of noninstitutionalized children.[19] Households were sampled by random-digit dialing of cellular and landline telephone numbers. A parent or guardian was asked to respond to questions related to the physical and emotional health of one randomly chosen child

between the ages of 0-17 years old in the household. A total of 95,677 surveys were completed and results were weighted to reflect the demographic makeup of noninstitutionalized children ages 0-17 in each state and were conducted in English and Spanish.[19] Details can be found at http://www.childhealthdata.org/learn/NSCH. This study was considered IRB exempt as it uses a de-identified, publically available dataset and is not considered human subjects research.

Exposures and co-variates

The main exposure in this study was defined as total combined DME time in an average weekday for children aged 6-17. Children aged 0-5 were excluded to focus on the relationship between daily DME and flourishing in school-aged children. DME was assessed by two questions in the NSCH survey. The first was: "On an average weekday, about how much time does [the child] usually spend in front of a TV watching TV programs, videos, DVDs, or playing videogames?" Respondents were advised to not include time spent watching TV programs, videos, or DVDs at school. The second was: "On an average weekday, about how much time does [the child] spend with computers, cell phones, handheld video games, and other electronic devices, doing things other than schoolwork?" Responses to both questions were expressed as continuous variables reported in total number of minutes or hours per weekday for all media outlets, ranging from 0- 24 hours per day. A total DME continuous variable was generated by combining the number of hours reported in the above two questions similar to a combined total media time variable previously described by Russ *et al*.[5] The continuous DME variable was converted to a categorical variable with a reference category of zero to <2 hours per

day and subsequent categories of two to < 4, four to < 6, and ≥ 6 hours per day to assess dose impact.

Primary outcomes were demonstration of five childhood flourishing markers. For children aged 6-17, respondents were asked how often: [During the past month] "he/she does all required homework," "he/she cares about doing well in school," "he/she finishes the tasks he/she starts and follows through with what he/she says he'll/she'll do," "he/she stays calm and in control when faced with a challenge," and "he/she shows interest and curiosity in learning new things." Consistent with the Child Trends previous publications using the NSCH data[18] the five NSCH response categories were combined into: sometimes/rarely/never and usually/always.

A total of 64,464 surveys met inclusion criteria based on age and valid responses to the exposure and outcome variables, constituting 98.1% of the eligible population. Responses were characterized as "missing" observations if respondents refused to answer or replied "don't know" to relevant questions. Missing values for all variables were < 5% with the exception of poverty level and maternal education level, which had < 10% of values with missing/invalid responses. For these two variables, a "missing/invalid" category was generated and included in the analysis.

Prior studies have identified a number of covariates and potential confounders that are related to media use (sex, race, socioeconomic status, parental education, and parental limits to media use).[5, 21-22] As such, data was analyzed based on child age, sex, race, primary language spoken at home, poverty level, mother's highest education level and limits set on media time.

For age, 3 categories of 6-9 years, 10-13 years, and 14-17 years were generated to represent elementary school, middle school, and high school age groups. Race was reported as "white only," "black only" and "other" by the NSCH; respondents were instructed to answer "whatever you consider yourself to be" and did not further define these categories.[19] The primary language spoken at home was reported as "English" and "non-English." The poverty level of the respondent's family was based on the Department of Health and Human Services' poverty guidelines using the respondent's report of household size and income. The 8 separate poverty level categories reported by the NSCH were re-operationalized into "≤200% of the poverty level," "201-400% of the poverty level," and ">400% of the poverty level." Maternal education level was reported as "≤ high school graduate" or "education beyond high school graduate." Finally, the parent/caregiver was asked if there were household limits to the amount of time the child "spends watching TV, playing on the computer, or using electronic devices," reported as "yes" or "no." Additional categorical variables were generated for type of school attended, family structure, parental monitoring of media content, and access to devices in the bedroom; see Table 1 for subcategories.

Statistical Analysis

Analysis was performed using STATA 14.0 (StataCorp LP, College Station, TX). Sampling weights were applied as recommended by the data source and accounted for complex survey design to adjust for nonresponse, non-coverage, and possible imbalance in the selected sample. Bivariate analysis was performed to establish associations between the main exposure of combined DME time and the five flourishing outcomes of interest, as well as between DME and each of the covariates. Logistic regression was

performed to generate unadjusted odds ratios (uOR) for each outcome. A final multivariable adjusted model was generated by testing each covariate (age, sex, race, primary language spoken at home, poverty level, maternal education level, and parental limits on media time). If the adjusted OR (aOR) for DME with that covariate in the model was >10% changed from the uOR, the covariate was included in the model. The final adjusted model accounted for age, sex, and poverty level. To assess if the association between DME and flourishing varied by age group, sex, and poverty level, additional subgroup analyses were performed and aORs were obtained.

Adjusted ORs for poverty level were calculated including the missing/invalid responses as a category in the analyses. To test if the missing/invalid responses impacted the outcome odds ratios, the adjusted analysis was calculated a second time with a poverty level variable that did not include missing/invalid observations. The aORs with and without the missing observations were essentially unchanged. Therefore, the observations with missing/invalid responses were left in the final adjusted model.

Results

Only 30.6% (N=20,144) of children were reported to have a combined daily DME of 0 to < 2 hours per day. For others, 35.7% (N=23,524) had 2 to < 4 hours, 17.3% (N=10,845) had 4 to < 6 hours, and 16.5% (N=9,951) had ≥ 6 hours per day of DME (Table 1).

Overall, approximately 97% (N=62,781) of children were enrolled in public or private school (the majority in public school), 73% (N=46,363) of children lived in a two parent home, 94% (N=60,248) of children's parents monitored the media content watched, 82% (N=52,694) of children's parents set limits on media use, and 56%

(N=35,999) had access to devices in the bedroom (Table 1). Notably, among children with <2 hours of DME, only 38% had access to media devices in their bedroom compared to 73% in the ≥6 hour exposure group. Additional demographic details can be seen in Table 1.

For the 5 domains of childhood flourishing, parents/caregivers reported that overall, 87.6% (N=56,654) of children usually/always complete their homework, 86.5% (N=55,852) usually/always care about doing well in school, 66.5% (N=42,934) usually/always finish tasks that they start, 67.5% (N=43,593) usually/always stay calm when faced with challenges, and 86.4% (N=55,854) usually/always show interest and curiosity in learning new things.

Table 2 presents the breakdown of flourishing markers based on daily DME. Children with the lowest average daily DME were reported to have higher odds of demonstrating all 5 flourishing makers than their counterparts with higher daily averages. As the number of daily DME hours increased, an incremental decrease in the proportion of children that usually/always demonstrate each of the individual markers was observed. Further elucidating this association, odds ratios adjusted for age, sex, and poverty level demonstrated a dose-dependent relationship between hours of daily DME and the flourishing outcome measures (Figure 1, Table 3). For example, in the adjusted model (Table 3), children who had two to <4 hours of DME per weekday not related to schoolwork had 23% lower odds of always/usually finishing their homework, as compared to children who had <2 hours (95% confidence interval [CI] 0.65-0.90). Those with four to <6 hours per day had 49% lower odds (95% CI 0.42-0.61) and those with ≥6 hours per day had 63% lower odds (95% CI 0.31-0.44) of demonstrating this marker as

compared to children with <2 hours; test for trend P<0.001. There was a similar decline in odds seen with each of the remaining four flourishing markers (test for trend P < 0.001 for each marker; Table 3).

These dose-dependent trends held true among all subgroups analyzed regardless of a child's age, sex, or poverty level (Supplemental Table 1). When stratifying each flourishing marker by age group (6-9, 10-13, and 14-17 years), the adjusted odds of usually/always demonstrating each marker still followed the same incremental decline (controlling for sex and poverty); test for trend P< 0.001 for all markers except for caring about school among 6-9 year olds (aOR P=0.013).

Independent of media exposure time, female sex appears to be a protective factor for all 5 flourishing markers, with adjusted odds of 2.05 (95% CI 1.83-2.29), 2.58 (95% CI 2.31-2.88), 1.41 (95% CI 1.27-1.56), 1.25 (95% CI 1.15-1.35), and 1.39 (95% CI 1.29-1.50), for usually/always completing homework, caring about school, showing interest in learning, staying calm when faced with challenges, and finishing tasks that are started, respectively as compared to males. When sub-analyses were done by gender and controlled for age and poverty level, the DME dose-dependent trends again held true for both males and females (test for trend P<0.001).

Finally, sub-analysis of flourishing markers based on DME time and stratified by poverty level was also done, controlling for age and sex. The linear test for trend for each of the five flourishing markers remained statistically significant (P<0.001) when stratified by poverty level.

Discussion

The present study, using a large nationally-representative dataset, adds to the literature by demonstrating a negative dose-dependent relationship between the total hours of DME and multiple childhood flourishing markers. The size and diversity of the study population is a notable strength of this study, setting it apart from previous media-related studies with smaller study populations.[4,5,22-26]

The 2016 AAP policy statement recommends setting limits on DME and encourages parents/caregivers to generate individualized digital media plans for their children. This study's findings re-emphasize the need for anticipatory guidance by health care providers by showing that > 2/3^{rds} of school-aged children in this study have >2 hours of total DME per day, >½ have access to devices in the bedroom, and 1/3rd with ≥6 hours of daily DME have *no* parental limits set for DME.

Not only was a strong overall negative relationship between increasing daily DME time and all measured markers of flourishing demonstrated, but this effect remained significant after controlling for age, sex, and poverty level as well as across subgroup analyses, stratifying by age, sex, and poverty level. The results of this study suggest that there may be an additive effect of all of the time spent with digital media each day and its impact on childhood flourishing. With this in mind, parents and caregivers should account for the periods of time spent with each device throughout the day when developing the media plans for their children.

Previous studies have attempted to understand the relationship between media use and academic performance, one measure of childhood flourishing. It has been hypothesized that time spent utilizing media devices takes away from time that would

otherwise be spent on homework, studying, reading for pleasure, and engaging in other academically rich behaviors.[21, 26-27] Anderson *et al* coined this the "displacement hypothesis."[27] A 2006 population-based cross-sectional survey middle school students found that the odds of poorer school performance (as measured by participant self-report) increased as weekday DME increased.[21] A follow-up longitudinal study in 2010 by the same author was conducted to identify possible mechanisms for the impact of visual media use on adolescents' school performance and demonstrated that the impact on school performance is partly due to the displacement mechanism.[22] A 2010 Kaiser Family Foundation study demonstrated that among the 21% of respondents that reported >16 hours of combined daily DME, nearly 50% also reported fair or poor grades compared to only 23% of children who are exposed to < 3 hours daily. [24] The data from the current study supports the notion that academic performance, measured here as frequency of homework completion, decreases with increasing DME. Furthermore, this study adds to the previous literature by demonstrating that children are also less likely to care about doing well in school, finish tasks that are started, or show interest and curiosity in learning new things with increasing daily DME.

Limitations

Although the sample size is robust with over 64,000 valid observations and generalizable to non-institutionalized U.S. children, the nature of a cross-sectional study design of the NSCH is a limitation. The authors cannot make conclusions about the directionality of the relationship between DME and outcome measures. It is unclear if increasing DME results in the decrease in flourishing markers, or if children with inherently lower flourishing markers tend to subsequently have higher DME.

Furthermore, this study defines DME based on the amount of time that is not school-related. The data does not reflect the quality or content of the media exposure. Digital media with educational or social components may have a different impact on children than media that does not involve these elements, for example. While the current data does not address the content and quality of media exposure, it is quite striking that a negative dose-response relationship is independent of age, sex, and poverty level and observed *within* each strata of age, sex, and poverty level.

Additionally, the outcomes and exposure are based on parental report, which may introduce recall bias and may not be an accurate reflection of the child's true behaviors. Also, parents may report up to 24 hours of daily DME if their child has access to a digital device at all times. While the child may have the device, he/she may not be actively using it throughout that time; this possible over-reporting of exposure may have impacted the relationships with the outcome variables.

Finally, the questions offered by the NSCH only asked about *weekday* exposure and not weekend exposure. It is unclear if the amount of time spent on weekdays as opposed to weekends has any impact on the outcomes of interest. At current, there are no specific recommendations from the AAP regarding DME exposure on weekends versus weekdays.

Conclusions

Daily DME, when measured in combined daily hours, is negatively associated with behaviors and attitudes that have been identified as markers of childhood flourishing in a dose-dependent manner, thus expanding and re-enforcing the current literature base. Future studies should continue to work towards elucidating the complex relationship

between total DME time *in conjunction with* the content of the media and how the interplay between these two components affect childhood flourishing.

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Table 1. Demographics based on hours of weekday daily digital media exposure (DME)[a] for children aged 6-17 years: National Survey of Children's Health, 2011-2012 (N=64,464)

	Weekday DME Time[b]			
	0 - <2 hours/day 30.6% (N=20,144) Weighted %	**2 - <4 hours/day** 35.7% (N=23,524) Weighted %	**4 - <6 hours/day** 17.3% (N=10,845) Weighted %	**≥6 hours/day** 16.5% (N=9,951) Weighted %
Age[c]				
6-9 years	48.7%	34.1%	21.0%	13.6%
10-13 years	33.2%	35.0%	35.3%	27.5%
14-17 years	18.0%	30.9%	43.8%	58.9%
Sex[c]				
Female	52.2%	47.3%	47.7%	47.1%
Race[c]				
White only	70.3%	69.7%	64.0%	56.2%
Black only	10.4%	12.6%	17.6%	26.3%
Other	19.3%	17.8%	18.5%	17.5%
Primary language spoken at home[c]				
English	86.3%	85.8%	85.2%	90.1%
Poverty level[c]				
≤200% of poverty level	32.2%	35.9%	41.9%	47.0%
201%-400% of poverty level	26.8%	26.8%	26.9%	27.2%
>400% of poverty level	31.3%	28.1%	21.3%	17.5%
Missing/invalid	9.6%	9.2%	10.0%	8.3%
Mother's highest education level[c]				
≤ High school graduate	26.1%	30.6%	38.3%	39.4%
> High school graduate	66.2%	60.1%	50.2%	47.3%
Missing/Invalid	7.7%	9.3%	11.5%	13.3%
Type of school attended[c]				
Public	83.3%	89.0%	90.0%	91.2%
Private	13.8%	8.9%	7.5%	5.8%
Home	2.5%	1.9%	2.2%	2.3%
Not enrolled/missing/invalid	0.2%	<0.1%	0.1%	0.6%
Family/household structure[c,d]				
Two parent household	77.9%	74.8%	68.6%	63.0%
Single mother, previously married[e]	11.0%	12.2%	14.6%	16.2%
Single mother, never married	5.4%	5.8%	7.8%	9.3%
Other/missing/invalid	5.7%	7.2%	9.1%	9.1%
Parent limits set on DME[c]				
Yes	90.3%	85.4%	75.1%	65.0%
Parental monitoring of content[c,f]				
Yes	96.3%	95.0%	91.5%	87.5%
Electronic devices in bedroom[c,g]				
Yes	38.2%	57.4%	67.3%	73.4%

a – Total weekday digital media exposure is a combined variable of a child's reported time spent "in front of a TV watching TV programs, videos, DVDs or playing video games," and "with computers, cell phones, handheld video games, and other electronic devices," for purposes other than school work
b - Percentages may not equal 100% due to rounding, c - P < 0.001, d - N=63,721, e - Single mother previously married *or* living separately from significant other, f - N = 64,382, g - N = 64,446

Table 2. Reported frequency of demonstrating flourishing markers among children 6-17 years of age based on daily digital media exposure (DME): National Survey of Children's Health, 2011-2012 (N = 64,464)

	Weekday DME Time[a]			
	0 - <2 hours/day 30.6% (N=20,144) _____ Weighted %	**2 - <4 hours/day** 35.7% (N=23,524) _____ Weighted %	**4 - <6 hours/day** 17.3% (N=10,845) _____ Weighted %	**≥6 hours/day** 16.5% (N=9,951) _____ Weighted %
Does the child complete homework[b]				
Never/Rarely/Sometimes	7.0%	10.6%	17.1%	24.2%
Usually/Always	93.0%	89.4%	83.0%	75.9%
Does the child care about doing well in school[b]				
Never/Rarely/Sometimes	9.2%	12.1%	17.8%	22.3%
Usually/Always	90.8%	87.9%	82.2%	77.7%
Does the child finish tasks that have been started[b]				
Never/Rarely/Sometimes	28.7%	32.9%	38.8%	45.1%
Usually/Always	71.3%	67.1%	61.1%	54.9%
Does the child stay calm when faced with challenges[b]				
Never/Rarely/Sometimes	31.1%	34.0%	37.8%	42.3%
Usually/Always	68.9%	66.0%	62.2%	57.7%
Does the child show interest in learning new things[b]				
Never/Rarely/Sometimes	9.2%	13.6%	18.6%	24.0%
Usually/Always	90.8%	86.4%	81.5%	76.0%

a - Percentages may not equal 100% due to rounding
b - $P < 0.001$

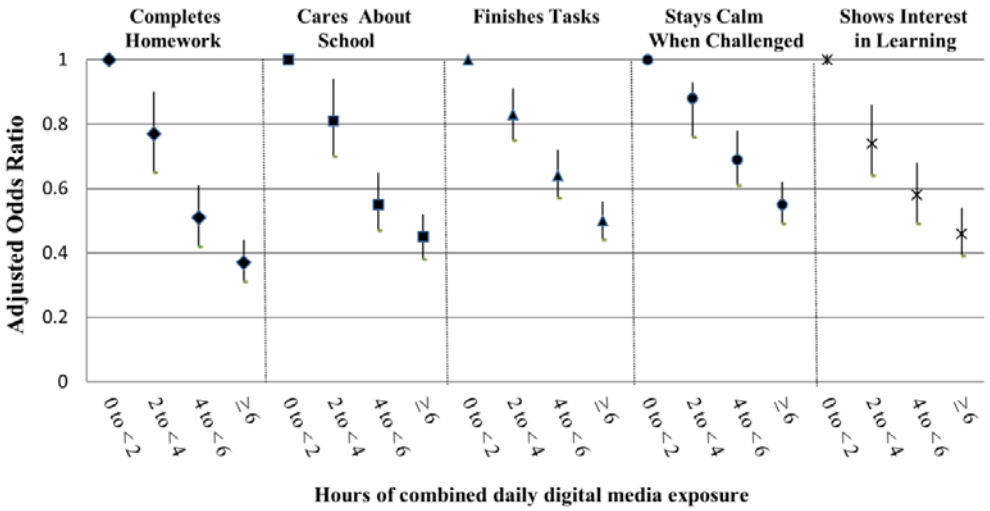
Table 3. Unadjusted and adjusted[a] odds ratios for childhood flourishing markers based on daily digital media exposure (DME) among US children 6-17 years of age: National Survey of Children's Health, 2011-2012 (N = 64,464)

	Weekday DME Time			
	0 to < 2 hours/day OR (95% CI)	**2 to < 4 hours/day OR (95% CI)**	**4 to < 6 hours/day OR (95% CI)**	**≥6 hours/day OR (95% CI)**
Usually/always completes homework[b]				
Unadjusted OR	1.0 (ref)	0.63 (0.54-0.75)	0.37 (0.31-0.44)	0.24 (0.20-0.28)
Adjusted OR	1.0 (ref)	0.77 (0.65-0.90)	0.51 (0.42-0.61)	0.37 (0.31-0.44)
Usually/always cares about doing well in school[b]				
Unadjusted OR	1.0 (ref)	0.74 (0.64-0.85)	0.47 (0.40-0.55)	0.35 (0.30-0.41)
Adjusted OR	1.0 (ref)	0.81 (0.70-0.94)	0.55 (0.47-0.65)	0.45 (0.38-0.52)
Usually/always finishes tasks that are started[b]				
Unadjusted OR	1.0 (ref)	0.82 (0.74-0.90)	0.63 (0.57-0.71)	0.49 (0.44-0.55)
Adjusted OR	1.0 (ref)	0.83 (0.75-0.91)	0.64 (0.57-0.72)	0.50 (0.44-0.56)
Usually/always stays calm when challenged[b]				
Unadjusted OR	1.0 (ref)	0.88 (0.80-0.96)	0.74 (0.66-0.83)	0.62 (0.55-0.69)
Adjusted OR	1.0 (ref)	0.84 (0.76-0.93)	0.69 (0.61-0.78)	0.55 (0.49-0.62)
Usually/always shows interest in learning[b]				
Unadjusted OR	1.0 (ref)	0.64 (0.55-0.74)	0.44 (0.38-0.52)	0.32 (0.27-0.37)
Adjusted OR	1.0 (ref)	0.74 (0.64-0.86)	0.58 (0.49-0.68)	0.46 (0.39-0.54)

a - Adjusted ORs controlled for age, sex, and poverty level

b - Test for trend $P < 0.001$

Figure. Adjusted odds ratios for flourishing markers based on hours of daily digital media exposure among US Children between 6-17 years of age: National Survey of Children's Health, 2011-2012 (N = 64,464)[a]



a - Odds ratios were adjusted for age, sex, and poverty level. Linear test for trend for all flourishing outcome markers $P < 0.001$

Supplemental Table. Adjusted odds ratios for flourishing markers; subgroup analyses by age group,[a] sex,[b] and poverty level[c] among US children 6-17 years of age: National Survey of Children's Health, 2011-2012 (N = 64,464)

	Total Average Weekday Digital Media Exposure (hours/day)			
	0 to <2 aOR (95% CI)	2 to <4 aOR (95% CI)	4 to <6 aOR (95% CI)	≥6 aOR (95% CI)
Usually/always completes homework				
Age				
OR 6-9 years*		0.81 (0.60-1.09)	0.57 (0.41-0.79)	0.42 (0.26-0.67)
OR 10-13 years*	1.0 (ref)	0.72 (0.55-0.94)	0.51 (0.38-0.67)	0.43 (0.32-0.58)
OR 14-17 years*		0.77 (0.56-1.07)	0.50 (0.34-0.67)	0.33 (0.24-0.45)
Sex				
OR Females*	1.0 (ref)	0.87 (0.68-1.16)	0.56 (0.42-0.75)	0.37 (0.28-0.48)
OR Males*		0.70 (0.57-0.87	0.48 (0.38-0.60)	0.37 (0.30-0.57)
Poverty Level				
OR <200% poverty level*	1.0 (ref)	0.84 (0.65-1.09)	0.58 (0.44-0.77)	0.40 (0.32-0.52)
OR 200-400% poverty level*		0.87 (0.64-1.24)	0.70 (0.49-0.99)	0.52 (0.36-0.74)
OR >400% poverty level*		0.53 (0.40-0.69)	0.28 (0.21-0.39)	0.24 (0.18-0.33)
Usually/always cares about school				
Age				
OR 6-9 years**	1.0 (ref)	1.02 (0.80-1.30)	0.74 (0.53-1.02)	0.61 (0.41-0.90)
OR 10-13 years*		0.73 (0.57-0.93)	0.53 (0.40-0.69)	0.48 (0.37-0.63)
OR 14-17 years*		0.63 (0.48-0.82)	0.40 (0.30-0.53)	0.31 (0.24-0.40)
Sex				
OR Females*	1.0 (ref)	0.74 (0.58-0.95)	0.44 (0.34-0.58)	0.35 (0.27-0.46)
OR Males*		0.86 (0.72-1.03)	0.62 (0.50-0.76)	0.50 (0.51-0.62)
Poverty Level				
OR <200% poverty level*	1.0 (ref)	0.95 (0.74-1.21)	0.65 (0.50-0.84)	0.47 (0.37-0.60)
OR 200-400% poverty level*		0.90 (0.69-1.19)	0.62 (0.45-0.84)	0.48 (0.36-0.65)
OR >400% poverty level*		0.62 (0.49-0.79)	0.43 (0.33-0.56)	0.41 (0.31-0.54)
Usually/Always Finishes Tasks				
Age				
OR 6-9 years*		0.93 (0.81-1.07)	0.68 (0.55-0.85)	0.71 (0.55-0.93)
OR 10-13 years*	1.0 (ref)	0.81 (0.69-0.96)	0.73 (0.60-0.89)	0.62 (0.50-0.76)
OR 14-17 years*		0.60 (0.48-0.76)	0.43 (0.34-0.55)	0.30 (0.24-0.38)
Sex				
OR Females*	1.0 (ref)	0.78 (0.68-0.89)	0.56 (0.47-0.66)	0.45 (0.47-0.66)
OR Males*		0.88 (0.77-1.00)	0.73 (0.62-0.86)	0.54 (0.45-0.63)
Poverty Level				
OR <200% poverty level*	1.0 (ref)	0.83 (0.70-0.99)	0.70 (0.58-0.86)	0.48 (0.40-0.59)
OR 200-400% poverty level*		0.89 (0.74-1.07)	0.70 (0.55-0.88)	0.55 (0.43-0.69)
OR >400% poverty level*		0.79 (0.68-0.92)	0.55 (0.45-0.68)	0.52 (0.42-0.65)
Usually/Always Stays Calm				
Age				
OR 6-9 years*		0.88 (0.76-1.02)	0.64 (0.52-0.80)	0.78 (0.60-1.01)
OR 10-13 years*	1.0 (ref)	0.86 (0.73-1.01)	0.77 (0.63-0.95)	0.63 (0.51-0.78)
OR 14-17 years*		0.69 (0.54-0.87)	0.55 (0.43-0.71)	0.40 (0.31-0.49)
Sex				
OR Females*	1.0 (ref)	0.84 (0.73-0.97)	0.67 (0.57-0.80)	0.61 (0.51-0.73)
OR Males*		0.84 (0.73-0.96)	0.71 (0.60-0.83)	0.50 (0.42-0.59)

Continued on next page

	0 to <2 aOR (95% CI)	2 to <4 aOR (95% CI)	4 to <6 aOR (95% CI)	≥6 aOR (95% CI)
Usually/Always Stays Calm				
Poverty Level				
OR <200% poverty level*	1.0 (ref)	0.83 (0.70-0.98)	0.77 (0.63-0.94)	0.55 (0.45-0.67)
OR 200-400% poverty level*		0.86 (0.72-1.04)	0.66 (0.53-0.83)	0.58 (0.46-0.73)
OR >400% poverty level*		0.80 (0.67-0.95)	0.62 (0.49-0.78)	0.54 (0.42-0.69)
Usually/Always Shows Interest in Learning				
Age				
OR 6-9 years*	1.0 (ref)	0.88 (0.69-1.13)	0.59 (0.43-0.81)	0.43 (0.29-0.63)
OR 10-13 years*		0.81 (0.63-1.04)	0.66 (0.49-0.88)	0.54 (0.40-0.71)
OR 14-17 years*		0.58 (0.44-0.77)	0.48 (0.36-0.64)	0.37 (0.28-0.49)
Sex				
OR Females*	1.0 (ref)	0.64 (0.52-0.80)	0.53 (0.42-0.67)	0.38 (0.30-0.48)
OR Males*		0.82 (0.67-1.01)	0.62 (0.49-0.78)	0.53 (0.42-0.66)
Poverty Level				
OR <200% poverty level*	1.0 (ref)	0.74 (0.58-0.94)	0.64 (0.49-0.84)	0.46 (0.36-0.60)
OR 200-400% poverty level*		0.94 (0.69-1.27)	0.67 (0.48-0.93)	0.55 (0.39-0.76)
OR >400% poverty level*		0.55 (0.42-0.73)	0.41 (0.30-0.56)	0.36 (0.26-0.50)

a – Adjusted ORs controlled for sex and poverty level
b – Adjusted OR's controlled for age and poverty level
c – Adjusted OR's controlled for age and sex
* - Test for trend P < 0.001
** - Test for trend P = 0.013