ARTICLE

Using Ecological Momentary Assessment to Determine Media Use by Individuals With and Without Major Depressive Disorder

Brian A. Primack, MD, EdM, MS; Jennifer S. Silk, PhD; Christian R. DeLozier, BS; William G. Shadel, PhD; Francesca R. Dillman Carpentier, PhD; Ronald E. Dahl, MD; Galen E. Switzer, PhD

Objective: To use ecological momentary assessment techniques to measure the association of major depressive disorder (MDD) with media use.

Design: Data were collected using an ecological momentary assessment protocol with cellular telephone–based brief interviews.

Setting: Participants received as many as 60 telephone calls from a trained staff member during 5 extended weekends in an 8-week period.

Participants: One hundred six adolescent participants who were part of a larger neurobehavioral study of depression in Pittsburgh from January 1, 2003, through December 31, 2008.

Main Exposure: At each call, participants were asked whether they were using the following 5 types of media: television or movies, music, video games, Internet, and print media, such as magazines, newspapers, and books.

Main Outcome Measures: We developed multivariable models to determine the independent association of each type of media use with MDD, controlling for sociodemographic variables.

Results: Of the 106 participants, 46 were diagnosed as having MDD. In multivariable models controlling for age, sex, and race, each increasing quartile of audio use was associated with an 80% increase in the odds of having MDD (odds ratio, 1.8; 95% confidence interval, 1.1-2.8; $P=.01$ for trend). Conversely, each increasing quartile of print media use was associated with a 50% decrease in the odds of having MDD (odds ratio, 0.5; 95% confidence interval, 0.3-0.9; $P=.009$ for trend).

Conclusions: Major depressive disorder is positively associated with popular music exposure and negatively associated with reading print media such as books. Further research elucidating the directionality and strength of these relationships may help advance understanding of the relationships between media use and MDD.

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Author Affiliations: Division of General Internal Medicine, Department of Medicine (Drs Primack and Switzer and Mr DeLozier), and Departments of Pediatrics (Dr Primack) and Psychiatry (Dr Silk), University of Pittsburgh School of Medicine, RAND Corporation (Dr Shadel), and Center for Heath Equity Research and Promotion, Veterans Affairs Pittsburgh Healthcare System (Dr Switzer), Pittsburgh, Pennsylvania; School of Journalism and Mass Communication, University of North Carolina, Chapel Hill (Dr Dillman Carpentier); and Community Health and Human Development and Joint Medical Program, School of Public Health, University of California, Berkeley (Dr Dahl).

MAJOR DEPRESSIVE DISORder (MDD) is the leading cause of disability in the world.[1] Because its onset is common in adolescence and young adulthood,[2,3] it coincides with a pivotal period of physical and psychological development and can lead to substantial morbidity and mortality.[4,5] The development of MDD is a biopsychosocial, multifactorial process influenced by multiple risk and protective factors.[2,3,5-7] Moreover, given the high rates of media use in adolescence[8,9] and the potential bidirectional effects between mood and media use,[10-17] examining real-life media use in samples of depressed adolescents is an important area of research in adolescent affect regulation.

Current total media exposure for youth aged 8 to 18 years is estimated at more than 10 hours per day.[8] Cultural messages transmitted through media affect other behaviors related to mental health, such as eating disorders and aggressive behavior.[14,15,17,18] Media use may similarly contribute to the development of depression via reinforcement of cognitions and/or affective states.[15,17,19] For example, certain televised media situations are saturated with highly idealized characters and situations,[17,20] and constant comparison of one's self to these unattainable images may contribute to or exacerbate depression.[19,21] Other media exposures—particularly on television, in music, and in video games—are highly negative or violent,[16,17,22] and repeated exposure to these messages may engender a negative and fearful perception of the world, which can also contribute to or exacerbate depression.[21]

Being depressed may, in turn, influence media use. For example, individuals with MDD may lack the initiative and/or con-

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centration to use media requiring high cognitive involvement, such as reading, but may be more likely to consume media with low cognitive involvement, such as television[23-25] and radio.[23,24] Thus, we might expect there to be a positive association between television or music exposure and MDD and a negative association between nonelectronic media exposure (such as reading books) and MDD. Similarly, individuals with MDD may seek out media with positive emotional content to find refuge from their negative emotions,[26] or they may seek out negative emotional content to feel a sense of connection with others who are in pain[27,28] or to cope with their own struggles.[26,29]

Determining which types of media use are most often associated with depression may assist with elucidation of these mechanisms linking media exposure and MDD, and the knowledge that MDD is associated with particular media exposures could help us effectively target screening, preventive, and/or therapeutic programs. To this end, we previously used the National Longitudinal Survey of Adolescent Health to investigate electronic media exposure in nondepressed middle adolescents and subsequent development of MDD after 7 years of follow-up. Those reporting higher television use had significantly greater odds of developing MDD (odds ratio [OR], 1.09; 95% confidence interval [CI], 1.02-1.16) for each additional hour of daily television use, even after controlling for multiple covariates.[10] Also, MDD was inversely associated with exposure to books. However, there were no statistically significant associations between MDD and exposure to music, video games, or videocassettes.

Although these results were interesting, they were not necessarily consistent with other notable studies investigating associations between depression and media use.[11,30] In addition, large survey measurements, such as those of the National Longitudinal Survey of Adolescent Health, can be imprecise and subject to recall bias. Ecological momentary assessment (EMA) is an ecologically valid method of gathering real-time data on context, behavior, and mood in natural environments through the use of signaling devices to minimize recall bias. Ecological momentary assessment uses various methods (eg, telephone calls and handheld computers) to monitor psychological phenomena in real time and real life.[31-35] It combines the measurement precision of a laboratory setting with the heightened external validity of naturalistic quasi-experimental field studies.[35] Thus, it has the potential to address the methodological gaps in this domain of inquiry and to strengthen the evidence of associations between mass media exposure and psychological dysfunction in an at-risk population.[35,36]

The purpose of this study was to use EMA measurement techniques to assess the association of MDD with various media exposures. Based on results of prior empirical and theoretical work described in the preceding paragraphs, we hypothesized that MDD would be positively associated most strongly with television but also moderately associated with music exposure. We also expected that MDD would be inversely associated with exposure to print media. Because of a lack of prior consistent data,[10,11,13,30] we did not hypothesize that MDD would be significantly associated with other media exposures (ie, video games and Internet).

METHODS

CONTEXT AND PARTICIPANTS

The data used in this study were collected as part of the Child and Adolescent Depression and Anxiety Study at the Western Psychiatric Institute and Clinic in Pittsburgh from January 1, 2003, through December 31, 2008. Participants were recruited from the following 3 sources: (1) community advertisements (primarily radio and newspaper), (2) inpatient and outpatient clinics at a major medical center in which the youth or their parents were being treated, and (3) referrals from other research studies or other participants in the present study. Participants were in a current episode of MDD (n=46) or were healthy control participants with no history of psychiatric disorder (n=60). Consistent with epidemiological reports of comorbidity rates,[37] 34 of the 46 participants with MDD (74%) had a comorbid anxiety disorder (separation anxiety disorder, generalized anxiety disorder, and/or social phobia).

Youth with MDD were required to meet diagnostic criteria according to *Diagnostic and Statistical Manual of Mental Disorders (DSM)* (Third Edition Revised)[38] or *DSM* (Fourth Edition)[39] classification for MDD. Healthy controls were required to be free of any lifetime psychopathology. In addition to media-related data, this study was designed to assess a number of biomedical factors established as relevant in our previous work.[40,41] For this reason, we applied the following exclusionary criteria: (1) the use of any medication with central nervous system effects within the past 2 weeks; (2) significant medical illness; (3) extreme obesity (weight greater than 150% of ideal body weight) or growth failure (height or weight below the third percentile); (4) IQ of 70 or less; (5) inordinate fear of intravenous needles (because of the need to draw blood for biological assays); and (6) specific learning disabilities. Participants with MDD were also excluded if they had schizophrenic, schizoaffective, or bipolar disorders. After complete description of the study to the subjects and parents/guardians, written informed consent was obtained.

INITIAL PSYCHIATRIC INTERVIEW

Each youth and his or her parents were interviewed to determine the youth's psychiatric history, using the Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime Version.[42] Parents and youth were interviewed separately, with clinical interviewers integrating data from both informants to arrive at a final diagnosis. All interviews were conducted by trained BA- and MA-level research clinicians. Interrater reliabilities for diagnoses assessed during the course of this study were $\kappa \geq 0.70$. The results of the interview were presented at a consensus case conference with a child psychiatrist, who reviewed the findings and preliminary diagnosis and provided a final diagnosis based on *DSM-III-R* or *DSM-IV* criteria.[38,39]

DATA COLLECTION PROCEDURES

The study was approved by the University of Pittsburgh's institutional review board. Data were collected using a cellular telephone–based EMA protocol.[36] Participants were given a modified answer-only cellular telephone on which they received telephone calls from a trained staff member during 5 extended weekends (Friday through Monday) in an 8-week period. Participants received 12 calls during each extended weekend (2 calls each on Friday and Monday from 4 to 10 PM and 4 calls each on Saturday and Sunday from 11 AM to 10 PM). Participants who did not initially answer their cellular telephone received a follow-up call 10 minutes later. Participants

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earned a bonus each weekend for completing all 12 calls, and those who completed all 60 calls during the study earned $250.

MEASURES

Our dependent variable was presence of MDD as determined by psychiatric diagnosis. Our independent variables were media exposures as estimated by EMA. Participants were asked at every telephone call to identify any media they were using. They were asked specifically about the following 6 types of media: (1) television or movies, (2) music, (3) video games, (4) Internet, (5) magazines or newspapers, and (6) books. Each media type was coded as yes vs no for each call. For each individual, we computed the percentage of calls on which he or she was using each of these types of media. Because there were so few individuals who used magazines and/or newspapers, we combined these data with books into a single print media category. It was possible for participants to be using 1 or more of these media types at the same time. For example, if a participant was watching television on the Internet (via a site such as http://www.hulu.com), the television or movies and Internet categories were each coded as yes.

ANALYSIS

We first compared the percentage of calls on which participants were exposed to a given media type using Mann-Whitney tests because media exposure variables were not normally distributed. We then developed multivariable models using logistic regression to determine the independent association of each independent variable and MDD controlling for age, sex, and race. Age was represented in years as a continuous variable. Race compared nonwhite with white participants. For multivariable analyses, independent variables were grouped into 4 quartiles based on the amount of media use. This was performed for ease of interpretation; summary ORs represented the odds of having depression for each increasing quartile of use. We defined statistical significance with a 2-tailed $\alpha = .05$ a priori.

We conducted exploratory analyses that included interaction terms between (1) age and any of the media exposures and (2) sex and any of the media exposures in our regression models. These analyses investigated whether associations between independent and dependent variables may have differed by age and/or sex.

Not every participant was reached on every telephone call. Because there were 106 individuals, there were a total of 6360 possible calls. In total, 723 calls (11.4%) were not completed and 5637 (88.6%) were completed. Compared with calls with individuals without MDD, calls with participants with MDD were more likely to be missed (13.5% vs 9.7%; $P < .001$). However, because the predictor variables ultimately used were based on the proportion of calls during which students were reached, there were no missing data for these variables.

RESULTS

Most of the 106 study participants were white (88.7%); the remainder were black, Hispanic, or biracial. Most (63.2%) were female, and the mean age was 12.7 (range, 7-17; SD, 2.7) years. Age was not significantly different between those with and without MDD (12.8 vs 12.6 years; $P = .67$). Sex was also not significantly different between those with and without MDD (38 [63.3%] vs 29 [63.0%] female; $P = .98$). However, nonwhite participants in the sample were more likely to have MDD than their white counterparts (10 [21.7%] vs 2 [3.3%]; $P = .003$).

The average participant was watching a movie or television on 26.3% of calls (SD, 13.7%). Other mean media exposures were as follows: 9.1% (SD, 8.5%) for audio, 6.1% (SD, 6.6%) for Internet, 6.0% (SD, 8.1%) for video games, and 0.2% (SD, 0.3%) for reading nonelectronic media.

In bivariable analyses, those with MDD were more commonly watching television or movies than those without MDD (29.6% vs 23.9%; $P = .04$). There also was a trend toward more audio exposure in those with MDD (10.2% vs 8.4%; $P = .06$). Other comparisons were nonsignificant and are shown in the **Table**.

In multivariable models controlling for age, sex, and race, increasing exposure to television or movies was not associated with increased likelihood of having MDD (OR, 1.2 for each increasing quartile of use; 95% CI, 0.8-1.7; $P = .37$ for trend). However, audio use was significantly associated with having MDD (OR, 1.8 for each increasing quartile of exposure; 95% CI, 1.1-2.8; $P = .01$ for trend). Use of print media was significantly inversely associated with having MDD (OR, 0.5 for each increasing quartile of use; 95% CI, 0.3-0.9; $P = .009$ for trend). Other associations are shown in the Table.

Exploratory analyses revealed no interaction terms between age or sex and any of the media exposures when multivariable logistic regressions models were built with presence of MDD as the dependent variable (data not shown; $P > .05$ for all comparisons).

COMMENT

In this study using EMA to measure media exposure, we found that increasing use of audio-based media (eg, MP3 players and compact disc players) was linearly associated with increasing likelihood of MDD diagnosis. We also found a negative association between reading print material and MDD. Although point estimates suggested weak positive associations of MDD with other electronic media exposures, these associations were not statistically significant.

Lower nonelectronic media use among those with MDD is consistent with other work in this area, which found book exposure during adolescence to be inversely associated with development of MDD by young adulthood.[10] The use of the more rigorous EMA assessment technique in the present investigation supports and strengthens that finding. Because the previous study was longitudinal, it suggests that reading may somehow subsequently protect against MDD.[10] However, it may also be that those with MDD tend to lack the concentration and/or motivation to read, which requires more cognitive energy than consumption of other media.[23-25]

That same large study found that television exposure was associated with MDD,[10] whereas the present study found that an initially significant bivariable association between television or movie exposure and MDD did not persist after correction for sociodemographic variables. The previous study was longitudinal; thus, it is possible that this association is not present initially but that, over time, increased television exposure may become more strongly associated with MDD. However, because the present study used a more rigorous EMA-based mea-

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Table. Media Exposure by Presence of MDD

Media Type	Diagnostic Group, % of Calls[a]				Quartile of Use	OR (95% CI)	*P* Value for Trend[d]
	Without MDD (n=60)	With MDD (n=46)	*P* Value[b]	OR (95% CI)[c]			
Watching movie or television	23.9	29.6	.04	1.2 (0.8-1.7)	1	1 [Reference]	.37
					2	1.3 (0.4-4.2)	
					3	1.9 (0.6-6.2)	
					4	1.5 (0.5-5.0)	
Listening to audio	8.4	10.2	.06	1.8 (1.1-2.8)	1	1 [Reference]	.01
					2	4.2 (1.03-16.8)	
					3	3.4 (0.8-14.3)	
					4	8.3 (1.9-37.5)	
Using Internet	5.9	6.4	.74	1.1 (0.7-1.6)	1	1 [Reference]	.74
					2	0.5 (0.2-1.8)	
					3	0.7 (0.2-2.2)	
					4	1.2 (0.3-4.1)	
Playing video game	5.2	7.0	.24	1.3 (0.8-2.1)	1	1 [Reference]	.23
					2	1.3 (0.4-4.5)	
					3	3.0 (0.9-10.5)	
					4	1.8 (0.4-7.8)	
Reading print media[e]	0.6	0.2	.18	0.5 (0.3-0.8)	1	1 [Reference]	.009
					2	0.6 (0.2-1.6)	
					3	0.3 (0.1-1.2)	
					4	0.1 (0.1-0.9)	

Abbreviations: CI, confidence interval; MDD, major depressive disorder; OR, odds ratio.
[a] Indicates percentage of completed cellular telephone calls on which individuals were using that particular media type.
[b] Calculated using the Mann-Whitney test.
[c] For logistic regression controlling for race, sex, and age. For these analyses, the independent variable was the particular media type (eg, watching television or movies) divided into quartiles. Thus, ORs represent the odds of having MDD for each increasing quartile of exposure.
[d] Calculated using a nonparametric test for trend.
[e] Includes magazine, newspaper, and/or book use.

surement of media exposure, it is also possible that the previous study, which relied on participant self-report, may have been affected by recall bias and that the hypothesized association between television exposure and depression may not be as strong as suggested.

After adjustment for sociodemographic variables, audio (music) exposure had a strong linear association with MDD, but television exposure did not bear this association. Association of music exposure with MDD has been hypothesized. For example, sadness is a common theme in popular music, and it may be that individuals with depression turn to these messages to make themselves feel less alone in their sadness.[43-46] Conversely, it may also be that individuals with MDD turn to happy music to "tune out" their negative moods or to elevate their moods.[47] Other researchers have suggested that heavy exposure to the sometimes dark themes of popular music may contribute to the development of conditions such as MDD.[43-46] Whatever the mechanism, this empirical study suggests that this association may be stronger than previously considered.

Although MDD was not significantly associated with Internet or video game use, there was a nonsignificant trend toward higher use/exposure to video games among those with MDD. Previous studies[30,48] have demonstrated associations between depression and video games in adolescents, and a recent study[49] linked video game use with MDD in women. The authors of the last study noted that women may self-medicate for depression by "losing themselves" in virtual game worlds.[49] It is also possible that women may be particularly vulnerable to stereotypical and/or otherwise negative portrayals of female characters in video games.[17,50]

Web-based media may be processed similarly to print,[51] suggesting that computer use (much of which is Web based) and print media use may have similar associations with MDD. However, more recent work[52] highlights the fact that individuals tend to selectively scan Web content rather than absorbing it more fully, suggesting that in other ways Web use may be more similar to television use. Our results—which did not find statistically significant associations between Internet use and MDD—are consistent with the Web as a possible amalgamation of print- and television-type content.

Recruitment for this study focused on a particular geographic region and was not randomly generated; therefore, these results are not necessarily broadly generalizable. The cross-sectional method also precludes inferences about the directionality of the associations observed herein. Future studies will need to more specifically assess the hypothesized relationships in either direction. Another limitation is related to the EMA method, which relies on probability to accurately measure media exposures. Although in general we would expect that EMA-based estimates of media exposure will correspond to actual exposure and be less error prone than self-reported data, any intermittent sampling method may be subject to error.

In addition, our study used types of media exposures as independent variables without assessing specific types of media use (eg, Internet use for real-time social net-

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working vs browsing) and/or contextual elements of use (eg, whether television viewing occurs with friends, family, or alone). Future research in this area may find it valuable to use more nuanced independent variables. Two final limitations involve the outcome variable (psychiatric diagnosis). Of our participants with depression, 74% had a comorbid anxiety disorder. Thus, owing to the high occurrence of both disorders within individuals, it may be hard to tease apart the associations between depression and media use from those between anxiety and media use. Finally, although we used an intensive method to determine diagnoses, we were not able to update this process during the 8-week period of the study, suggesting that diagnosis could have changed during that time, particularly if youth improved in treatment. However, this limitation should have the effect of biasing our findings toward the null hypothesis (because of regression to the mean and potential improvements in depression). Therefore, it does not diminish our credence in the major findings noted in this study.

CONCLUSIONS

Despite its limitations, this study provides valuable insight into potential associations of media exposure with MDD. In particular, it lends additional support to previous theoretical concepts and empirical studies linking MDD with increased popular music use and decreased print media use. Although this study helps clarify some of the theoretical relationships of our conceptual model, it also suggests the need to further elucidate the directionality and strength of those relationships. Determining the potential role of media use in the development or perpetuation of MDD may lead to interventions designed to better screen for and prevent MDD.

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Correspondence: Brian A. Primack, MD, EdM, MS, Division of General Internal Medicine, Department of Medicine, University of Pittsburgh, 230 McKee Pl, Ste 600, Pittsburgh, PA 15213 (bprimack@pitt.edu).
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