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ORIGINAL ARTICLE

Mental Health Information Seeking Online: A Google Trends Analysis of ADHD

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Abstract

Health information influences consumer decision making to seek, select, and utilize services. Online searching for mental health information is increasingly common, especially by adolescents and parents. We examined historical trends and factors that may influence population-level patterns in information seeking for attention-deficit/hyperactivity disorder (ADHD). We extracted Google Trends data from January 2004 to February 2020. Keywords included "ADHD," "ADHD treatment," "ADHD medication," and "ADHD therapy." We examined trends (systematic change over time) and seasonality (repeating pattern of change) via time-series analyses and graphics. We also used interrupted time-series analyses to examine the impact of celebrity and pharmaceutical events. Queries of "ADHD medication" increase, while queries for "ADHD therapy" remain relatively low despite a positive linear trend. Searches for "ADHD treatment" displayed a downward trend in more recent years. Analyses on seasonality revealed that holiday breaks coincided with a decrease in search interest, while post-break periods illustrated a rise, and the ADHD Awareness Month (October) coincided with a rise of public interest in all four search terms. Celebrity effects were more prominent in earlier years; the "Own It" pharmaceutical campaign may have increased ADHD awareness and the specificity of searches for "ADHD medication." The anonymous, accessible, and low-cost nature of seeking information online makes search engines like Google important sources of mental health information. Changing search patterns in response to seasonal, advocacy, and media events highlight internet-based opportunities for raising awareness and disseminating empirically supported information.

Keywords ADHD · Time series · Information seeking · Google Trends

Introduction

Despite significant advances in evidence-based practice, including personalized therapy (Ng & Weisz, 2016), telehealth formats (Myers & Comer, 2016), and brief interventions (Schleider et al., 2019) for mental health problems, approximately one-half of families do not receive treatment for clinically elevated symptoms (Merikangas et al., 2011). Unpacking disparities requires a closer examination of the vast amount of information and resources available online, which may help to explain associations between information- and help-seeking. According to a recent systematic review (Kubb & Foran, 2020), parents search online for information to determine treatment need (e.g., do their child's symptoms or impairment require a visit to the doctor), prepare for their appointment (e.g., what to bring, what to ask), and find answers to outstanding questions (following their appointment). A recent study of browsing histories by Schueller et al. (2020) further shows that keywords entered into search engines (e.g., the number of times "depression" was searched) were associated with perceived barriers to psychosocial treatment. It follows that search engine data related to mental health may reveal untapped opportunities to influence information-seeking efforts and help-seeking decisions. In this paper, we used Google Trends (Google Inc., 2020) to explore information-seeking patterns related to attention-deficit/hyperactivity disorder (ADHD), a common, impairing, and widely searched neurodevelopmental disorder (Barkley, 2014; Danielson et al., 2018; Sage et al., 2018).

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Health Information Seeking

Health information seeking is broadly conceptualized as "the active pursuit of health information" (Zimmerman & Shaw, 2020, p. 5). Based on a range of theoretical frameworks across fields (Marton & Choo, 2012; Zimmerman & Shaw, 2020), health information seeking can be understood as a function of *need* (interest, desire and perceived necessity of unknown health information) and *access* (availability, quality, and convenience of information sources). Symptom elevation and/or functional impairment among selves, relatives and friends (problem recognition) increase information needs and inspire health information seeking (Mishra et al., 2009; Srebnik et al., 1996). Access to health information is fluid as it varies over time, corresponding to individual traits (e.g., knowledge, perceived stigma, and beliefs) and contextual factors (e.g., social network and cultures) to influence decision making to seek, select, and utilize services (Lannin et al., 2016; Mishra et al., 2009; Turner et al., 2015; Yigzaw et al., 2020).

Sources of health information include the internet, traditional media (e.g., library, books, brochures, magazines), social networks (e.g., family, peers, coworkers), and healthcare professionals (Cline & Haynes, 2001; Gray et al., 2005). Compared to other sources, the internet is accessible (low cost), convenient (i.e., speed, ease), anonymous, private, and interactive (Cline & Haynes, 2001; Jacobs et al., 2017; Kauer et al., 2014). As access to digital devices has increased in the past two decades (Pew Research Center, 2019), internet use also increased, while use of traditional media decreased (Jacobs et al., 2017). Although the internet does not replace health professionals as a health information source (Gray et al., 2005; Jacobs et al., 2017), many rely on search engines like Google as a first step (Kubb & Foran, 2020; Lee et al., 2014). The internet is an especially important source for health information among individuals who have difficulty accessing timely services (Chen & Zhu, 2016) and parents (Khoo et al., 2008; Kubb & Foran, 2020). In fact, Kubb and Foran's (2020) systematic review revealed that approximately 90% of parents/caregivers (in most recent studies) search for health information online, before scheduling doctor visits (to decide whether or not to schedule), prior to appointments (to prepare for them), and/or after (for answers to remaining questions).

Health information, when pursued and consumed, can impact treatment-related decisions, treatment-seeking behaviors and both provider-patient and provider-caregiver interactions. Adults who used web search engines were more likely to decide to visit a health professional (help-seeking *decision*) as well as actually visit a physician (help-seeking *behavior*) for their own health care, compared to those who had not used web search engines to seek health information, according to a large-scale cross-sectional survey study from Norway (Yigzaw et al., 2020). Also, Yigzaw et al. (2020) reported that those who used Web search engines were also more likely to decide *not* to visit a physician (also a help-seeking *decision*), with a slightly lower odds ratio than findings on decisions to visit a physician, suggesting online information seeking can either encourage or discourage service utilization. Similarly, parents recruited at a hospital in Australia reported online searching for health information before scheduling a doctor's appointment for their child (help-seeking *decision*) and to prepare for questions in advance (provider-caregiver interaction) (Yardi et al., 2018). Notably, these cross-sectional surveys displayed *associations* rather than *causal inferences* (which require temporal precedence), and moderation by factors such as age (Yigzaw et al., 2020) and illness severity (Yardi et al., 2018). It is additionally worth noting that these findings reflect studies of "active searches for" rather than "passive receipt of" health information. Costin et al. (2009) reported that simply receiving disorder-specific information (i.e., a short series of depression e-cards) did not yield positive changes, relative to a comparison condition, in beliefs of treatment efficacy, intention, or behavior to seek professional help.

Google Trends

Search engine data can be particularly useful in understanding information-seeking patterns (e.g., "active searches for" mental health information). Google holds a dominant market share (88%) in the United States (Statcounter, 2020) and represents a common source for health information (Lee et al., 2014). Google Trends is a viable tool to understand, monitor, and even forecast trends of information seeking and public interest (e.g., see Jun et al., 2018; Mavragani et al., 2018; Nuti et al., 2014 for reviews). An increasing number of studies (20-fold from 2009 to 2018 on PubMed) have been using Google Trends data to examine temporal patterns and/or geographical variations pertaining to various health conditions, including influenza, cancer, and mental health (Arora et al., 2019; Nuti et al., 2014). Examples related to mental health include understanding seasonal trends for information seeking related to mood and neurodevelopmental disorders (e.g., Ayers et al., 2013; DeVilbiss & Lee, 2014) and the impact of celebrity events on suicide-related searches (e.g., Arendt & Scherr, 2017; Fond et al., 2015; Gunn et al., 2020; Koburger et al., 2015).

ADHD, Information Seeking, and Help Seeking

ADHD is a burdensome, stigmatized, and untreated condition for millions (Barkley, 2014; Doshi et al., 2012; Hinshaw & Scheffler, 2014). ADHD is associated with long-term financial and occupational impairments (Gordon & Fabiano, 2019; Pelham et al., 2020) and incurs substantial economic burden to families and society in general (Doshi et al., 2012; Hinshaw & Scheffler, 2014; Zhao et al., 2019). Individuals with ADHD are widely stigmatized, as children with ADHD are perceived as more dangerous, lazier, and more shameful than children with asthma, and adults with ADHD are perceived as irresponsible and less socially desirable (see Lebowitz, 2016; Parcesepe & Cabasssa, 2013, for reviews). One in ten youth is diagnosed with ADHD, and an increasing number of adults have been diagnosed with ADHD in recent years. Most youth are treated with psychotropic medications and one-quarter remain untreated (Danielson et al., 2018; Visser et al., 2014). Despite robust support for psychosocial interventions (Fabiano & Pyle, 2019; Schatz et al., 2020), fewer than half of insured children diagnosed with ADHD have received behavioral therapy (Waxmonsky et al., 2019), highlighting the large science-to-service gap.

Information needs are both general—knowledge about ADHD—and specific—knowledge about ADHD *treatment* (Ahmed et al., 2014; Akram, et al., 2009; Rosenblum & Yom-Tov, 2017; Sciberras et al., 2010; Yu et al., 2019). Among a variety of search terms related to ADHD, Rosenblum and Yom-Tov (2017) reported "ADHD medication" as the most common search query after "ADHD" in Microsoft Bing search engine data. Beyond pharmaceutical treatment, information about psychosocial strategies is also commonly sought, especially among parents of children with suspected or confirmed ADHD diagnoses (Ahmed et al., 2014; Yu et al., 2019). Rosenblum and Yom-Tov (2017) analyzed 979 questions asked on Yahoo Answers by parents—26% reported a child with a suspected ADHD diagnosis and 70% reported an ADHD diagnosis—revealing the internet to be a valued resource for parents prior to engaging with services (possibly following concerns, for instance by teachers) and for families currently engaging with care (after the child received a diagnosis). These studies also highlight the importance of understanding online information seeking specific to ADHD and its treatment.

The vast amount of information online about ADHD varies in quality, presentation and reliability (King et al., 2021; Kisely et al., 2003), which may contribute to the poor uptake of empirically supported ADHD care, especially for behavior therapy. About two decades ago, around 50% of websites mentioned medications and 50% of websites mentioned psychosocial therapy; approximately 50% of websites also recommended seeking the advice of a healthcare professional (Kisely et al., 2003). In a more recent review of popular websites (King et al., 2021), the percentage of information about medications has increased while information about therapy has not. Specifically, 80% of websites mentioned Food and Drug Administration (FDA)-approved ADHD medications, while only a few more than half of websites mentioned behavior therapy. Nearly 80% of websites recommended following up with healthcare professionals. Despite a generally poor alignment between online information and empirical literature about ADHD, the increased availability of empirically supported information about medication and increased emphasis on seeking further advice from professionals (King et al., 2021; Kisely et al., 2003) highlight the value of understanding online information-seeking patterns related to ADHD.

Despite the aforementioned variation in quality of online information related to ADHD (Kisely et al., 2003), internet searching has been increasingly popular in youth-serving settings. Across several survey studies, more than half of adolescents and parents identified the internet as their preferred information source when they want to learn about ADHD and its treatment (e.g., Bussing et al., 2012; Sciberras et al., 2010; Yu et al., 2019). For instance, in a large school district sample in Florida (374 at high risk for ADHD and 165 at low risk for ADHD; mean age = 15 years), half of the parents and adolescents listed the internet as a preferred source for ADHD-related information (by eliciting open-ended response to "if you wanted more information about attention deficit or hyperactivity where would you prefer to get it"); fewer parents and adolescents listed social network, written materials (e.g., magazines, library), and health professionals as their preferred resources (Bussing et al., 2012). In another survey study from Scotland, more than 80% of teachers (N = 59; including both student and experienced teachers recruited at the beginning of university-based teacher training programs) chose the internet and their teaching colleagues among a list of options as their information sources about ADHD and its pharmacological treatment (Akram et al., 2009). Although most existing studies provide information related to the preferences and content of information seeking at the individual level (e.g., Akram et al., 2009; Bussing et al., 2012; Cunningham et al., 2009; Sage et al., 2018; Yu et al., 2019), small-*N*, geographically restricted, and cross-sectional survey studies are often not theory-driven and offer limited insights into population-level patterns.

Trends, Seasonality, and Media Influence

Trends

Trends in ADHD Information Seeking Over the past two decades, there appears to be an upward trend in reporting the internet as a preferred source for ADHD-related infor-

mation in survey studies (Bussing et al., 2007, 2012; Sage et al., 2018). For instance, in a longitudinal study of the aforementioned school district sample in Florida, 5% at the initial screening in 1998 (Bussing et al., 2007) and around 50% of the parents at the final follow-up in 2008 reported the internet as their preferred source for information about ADHD (Bussing et al., 2012). More recently, in a sample recruited in pediatric offices in North Carolina, nearly 90% of parents reported seeking ADHD information online (Sage et al., 2018).

Trends in ADHD Diagnoses and Treatment We have witnessed a steep increase in the diagnostic prevalence of ADHD in youth from 1997 to 2016 in national data (Xu et al., 2018). The total consumption of four commonly used stimulant medications (i.e., lisdexamfetamine, methylphenidate, amphetamine, methamphetamine) doubled from 2006 to 2016 (Piper et al., 2018). Despite significant advancement in behavioral therapy, such as adaptive interventions, tiered strategies, and collaborative care models (Fabiano & Pyle, 2019; Schatz et al., 2020), psychosocial treatment is underutilized by families of children and adolescents with ADHD (Morrow et al., 2020; Waxmonsky et al., 2019).

Seasonality

Two studies examined seasonal patterns in search queries of ADHD using Google Trends (Ayers et al., 2013; DeVilbiss & Lee, 2014). Ayers et al. (2013) analyzed Google Trends data from 2006 to 2010 for the United States and Australia and reported a noticeably higher search interest in "ADHD" and affective disorders during winter compared to summer. Seasonal differences may correspond to vitamin D deficiencies and opportunities for social engagement and exercise, though these may apply more to affective disorders (Ayers et al., 2013); monthly fluctuations examined in the present study may point to advocacy events and academic motivations more relevant for ADHD. DeVilbiss and Lee (2014) utilized Google Trends data from 2004 to 2014 in the United States and reported annual rises in searches for "ADHD" during spring and fall, and identified Awareness Month as an effective tool for promoting online search interest. Both studies were limited by their single search term for "ADHD" and their examination of only seasonal patterns that may vary by treatment modality and obscure monthly fluctuations. For instance, families of school-aged children may seek information about medications, specifically, as the school year approaches and about more intensive and time-consuming psychosocial interventions (e.g., the Summer Treatment Program; Pelham et al., 1999) as summer arrives. College students, on the other hand, may seek information about ADHD counseling just in advance of midterms and final exams. Search patterns related to "ADHD treatment" specifically may yield additional insights into effective public health initiatives to increase access to information about services.

Media Impact: Celebrity and Pharmaceutical Events

Celebrities can strongly influence people's health-related behaviors. In a systematic review, Hoffman and Tan (2015) identified 14 social, biological, and psychological pathways to explain why celebrities influenced health-related behaviors. More recently, there is increasing attention to Google Trends data relating celebrity events to mental health information seeking, in particular in suicide research (e.g., Arendt & Scherr, 2017; Fond et al., 2015; Gunn et al., 2020; Koburger et al., 2015). The extent to which reported celebrity suicides increase or decrease public risk for suicide remains unclear; however, existing studies support Google Trends as a viable tool to examine the effects of celebrity news on mental health information seeking (e.g., Arendt & Scherr, 2017). In turn, findings may point toward challenges and opportunities online, related to public mental health knowledge, stigma, awareness, and treatment seeking.

Well-resourced pharmaceutical companies also help shape people's health decisions and treatment-seeking behaviors, largely through public messaging and media campaigns (Hinshaw & Scheffler, 2014). Hinshaw and Scheffler (2014) propose that pharmaceutical companies may be partially responsible for the increase in ADHD diagnoses and medications. Raising mental health awareness is a common strategy in pharmaceutical marketing (e.g., Monica Seles paid by Shires for Vyvanse to treat binge eating disorder; Thomas, 2015). Shire's "it's your ADHD, own it" campaign—launched on June 20th, 2011—was among the most successful marketing campaigns, rated as "genius" (top ranking) by L2ThinkTank.com (Schwarz, 2013). Their one-minute videos starring celebrities such as Adam Levine were followed by a screener to assess symptoms and encourage discussions with doctors. To our knowledge, no study has examined the impact of the "Own It" campaign on public information seeking related to ADHD treatment.

What We Know, What We Don't Know, and the Current Study

Seeking health information online using search engines like Google is increasingly common. Many individuals with suspected or confirmed ADHD diagnoses, and their caregivers, identify the internet as a trusted, primary or preferred source for mental health information (e.g., Bussing et al., 2012; Yu et al., 2019). Tools like Google Trends show promise to understand population-level information seeking patterns of various health conditions (Arora et al., 2019; Nuti

et al., 2014), but limited work thus far has examined online search patterns related to ADHD. Two prior studies reveal higher search interest in winter (2006 to 2010) (Ayers et al., 2013) and suggest ADHD Awareness Month is an effective time to promote online information seeking (2004 to 2014) (DeVilbiss & Lee, 2014). The present study advances this literature in three ways: (1) expanding search terms beyond "ADHD" generally to "ADHD treatment" and related terms; (2) examining and interpreting monthly and event-related fluctuations; and (3) considering recent trends through data available in 2020, especially important in context of the rise in access to smartphones from 60 to 80% between 2014 and 2019 (Pew Research Center, 2019) and changes in mental health funding during that same time (National Institute of Mental Health, 2021).

In the current study, we used Google Trends to examine (1) the trends and seasonality of seeking information related to ADHD and (2) the impact of celebrity and pharmaceutical events. First, reflecting upon the upward trends in the prevalence of ADHD diagnoses and medication consumption (Danielson et al., 2018; Piper et al., 2018; Visser et al., 2014; Xu et al., 2018), we hypothesized that online search interest in ADHD and its treatment would rise over time. Second, based on previous work on National Autism Awareness Month (DeVilbiss & Lee, 2014) and seasonality of mental health disorders (Ayer et al., 2013), we hypothesized that seasonality in ADHD and ADHD treatment would coincide with ADHD Awareness Month and correspond to a school year schedule. Third, we hypothesized that celebrity announcements (i.e., a priori list of seven celebrity events by searching for "celebrity and ADHD" on Google and reviewing Twitter profiles; see details in Method) would increase search interest in ADHD, generally. Fourth, we hypothesized that the "Own It" pharmaceutical campaign would increase search interest in ADHD medication yet would not have an impact on ADHD therapy and ADHD treatment, specifically. Findings are interpreted in relation to closing the science-to-public gap in health information.

Method

Data Source

Selection of Search Terms

Four search terms were selected to reflect online search interest in the disorder ("ADHD") and associated treatment options ("ADHD treatment," "ADHD medication," "ADHD therapy"). Additionally, we explored "ADHD counseling" as a potential search term (young adults in particular may search for "counseling" reflecting, for instance, that colleges offer "Counseling and Psychological Services" for ADHD management). Search interest in "ADHD counseling" was low (leading to all zero values) compared to the other three search terms (i.e., "ADHD treatment," "ADHD therapy," "ADHD medication") according to our data inspection (https://trends.google.com/trends/?geo=US); thus, we did not include "ADHD counseling" in our analyses.

Google Trends Relative Search Volumes

We extracted monthly relative search volume (RSV) data, publicly available beginning in 2004, directly from Google Trends (https://trends.google.com/trends/?geo=US). All of Google Trends data points are normalized and scaled (Google Inc., 2020). The number of searches performed for a particular term (e.g., "ADHD") is divided by the total number of searches for all topics at a given location and within the specified timeframe, which yields a normalized score. All normalized scores are scaled to have a maximum of 100 (i.e., each data point was divided by the highest normalized and multiplied by 100) on any given plot. Scaled scores range from 0 to 100, called the RSVs; the RSV for each individual month represents search interest *relative to the month with the highest search interest*. This method of scaling and normalization adjusts RSVs for internet access and population size.

We extracted monthly U.S. RSV data from January 2004 to February 2020 (N = 193 months; each month has its own RSV) using the "gtrends" function with "web" as the specified argument. We restricted to U.S. data because more than 88% of adults in the U.S. use Google (Statcounter, 2020) and Google Trends data offer more geographical precision in developed countries (Arora et al., 2019). The first time series was extracted using the search term "ADHD." For example, an RSV = 75 would mean that online searching for "ADHD" during that particular month occurred at a volume equal to 75% of online searching during the highest volume month (among all 193 months), after adjusting for population size and internet use. We then extracted three additional treatment-related time series corresponding to search terms: "ADHD treatment," "ADHD medication," and "ADHD therapy," yielding values relative to one another.

Celebrity Events

We identified an a priori list of seven celebrity events (e.g., Michael Phelps discussed his struggles battling ADHD [Parker-Pope, 2008]) by searching for "celebrity and ADHD" on Google and reviewing Twitter profiles. The scoping search yielded a list of 15 celebrities who talked about their long-standing battles with ADHD publicly. Among the 15 celebrities identified, dates and contents of interviews and news articles of celebrities with close to or

more than 1 million followers on Twitter were extracted and included in our final analyses (see Table 1S, for event details).

Pharmaceutical Event

We examined the impact of Shire's "it's your ADHD, own it" campaign, which was rated as one of the most successful marketing campaigns (Schwarz, 2013) and clearly targeted individuals with ADHD through the internet. We used the date of campaign launch (June 20th, 2011) in our analyses.

Data Analysis

We used time-series analyses to examine trends and seasonality ($N = 193$). $N \geq 50$ is deemed appropriate for time-series analyses (McCleary et al., 1980). While traditional regression analyses are typically used for examining relations between independent and dependent variables, time series analyses allow us to understand the relations between variables and time using a set of temporally sequenced observations of a variable. A time series can be decomposed to the trend, seasonal, cyclical, and irregular (random) components (Jebb et al., 2015).

Data Visualization

We plotted historical fluctuations of the RSVs in their respective time-series and added locally weighted scatterplot smoothing (loess) lines to visualize the general trends.

Model Selection

We compared the linear, quadratic, and cubic models for each of the search terms. We fit the trends and examined the best-fitting model from linear, quadratic, and cubic models; lower Akaike information criterion (AIC; Akaike, 1974) indicates better fit (i.e., comparable model fit: $\Delta AIC < 2$; considerably better-fitting: $4 < \Delta AIC < 7$; full support for better-fitting: $\Delta AIC > 10$) (Burnham & Anderson, 2004).

Trend and Seasonality

The trend component represents the systematic change over time. The seasonal component captures repeating patterns of increase and/or decrease with regards to timing and magnitude. The cyclic component signifies repeating patterns beyond seasonality across irregular time periods (e.g., economic cycles). As we do not have substantive reasons for long-term cycles in information seeking related to neurodevelopmental disorders (i.e., cyclic fluctuations beyond one year), cyclic components were not included. The random component represents the leftover variations after all trend, seasonal, and cyclical components are partitioned out, conceptually similar to the error terms in regular regression models. Because the magnitude of monthly fluctuations changes over time, we chose the multiplicative decomposition method over additive decomposition for all time-series models (Jebb et al., 2015).

The Impact of Nonseasonal Events

We used interrupted time-series analyses to examine event-related changes: (1) the impact of celebrity events on RSVs for "ADHD"; (2) the impact of the "Own It" campaign, one of the most successful pharmaceutical marketing campaigns (Schwarz, 2013), on RSVs for "ADHD treatment," "ADHD medication," and "ADHD therapy." After selecting the best-fitting model and accounting for trends and seasonality, we reported (1) the baseline and underlying trend in search interest before an event, (2) immediate change during the month after the event, and (3) the change in linear, quadratic, and cubic terms of the post-event trend as appropriate. We also calculated pre- and post-event descriptive statistics (*M*s and *SD*s).

Results

Online Search Interest in ADHD

Data Visualization

The patterns of Google searches of ADHD are presented in Fig. 1. Search interest in "ADHD" rose over time with seasonal and potentially event-related fluctuations.

Model Selection

The quadratic model outperformed the linear and cubic models for searches for "ADHD" ($\Delta AIC > 10$; Table 1).

Trends

The linear, $b = 0.12$, $SE = 0.007$, $t = 16.70$, $p < 0.01$, and quadratic terms, $b = 0.0010$, $SE = 0.0001$, $t = 6.87$, $p < 0.01$, were statistically significant, indicating the overall positive trend (linear) with change of rates over time (quadratic), consistent with the subtly noticeable trough prior to the rise demonstrated in Fig. 1.

Seasonality

Holiday breaks (i.e., May, June, July, November, December) coincided with decrease in search interest, $ps < 0.05$, yet post-break periods (i.e., January, February, August,

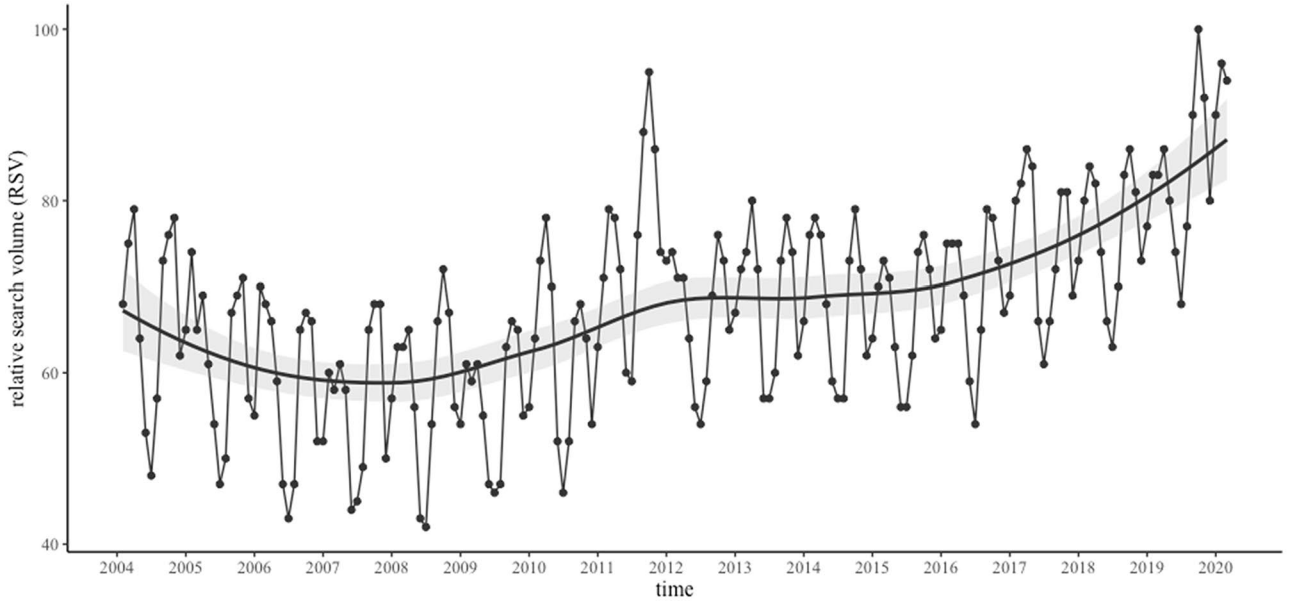

Fig. 1 Google Trends Relative Search Volumes for attention-deficit hyperactivity disorder (ADHD). We extracted monthly for January 2004 to February 2020 using search term "ADHD." We used Locally weighted smoothing (LOESS) to create a smooth line to visualize the general temporal trend. Trend line represents quadratic polynomial regression. N = 193

Table 1 Comparison of fit indices in models that examine trends of relative search volume

Models	*df*	AIC	BIC	LL	Comparison	LR	*p*
ADHD							
Linear	3	1247.20	1256.95	−620.60			
*Quadratic	4	1225.46	1238.44	−608.73	linear vs. quadratic	23.74	< 0.01
Cubic	5	1248.64	1264.85	−619.32	quadratic vs. cubic	21.19	< 0.01
ADHD treatment							
*Linear	3	1080.42	1090.18	−537.21			
Quadratic	4	1094.07	1107.05	−543.03	linear vs. quadratic	11.64	< 0.01
Cubic	5	1117.83	1134.04	−553.91	quadratic vs. cubic	21.76	< 0.01
ADHD medication							
Linear	3	1381.82	1391.58	−687.91			
*Quadratic	4	1358.52	1371.51	−675.26	linear vs. quadratic	25.30	< 0.01
Cubic	5	1361.68	1377.89	−675.84	quadratic vs. cubic	1.16	0.28
ADHD therapy							
Linear	3	872.13	881.89	−433.07			
*Quadratic	4	858.72	871.70	−425.36	linear vs. quadratic	15.42	< 0.01
Cubic	5	884.18	900.39	−437.09	quadratic vs. cubic	23.46	< 0.01

df degree of freedom, *AIC* Akaike information criterion, *BIC* Bayesian information criterion, *LL* log likelihood, *LR* likelihood ratio

*Best-fitting model

September) overlapped with rise in search interest, $ps < 0.05$ (Table 2). The largest seasonal factor was for September, $b = 12.80$, $SE = 0.97$, $t = 13.14$, $p < 0.01$, indicating a peak in searching for "ADHD" online in September. The lowest seasonal factor was for December, $b = -11.71$, $SE = 0.98$, $t = -11.95$, $p < 0.01$, suggesting a trough in searching for "ADHD" online in December. ADHD Awareness Month (October) coincided with rise of public interest in ADHD, $b = 4.98$, $SE = 0.98$, $t = 5.11$, $p < 0.01$.

Table 2 Seasonality (monthly fluctuations) of online searches of ADHD and its treatment

	ADHD			ADHD medication			ADHD therapy			ADHD treatment		
	b	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*	*b*	*SE*	*t*
January	2.21*	0.98	2.25	2.37	1.77	1.34	0.14	0.71	0.20	−1.13	1.21	−0.93
February	7.33 **	0.98	7.44	6.37**	1.77	3.59	1.20	0.71	1.69	4.25**	1.22	3.49
March	0.49	0.96	0.51	1.48	1.73	0.85	0.47	0.70	0.67	−1.36	1.19	−1.15
April	1.24	0.96	1.28	1.35	1.74	0.78	0.28	0.70	0.40	1.07	1.19	0.90
May	−8.02**	0.97	−8.29	−7.65**	1.74	−4.40	−2.54**	0.70	−3.63	−5.49**	1.19	−4.60
June	−10.71**	0.97	11.06	−8.66**	1.74	−4.96	−0.79	0.70	−1.13	−1.87	1.20	−1.56
July	−2.58*	0.97	−2.66	0.09	1.75	0.05	−0.29	0.70	−0.41	−1.81	1.20	−1.51
August	5.29**	0.97	5.44	3.21	1.75	1.83	−0.29	0.70	−0.41	0.25	1.20	0.21
September	13.28**	0.97	13.63	9.70**	1.76	5.53	1.90*	0.70	2.70	6.00**	1.20	4.99
October	4.09**	0.98	4.19	3.64*	1.76	2.07	1.65*	0.71	2.33	4.00**	1.21	3.32
November	−3.85**	0.98	−3.93	−4.87*	1.76	−2.76	0.14	0.71	0.20	−1.56	1.21	−1.29
December	−11.16**	0.98	11.39	−8.31**	1.77	−4.70	−2.98**	0.71	−4.21	−4.50**	1.21	−3.72

ADHD attention deficit hyperactivity disorder, *SE* standard errors

*$p < 0.05$. **$p < 0.01$

The Impact of Celebrity Events

Descriptive statistics of monthly RSVs before and after celebrity events and inferential statistics from regression models using interrupted series analyses are presented in Table 3. Celebrity events, such as Justin Timberlake's Interview (Weintraub, 2008), the New York Times article about Michael Phelps and ADHD (Parker-Pope, 2008), and the HuffPost blog about Glenn Beck and ADHD (Laskoff, 2009), were associated with post-event baseline (immediate increase in search interest of ADHD in the month following these events), as well as post-event changes in the linear trends, $ps < 0.01$. Celebrity events, including the blog about Glenn Beck and ADHD (Laskoff, 2009), the HuffPost article about Ty Pennington and ADHD (Gostin, 2012), and Will.i.am admitting to having been diagnosed with ADHD ("Will.i.am Admits To," 2013), are associated with changes in quadratic trends, $ps < 0.01$. No other significant results were reported for celebrity events impacting post-event baselines, linear trends, or quadratic trends, $ps > 0.05$.

Online Search Interest in "ADHD Treatment," "ADHD Medication," and "ADHD Therapy"

Data Visualization

The patterns of treatment-related searches on the Google website are presented in Fig. 2. Given the similar rates of searches for "ADHD treatment" and "ADHD medication" before 2008, it is possible that the general public interchangeably used "ADHD treatment" and "ADHD medication" as search terms in earlier years. There was a significant increase in searching for "ADHD medication." Searches for "ADHD therapy" remained relatively low, compared to "ADHD medication" and "ADHD treatment."

Model Selection

The linear model outperformed the quadratic and cubic models for the searches for "ADHD treatment" ($\Delta AIC > 10$). For "ADHD medication," the quadratic model was considerably better than the linear model ($\Delta AIC > 10$); the difference between the quadratic model and the cubic model was minimal ($\Delta AIC = 3$) and therefore the more parsimonious quadratic model was selected. For "ADHD therapy," the quadratic model outperformed the linear and cubic models ($\Delta AIC > 10$).

Trends

For "ADHD treatment," the linear term was negative and statistically significant ($b = -0.03$, $SE = 0.005$, $t = -6.97$, $p < 0.01$), suggesting a downward trend in using "ADHD treatment" as a search term over time. For "ADHD medication," the linear, $b = 0.26$, $SE = 0.01$, $t = 26.39$, $p < 0.01$, and quadratic terms, $b = 0.001$, $SE = 0.0002$, $t = 6.70$, $p < 0.01$, were positive and statistically significant, representing an overall upward trend with change in rates over time. For "ADHD therapy," in spite of having smaller magnitude, the linear, $b = 0.02$, $SE = 0.003$, $t = 6.85$, $p < 0.01$, and quadratic

Table 3 The impact of celebrity events on searches of ADHD

Events	Pre-event	Post-event	Pre-event						Post-event							
			Baseline			Trend			Baseline			Change in linear trend			Change in quadratic trend	
	M(*SD*)	*M*(*SD*)	*B*	*SE*	*t*	*B*	*SE*	*t*	*B*	*SE*	*t*	*B*	*SE*	*t*	*B*	*SE*	*t*
1	60.88 (5.09)	70.63 (8.42)	66.29**	1.58	42.07	−0.23**	0.04	−5.29	5.98**	1.87	3.21	0.38**	0.05	8.08	0.0004	0.0003	1.28
2	60.79 (4.96)	71.03 (8.29)	65.31**	1.52	42.94	−0.19**	0.04	−4.77	6.30**	1.86	3.38	0.32**	0.04	7.61	0.0005	0.0003	1.43
3	60.19 (4.78)	72.38 (7.38)	62.80**	1.27	49.29	−0.15**	0.03	−5.41	13.45**	1.71	7.88	0.20**	0.03	5.95	0.0018**	0.0004	4.66
4	62.60 (7.25)	73.35 (6.68)	57.22**	1.22	47.05	0.07**	0.02	3.48	3.64	2.05	1.78	−0.05	0.05	−0.96	0.0035**	0.0008	4.23
5	63.27 (7.08)	74.26 (6.71)	57.35**	1.11	51.89	0.08**	0.01	4.88	2.95	2.12	1.39	−0.09	0.07	−1.32	0.0049**	0.0012	4.06
6	63.74 (7.03)	74.84 (6.86)	57.70**	1.05	54.87	0.08**	0.01	5.83	0.74	2.21	0.33	−0.04	0.08	−0.52	0.0049**	0.0016	3.05
7	64.49 (6.82)	77.28 (6.50)	58.71**	0.95	61.94	0.08**	0.01	6.92	−0.19	2.55	−0.08	0.12	0.16	0.75	0.0042	0.0038	1.11

M mean, *SE* standard error. Event 1: 6/16/08 Justin Timberlake's interview—The love guru (Collider); Event 2: 11/24/08 Michael Phelps and the Potential of A.D.H.D. (New York Times); Event 3: 11/21/09 Glenn Beck for Governor (HuffPost); Event 4: 2/21/12 Revolution' Host Ty Pennington Talks Lifelong Battle With ADHD (HuffPost); Event 5: 4/29/13 Will.i.am Admits to Suffering from ADHD: "It works well for me" (Capital FM); Event 6: 2/24/14 Adam Levine Talks about ADHD Symptoms, 'I Really Can't Pay Attention' (Inquisitr); Event 7: 10/14/14 Channing Tatum: A Work in Progress. (New York Times)

*$p < 0.05$. **$p < 0.01$

terms, $b = 0.0003$, $SE = 0.00005$, $t = 6.01$, $p < 0.01$, were also positive and statistically significant.

Seasonality

June, November, and December coincided with decreases in searches for "ADHD medication" and "ADHD treatment," $ps < 0.05$; on the other hand, February and September were associated with increased searches for "ADHD medication" and "ADHD treatment," $ps < 0.05$ (Table 2). The largest seasonal factor was September for searches for "ADHD treatment," $b = 6.00$, $SE = 1.20$, $t = 4.99$, $p < 0.01$, "ADHD medication," $b = 9.70$, $SE = 1.76$, $t = 5.53$, $p < 0.01$, and "ADHD therapy," $b = 1.90$, $SE = 0.70$, $t = 2.70$, $p = 0.01$, indicating peaks in searching for different ADHD-related treatment options online at the beginning of the school year. Peaks in searches for "ADHD treatment," $b = 4.25$, $SE = 1.22$, $t = 3.49$, $p < 0.01$, and "ADHD medication," $b = 6.37$, $SE = 1.77$, $t = 3.59$, $p < 0.01$, also were detected after the new year, yet such peaks were not detected as a seasonal pattern for searches for "ADHD therapy," $b = 1.20$, $SE = 0.71$, $t = 1.69$, $p = 0.09$. The lowest seasonal factor was June for searches for "ADHD medication," $b = -8.66$, $SE = 1.74$, $t = -4.96$, $p < 0.01$, and "ADHD treatment," $b = -5.49$, $SE = 1.19$, $t = -4.60$, $p < 0.01$, suggesting a trough in searching for "ADHD medications" in summer. The lowest seasonal factor of searching for "ADHD therapy" was for December, $b = -2.98$, $SE = 0.71$, $t = -4.21$, $p < 0.01$, suggesting troughs in searching for "ADHD therapy" during winter breaks. Again, there was increased searching for "ADHD treatment," "ADHD medication," and ADHD therapy" during October's ADHD Awareness Month, $ps < 0.05$.

The Impact of "Own It" Campaign

The impact of the "Own It" pharmaceutical campaign on search patterns of "ADHD treatment," "ADHD medication," and "ADHD therapy" are displayed in Table 4. This campaign did not yield significant immediate impact (post-event baseline) during the month the campaign was initiated, $ps > 0.05$. Initiating the "Own It" pharmaceutical campaign induced a negative change of linear trend in searching for "ADHD treatment" after the event, $b = -0.08$, $SE = 0.02$, $t = -3.90$, $p < 0.01$. For "ADHD medication," starting the "Own It" pharmaceutical campaign induced a negative change of linear trend, $b = -0.14$, $SE = 0.05$, $t = -2.73$, $p = 0.01$, and positive change of the quadratic trend, $b = 0.01$, $SE = 0.001$, $t = 7.69$, $p < 0.01$. For "ADHD therapy," starting the "Own It" pharmaceutical campaign induced a positive change of linear trend after the event, $b = 0.04$, $SE = 0.02$, $t = 2.66$, $p = 0.01$; the change of the quadratic trend was not significant, $b = 0.001$, $SE = 0.001$, $t = 1.13$, $p = 0.26$.

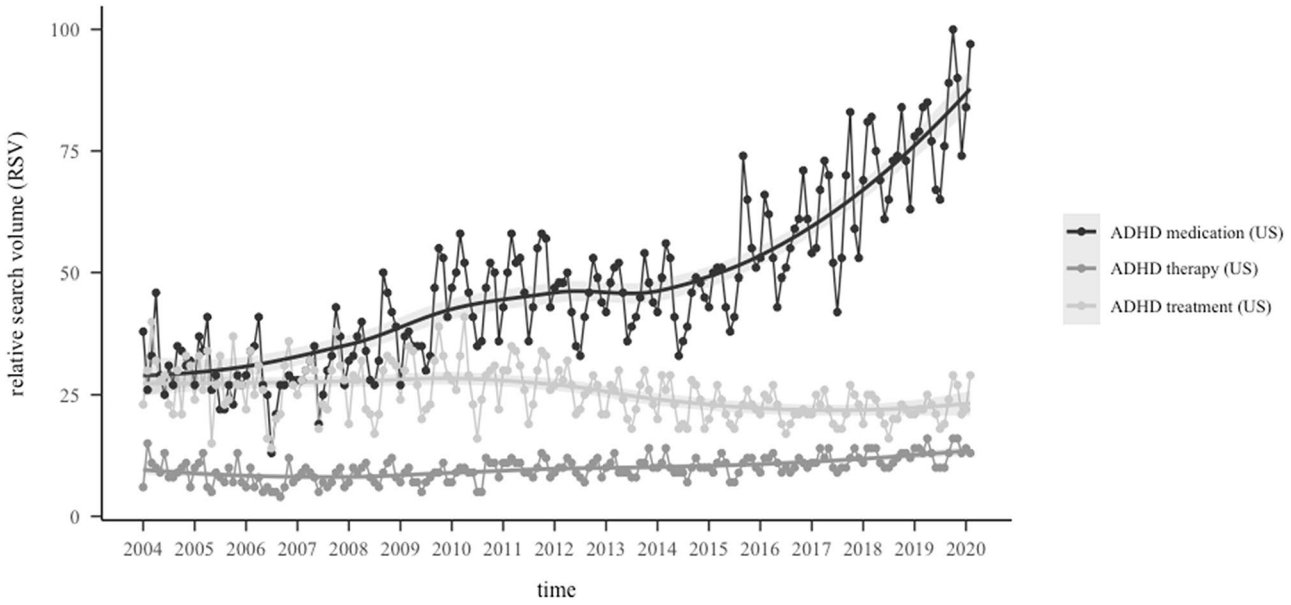

Fig. 2 Google Trends Relative Search Volumes for "ADHD Treatment," "ADHD Medication," and "ADHD Therapy." We extracted monthly data with three treatment-related search terms: "ADHD treatment," "ADHD medication," and "ADHD therapy" concurrently, yielding values relative to each other, for January 2004 to February 2020. We used Locally weighted smoothing (LOESS) to create a smooth line to visualize the general temporal trends. Trend line represents quadratic polynomial regression. N = 193. ADHD = attention-deficit hyperactivity disorder

Discussion

We used time-series analyses of Google Trends data to examine temporal and seasonal search patterns of ADHD disorder- and treatment-related terms. Our results suggest that (1) upward trends over time in searching for ADHD, and with increased specificity, may reflect progress in advocacy and treatment development; (2) school-based settings may be important for information dissemination; and (3) single events are minimally influential on population-level search trends in recent years.

Trends

Information-seeking trends align with trends of mental health beliefs, diagnostic prevalence and service utilization (Danielson et al., 2018; Parcesepe & Cabassa, 2013; Piper et al., 2018; Visser et al., 2014; Xu et al., 2018). Overall, searches for "ADHD" rose, consistent with the increasing usage of the internet to seek ADHD-related information (Bussing et al., 2007, 2012) and the increasing prevalence of ADHD diagnoses (Danielson et al., 2018; Visser et al., 2014; Xu et al., 2018). Changes in the diagnostic guidelines (e.g., required age of onset changed from 7 to 12 years old in the Diagnostic and Statistical Manual of Mental Disorders [DSM–5]) may have contributed to increasing prevalence of ADHD diagnoses and search interest in ADHD. Additionally, changes in school accountability and psychotropic medication laws have also contributed to changes in diagnoses and treatment (Fulton et al., 2009, 2015), and thereby may have contributed to changes in online search interest.

Searches for "ADHD treatment" decreased yet searches for "ADHD medication" and "ADHD therapy" increased, perhaps reflecting an increase in specificity of searches for and public knowledge of ADHD treatment (Bussing et al., 2007, 2012). Especially notable, searches for "ADHD medication" increased dramatically in recent years, consistent with the upsurge of psychotropic medication prescription and consumption (Piper et al., 2018) and more widely and publicly accepted neurobiological basis (and, corresponding treatment) for the disorder (Parcesepe & Cabassa, 2013). In contrast, we found searches for "ADHD therapy," despite its statistically significant upward trend, remained relatively low, according to our visual inspection of Fig. 2. Increasing calls in practice guidelines for involving multiple informants and stakeholders in collaborative care models (e.g., American Academy of Pediatrics ADHD guidelines; Wolraich et al., 2019) may have contributed to more online searches about ADHD therapy and medication. The contrast between search interest in therapy and medication may be explained by national trends in service utilization: (1) medications are first-line treatments for most children diagnosed with ADHD (Danielson et al., 2018; Visser et al., 2014) and (2) psychosocial interventions are under-utilized (Danielson et al., 2018; Morrow et al., 2020; Waxmonsky et al., 2019).

Table 4 The impact of the "Own It" Campaign on Searches of "ADHD Treatment," "ADHD Medication," and "ADHD Therapy"

Search term	Pre-event	Post-event	Pre-event						Post-event								
			Baseline			Trend			Baseline			Change in linear trend			Change in quadratic trend		
	$M(SD)$	$M(SD)$	B	SE	t	B	SE	t	B	SE	t	B	SE	t	B	SE	t
ADHD treatment	27.27 (4.77)	23.60 (0.99)	6.16**	0.79	33.20	0.02*	0.02	1.63	−2.2	1.06	−2.00	−0.08**	0.02	−3.90	–	–	–
ADHD medication	35.46(10.10)	57.54 (14.51)	19.08**	1.57	12.20	0.25**	0.03	9.17	0.93	2.45	0.38	−0.14*	0.05	−2.70	0.01**	0.001	7.69
ADHD therapy	9.38(2.79)	11.03 (1.78)	9.80**	0.49	20.00	-0.01*	0.01	-1.7	0.54	0.76	0.70	0.04*	0.02	2.66	0.001	0.001	1.13

M mean, *SE* standard error

$^{*}p < 0.05$. $^{**}p < 0.01$

Seasonality

Our findings on seasonality extend work by Ayer et al. (2013) and DeVilbiss and Lee (2014). Ayer et al. (2013) reported larger seasonal factors in affective disorders than ADHD. Unlike affective disorders for which severity and impairment may vary with sunlight and seasons (Hidaka, 2012; Lambert et al., 2002), ADHD is a neurodevelopmental disorder characterized by symptoms likely to cause the greatest impairments during the school year—when demands for attention and task persistence are high—often leading to academic underachievement (Barkley, 2014). In other words, academic demands coincide with academic calendars, potentially motivating different patterns of information seeking by parents that associate with the beginning and end of the school year, and for instance, with the timing of exams. Unique to "ADHD therapy," the large coefficients detected in the fall were not observed during spring, which may reflect the timing of Individualized Educational Plan (IEP) meetings that are typically scheduled at the beginning of the school year. The absence of statistically significant change in search patterns from June to August aligns with a documented lack of (opportunity for) proactive discussions, with mental health professionals, related to medication breaks (Ibrahim & Donyai, 2018) and shortage of evidence-based summer programs at the national level. The peaks in searching for ADHD and its treatment (i.e., searches for "ADHD," "ADHD treatment," "ADHD medication," "ADHD therapy") every October align with the designation of October as ADHD Awareness Month, a collaborative initiative started in 2004 (ADHD Awareness Month, 2004). Similar patterns have been observed for information seeking during the Breast Cancer Awareness Month (Glynn et al., 2011) and the National Autism Awareness month (DeVilbiss & Lee, 2014). Findings related to seasonality suggest (1) ADHD Awareness Month is an effective public health initiative to increase public interest in ADHD and (2) IEP meetings and other systematically scheduled school events may offer insights into underutilized opportunities to enhance public knowledge of school structures and tiered interventions (Fabiano & Pyle, 2019).

Media Impact: Celebrity and Pharmaceutical Events

Fluctuations in online searches related to ADHD cannot be attributed to one specific celebrity event, consistent with findings that indicate the influence of celebrity events on suicide-related online searches varied with celebrities' popularity (e.g., Gunn et al., 2020). Our findings (of popularity based on Twitter followers) included events of seven very popular celebrities (with close to or more than 1 million followers on Twitter). Thus, we cannot draw conclusions directly linking celebrities' popularity to the magnitude

of impact for online information seeking. Our findings do suggest, however, that celebrity effects are more salient in earlier years, specifically three that occurred between 2008 and 2009, that altogether (and by their proximity to one another) may have increased public awareness of the disorder and its indicated treatments. Perhaps more recent events are less impactful because, during the last decade, ADHD has become more widely known, as evidenced by Bussing et al.'s (2012) report that only around 10% of parents had never heard of ADHD.

Finally, there were no immediate changes in treatment-related searches during the month following the launch of the "Own It" pharmaceutical campaign. An examination of corporate motivations and industry contexts may help to explain this unanticipated finding. The impact of pharmaceutical marketing on online information seeking may be medication-specific to encourage interest in medications produced by the manufacture sponsor, rather than all ADHD medications, as evidenced by Shire's sale record in 2011 (having outpaced the 10% growth of the US ADHD medication market) (Shire pharmaceuticals, 2012). Although pharmaceutical campaigns are motivated by financial incentives, they may increase public awareness, interest, and knowledge of ADHD, evidenced by a decrease in linear trends of "ADHD treatment," as well as a negative change in linear trend yet positive quadratic change of "ADHD medication." Possibly, more searches are driven by extracting and verifying medication-specific information, rather than exploratory browsing (see Wilson, 1999 for definitions of browsing, extracting, and verifying in information behavior research). Notably, the post-campaign change in searching for "ADHD therapy" showed the opposite pattern (i.e., a small positive change in the linear trend). Altogether then, the "Own It" campaign may have contributed to raising interest and awareness about Shire's ADHD medications, but not to generating knowledge of ADHD therapy more broadly.

Limitations and Future Direction

Findings warrant caution due to study limitations. First, similar to other health-related studies using Google Trends (Arora et al., 2019; Mavragani et al., 2018; Nuti et al., 2014), data prior to 2004 are not available. Thus, we are not able to examine the impact of events before 2004, such as the release of Concerta and the initiation of the Multimodal Treatment of ADHD Study (MTA Cooperative Group, 1999). However, it is worth noting that only 5% of parents and adolescents reported the internet as their primary source for information about ADHD in a community sample in 1998 (Bussing et al., 2007) and Google did not become the default search engine for Yahoo!, one of the most common directory websites in the 1990s, until June of 2000 (Google News, 2000).

Second, the scope of the study is for understanding information-seeking patterns in the United States. Future research may benefit from an examination of international variations in information seeking, as large variations in ADHD treatment procedures (Hinshaw et al., 2011) have been reported across countries. Notably, global differences in search engines and languages will lead to challenges in this line of research. The market share of the Google search engine varies; for instance, Google only takes up 2% of the search engine market in China (Statcounter, 2021). RSVs for our selected four search terms will be the highest in English-speaking countries; in Spanish-speaking regions, "TDAH" (el *déficit de atención e hiperactividad*) would have been more commonly searched. Additionally, large state variations in adoption and implementation of school accountability and psychotropic medication laws corresponded to large state variations in diagnostic prevalence and medication prescription for ADHD in youth (Fulton et al., 2009, 2015), indicating the need for understanding state variations in information seeking.

Third, our results cannot be extrapolated to any specific subpopulation. Although Google Trends data represent all types of searches conducted related to ADHD on Google—including those of patients, caregivers, providers, and teachers—we speculate, based on prior findings (Kubb, & Foran, 2020), that a large proportion of searches may come from parents of children with suspected or confirmed ADHD diagnoses. Notably, despite the closing gap in access to smartphones (Pew Research Center, 2019), individuals from disadvantaged socioeconomic backgrounds still may be under-represented in search engine data (especially the first decade of data); for example, individuals who are younger with higher education and higher internet skills are more likely to seek health information online (Chen & Zhu, 2016; Jacobs et al., 2017).

Fourth, we did not include the full universe of search terms that may be used to browse the internet for information about ADHD, which may have excluded some individuals with low psychological literacy or others that prefer to avoid diagnostic labels. Limitations related to identifying search terms are common in studies using Google Trends to study online health information seeking (Arora et al., 2019; Mavragani & Ochoa, 2018). Some may search instead for symptoms (e.g., "impulsivity," and inattention), functional deficits (e.g., "failing school"), solutions (e.g., "parenting strategies") (Yu et al., 2019), and/or generic names of medications (e.g., Concerta). However, these search terms present other challenges, as they also may be associated with other disorders (e.g., parents of children with autism spectrum disorders may also search for "parenting strategies" and "impulsivity," Concerta can also be used to treat narcolepsy). We included "ADHD" in all four search terms to study information-seeking patterns

specific to the disorder. Although not every individual knows and uses the term "ADHD," recall Bussing et al.'s (2012) findings that most parents and adolescents (93% and 98%, respectively) in a community sample had heard about ADHD. Future studies of search engine data may benefit from including terms that reflect transdiagnostic language or common element approaches (see Chorpita et al., 2005 for details of the Distillation and Matching Model).

Fifth, our population-level Google RSVs do not afford us the opportunity to examine individual-level predictors and processes. Help-seeking models (Eiraldi et al., 2006) suggest racial/ethnic and socioeconomic variations in cultural beliefs, psychological literacy, and mental health stigma as potential mediators and moderators (see Turner et al., 2015, for an empirical example). Problem recognition and online mental health information seeking do not often lead to seeking professional help; for instance, in a recent study from China, among parents who both suspected their child might have ADHD and searched online for information about the disorder, fewer than one-third sought a professional evaluation (Yu et al., 2019).

Sixth, we were not able to examine (1) whether increasing online search interest reflected increasing need for and/or access to *empirically supported* information and (2) which subgroups were more likely to consume high-quality information to inform treatment-seeking decisions. Existing studies indicate that (1) a vast amount of information about ADHD online is misleading, conflicting, and hard to digest (Ahmed et al., 2014; King et al., 2021; Kisely et al., 2003); (2) websites with empirically supported information are not necessarily clicked and consumed even when displayed (Rosenblum & Yom-Tov, 2017); and (3) approximately half of parents report feeling unequipped to evaluate quality and reliability of online health information (Yardi et al., 2018). Future research may benefit from a closer examination of individual predictors related to information need (e.g., whether or what to search online), information access (e.g., quality and digestibility of website content) and eHealth literacy.

Finally, media influence was limited to seven celebrities based on an arbitrary cutoff of one million Twitter followers and one pharmaceutical campaign. Notably, more followers do not necessarily represent more influence (i.e., "million follower fallacies"; see Cha et al., 2010, for more details). Dynamics of user influence varies by topic and time; hence, future studies may consider identifying influential celebrities using multi-metric approaches (e.g., the number of retweets and replies) (see Cha et al., 2010, for an example). Additionally, the small sample size limited our ability to examine event features more closely (e.g., prominence of the celebrity, racial/ethnic background). Racially/ethnically diverse celebrities in public health initiatives may be particularly influential in reaching families of color; for instance, in a focus group study of African American adults, celebrity effects were perceived stronger when the participants and the celebrity share the same racial/ethnic backgrounds (Mishra et al., 2009). Regarding the "Own It" campaign specifically, Levine's video aired until January 15th, 2017 (more than 5 years since its launch date) and remains available on YouTube and other channels. It is unknown how long it takes for a pharmaceutical campaign to influence information-seeking behaviors (or how long the influence may last). In this study, we defined the launching month (June 2011) as the event in interrupted time-series analyses to avoid the potential confounding influence of subsequent events. Future studies can benefit from incorporating theoretical frameworks across fields (Hoffman & Tan, 2015) to examine the "active ingredients" of media events, such as involvement of racially/ethnically diverse celebrities, intentions of celebrities (i.e., blaming or advocating for ADHD), and structure of incentive systems, that can influence mental health information seeking, along with prescribing decisions, treatment preferences, and service uptake.

Policy and Clinical Implications

Findings point to opportunities for improving information dissemination. Upward trends in searching for ADHD over time and increased specificity in information seeking related to treatment (from "ADHD treatment" to "ADHD medication" and "ADHD therapy") may reflect progress in advocacy and treatment development (Hinshaw & Scheffler, 2014) and changes in diagnostic and practice guidelines (Wolraich et al., 2019). Policymakers can allocate resources toward mental health advocacy, such as ADHD Awareness Month to reduce stigma (see Parcesepe & Cabassa, 2013, for recommendations related to anti-stigma) and raise awareness about existing resources (Pilapil et al., 2017).

Schools may be especially important in disseminating mental health information to families, highlighting the potential benefits of allocating funding for school-based resources and research. Existing literature points to a lack of science-informed knowledge about ADHD among preservice and experienced teachers (Akram et al., 2009; Poznanski et al., 2018, 2021), indicating high need for evidence-based information and training to help teachers organize their classrooms in ways that minimize distractions and maximize task persistence (universal strategies), recognize problems and offer class-wide or individual accommodations or interventions (targeted strategies) and make referrals for higher levels of care (intensive strategies) (Atkins & Frazier, 2011). In addition, In addition, the seasonal peaks in online search interest in ADHD may suggest a need for targeted efforts at the beginning of the school year and post winter holidays. It may be beneficial to include mental health

information for caregivers in family information packets (alongside procedural and emergency information from school districts), student folders (sent home at the beginning of the year by individual teachers), on school websites (parent resources tab) or ClassDojo (for routine check-ins).

Effective dissemination requires evidence-based information to be *distributed* and *consumed*. Consumption of inaccurate and unsubstantiated information may hinder receipt of proper and timely care. Thus, our preliminary findings on the rising interest in ADHD suggests an urgent need for increasing the accessibility of digestible science for the public. To improve the quality of information on the internet, Youngstrom and Cotuna (2020) have been developing Wikipedia and Wikiversity pages via the Helping Give Away Psychological Science initiative. Additional efforts toward improving e-health literacy may benefit from systematic attention to six domains: traditional, information, media, health, scientific, computer (Norman & Skinner, 2006). Standard guidelines, for example by the Stanford Persuasive Tech Lab (Fogg, 2002) and the Health on the Net Foundation (Boyer et al., 2007), support developers to improve website quality and provide tools (for health care providers and consumers) to evaluate health information online; however, not every consumer is aware of or prepared to apply these guidelines, due to disparities in e-health literacy.

Healthcare professionals should share the responsibility for guiding patients to seek and consume mental health information on the internet, in particular because they are often perceived as the most trusted and reliable information source (Gray et al., 2005; Jacobs et al., 2017; Mishra et al., 2009), especially by parents of youth with suspected or confirmed diagnoses of ADHD (Bussing et al., 2012; Rosenblum & Yom-Tov, 2017; Sciberras et al., 2010). Discussing health information presented online in an open, respectful, and culturally sensitive manner can also improve patient-provider relationships (Tan & Goonawardene, 2017). Thus, increasing social and cultural responsiveness in disseminating empirically supported information online, in comprehensible terms, should be a universal training goal for mental health professionals. We hope this paper can help (1) initiate a research agenda to improve the speed and reach of scientific communication and (2) provide a roadmap for leveraging internet search patterns to improve policy and clinical practices.

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Declarations

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