



## Effects of depression, anxiety and screen use on adolescent substance use

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### ABSTRACT

The current study examined relations between depression risk, anxiety risk, screen time and substance use among adolescents receiving SBIRT services. Between October 2018 and June 2020, 1701 youth ages 12 to 17 received SBIRT services (47% male, 24.2% non-white). SBIRT screening included the completion of the Patient Health Questionnaire for depression risk, Generalized Anxiety Disorder-7 item scale, a question on average amount of screen time daily, and the S2BI for substance use. Analyses included t-tests and chi-squares to examine demographic differences across variables, bivariate correlations among independent variables to assess for use within regression analyses, and stepwise linear regressions to examine relations between depression risk, anxiety risk, screen time and substance use. Analyses were examined using the full sample as well as those who scored positive for mild mental health symptoms. Median screen time was 3 to 4 h daily, 29% met criteria for mental health problems or risky substance use with high comorbidity of depression and anxiety risk. Findings demonstrated a significant risk of increased substance use associated with depression risk, severe anxiety risk, and screen time. Anxiety risk alone was not related to substance use risk when accounting for depression risk. Routine screening for depression, other mental health concerns, screen time and substance use is critical in supporting adolescent health and development, especially given comorbidity and their relative contributions. Interventions aimed at decreasing screen time, and identifying mental health problems may aid in decreasing substance use risk in adolescents.

### 1. Introduction

The National Survey on Drug Use and Health estimates 9.4% of adolescents, initiated alcohol use in the past year, while 4.8% initiated marijuana use and 2.4% initiated cigarette use (Administration, 2019). Use of these substances in adolescence is correlated with substance use disorder (SUD) later in adolescence and adulthood (Cunningham, et al., 2015; Lynskey, et al., 2003; Dawson, et al., 2008). Risky substance use at young age also predicts poor outcomes in adulthood (Bonomo, et al., 2004; Degenhardt et al., 2013; McCabe et al., 2017; Merline et al., 2004). Given the morbidity, mortality, and social consequences associated with substance use, efforts to decrease use in youth have been implemented. In the last several years the United States has seen decreases in initiation of all three substances (Administration, 2017). However, many adolescents still do not consider use harmful. For instance, one-third of US adolescents indicated consuming 4–5 alcoholic drinks or 1 pack of cigarettes daily was unlikely to cause great harm, while the majority reported using marijuana 1–3 times weekly is

unlikely to cause significant harm (Administration, 2017). Furthermore, wide spread use of vaporized tobacco, and legalization of adult recreational use of marijuana in several states raises concern for increases in adolescent substance use in the near future. Thus, it remains imperative to understand key drivers of substance use to direct public health strategies to decrease use and mitigate the risk associated for adolescents.

Depression is known to increase substance use among adolescents (Meyers and Dick, 2010). Rao et al found depressed adolescents developed earlier substance use disorder and adolescents with comorbid SUD and depression had significantly more psychosocial distress than those with depression alone (RAO et al., 1999). Additionally, co-morbid depression and substance use increases the risk of suicide (Davis, et al., 2008). Other mental health disorders, specifically anxiety, are less definitively associated with substance use in adolescents. Nonetheless, studies suggest a small correlation between anxious symptoms and increased substance use (Ohannessian, 2014; Lemyre et al., 2019). For instance, depressed adolescents with anxious symptoms demonstrate higher risk for substance use than their non-anxious counterparts (RAO

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et al., 1999).

The relationship between screen time and substance use is less well understood. Though exposure to substance-related media increases risky behaviors in adolescents, general screen use has been less studied (Dalton, et al., 2009; Davis et al., 2019; Titus-Ernstoff, et al., 2008). Screen time has been associated with several negative outcomes such as increased sedentary behavior, isolation and depressed mood (Boers et al., 2019; Mathers et al., 2009; Kremer et al., 2014). Given the impact on several aspects of adolescent behavior, it is plausible that screen time also impacts adolescent substance use. The magnitude, direction and clinical significance of this relationship is yet to be established.

It is most likely that adolescent substance use is affected by a multitude of risk factors spanning the socio-ecological model many moderating each other. Many studies have evaluated these risk factors in isolation; however, efforts to better understand the complex relationship of risk factors simultaneously are needed.

Comprehensive health screening that includes questions about lifestyle, behavioral health characteristics such as screen time and sleep behaviors, mental health, and substance use allows for improvement in our understanding of the factors leading to risky drug use. Incorporation of universal substance use screening, brief intervention and referral to treatment (SBIRT) into multiple clinical care settings serving adolescents may aid in obtaining data necessary to better our understanding of relations between risk factors.

In efforts to better care of adolescents, particularly as it relates to substance use identification and treatment, we implemented a state-wide strategy to include SBIRT in primary care, youth outreach programs and emergency department (ED) settings. Our screening, though not inclusive of all possible risk factors, does allow for investigation of relations between mental health, screen time and substance use in a representative sample of youth. Therefore, we aimed to describe relations between depression, anxiety and screen time as it relates to adolescent substance use.

#### Methods

## 2. Sample

The sample was derived from a state-wide SBIRT initiative focused on youth and young adults in rural New England. Individuals are screened as part of a medical or other related service. Participants included adolescents ages 12 to 17 screened at one of seven sites including two EDs, two primary care clinics, and a youth-serving community nonprofit organization. The SBIRT evaluation was a quality improvement effort focused on measuring and enhancing the standard of care. Thus, the current study was exempt from Institutional Review Board approval. In addition, data provided for the current study were de-identified to ensure confidentiality and participant protection.

## 3. Measures

**Screen time** was measured using the following question: "On average, how much screen time do you have a day NOT COUNTING SCHOOL OR WORK? (include phone, video games, tv, etc.)" with response choices ranging from '1 h or less' to '4 h or more'. One site utilized two questions for screen time to differentiate between days during the week and weekend days. These questions were combined to create an average score allowing for responses to be combined into a single item.

**Mental health risk** was measured using the Patient Health Questionnaire two- and nine-item modules for depression risk (PHQ-2,  $\alpha = 0.81$ ; PHQ-9,  $\alpha = 0.85$ ) and the Generalized Anxiety Disorders two- and seven-item scales (GAD-2,  $\alpha = 0.77$ ; GAD-7,  $\alpha = 0.85$ ,  $\alpha = 0.92$ ) for general anxiety risk (Spitzer, et al., 2006; Spitzer et al., 1999). Because suicidality is an increasing concern, the first two items (anhedonia, depressed mood), the PHQ-2, and item 9 (suicidal thoughts) of the PHQ-9 were utilized as initial screening. Those scoring three or higher or endorsing

suicidal thinking, completed the remaining items of the PHQ-9. Similarly, adolescents completed the GAD-2, and if they scored three or higher, completed the remaining five items. The PHQ-2 has demonstrated excellent specificity and sensitivity as an initial screener for depression and the GAD-2 has demonstrated acceptable psychometric properties for anxiety (Kroenke et al., 2003; Staples et al., 2019). Items across both measures range from '0 = not at all' to '3 = nearly every day'.

**Substance use** was measured using the S2BI (Screen to brief intervention). The S2BI is a screening tool developed by Levy et al to identify risky substance use. It has validated risk levels from no risk to severe risk based on frequency of use and has demonstrated good sensitivity and specificity to identifying past year substance use (90%, 83%) and the presence of a SUD (90%, 91%) (Levy et al., 2014). It provides an initial screen which asks about frequency of nicotine (including all forms of inhaled nicotine and chewing tobacco), alcohol and cannabis use in the past year. Endorsement of any use of the three substances prompts additional questions about frequency of other drugs.

### 3.1. Data analysis

Means and frequencies were analyzed with *t*-test and chi squared respectively. Outcome variables were examined for differences among the demographic variables of gender, age, and race. For both depression and anxiety risk, two dichotomous variables were created to indicate the presence of any depression and any anxiety risk. Those with a score of five or higher on the PHQ-9 were considered positive for depression risk and those with five or higher on the GAD-7 were considered positive for anxiety risk. This is consistent with the instruments' published scoring thresholds. In addition, analyses were examined utilizing the full sample as well as a sample of individuals with any depressive risk. This was repeated for those positive for any anxiety risk. This secondary analysis was pursued to examine if relations differed among a general sample with lower mental health prevalence and a clinical sample in which all individuals present with mental health risk.

Bivariate correlations were used to examine relations between substance use risk, depression risk, anxiety risk, and screen time. Stepwise linear regression analyses examined relations between depression risk, anxiety risk, and screen time in relation to predicting substance use risk. The first model utilized any depression risk and screen time as predictors of substance use risk using the S2BI score, adjusting for anxiety risk severity, age, and gender. The second model utilized any anxiety risk and screen time as predictors for substance use, adjusting for depressive risk severity, age, and gender. Variance inflation factors were utilized across all models to assess for collinearity.

## 4. Results

Between October 2018 and June 2020, 1701 youth ages 12–17 received SBIRT services. 47% were male and median age was 15. Median daily screen time was 3–4 h. 29% met criteria for risky substance use or mental health problems. Distribution of demographic characteristics and outcomes are represented in [table 1](#).

1244 patients (73% of the total) had both depression and anxiety risk screening. Although 919 patients had neither depression risk, nor anxiety risk, there was high comorbidity in those with mental health disease. As severity of depression or anxiety risk increased, so did the proportion with comorbid mental health disease. For instance, 60% of patients with severe depression risk also had severe anxiety risk, conversely 53% of those with severe anxiety risk also had severe depression risk. The results of mental health disease and comorbidity is represented in [table 2](#).

**Table 1**  
Characteristics of all 1701 adolescents receiving SBIRT.

	N=1701
Age in years	15 (SD 1.8)
Gender	
Male	801 (48.9%)
Female	853 (51.0%)
Transgender	12 (0.7%)
Other	7 (0.4%)
Race	
Asian/Pacific Islander	151 (8.6%)
Alaska Native/American Indian	64 (3.6%)
Black	189 (10.8%)
White	1,331 (75.8%)
Other	21 (1.2%)
Nicotine use in the past year	
Never	1,413 (83.3%)
Once or twice	135 (8.0%)
Monthly or less	38 (2.2%)
Weekly or more	40 (2.4%)
Daily	70 (4.1%)
Alcohol use in the past year	
Never	1,458 (85.7%)
Once or twice	175 (10.3%)
Monthly or less	55 (3.2%)
Weekly or more	12 (0.7%)
Daily	1 (0.1%)
Marijuana use in the past year	
Never	1,429 (84.4%)
Once or twice	102 (6.0%)
Monthly or less	48 (2.8%)
Weekly or more	44 (2.6%)
Daily	71 (4.2%)
PHQ 9 category	
No depression	1,128 (80.1%)
Mild depression	109 (7.7%)
Moderate depression	103 (7.3%)
Severe depression	69 (4.9%)
GAD 7 category	
No anxiety	1,167 (81.5%)
Mild anxiety	102 (7.1%)
Moderate anxiety	83 (5.8%)
Severe anxiety	80 (5.6%)
Average daily screen time	
0-1 hrs	138 (8.7%)
2 hrs	386 (24.2%)
3-4 hrs	427 (26.8%)
> 4 hrs	643 (40.3%)

**Table 2**  
Distribution of severity of mental health disorders by severity<sup>a</sup>.

	No anxiety	Mild anxiety	Moderate anxiety	Severe anxiety	Total
No depression	919	37	24	16	996
Mild depression	54	28	9	6	97
Moderate depression	28	25	22	12	87
Severe depression	7	4	15	38	64

<sup>a</sup> Numbers represent the absolute number of subjects in each category.

4.1. Primary outcomes

4.1.1. Depression risk as a predictor of substance use

The stepwise linear regression analysis demonstrated highest adjusted R-squared value (0.17) when depression risk category, average screen time, GAD 7 level, age, and gender were included (Table 3). As anticipated, substance use increased with age. Males also participated in

**Table 3**  
Full regression models for mental health problems and screen time as predictors of substance use.

	p		p		
Age	0.4 (0.3, 0.4)	<0.001	Age	0.4 (0.3, 0.4)	<0.001
Gender <sup>a</sup>	-0.3 (-0.5, 0.0005)	0.05	Gender	-0.3 (-0.5, -0.01)	0.039
Depression risk	1.3 (0.9, 1.7)	<0.001	Anxiety risk	0.1 (-0.3, 0.6)	0.533
Average screen time			Average screen time		
1-2 h	0.1 (-0.4, 0.6)	0.799	1-2 h	0.1 (-0.4, 0.5)	0.803
3-4 h	0.4 (-0.1, 0.9)	0.094	3-4 h	0.4 (-0.1, 0.9)	0.086
> 4 h	0.5 (0.04-1.0)	0.034	> 4 h	0.5 (0.04-1.0)	0.033
GAD 7 category			PHQ 9 category		
Mild anxiety	0.2 (-0.4, 0.7)	0.482	Mild depression	0.7 (0.2, 1.2)	0.006
Moderate anxiety	0.3 (-0.4, 0.9)	0.413	Moderate depression	1.8 (1.2, 2.4)	<0.001
Severe anxiety	0.9 (0.3, 1.5)	0.005	Severe depression	2.6 (1.9, 3.3)	<0.001

<sup>a</sup> Males were coded as 0, females as 1, thus negative coefficients indicate increased use in males.

increased substance use. After adjusting for age, and gender, substance use was significantly increased in those with depression risk. Lastly, after accounting for the aforementioned variables, only the highest GAD score category (score of 15-21), accounted for an additional increase in substance use.

4.1.2. Anxiety risk as a predictor of substance use

Adjusted R-squared was 0.18, highest when including anxiety risk, screen time, PHQ 9 level, age and gender were included in the model (table 3). After accounting for depression risk severity, general risk of anxiety was not correlated with increased substance use. Similar to the depression risk analysis, depression risk severity demonstrated a dose dependent association with substance use when compared to no risk of depression. Furthermore, males again had increased substance use and increasing age remained independently associated with increased substance use.

Variance inflation factors (VIF) were all were <2 indicating low concern for collinearity.

4.1.3. Impact of screen time

In both models, increased screen time was associated increased substance use after accounting for in the impact of mental health illness, age and gender. The increase associated with screen time >4 h a day was statistically significant when compared to use < 1 h daily. Average screen use between 3 and 4 h was also near statistical significance. Unique variance due to screen time was <1% in both models: 0.5% and 0.9% in the depression risk and anxiety risk analyses respectively.

4.2. Secondary analysis

Of the 281 patients with depression risk, 109 (39%) were mild, 103 (37%) moderate and 69 (24%) severe risk. In this population, screen time had significantly elevated VIFs indicating possible collinearity, therefore was not included in the final regression. Regression analysis demonstrated increasing depression risk severity was correlated with increased substance use. Those with moderate depression risk had a significant increase in substance use compared to those with mild depression risk. Similarly, those with severe depression risk had increased substance use when compared to both patients with mild and

moderate depression risk. In this subgroup, anxiety problems did not have a statistically significant effect on substance use after accounting for depression risk severity.

265 patients had clinically significant anxiety risk. Of these 102 (38%), 83 (31%) and 80 (30%) had mild, moderate and severe risk respectively. Consistent with the primary analysis, when adjusting for presence of depression risk, there was not an increase in substance use in those with moderate or severe anxiety risk when compared to those with mild anxiety risk. Even so, severe depression risk was associated with increased substance use among those patients with anxiety risk.

#### 4.3. Post hoc COVID analysis

A post hoc analysis of differences based on presentation after the state-wide stay home orders were in place, March 24, 2020, indicated 34 patients were seen in the post COVID shutdown era. Excluding these participants from the above analyses did not change significance demonstrated in the models. There were univariate differences in substance use frequency with slightly more patients reporting ever nicotine use and marijuana use after the shutdown, without changes in alcohol use, depression risk, anxiety risk and screen time.

### 5. Discussion

To our knowledge this is the first study that examines relations between substance use, mental health and screen time simultaneously. One key strength of our study is that it includes a large sample size of adolescents being evaluated in various clinical settings. Using a clinical sample decreases participant bias as all subject received the same standard of care. Importantly, our sample demonstrated prevalence of tobacco, alcohol and marijuana use consistent with the most recent National Survey on Drug Use and Health (Administration, 2019). Prevalence of mental health problems was slightly higher in our study population than recent estimated state specific prevalence. 26% of participants had either depression risk, anxiety risk or comorbid mental health risk compared to 17–19% estimated in the 2016 National Survey of Children's Health (Whitney and Peterson, 2019). While the 2016 national survey includes all children younger than 18 and uses diagnostic thresholds to measure prevalence, given the nature of SBIRT, the current sample uses a threshold of the presence of risk. Thus, we might expect our prevalence rates to be higher. Our broad sample well represents the adolescents in our state.

Our findings demonstrate a significant risk of increased substance use associated with depression risk, severe anxiety risk and screen time. The comorbidity of mental health problems and substance use has been well established and the magnitude of the increased risk associated with depression we found is striking. Our findings regarding risk associated with depression risk are supported by the extant literature. The correlation between depression risk and substance use likely has a common neurobiological foundation. Depressed mood and anhedonia are the predominant symptoms of depression and likely reflect an alteration in the reward processing of the brain. Similar changes in reward signaling result in addictive drug use patterns in substance use disorder (Rao, 2006). The extent to which depression severity impacts substance use patterns has been less well described. One study in adolescents in Taiwan describe an increase in substance use risk associated with increasing depression severity (Wang et al., 2012). Our data are consistent with this finding indicating there is a “dose-dependent” relationship between the two. This phenomenon may represent an important risk factor in prognosis and treatment strategy and warrants further investigation.

Findings for anxiety risk were more complicated with results indicating general anxiety risk alone is not independently related to substance use risk among adolescents after accounting for depression risk. However, when depression risk is comorbid with severe anxiety risk, there is an increase in risky substance use over and above depression risk

alone. These findings are consistent with several epidemiological studies that have found high rates of comorbidity of anxiety disorders, mood disorders and substance use disorders (de Graaf et al., 2003; Kessler et al., 2010). DeGraaf's work demonstrated that nearly two-thirds of those with a mood disorder also experienced either an anxiety disorder, substance use disorder, or both. Further, the age of onset of any anxiety disorder, but particularly Generalized Anxiety Disorder (GAD), preceded mood and substance use disorders. Data have suggested that anxiety may predispose depression or simply develop into a mood disorder, indicating GAD and depression may be more closely related than previously understood (de Graaf et al., 2003; Wittchen et al., 1991). Further, longitudinal research on adults has found individuals with anxiety disorders who specifically reported using alcohol or other drugs to manage their symptoms experienced greater odds of developing a substance use disorder compared to those who did not report self-medicating (Robinson, 2011).

In our study sample, comorbidity of mental health problems was high with two-thirds of patients with depression risk also positive for anxiety risk and vice versa. This finding, in combination with epidemiological studies such as those by deGraaf and colleagues, highlight the importance of the need for research that incorporates both mental health concerns when examining substance use risk among adolescents (de Graaf et al., 2003). Further, because of the significant impact of depression, research must account for the relative impact of depression when assessing other factors that may or may not impact risky substance use.

Lastly, our study offers novel findings regarding the impact of screen time on substance use. A recent nationally representative study estimated average screen time, excluding use for homework, among adolescents 13–18 years is approximately 6.5 h per day (Rideout, 2019). However, among adolescents, use is quite variable. The same study also found that 6% of youth do not use screen media and additional 17% use 2–4 h of screen media daily. In our study, the median daily screen time was 3–4 h, slightly lower than that of the aforementioned national sample. Even so, the data demonstrated a small but independent increased risk of risky substance use associated with increasing screen exposure. This is particularly evident in those consuming more than 4 h of screen time daily.

Importantly in those with any depression risk, screen time became collinear. The risk associated with excessive screen use may play a larger role in adolescents without mental health problems. Since the majority of adolescents do not experience mental health problems this may indicate interventions targeting decreased screen time more appropriate for a generalized audience. The current AAP guidelines outline discussing media use as a family and developing a family media plan (Media Use in School-Aged Children and Adolescents, 2016). However, there is not a suggested amount of screen use articulated by the AAP. Several other studies use 2 h of daily use as a cut off for “heavy” use (Kremer et al., 2014; Herman et al., 2015; Belanger, et al., 2011). This is also the maximum suggested amount of screen time in young children (Brown, 2011). In fact, other countries such as Canada and Australia use the 2 h daily limit as a guideline for adolescents as well. Our data indicate this could be a reasonable level to mitigate risky substance use, or at least not increase it.

Clinically, our data and the current literature indicate presence of comorbid mental health problems, and substance use is common, and significantly raises the health risks associated with both. This emphasizes the importance of screening for both mental health and substance use problems simultaneously in clinical settings. Certainly, on an individual level, for youth with mental health problems, addressing those issues are the priority as they have many lifelong repercussions and may impact prognosis and treatment strategy. McKowen et al. suggest successfully treating comorbid depression improves substance use treatment outcomes, however others suggest those with comorbidity are, in general, more refractory to treatment (McKowen et al., 2013; Essau, 2009).

From a research perspective, accounting for depression and other mental health problems when analyzing other risk factors of risky substance use is critical. This is particularly true when assessing risk factors which share similar behavioral differences. Excessive screen time and depression share many common associated behaviors such as increased sedentary behavior, poor sleep and decreased social interactions. As such, the collinearity between screen time and mental health problems in the population with known depression described above may represent an example of different symptomatic presentations of a common underlying complex psychosocial problem.

## 6. Limitations

There are several limitations in the current study. Data are self-reported which may raise concerns regarding accuracy. Regarding screen time, research has found individuals tend to underreport their smartphone usage and factors such as short-term exposure, inconsistent usage, and multi-tasking can affect accurate recall of time spent on a given device (Ohme et al., 2020; Vanden Abeele et al., 2013). Research on self-report for substance use has been mixed. While studies have found that up to a quarter of respondents' self-reports are not corroborated by urinalysis, other studies have found that accuracy of self-report data can be enhanced by implementing specific methodology (Williams and Nowatzki, 2005). All participants were provided rationale for SBIRT screening normalizing substance use and mental health and surveys were administered via web-based survey on a tablet. Further, a primary concern for reporting bias for substance use is that individuals underreport due to fear of judgment or punishment. Our rates of substance use were consistent with national surveys, decreasing that concern. Other limitations include a lack of racial and ethnic diversity among our samples and an inability to assess for other variables due to the nature of the SBIRT implementation. These limitations may impact generalizability and a comprehensive understanding of additional factors that may impact relations between screen time, mental health and substance use. Lastly, the cross-sectional nature of the data prohibit any inference to causality.

Despite these limitations, the current study adds a significant contribution to the literature by furthering our understanding of relations between screen time, mental health and substance use using a large sample of adolescents. It is one of the only studies to examine relations between screen time, depression risk, anxiety risk, and substance use simultaneously. Consequently, the identification of an independently significant, though modest, increase in risky substance use associated with screen time is important and novel.

## 7. Conclusion

In sum, comorbid substance use and mental health disorders in adolescents are common. Increasing severity of depression risk is associated with increasingly risky substance use. Additionally, among those with depression risk, comorbid severe anxiety risk further increases risky use. For these reasons, screening for mental health problems when examining substance use risk is imperative to understanding the whole picture. Accounting for this comorbidity is equally important when studying the impact of other possible risk factors. Even after doing so, our data indicate increased screen time is associated with increased substance use. As such, promoting healthy screen habits may also have an impact on substance use risk, particularly in those who have yet to develop mental health problems.

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## CRediT authorship contribution statement

**Leigh-Anne Cioffredi:** Conceptualization. **Jody Kamon:** Project administration, Funding acquisition. **Win Turner:** Project administration, Funding acquisition.

## References

- Administration, S.A.a.M.H.S., Key Substance Use and Mental Health Indicators in the United States: Results from the 2016 National Survey on Drug Use and Health. 2017, Substance Abuse and Mental Health Services Administration: Rockville, MD.
- Administration, S.A.a.M.H.S. Behavioral Health Barometer: Vermont, Volume 5: Indicators as measured through 2017 National Survey on Drug Use and Health and the National Survey on Substance Abuse Treatment Services. 2019.
- Belanger, R.E., et al., 2011. A U-shaped association between intensity of Internet use and adolescent health. *Pediatrics*, 127(2): p. e330-5.
- Boers, Elroy, et al., 2019. Association of screen time and depression in adolescence. *JAMA Pediatr.*
- Bonomo, Y.A., et al., 2004. Teenage drinking and the onset of alcohol dependence: a cohort study over seven years. *Addiction*, 99(12): p. 1520-8.
- Brown, A., 2011. Media use by children younger than 2 years. *Pediatrics* 128 (5), 1040-1045.
- Cunningham, R.M., et al., 2015. Alcohol Interventions Among Underage Drinkers in the ED: A Randomized Controlled Trial. *Pediatrics*, 136(4): p. e783-93.
- Dalton, M.A., et al., 2009. Early exposure to movie smoking predicts established smoking by older teens and young adults. *Pediatrics*, 123(4): p. e551-8.
- Davis, Jordan P., et al., 2019. Long-term associations between substance use-related media exposure, descriptive norms, and alcohol use from adolescence to young adulthood. *J. Youth Adolesc.* 48 (7), 1311-1326.
- Davis, L., et al., 2008. Major depression and comorbid substance use disorders. *Curr Opin Psychiatry*, 21(1): p. 14-8.
- Dawson, D.A., et al., 2008. Age at first drink and the first incidence of adult-onset DSM-IV alcohol use disorders. *Alcohol Clin Exp Res*, 32(12): p. 2149-60.
- de Graaf, R., et al., 2003. Temporal sequencing of lifetime mood disorders in relation to comorbid anxiety and substance use disorders—findings from the Netherlands Mental Health Survey and Incidence Study. *Soc Psychiatry Psychiatr Epidemiol*, 38(1): p. 1-11.
- Degenhardt, L., et al., 2013. The persistence of adolescent binge drinking into adulthood: findings from a 15-year prospective cohort study. *BMJ Open* 3 (8), e003015.
- Essau, C., 2009. Treatments for adolescent depression: theory and practice. Oxford ; New York: Oxford University Press. xii, 328 p.
- Herman, Katya M., Hopman, Wilma M., Sabiston, Catherine M., 2015. Physical activity, screen time and self-rated health and mental health in Canadian adolescents. *Prev. Med.* 73, 112-116.
- Kessler, Ronald C., et al., 2010. Age differences in the prevalence and co-morbidity of DSM-IV major depressive episodes: results from the WHO World Mental Health Survey Initiative. *Depress Anxiety* 27 (4), 351-364.
- Kremer, Peter, et al., 2014. Physical activity, leisure-time screen use and depression among children and young adolescents. *J. Sci. Med. Sport* 17 (2), 183-187.
- Kroenke, K., Spitzer, R.L., Williams, J.B., 2003. The patient health questionnaire-2: validity of a two-item depression screener. *Med. Care* 41 (11), 1284-1292.
- Lemyre, Alexandre, Gauthier-Légaré, Audrey, Bélanger, Richard E., 2019. Shyness, social anxiety, social anxiety disorder, and substance use among normative adolescent populations: a systematic review. *Am. J. Drug Alcohol Abuse* 45 (3), 230-247.
- Levy, Sharon, et al., 2014. An electronic screen for triaging adolescent substance use by risk levels. *JAMA Pediatr.* 168 (9), 822-828.
- Lynskey, M.T., et al., 2003. Escalation of drug use in early-onset cannabis users vs co-twin controls. *JAMA*, 289(4): p. 427-33.
- Mathers, M., et al., 2009. Electronic media use and adolescent health and well-being: cross-sectional community study. *Acad. Pediatr.* 9 (5), 307-314.
- McCabe, Sean Esteban, et al., 2017. Medical and nonmedical use of prescription sedatives and anxiolytics: Adolescents' use and substance use disorder symptoms in adulthood. *Addict. Behav.* 65, 296-301.
- Mccauley Ohannessian, C., 2014. Anxiety and substance use during adolescence. *Subst. Abuse*. 35 (4), 418-425.
- McKowen, James W., et al., 2013. Longitudinal associations between depression and problematic substance use in the Youth Partners in Care study. *J. Clin. Child. Adolesc. Psychol.* 42 (5), 669-680.
- Media Use in School-Aged Children and Adolescents. *Pediatrics*, 2016. 138(5).
- Merline, A.C., et al., 2004. Substance use among adults 35 years of age: prevalence, adulthood predictors, and impact of adolescent substance use. *Am. J. Public Health* 94 (1), 96-102.
- Meyers, J.L., Dick, D.M., 2010. Genetic and environmental risk factors for adolescent-onset substance use disorders. *Child Adolesc. Psychiatr. Clin. N. Am.* 19 (3), 465-477.
- Ohme, J., Araujo, T., de Verese, C., Piotrowski, J., 2020. Mobile data donations: assessing self-report accuracy and sample biases with the iOS Screen Time function. *Mobile Media Commun.* 1-21.
- RAO, U., et al., 1999. Factors associated with the development of substance use disorder in depressed adolescents. *J. Am. Acad. Child Adolesc. Psychiatry* 38 (9), 1109-1117.
- Rao, Uma, 2006. Links between depression and substance abuse in adolescents: neurobiological mechanisms. *Am. J. Prev. Med.* 31 (6), 161-174.
- Rideout, V.R., M 2019, The Common Sense census: Media use by tweens and teens, Common Sense Media: San Francisco, CA.

- Robinson, J., et al., 2011. Role of self-medication in the development of comorbid anxiety and substance use disorders: a longitudinal investigation. *Arch. Gen. Psychiatry* 68 (8), 800–807.
- Spitzer, R.L., Kroenke, K., Williams, J.B., 1999. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. *Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. JAMA*, 282(18): p. 1737-44.
- Spitzer, R.L., et al., 2006. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med*, 166(10): p. 1092-7.
- Staples, Lauren G., et al., 2019. Psychometric properties and clinical utility of brief measures of depression, anxiety, and general distress: The PHQ-2, GAD-2, and K-6. *Gen. Hosp. Psychiatry* 56, 13–18.
- Titus-Ernstoff, L., et al., 2008. Longitudinal study of viewing smoking in movies and initiation of smoking by children. *Pediatrics*, 121(1): p. 15-21.
- Vanden Abeele, Mariek, Beullens, Kathleen, Roe, Keith, 2013. Measuring mobile phone use: gender, age and real usage level in relation to the accuracy and validity of self-reported mobile phone use. *Mobile Media Commun.* 1 (2), 213–236.
- Wang, Peng-Wei, et al., 2012. The relation of substance use with different levels of depressive symptoms and the moderating effect of sex and age in Taiwanese adolescents. *Compr. Psychiatry* 53 (7), 1013–1020.
- Whitney, D.G., Peterson, M.D., 2019. US national and state-level prevalence of mental health disorders and disparities of mental health care use in children. *JAMA Pediatr.* 173 (4), 389–391.
- Williams, Robert J., Nowatzki, Nadine, 2005. Validity of adolescent self-report of substance use. *Subst. Use Misuse* 40 (3), 299–311.
- Wittchen, Hans-Ulrich, Essau, Cecilia Ahmoi, Krieg, Jürgen-Christian, 1991. Anxiety disorders: similarities and differences of comorbidity in treated and untreated groups. *Br. J. Psychiatry Suppl.* 159 (S12), 23–33.