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Problem Electronic Device Use in a Representative Sample of Adults in Ontario

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Abstract

There is growing evidence of correlations between the amount of time spent using electronic devices in leisure and negative health outcomes. However, studies often lack indicators of problematic technology use, rarely investigate relationships between such problem use patterns and indicators of poor mental health, and use samples that are unrepresentative of the adult population. Using a representative telephone survey of adults, we applied the Problem Electronic Device Use (PEDU) scale to estimate the level of PEDU in Ontario, Canada, and the associations between PEDU scores and a wide range of outcomes with a series of multivariate logistic regressions. We found an average weekly electronic device use of 15.57 hr, excluding work or school, and moderate to severe problem technology use among 7.9% of the adult population. Moderate to severe PEDU was significantly associated with suicidal ideation, serious psychological distress, problem alcohol use, and treatment for anxiety. Implications for the findings are discussed.

Keywords: electronic device, mental health, population survey, problem technology use, adults

Résumé

Il existe des preuves croissantes de corrélations entre la durée d'utilisation d'un appareil électronique à des fins de divertissement et les conséquences négatives sur la santé. On note souvent l'absence d'indicateurs de l'usage problématique des technologies dans les études qui examinent les corrélations entre cet usage et les

indicateurs de troubles de santé mentale ou qui utilisent des échantillons représentatifs de la population adulte. À partir des résultats d'un sondage téléphonique représentatif mené auprès d'adultes, la présente étude a eu recours à l'échelle d'évaluation de l'usage problématique des appareils électroniques (*Problem Electronic Device Use* ou PEDU) pour estimer l'ampleur de ce phénomène dans la province (Ontario) et a appliqué une série de régressions logistiques multivariées pour établir des liens entre les résultats PEDU et un large éventail de conséquences sur la santé mentale. L'étude a révélé que l'usage hebdomadaire moyen des appareils électroniques chez les adultes sondés était de 15,57 heures et que 7,9 % d'entre eux rapportaient un niveau modéré à sévère d'usage problématique de la technologie. Des liens significatifs ont été établis entre l'usage problématique des appareils électroniques et plusieurs indicateurs de troubles de santé mentale et de consommation de substances psychoactives. Les implications de ces constats sont discutées ici.

Introduction

In view of the substantial spread of electronic devices such as smartphones, tablet computers, and laptop and desktop computers and their high rate of daily use, it is important to understand the impact that they have on the mental health of the adult population. Problem electronic device use (PEDU) can be defined as interference with daily life or the experience of negative emotional states as a result of using electronic devices for activities other than school or work. The majority of research on the subject of electronic device use has focused on minors (see Hale & Guan, 2015, for a review). In addition, the information that exists on the mental health correlates of electronic device use among adults tends to conflate device use with more general measures of sedentary behaviour or with more specific types of device use such as mobile phones. Whencorrelations of technology and mental health outcomes are explored, the data are typically derived from clinical samples or convenience community samples that are not representative of the larger adult population. In the current study, we attempted to fill this gap in the literature by investigating how both the level of technology use and moderate to severe PEDU correlate with sociodemographic characteristics and mental health outcomes in a large representative sample of adults.

A concern with excessive use of technology is that it may reflect a pattern of addiction, more particularly a behavioural addiction (Griffiths, 1996). Behavioural addictions are defined by their similarity to substance use disorders in areas such as phenomenology, natural history, comorbidity, genetic markers, neurobiological mechanisms, and response to treatment (Petry, 2015). Advances in the quality of research on behavioural addictions has led to the inclusion of gambling disorder in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; American Psychiatric Association, 2013) and the inclusion of gaming disorder in the

International Classification of Diseases and Related Health Problems (11th ed.; World Health Organization, 2019). However, as pointed out by Widyanto and Griffiths (2007) regarding internet addiction, it is unclear whether these apparent behavioural addictions are directly linked to the technology itself, or whether the technology is simply the medium through which an individual accesses or engages with an addiction. As an example, there may be an important distinction between a person who has a gambling disorder and chooses online casinos to gamble versus a person who spends excessive amounts of time texting over their mobile phone, something that is a key feature of the technology itself.

The transdiagnostic dimensional interpretation of addiction provides another conceptualization of behavioural addictions that is gaining support from the research community. This perspective asserts that all types of addictive disorders tend to develop in individuals who show neurological deficits in reward functions, stress management, and cognitive control (Yücel et al., 2019). In these cases, the problematic use of electronic devices would be rooted in the same deficits in cognitive function as occur in addictive disorders and would suggest high comorbidity between PEDU and indicators of substance use disorders and behavioural addictions such as problem gambling.

Electronic Device Use and Demographic Correlates

Although most measures of sedentary behaviour include some forms of electronic device use, they often include other behaviours as well, such as reading, driving, and watching television (Thorp et al., 2011). As noted in a review by LeBlanc et al. (2017), electronic device use and screen time are becoming increasingly central to definitions of sedentary behaviour. According to data from the results of the 2014–2015 Canadian Health Monitoring Survey, Canadian adults between the ages of 18 and 79 years spend an average of 25 hr per week watching television or using a computer or tablet to watch videos, play computer games, email, or surf the Internet (Statistics Canada, 2017b). The same survey found no significant differences in leisure screen time between men and women, but did show significant variation by age, with an interesting single curve pattern in which leisure screen time was highest in young adults, dipped lower in middle age, and increased again in older age.

More recently, the research on overuse of technology has increasingly focused on the problem use of mobile telephones. However, this research tends to focus on relatively young samples. For example, in a systematic review of studies on smartphone use (Elhai et al., 2017), 20 of the 23 studies selected used convenience samples, 18 of which involved students who were mostly from university or college, with some inclusion of high school and elementary student samples. Studies that provide estimates of problem use prevalence tend to focus on adolescent populations. Lopez-Fernandez and colleagues (2014), in a sample of British secondary school students, found that 10% were problem users according to the Mobile Phone Problem Use Scale. In a review of cell phone addiction research, De-Sola Gutiérrez et al. (2016) reported a range of 2.9% to 64.5% in the prevalence of mobile device addiction,

noting that a wide range of methodological choices makes comparisons difficult. Twenty of 24 of these studies had samples between the ages of 11 and 30 years and no studies contained adults over the age of 60. Several studies have samples that include adults from a larger age range (Alhassan et al., 2018; Chen et al., 2017; Cho et al., 2017; Duke & Montag, 2017). However, none of these studies used a full range of adult ages or representative sampling techniques. For example, one study (De-Sola et al., 2017) that used the Mobile Phone Problem Use Scale showed a problem user prevalence of 5.1%, with an additional 15.4% at risk, in a sample of Spanish residents aged 16-64. Although incorporating a larger age range than most, this study did not use representative sampling techniques and did not capture information on adults over the age of 64.

Research findings are mixed on the relationships between problem mobile device use and demographic characteristics. In one review, Elhai et al. (2017) reported a consistent and significant negative association between problem device use and age. Problem device use has been consistently shown to be more common among younger age groups (Bianchi & Phillips, 2005; Van Deursen et al., 2015). In contrast, the relationship between problem mobile device use and gender is less clear. One review (De-Sola Gutiérrez et al., 2016) found a consistent gender effect on problem mobile device use, with women showing higher rates than men. However, a systematic review indicated that, compared with age, gender tends to have much lower effect sizes in predicting problem mobile device use, those effects often being overshadowed by psychopathological correlates (Elhai et al., 2017). Van Deursen et al. (2015) suggested that the tendency of women to focus more on using their mobile devices for social purposes may expose them to a greater risk of problem mobile device use than men. However, their analysis showed no difference between genders in predicting addictive mobile device behaviour. Although problem mobile device use has been associated with women, high-risk mobile device use, such as driving while texting, has been observed more often in men (Billieux et al., 2008). This may lead to increased risks of harms among men, such as motor vehicle collisions when engaged in device use while driving.

Electronic Device Use and Mental Health Outcomes

There have long been concerns over the connection between poor mental health and emerging technologies such as the internet (Kraut et al., 1998), a field of research that continues to grow. In their review, Elhai et al. (2017) found that, across the 10 studies that included a measure for depression in their analyses, nine reported significant positive relationships with problem mobile device use. For example, in a sample of university students in Isparta, Turkey, one study indicated that both high mobile phone use and high Smartphone Addiction Scale scores were associated with depression, as indicated by the Beck Depression Inventory (Demirci et al., 2015). The study also indicated that greater mobile device use was associated with disrupted sleeping patterns. A study based in Korea (Choi et al., 2015) suggested that the connection between PEDU and depression is a consequence of the fact that electronic devices are often used by those with depressive disorders to alleviate

negative moods. Other studies complicate this interpretation. For example, a study of college students in a midwestern American university found that mobile device use decreased over the study period among those who had the highest depression scores (Elhai et al., 2018). In contrast to that for poor mental health, the evidence connecting problem mobile device use and various forms of substance use and misuse is more mixed. The most commonly studied substance use correlate of problem device use is alcohol. In their study of personality traits and PEDU, Choi et al. (2015) found that PEDU scores were positively associated with Alcohol Use Disorder Identification Test scores and negatively associated with temperance. Family history of alcohol addiction has also been found to be associated with PEDU (Beison & Rademacher, 2016). Sánchez-Martínez and Otero (2009) indicated that intensive cell phone use (four or more times a day) was associated with tobacco, alcohol, and cannabis use. Problem gambling has also been shown to correlate with PEDU. In an online survey, Phillips et al. (2012) found that gambling problems were significantly higher among respondents who reported difficulties in limiting their television and mobile use. In contrast, several studies reported no relationship between substance use and electronic device use or PEDU. For example, a study of Swedish postsecondary students found no relationship between smartphone use and tobacco or alcohol use (Haug et al., 2015). Similarly, De-Sola et al. (2017) found no relationship between illicit drug use and PEDU.

Research Goal

There are two important concerns with the current state of research on problematic use of electronic devices. First, very few studies have included data that are representative of the general adult population, and second, few researchers have investigated the relationship between problematic device use and indicators of poor mental health and substance use. In the current study, we sought to remedy these shortcomings by investigating the correlates of PEDU in a large population-based sample of adults in Ontario. The goal was to provide generalizable estimates of the associations between PEDU and demographic characteristics, poor mental health, and substance use. A secondary goal was to identify associations between the level of electronic device use and demographic characteristics, poor mental health, and substance use.

Method

Sampling Design

Operating periodically since 1977 and continuously since 1996, the Centre for Addiction and Mental Health (CAMH) Monitor is the longest ongoing population survey of adult substance use in Canada.[1] The data that we analysed were derived from the 2015 and 2016 CAMH Monitor, a rolling survey of non-institutionalized

[1]This project, which spans 39 years, is based on 30 cross-sectional probability surveys conducted between 1977 and 2015.

adults 18 years of age and older in Ontario, Canada (Ialomiteanu et al., 2016). Exclusions to the survey population included adults residing in phoneless households, those who were too ill or aged to be interviewed, and those who were unable to complete the interview in English. To minimize respondent burden and maximize questionnaire content and flexibility, the CAMH Monitor uses a matrix interview design in which content and respondents may vary (Ialomiteanu et al., 2016).

This rolling cross-sectional survey drawn each quarter uses a regionally stratified design with the sample equally allocated within each of six regions in Ontario. Data are collected by means of computer-assisted telephone interviewing that draws a two-stage (telephone number followed by household respondent based on the last birthday of household members) probability selection of telephone numbers by using list-assisted random digit dialling of landline and mobile numbers. Each annual data cycle reflects accumulated data from four quarterly non-overlapping continuous or rolling samples from January to December. The CAMH Monitor survey primarily focuses on substance use and general well-being. The 2015 and 2016 Monitor included a special gambling module fielded during a 15-month period from January 2015 to March 2016. A random subset of respondents selected for the Monitor were administered the gambling module, which included questions on problematic use of electronic devices. Data analysed in the present study were from this gambling module, which yielded a sample of 4,016 adults (n = 3,002 in 2015, n = 1,014 in 2016). After we excluded respondents who did not complete all problem device use questions, the sample was left with 3,715 respondents. This module had a cooperation rate of 46% and an eligibility-adjusted (adjusted for the number of unknown eligible participants produced by non-contact calls) response rate of 41% (Ialomiteanu et al., 2018).

The 2015 and 2016 CAMH Monitor protocols were approved by the Research Ethics Boards of the Centre for Addiction and Mental Health and York University. The survey has been administered by the Institute for Social Research at York University since 1991.

Study Variables

Problematic Electronic Device Use

At-risk/problemuse of electronic devices was assessed by using modified items from the Problematic Internet Use (PIU) scale (Liu et al., 2011; Yau et al., 2012). The six PIU items were based on the Minnesota Impulsive Disorder Interview, which is a reliable and valid screener for impulse control disorders (Grant et al., 2005). These items were modified to reflect electronic device use generally, which includes computers, tablets, smartphones, and gaming consoles.

Each of the following six items was prefaced by the phrase, "Thinking about your use of these electronic devices in the past 12 months, for games, social media,

chatting or other uses, but not counting use of these electronic devices for work or school…": (1) Have you ever tried to cut back on your use of electronic devices? (2) Has a family member ever expressed concern about the amount of time you use electronic devices? (3) Have you ever missed school, work, or important social activities because you were using electronic devices? (4) Did you think you have a problem with excessive use of electronic devices? (5) Have you ever experienced an irresistible urge or uncontrollable need to use electronic devices? (6) Have you ever experienced a growing tension or anxiety that can only be relieved by using electronic devices? Responses of yes (1) or no (0) to the six items were summed to produce a symptom count measure ranging from 0 to 6.

The PIU has previously been dichotomized to indicate significant problem internet use with endorsement of symptoms from three domains from the Minnesota Impulsive Disorder Interview (Liu et al., 2011). A principal component analysis of the PEDU scale showed that a unifactorial model best fit the data (see Appendix), suggesting that specific symptom endorsement was unnecessary. We adopted a cut-off score of 3 or more to identify individuals who were experiencing "moderate to severe" symptoms of problemtechnology use. Because of the tendency of Cronbach's alpha to underestimate the reliability of scales consisting of dichotomous questions, we applied Guttman's Lambda 2 by using the greatest lower bound adjustment (Sijtsma, 2009). The resulting statistic was 0.75, which shows acceptable internal consistency for the measure. The mean inter-item correlation was 0.259 (minimum = 0.140, maximum = 0.453), which is within a typical range of 0.2 and 0.4 (Piedmont, 2014).

Frequency and Duration of Using Electronic Devices

Respondents were asked the frequency and duration of electronic device use for (1) playing video or computer games (i.e., gaming purposes) and (2) emailing, text messaging, accessing social media, or surfing the web (i.e., communication purposes). Each of the two frequency items was prefaced by the question, "During the past 12 months, how often, if at all, did you use electronic devices?" Response options were never, less than once a month, once a month, two to three times a month, once a week, two to three times a week, four to five times a week, about every day (includes six times a week), and every day. For the duration measures, respondents were prompted with the phrase, "During the past 12 months, on those days when you were playing/communicating, about how many hours did you spend…" Responseoptions were less than 1 hr, 1 to 2 hr, 3 to 4 hr, 5 to 6 hr, and 7 or more hr. Frequency measures and duration measures were then multiplied to estimate the amount of time spent on electronic devices for gaming and communication purposes in an average week.

Health Indicators

Overall self-rated health was captured by the following question: "In general, would you say your overall health is excellent, very good, good, fair, or poor?" This

variable was recoded such that 0 = excellent, very good, or good, and 1 = fair or poor. Traumatic brain injury was assessed by the following items: "We are interested in any head injuries that resulted in you being unconscious (knocked out) for at least 5 minutes, or you had to stay in the hospital for at least one night because of it." Respondents were then asked, "How many times, if ever in your life, have you had this type of head injury?" We binary coded the responses, separating those with one or more such events from those who reported none. Psychological distress was measured with the six-item version of Kessler's Psychological Distress scale (K6; Kessler et al., 2002, 2003). Response options were recoded to 0 through 4 and summed to create a scale ranging from 0 to 24. Scores of 8 or higher are considered to reflect a risk of mild/moderate-to-serious distress (Kessler et al., 2003). Suicidal ideation was assessed with a yes/no response to the following question: "In the PAST 12 MONTHS, did you ever seriously consider attempting suicide?" Symptoms of adult attention-deficit/hyperactivity disorder (ADHD) were assessed by using the Adult ADHD Self-Report Scale (v1.1), a screen designed to detect symptoms of ADHD (Kessler et al., 2005). A score of 14 or higher was used to indicate significant experience of ADHD symptoms (Van de Glind et al., 2013). Being prescribed medication for an anxiety disorder or a depressive disorder referred to a doctor's prescription given within the last 12 months.

Substance Use/Addictive Behaviour Indicators

Several indicators of substance use or problem behaviours were included in the study. Problem alcohol use was indicated by a score of 8 or higher on the AUDIT (Saunders et al., 1993). Regular cannabis use was indicated by self-reported use on a monthly or more frequent basis. Regular tobacco use was indicated by self-reported daily use of tobacco products. Moderate to severe problem gambling was indicated by a score of 3 or higher on the Canadian Problem Gambling Index (Ferris & Wynne, 2001).

Demographics

Demographic characteristics included sex (female vs. male), marital status (grouped into four categories of married or partnered, separated or divorced, widowed, and never married), and racialized status (non-White vs. White). A respondent's educational attainment was measured as an ordinal variable with three levels (completed high school or less, some post-secondary education, and university degree). Finally, the respondents' ages were measured in years and ranged from 18 to 98. Age was analysed as an ordinal variable with five levels (18–29, 30–39, 40–49, 50–64, and 65+) for the bivariate analyses and as a continuous variable for the regression analyses.

Analysis

Bivariate comparisons of categorical variables were performed by using the Pearson chi-square test. Because of the substantial skew of the mean hours per week spent on

electronic devices (skew = 2.07), non-parametric techniques were used to compare means across categorical variables. For binary variables, means were compared by using the standardized Mann–Whitney *U* test, and for variables of three or more categories, the Kruskal–Wallis test was used.

Logistic regression analysis was used to examine the relationship between indicators of mental health and substance use problems and scoring a 3 or higher on the PEDU scale. These analyses were controlled for age and sex. More complex models were not explored, because of the descriptive nature of the study goals. In all analyses, we controlled for the complex survey design by using the "survey" package of the R Project of Statistical Computing (Lumley, 2019).

Results

Time spent on electronic devices and PEDU scores were significantly positively associated, as shown by Spearman correlation analysis (r = -.40, $p < .001$). As displayed in Table 1, individuals showing no problems reported the lowest weekly device hours. Those experiencing one to two problems reported roughly similar weekly device hours at 19.79 and 21.45 hr, respectively. Those experiencing three to six problems, as captured by the PEDU scale, all reported roughly similar weekly device hours, approximately 30 hr per week.

The first set of analyses tested for bivariate associations between demographic characteristics and a score of 3 or higher on the PEDU. The results of these analyses are displayed in Table 2. The overall sample showed that 7.9% of respondents were classified as being at risk of moderate to severe PEDU. There was relatively little difference in the percentage of men versus women who were at moderate to severe risk, as 8.4% identified as male and 7.5% as female, and a chi-square test confirmed that this difference was not significant. Significant variation was shown across age for moderate to severe PEDU, with much higher proportions of younger cohorts than older cohorts falling into this category (χ^2 = 220.60, $p < .001$). Moderate to severe

Table 1
Bivariate Comparison of Problem Electronic Device Use (PEDU) Score and Weekly Hours Spent on Electronic Devices (N = 3,715)

PEDU score (0–6)	Mean number of hours of device use per week	N	SD
0	13.22	2,264	11.17
1	19.79	828	15.52
2	21.45	328	14.10
3	29.19	150	20.41
4	31.24	98	17.09
5	27.96	38	21.61
6	29.53	9	8.52
Total	15.57	3,715	14.35

Table 2

Bivariate Associations Between Demographic Characteristics and Electronic Device Use (N = 3,715)

	Problem electronic device use (PEDU score ⩾3)				Mean hours of device use per week		
Measure	No, *n* (%)	Yes, *n* (%)	χ2	*p*	Mean (SD)	Test statistic	*p*
Sex							
Female	1,784 (92.5)	144 (7.5)	1.31	.475	15.66 (14.05)	*U* = -0.87	.382
Male	1,636 (91.6)	151 (8.4)			15.47 (14.67)		
DK/REF/SM	0						
Age							
18–29	615 (80.5)	149 (19.5)	220.60	<.001	26.80 (18.40)	χ2 = 537.80	<.001
30–39	581 (91.6)	53 (8.4)			17.17 (13.28)		
40–49	634 (92.4)	52 (7.6)			14.74 (10.75)		
50–64	1,003 (96.5)	36 (3.5)			11.53 (11.14)		
65+	569 (99.0)	6 (1.0)			9.61 (10.49)		
DK/REF/SM	19						
Marital status							
Married/partner	2,314 (94.8)	126 (5.2)	139.84	<.001	13.00 (11.20)	χ2 = 265.48	<.001
Widowed	129 (100.0)	0 (0.0)			9.28 (12.56)		
Divorced/separated	196 (92.0)	17 (8.0)			14.02 (14.47)		
Never married	767 (83.5)	152 (16.5)			24.54 (18.30)		
DK/REF/SM	14						
Education[a]							
Completed high school or less	777 (91.6)	71 (8.4)	4.47	.424	14.33 (15.95)	χ2 = 29.68	<.001
Some post-secondary	1,234 (91.1)	120 (8.9)			16.81 (15.27)		
University degree	1,398 (93.1)	104 (6.9)			15.36 (12.14)		
DK/REF/SM	11						
Racialized minority							
Non-White	586 (86.7)	90 (13.3)	35.69	<.001	18.00 (15.13)	*U* = -2.88	.003
White	2,782 (93.2)	202 (6.8)			15.06 (14.10)		
DK/REF/SM	55						

Note. DK = Do not know; REF =Refused; SM = System Missing.

PEDU also varied significantly across marital status ($\chi^2 = 139.84$, $p < .001$). This difference seems to be largely an artefact of age variation, which might explain the 0% of widowed participants and the 16.5% of never married participants who had a high PEDU score. Moderate to severe PEDU did not show significant variation across level of education, with relatively similar percentages for all categories. Finally, those who identified as belonging to a racialized group ("non-White") showed significantly higher proportions of moderate to severe PEDU ($\chi^2 = 35.96$, $p < .001$).

Table 2 also displays the results of the comparisons of the mean time per week that participants spent on electronic devices for something other than work or school, which was 15.57 hr ($SD = 14.41$) for the overall sample. Similar to the percentages for moderate to severe PEDU, little difference was observed between the percentages of men and women for mean time spent on electronic devices per week, which was confirmed by the non-significant Mann-Whitney test statistic. Younger groups reported significantly more time on electronic devices than older groups did, with the youngest group spending nearly 27 hr per week. The variation between age groups was significant ($\chi^2 = 537.80$, $p < .001$), as indicated by a Kruskal-Wallis test. Marital status also showed significant variation in hours spent on electronic devices, with those identifying as having never married showing much higher use than the other groups ($\chi^2 = 265.48$, $p < .001$). In contrast to bivariate analyses of moderate to severe PEDU, there was significant variation in hours spent on electronic devices ($\chi^2 = 29.68$, $p < .001$) between levels of education. Those who identified as having a high school education or less showed the lowest use (14.33 hr), whereas those with some post-secondary education showed the highest use (16.81 hr). Finally, those identifying as belonging to a group other than White showed significantly more hours of device use ($U = -2.88$, $p = .003$), though the difference was relatively smaller than that observed for moderate to severe PEDU.

Bivariate associations with moderate to severe PEDU and weekly hours spent on electronic devices were also explored for mental health and substance use indicators (Table 3). Moderate to severe PEDU was first compared between those who reported poor to fair general health and those who reported good to excellent general health, with no significant difference observed. About 4 times as many of those who were identified as exhibiting moderate to serious psychological distress (25.5%, as indicated by the K6) were identified as experiencing moderate to severe PEDU compared with those with lower K6 scores (5.9%). This difference was highly significant ($\chi^2 = 195.65$, $p < .001$). Moderate to severe PEDU was significantly more common among those who reported suicidal ideation than among those who did not (32.5% vs. 7.4%, respectively, $\chi^2 = 71.27$, $p = .003$) and among those who showed significant symptoms of ADHD than among those who did not (26.9% vs. 6.5%, respectively, $\chi^2 = 151.22$, $p < .001$). Moderate to severe PEDU was significantly more common among those who had been prescribed medication to treat anxiety in the past year than among those who had not (13.3% vs. 7.4%, respectively, $\chi^2 = 16.36$, $p = .009$), but there was no significant difference between those who did and did not receive a prescription for medication to treat depression. There was also no

Table 3

Bivariate Associations Between Indicators of Mental Health and Substance Use and Electronic Device Use (N= 3,715)

	Problem electronic device use (PEDU score ⩾3)				Mean hours of device use per week		
Measure	No, *n* (%)	Yes, *n* (%)	χ2	*p*	Mean (SD)	*U*	*p*
General health							
Excellent, good	3,146 (92.2)	266 (7.8)	1.38	.399	15.73 (14.29)	-3.34	<.001
Fair, poor	269 (90.3)	29 (9.7)			14.14 (14.99)		
DK/REF/SM	5						
Moderate to serious psychological distress							
No	3,129 (94.1)	196 (5.9)	195.65	<.001	15.00 (13.60)	3.08	<.001
Yes	290 (74.6)	99 (25.5)			20.31 (18.93)		
DK/REF/SM	1						
Suicidal ideation							
No	3,360 (92.6)	270 (7.4)	71.269	<.001	15.42 (14.20)	2.59	.009
Yes	52 (67.5)	25 (32.5)			22.47 (19.43)		
DK/REF/SM	8						
Adult ADHD							
No	3,227 (93.5)	224 (6.5)	151.22	<.001	14.89 (13.713)	7.71	<.001
Yes	193 (73.1)	71 (26.9)			24.95 (18.94)		
DK/REF/SM	0						
Anxiety medication							
No	3,107 (92.6)	247 (7.4)	16.36	.009	15.40 (14.22)	1.72	.086
Yes	306 (86.7)	47 (13.3)			17.39 (15.50)		
DK/REF/SM	8						
Depression medication							
No	3,158 (92.4)	258 (7.6)	4.87	.175	15.28 (13.97)	2.40	.16
Yes	254 (88.8)	32 (11.2)			18.96 (17.90)		
DK/REF/SM	13						
Lifetime head injury							
No	2,931 (92.5)	236 (7.5)	8.19	.0679	15.42 (14.23)	0.83	.409
Yes	475 (89.1)	58 (10.9)			16.57 (15.04)		
DK/REF/SM	15						

Table 3 Continued.

Measure	Problem electronic device use (PEDU score ⩾3)				Mean hours of device use per week		
	No, *n* (%)	Yes, *n* (%)	$\chi 2$	*p*	Mean (SD)	*U*	*p*
Problematic use of alcohol							
No	2,891 (93.1)	215 (6.9)	47.41	<.001	15.01 (13.96)	4.11	<.001
Yes	414 (84.5)	76 (15.5)			19.58 (16.83)		
DK/REF/SM	119						
Monthly cannabis use							
Monthly	3,170 (92.9)	243 (7.1)	47.66	<.001	15.09 (14.01)	4.83	<.001
<Monthly	231 (81.9)	51 (18.1)			22.20 (17.13)		
DK/REF/SM	19						
Daily tobacco use							
No	3,106 (92.3)	258 (7.7)	4.67	.199	15.45 (14.13)	0.75	.451
Yes	301 (89.1)	37 (10.9)			16.93 (16.38)		
DK/REF/SM	13						
Risk level for problem gambling							
Low	3,366 (92.2)	284 (7.8)	11.18	.028	15.52 (14.29)	0.54	.589
Moderate/high	46 (80.7)	11 (19.3)			19.32 (17.96)		
DK/REF/SM	8						

Note. DK = Do not know; REF =Refused; SM = System Missing.

significant variation between those who did and did not report a history of head injury. Problem alcohol use, as indicated by the AUDIT, showed a significant association with moderate to severe PEDU, the percentage falling into this category being more than double for problem than for non-problem drinkers (15.5% vs. 6.9%, respectively $\chi^2 = 47.41$, $p < .001$). Similarly, moderate to severe PEDU was also higher among monthly cannabis users than among less than monthly users (18.1% vs. 7.1%, respectively, $\chi^2 = 47.66$, $p < .001$). Moderate to severe PEDU was significantly more common among those who identified as being at moderate to severe risk of problem gambling than among those who did not (19.3% vs. 7.8%, respectively, $\chi^2 = 11.18$, $p = .028$), whereas no significant relationship was observed between moderate to severe PEDU and daily tobacco use.

Table 3 also contains the results of bivariate analyses between the weekly hours spent using electronic devices for something other than work and the various indicators of health and substance use. Those who reported fair or poor general health showed lower weekly use of electronic devices in comparison to those who reported good to excellent health (14.14 vs. 15.73 hr, respectively, $U = -3.34$, $p = .001$), though the difference was relatively small at around 1.5 hr per week. Individuals at risk of moderate to serious psychological distress reported more hours per week on average (20.31 hr) than did those who did not report these symptoms (15.00 hr, $U = 3.08$, $p < .001$). Individuals who reported suicidal ideation spent significantly more time on electronic devices than did those who did not report it, at 22.47 versus 15.42 hr, respectively ($U = -2.59$, $p < .001$). Those who showed significant symptoms of ADHD also reported more weekly hours spent on electronic devices than did individuals who did not show these symptoms (24.95 vs. 14.89 hr, respectively, $U = 7.71$, $p < .001$). Time spent on electronic devices was not significantly different for those who were and were not prescribed medication for anxiety or depression. Similar to the findings on moderate to severe PEDU, lifetime head injury did not show a significant relationship with weekly hours on an electronic device. Those who indicated problem alcohol use reported more time on electronic devices than did those who did not indicate problem alcohol use (19.58 vs. 15.01 hr, respectively, $U = 4.11$, $p < .001$), as did those who reported monthly or more frequent cannabis use compared with those who reported less than monthly use (22.20 vs. 15.09 hr, respectively, $U = 4.83$, $p < .001$). In contrast to the findings on moderate to severe PEDU, moderate to severe risk of problem gambling did not show a significant relationship with hours spent on electronic devices. Daily tobacco use also did not show a significant relationship with weekly hours spent on an electronic device.

To further explore the relationships between mental health and substance use indicators and moderate to severe PEDU, we conducted a series of logistic regressions that predicted moderate to severe PEDU and controlled for age and sex. The results of these analyses are displayed in Table 4. They largely support the findings of the bivariate analysis with some important exceptions. Those who reported fair or poor general health had 2.239 times higher odds of moderate to severe PEDU. Moderate to serious psychological distress showed the strongest relationship with moderate to severe PEDU at an odds ratio of 4.470. Suicidal

Table 4
Logistic Regression Predicting Problem Electronic Device Use, Controlling for Age and Sex

Health or substance use indicator	*n*	OR	Lower CI	Upper CI	*p*
General health (fair or poor)	3,692	2.239	1.281	3.915	.005
Moderate to serious psychological distress	3,697	4.470	2.910	6.865	.000
Adult ADHD	3,697	3.197	1.897	5.389	.000
Suicidal ideation	3,707	4.180	1.617	10.809	.003
Anxiety medication	3,688	2.102	1.267	3.487	.004
Depression medication	3,684	1.634	0.878	3.042	.121
Lifetime head injury	3,683	1.728	1.066	2.801	.026
Problematic use of alcohol	3,579	1.791	1.094	2.930	.020
Monthly cannabis use	3,677	1.719	0.929	3.180	.085
Daily tobacco use	3,684	1.429	0.767	2.665	.261
Moderate to severe risk of problem gambling	3,689	2.778	1.005	7.680	.049

Note. OR, odds ratio; CI, confidence interval; ADHD, attention-deficit/hyperactivity disorder.

ideation also showed a strong relationship with moderate to severe PEDU with 4.180 times higher odds. Those who reported significant symptoms of ADHD had 3.197 times higher odds of moderate to severe PEDU, and those who reported being prescribed medication for the treatment of anxiety had 2.102 times higher odds of moderate to severe PEDU. As was shown in the results of the bivariate analysis, receiving a prescription for the treatment of depression was not associated with increased odds of moderate to severe PEDU. Lifetime head injury and problem use of alcohol both significantly increased the odds of moderate to severe PEDU by factors of 1.728 and 1.791, respectively. Contrary to the results of the bivariate analysis, monthly cannabis use was not significantly associated with increased odds of moderate to severe PEDU. Moderate to severe risk of problem gambling showed a comparatively substantial increase in odds of moderate to severe PEDU (odds ratio = 2.778), though the effect was barely significant, which was likely due to the very small number of problem gamblers.

Discussion

The goal of this study was to provide estimates of the associations between PEDU and demographic characteristics, indicators of poor mental health, and indicators of substance use in a representative sample of the Ontario adult population. We found a mean of 15.57 hr of electronic device use per week for something other than work or school and a general prevalence of moderate to severe PEDU of 7.9%. This proportion is somewhat lower than the figure reported by the Canadian Health Measures Survey (CHMS) for a similar period (2014–2015), but it is likely due to the inclusion of television watching by the CMHS, which was excluded from the measure in the current study (Statistics Canada, 2017a). Comparing this number to the existing literature is difficult due to the lack of comparable studies on population-representative samples.

The lack of existing clinical assessments for PEDU prevents us from identifying the relevance of the behavioural addiction category to PEDU. Similar to the dilemma identified by Widyanto and Griffiths (2007), it is difficult to identify whether problems associated with electronic devices captured by the PEDU scale represent a behavioural addiction related to the use of the technology itself or the access of other behavioural addictions through that technology. However, the associations of moderate to severe PEDU and numerous indicators of poor mental health and substance use are relevant to more transdiagnostic and dimensional approaches to addiction (Yücel et al., 2019). If the transdiagnostic dimensional approach to understanding addiction is the more appropriate way to conceptualize addiction as opposed to a specific disorder, that conclusion would support the use of scales that attempt to measure the overuse of technology more broadly rather than as more specific forms of technology such as mobile phones or video games. For example, in the current study, the types of technology use varied significantly by sex (men being more likely to be involved in gaming and women being more engaged in social networking). However, most comorbid relationships remained significant after controlling for gender and age in the logistic regression analyses. One interpretation of this result would be that the specific type of use is less relevant than is overall involvement.

In most cases, there was agreement between the amount of time spent on devices and moderate to severe PEDU. It stands to reason that, generally, similar to problem gambling, the greater a person's involvement in the potentially hazardous activity, the more problems a person is likely to experience (Welte et al., 2004). However, there were several instances in which this did not hold true. One interesting instance was in level of education. First, significant variation across educational level was shown in the hours spent on a device but not for moderate to severe PEDU. Second, although those with a high school education or less showed the lowest weekly device use, the percentage of moderate to severe PEDU was not significantly different from that of the other groups. Education may serve as a proxy for social class in the current study and these discrepancies may indicate increased vulnerability to moderate to severe PEDU for those with lower socioeconomic resources. Research on sedentary behaviour and socioeconomic status shows mixed results in the relationship between the two (O'Donoghue et al., 2016). For example, a study on TV viewing among women found that, for those at lower socioeconomic status levels, TV viewing was lower during the week but higher on the weekend (Kozo et al., 2012). The relationship between socioeconomic status and electronic device use is likely subject to a complex interplay between fiscal and family responsibilities, leisure options, and access to technology.

In cases of indicators of poor mental health, both being prescribed medication to treat anxiety and screening for moderate to severe problem gambling showed significant relationships with problem technology use, but not with the number of weekly device hours. This finding suggests that particular mental health correlates of problem use of technology may interact to increase the likelihood of the experience of harm as a result of the use of electronic devices, which is not dependent on the

actual time spent on those devices. Identifying comorbidities that expose a person to greater degrees of harm has important implications for treatment and prevention of PEDU. Such comorbidities may be especially relevant to modes of treatment that are informed by the transdiagnostic perspective (K. S. Kim & Hodgins, 2018).

These analyses highlight the important role of age in the analysis of problem technology use. The differences observed between older and younger age groups in both moderate to severe PEDU and in total time spent using electronic devices were substantial. Age is also likely to have a strong influence on other variables in the study. Marital status (Shields & Tremblay, 2008), education (O'Donoghue et al., 2016), and racialized status (Chui & Flanders, 2013) have all been shown to vary substantially by age, both in the literature and in the current sample. Further exploration of the relationships observed between these demographic characteristics and problem technology use should take age into consideration. Age may also have an important impact on the mental health correlates of PEDU. As might be expected, there was a high degree of agreement between the bivariate and regression analyses when we examined the relationships between moderate to severe PEDU and indicators of mental health and substance use. There were two notable exceptions. First, lifetime head injury was not significant in the bivariate analysis, but was significant after we controlled for sex and age. Second, monthly cannabis use showed a significant bivariate relationship with moderate to severe PEDU, but it was not significant after we controlled for age and sex. The tendency of cannabis use to be highest among younger age groups (Statistics Canada, 2019) and chances for lifetime head injury to increase with age may explain the discrepancies in the findings noted here (Corrigan et al., 2010).

The comorbidity of substance use disorders and psychiatric conditions represents a major contribution to the total global disease burden (Whiteford et al., 2013). Our results suggest that difficulties that arise from overuse of technology, as indicated here by moderate to severe PEDU scores, show important comorbidity with indicators of psychiatric and substance use problems, although this study cannot shed light on underlying causal pathways accounting for this co-occurrence. One possibility is that one or more common risk factors underlie behavioural addictions, as well as psychiatric and substance use problems. Another possibility is that an underlying psychiatric problem, such as elevated psychiatric distress levels, may act to cause other problems such as substance use and moderate to severe PEDU. More research to understand these commonalities and potential causal pathways is needed.

Limitations

A first limitation of this study is that the findings are based on a cross-sectional survey and thus temporality cannot be determined. A second limitation is that using measures of electronic device use that rely on recall can potentially bias the results. In a study in which recall of mobile device use was compared with objective monitored

data, the two measures were significantly associated with each other (Elhai et al., 2018).

Another limitation is that the current findings are based on a measure that is more inclusive than the current direction of research in electronic device use. The measure includes things like video game consoles and desktop computers, which are absent from scales that are more closely focused on mobile device use. As noted by Bianchi and Phillips (2005), the motivations and effects of types of problem technology use such as mobile phone use and internet use can vary in important ways. The findings of the current study should be considered in light of the possible conflation between types of technology included in the PEDU scale used in the study.

Conclusion

We found that 7.9% of the adult population in Ontario is at moderate to severe risk of PEDU and that the percentage is particularly high (19.5%) for those aged 18–29 years. People who scored in the moderate to severe range on the PEDU scale also had higher odds of having psychological distress, suicide ideation, ADHD, and problem alcohol use, but not of using cannabis, depression medication, or tobacco. Providing estimates of the prevalence of potentially harmful technology use that is representative of the adult population is a necessary step in better understanding, tracking, and responding to the issues that increased reliance on information technologies brings to individuals, as well as in establishing safer use guidelines.

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Ethics approval: The study is based on secondary de-identified data. The 2015 and 2016 "CAMH Monitor" surveys on which the analyses are based were approved by the Research Ethics Board at the Centre for Addiction and Mental Health on December 29, 2014 (305/2009-06) and December 15, 2015 (305/2009-08), respectively.

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Appendix

Principle Component Analysis for Problem Electronic Device Use Scale

Item	Component loading
During the past 12 months, have you ever tried to cut back on your use of electronic devices?	0.477
Has a family member ever expressed concern about the amount of time you use electronic devices?	0.601
Have you ever missed work, school, or an important social activity because you were using electronic devices?	0.522
Do you think you have a problem with excessive use of electronic devices?	0.697
Have you ever experienced an irresistible urge or uncontrollable need to use electronic devices?	0.723
Have you ever experienced a growing tension or anxiety that can only be relieved by using electronic devices?	0.654