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Determinants of Recreational Screen Time Behavior following the COVID-19 Pandemic among Canadian Adults

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27 ABSTRACT

28 The objectives of our study were to examine recreational screen time behavior before and two
29 years following the COVID-19 pandemic lockdown, and explore whether components of the
30 capability-opportunity-motivation-behavior (COM-B) model would predict changes in this
31 recreational screen time behavior profile over the two-year period. This cross-sectional,
32 retrospective study was conducted in March 2022. Canadian adults (n=977) completed an online
33 survey that collected demographic information, current screen time behavior, screen time
34 behavior prior to the pandemic, and beliefs about capability, opportunities, and motivation for
35 limiting screen time based on the COM-B model. We found that post-pandemic recreational
36 screen time (3.91 ± 2.85 h/day) was significantly higher than pre-pandemic levels (3.47 ± 2.50
37 h/day, $p < .01$). Three recreational screen time behavior profiles were identified based the
38 Canadian 24-Hour movement guidelines: 1) Always Met Screen Time Guidelines (≤ 3
39 hours/day) (47.8%; n = 454); 2) Increased Screen Time (10.1%; n = 96); 3) Never Met Screen
40 Time Guidelines (42%; n = 399). The overall discriminant function was found to be significant
41 among the groups [Wilks' $\lambda = .90$; canonical $r = .31$, $\chi^2 = (14) = 95.81$, $p < .001$]. The group that
42 Always Met Screen Time Guidelines had the highest levels of automatic motivation, reflective
43 motivation, social opportunity, and psychological capabilities to limit screen time compared to
44 the other screen-time profile groups. In conclusion, recreational screen time remains elevated
45 post-pandemic. Addressing motivation (automatic and reflective), psychological capabilities, and
46 social opportunities may be critical for future interventions aiming to limit recreational screen
47 time.

48 **Keywords:** Screen time, COVID-19, COM-B, Adults

49 INTRODUCTION

50 Recreational screen time activities, such as using a smartphone, watching T.V., or
51 playing video games, have quickly become a large part of modern lifestyles among adults.
52 Excessive screen time use among adults has been linked to a range of negative health outcomes.
53 Prolonged screen time use can lead to physical health problems such as neck and back pain, eye
54 strain, and headaches (Falkenberg et al. 2020). Additionally, increased screen time has also been
55 shown to result in difficulties falling asleep and staying asleep (Vallance et al. 2015). Studies
56 have also shown that mental health issues such as depression, anxiety, and stress have also been
57 associated with excessive screen time use, particularly social media use (Teychenne et al., 2015;
58 Wang et al., 2019). Furthermore, screen time use often replaces physical activity, which can lead
59 to a sedentary lifestyle and increase the risk of obesity, and chronic diseases such as type 2
60 diabetes and heart disease (Spence et al., 2017; Ford and Caspersen 2012; Mitchell et al. 2013).
61 To help prevent the negative effects of screen time for adults, health authorities in some
62 countries have implemented guidelines for recreational screen time behaviors. For example, the
63 Canadian 24-Hour Movement Guidelines (2020) recommend limiting recreational screen time to
64 no more than 3 hours/day for adults (Ross et al. 2020). Similarly, the World Health Organization
65 also recommends limiting sedentary behaviors in the form of recreational screen time,
66 specifically for children and adolescents (World Health Organization 2020). However, despite
67 guidelines and evidence-backed concerns of excessive use, recreational screen time remains high
68 in all age groups (Atkin et al. 2014; Wang et al. 2019; Harvey et al. 2022). Worldwide, daily
69 average per capita screen time is increasing and in 2019 total screen time was reported at 11
70 hours/day. From 2012 to 2019, total screen time was consistently highest among young adults
71 (Harvey et al. 2022). Mobile technology has increased the accessibility of screen time behaviors,

72 such as texting and using social media, and thus, limiting screen time remains crucial for the
73 health and wellness.

74 On March 11th of 2020, COVID-19 was declared a pandemic by the World Health
75 Organization (WHO) leading to restrictions and lockdowns worldwide (Cucinotta and Vanelli
76 2020). In response, countries across the world implemented strict physical distancing and
77 lockdown measures. These measures resulted in a further increase in screen time from an already
78 increasing average prior to the start of the pandemic. A 2021 meta-analysis found an overall
79 increase in participant sedentary behavior of 135.0 ± 46.0 min/day during COVID-19, where
80 screen time was the most consistent measure of sedentary behaviors (Runacres et al., 2021). A
81 study among Canadians aged 15 years and older ($n = 4524$) reported that 60% of male
82 participants showed an increase in T.V. time and 63% increased internet usage shortly after the
83 declaration of the pandemic (Colley et al. 2020). A U.S. study ($n = 2709$) reported that 64% of
84 the participants increased their recreational screen time (Chen et al. 2021). Similarly, a Polish
85 study ($n = 2381$) reported that 49% of the participants reported an increase in screen time shortly
86 after the start of the pandemic (Górnicka et al. 2020). Currently, much of the research about
87 recreational screen time took place immediately or up to one year following the start of the
88 pandemic. There is a lack of studies examining how screen time behaviors have changed
89 compared to pre-pandemic levels since most of the COVID-19 restrictions were lifted in March
90 of 2022. Understanding these changing trends of recreational screen time behavior two years
91 following the pandemic is critical to help inform researchers and public health agencies on future
92 interventions.

93 Furthermore, exploring the determinants of screen time behavior can help inform ways to
94 design effective interventions to limit recreational screen time. Previous research has identified

95 multiple correlates of screen time behaviors, including sociodemographic, behavioral and
96 environmental factors (Gorely et al. 2004). Screen time behaviors have been shown to be
97 associated with primarily behavioral and environmental factors, such as the number of TVs in
98 the house, unhealthy eating patterns as well as family screen time rules (Atkin et al., 2014;
99 Corkin et al., 2021; LeBlanc et al., 2015). Further, a socio-ecological framework has also been
100 used to predict variations in screen time behaviors, where factors such as parent education status
101 and neighborhood socioeconomic status are found to be negatively associated with screen time in
102 children and their parents (Carson et al. 2014). During the COVID-19 pandemic, one study
103 found that perceived lack of neighborhood safety, ethnic/racial minoritized identities, and low
104 socioeconomic status significantly predicted higher recreational screen time (Barr-Anderson et
105 al. 2021). In addition, common reasons for increased screen time behaviors in U.S. adults during
106 COVID-19 lockdowns were boredom and the desire to connect with others (Wagner et al. 2021).
107 While lockdowns presented an opportunity for increased screen time, few studies have examined
108 predictors of adhering to screen time guidelines, especially among Canadian population.

109 The capabilities, opportunities, motivations, and behavior (COM-B) model is a cohesive
110 theoretical framework used to understand health-related behaviors and help improve the design
111 of behavior change interventions (Michie et al. 2011). The COM-B model is comprised of three
112 main constructs (Capability, Opportunity, and Motivation), and each construct has sub-
113 components to further specify particular influences of behavior. Specifically, a person's
114 psychological (e.g., knowledge, reasoning) and physical (e.g., skills, strength) capabilities are the
115 sub-components that comprise the capability construct. Motivation refers to those brain
116 processes that energize and direct behavior, which consists of automatic (e.g., non-conscious
117 behavior, habits) and reflective motivation (e.g., beliefs, attitude). Finally, opportunity refers to

118 the external factors that enable or hinder the behavior. This construct is broken down into
119 physical (e.g., environment) and social (e.g., interpersonal, cultural) opportunities. COM-B is the
120 fundamental layer representing the sources determining behavior within the Behavior Change
121 Wheel Framework (ref), which provides a comprehensive approach to designing and
122 implementing behavior change interventions (Michie et al., 2011). Specifically, the COM-B
123 constructs serve as the critical mediators for specific intervention strategies (e.g., education,
124 persuasion, incentivization, restriction, environmental restructuring, etc.) and policies (e.g.,
125 regulation, service provision, legislation, guidelines, etc.) to support behavior change (Michie et
126 al., 2011). While this model is frequently used to evaluate physical activity and sedentary
127 behaviors (Spence et al., 2021) it is not widely used to predict variations in screen time
128 behaviors. For example, in a recent study following the COVID-19 pandemic, physical
129 opportunity and reflective motivation appeared to be the most consistent predictors of physical
130 activity related behavior (Spence et al. 2021). However, many determinants of screen time
131 behaviors would fit into the constructs within the COM-B model. For instance, our social and
132 physical environment provides opportunity to engage in screen time behaviors, such as
133 accessibility to screens throughout the day (LeBlanc et al. 2015). However, there is currently a
134 lack of studies examining recreational screen time behaviors among adults beyond the traditional
135 screen time behaviors, such as TV, gaming and computers. To our knowledge, the use of the
136 COM-B model to predict recreational screen time behavior among adults following the pandemic
137 has not been previously examined. However, previous studies have suggested that constructs of
138 the COM-B model may be predictive of screen time. For example, motivation to limit screen
139 time has been shown to be a significant mediator for screen time use among adolescence (Smith
140 et al. 2017). Another study has found that physical environment (e.g., computer, video games in

141 the bedroom) and parental self-efficacy to limit screen time was associated with child screen
142 time use (Carson and Janssen 2012). Furthermore, COM-B also separates reflective from
143 automatic motivations, and it has been hypothesized that screen time may be particularly
144 impacted by automatic motivation compared to behaviors such as physical activity (Spence et al.
145 2017). Thus, given the various contextual factors that can influence screen time, the COM-B
146 model may be well suited to provide an overview the relevant behavioral determinants
147 contributing to recreational screen time.

148 Thus, the objectives of this study were to 1) examine recreational screen time behaviors
149 before and following the COVID-19 pandemic lockdown among Canadian adults, and 2) explore
150 whether components of the COM-B model would predict changes in recreational screen time
151 behavior profile (e.g., never met screen time guideline, increased screen time, met the screen
152 time guideline). Based on previous research (Colley et al. 2020; Górnicka et al. 2020; Chen et al.
153 2021; Spence et al. 2021), we hypothesized that i) recreational screen time would be higher
154 compared to pre-pandemic, majority of the Canadians would not be meeting the recommended
155 recreational screen time (≤ 2 hours/day), and ii) recreational screen time behavior profile would
156 be influenced by a combination of motivation (automatic, reflective), capability (psychological,
157 physical), and opportunity (social and physical).

158

159 **METHODS**

160 **Study and Design**

161 This retrospective study was conducted online between March 12 and 16, 2022. A third-
162 party market research firm assisted in participant recruitment. The participant database by the
163 market research firm is largely representative of the Canadian census in terms of age, gender,
164 ethnicity, region, income, employment, and language spoke (Statistics Canada 2020). This study

165 was part of a larger study which evaluated changes in physical activity behavior following the
166 COVID-19 pandemic (Rhodes et al. n.d.). All participants were adults between the ages of 18
167 and 74 living in Canada. Study consents were obtained from the participants prior to the start of
168 the study. Participants were asked to complete an online survey. The study was approved by the
169 research ethics board at the University of Victoria.

170

171 **Measures**

172 **Demographics:** Participants were asked to report age, sex, education, employment status,
173 income, and ethnicity.

174

175 **Screen time:** Recreational screen time was measured using a 2-item questionnaire (Behavioral
176 Risk Factor Surveillance System Questionnaire, 2017). Participants were asked, on average, the
177 amount of time a day they used screen technology for recreation purposes during the week and
178 on weekends, before COVID-19 and currently.

179

180 **COM-B:** Perceived capability, opportunity, and motivation for limiting recreational screen time
181 were measured using instruments adapted from previous studies (Keyworth et al. 2020; Spence
182 et al. 2021). Specifically, participants were asked to rate how much they agreed with statements
183 about their ability to limit recreational screen time (i.e., for leisure, T.V., computer, smartphone)
184 during the past two weeks on five-point Likert scales from strongly disagree to strongly agree.
185 The participants were then asked about each of the COM-B beliefs in relation to recreational
186 screen time use. For example, "My physical environment (e.g., time, materials) would make it
187 easy for me to limit my recreational screen time, if I wanted to. My social network (e.g., friends,

188 family) would make it easy for me to limit my recreational screen time, if I wanted to. I am
189 motivated (e.g., I have the desire, feel the need) to limit my recreational screen time use.
190 Limiting my recreational screen time is something I do automatically (e.g., without much
191 thought or planning). I have the physical ability to limit my recreational screen time, if I wanted
192 to. I have the self-discipline skills to limit my recreational screen time, if I wanted to."

193

194 **Statistical Analysis**

195 Normality (skewness >2 and kurtosis >3) and outliers (z score >3.29) were checked to determine
196 whether any transformations were required. Paired sample t-test along with effect size
197 calculation (Cohen's d) were used to analyze the change in screen time. Screen time use prior to
198 the pandemic and current screen time use were coded as meeting versus not meeting (>3
199 hours/day) the Canadian 24 hours movement guideline for recreational screen time (Ross et al.
200 2020). This categorization provided the following possible recreational screen time profiles: 1)
201 Always Met Screen Time Guidelines (met guidelines pre-pandemic and currently), 2) Increased
202 Screen time (met guidelines pre-pandemic but not currently), 3) Never met screen time
203 Guidelines (have not met guideline pre-pandemic or currently), 4) Decreased screen time (have
204 not met guideline pre-pandemic but currently meeting guideline). Demographic characteristics
205 were compared based on the screen time profile groups using univariable analysis for continuous
206 variables and chi-squared for categorical variables. We used a discriminant function analysis to
207 evaluate the prediction of the COM-B factors for the screen time profile groups, followed by a
208 univariate analysis of variance to identify where there was a significant difference between the
209 groups. Discriminant function analysis (DFA) is a useful statistical analysis technic to determine
210 the relative contribution of different variables (e.g., COM-B factors) in predicting group profile

211 membership, such as screen time profiles (Manly et al. 2002). Bonferroni post-hoc analysis was
212 then carried out with effect size calculation (η^2). The effect size was interpreted as the following:
213 small effect $\eta^2 = 0.01$; medium effect $\eta^2 = 0.06$; large effect $\eta^2 = 0.14$ (Cohen 1969). We estimated
214 that 86 participants were needed in a particular screen-time profile to be included in the analyses
215 considering a small-medium effect size ($f = .20$), with an alpha of .01, and a power of .80. We
216 used $r = .10$ as the minimum recommended effect size for discriminative function based on
217 previous research (Cohen 1969). Data were analyzed using SPSS 26 (SPSS Inc., Chicago, IL,
218 USA). Alpha level was set at $p < .01$.

219

220 RESULTS

221 Baseline Characteristics of Participants

222 This study enrolled 977 participants (51% female, 49% male). The mean age of the
223 participants was 46.79 years (SD = 15.23). The sample consisted of 41% European, 38% North
224 American origins, 12.7% Asian, 2% North American Aboriginal, 1.6% Caribbean, 1% Latin,
225 Central and South American, 0.9% Oceania and 0.5% African. Participants had various levels of
226 education (20% Grade or High School; 31% College Diploma; 32% University Undergrad
227 Degree; 17% Graduate Degree), employment (67% currently employed), and income (57.7% at
228 or above the median for Canadians).

229 Recreational Screen Time Use and Profile

230 Participants reported that their mean recreational screen time significantly increased from
231 3.47 hours/day (SD = 2.50, Median: 3.0) pre-pandemic to 3.91 hours/day (SD = 2.85, Median:
232 3.25) ($p < .01$, $d = .29$) following the pandemic. Overall, relative to pre-pandemic screen time,
233 34% ($n = 335$) of the participants reported an increase in recreational screen time two years
234 following the pandemic. The percentage of individuals not meeting the recreational screen time

235 guideline increased from 43.7% (n=527) pre-pandemic to 50.7% following the lockdown
236 (n=495).

237 The screen time profile analyses consisted of the following groups: 1) Always Met
238 Screen Time Guidelines (47.8%; n = 454); 2) Increased Screen Time (10.1%; n = 96); 3) Never
239 Met Screen Time Guidelines (42%; n = 399). Due to the small sample size of those individuals
240 who reported a decreased screen time behavior (n = 28), this group was not included in the
241 analysis. Overall, of the 977 participants, a total of 949 participants were assigned to one of three
242 groups and used in the final sample for analysis. Demographics for participants in each group
243 can be found in Table 1. Only employment status was found to be significantly different among
244 the groups ($X^2(2, n = 931) = 18.89, p < .001$). Specifically, participants in the Always Met Screen
245 Time group had a higher employment rate than those in the Never Met Guidelines group. Change
246 in recreational screen time behavior pre- and post-pandemic is shown in Table 2. The groups that
247 Increased Screen Time, and Never Met Screen Time Guidelines, reported significantly greater
248 recreational screen time following the pandemic ($p < .05$) compared to the group that Always Met
249 Screen Time Guidelines.

250 **Predictors of Screen Time Profile using COM-B**

251 Discriminant function analysis results can be found in Table 3. Since employment status
252 was significantly associated with the recreational screen-time profile, we included this variable
253 as a covariable in the discriminatory function analysis. The overall discriminant function was
254 found to be significant among the three groups [Wilks' $\lambda = .90$; canonical $r = .31, \chi^2 = (14) =$
255 $95.81, p < .001$] and correctly classified 58.2% of cases. Automatic motivation ($r = .75$),
256 reflective motivation ($r = .53$), social opportunity ($r = .33$), and psychological capability ($r = .32$)
257 to limit recreational screen time had meaningful correlations with the discriminant function,

258 controlling for employment status. Post-hoc analysis revealed that the group that Always Met
259 Screen Time Guidelines had greater automatic motivation ($\eta^2 = 0.054$), reflective motivation (η^2
260 $= 0.030$), social opportunity ($\eta^2 = 0.013$), and psychological capabilities ($\eta^2 = 0.011$) than one or
261 both of the other profiles.

262

263 **DISCUSSION**

264 Understanding the change and the predictor of recreational screen time behavior two
265 years following the pandemic are critical to help inform researchers and public health agencies
266 on future lifestyle and screen-based interventions. This retrospective study aimed to examine
267 recreational screen time behavior before and two years following the COVID-19 pandemic
268 lockdown among Canadian adults. Our findings supported the hypothesis that recreational screen
269 time following lockdown was higher compared to pre-pandemic levels. This finding was similar
270 to previous studies reporting increased screen time following the start of the pandemic (Colley et
271 al. 2020; Górnicka et al. 2020; Arundell et al. 2021; Chen et al. 2021; Stockwell et al. 2021).
272 However, the percentage (34%) and the magnitude (0.44 hours/day) of increase in recreational
273 screen time compared to pre-pandemic levels were lower than studies conducted during
274 pandemic (~50-60% increase in screen time; increase ~1-3 hours/day; Chen et al., 2021; Colley
275 et al., 2020; Górnicka et al., 2020). This may be due to differences in the sample. However, a
276 recent study of Canadian adults (n = 64) reported that total screen time peaked in April/May
277 2020 (292.5 ± 143.0 min/day) and trended towards pre-pandemic levels (187.8 ± 118.3 min/day)
278 by the end of 2020 (Coyne et al. 2021). Similarly, a larger U.S. study of young adults (n = 1179)
279 reported that screen time had declined from 5.2 hours/day in spring 2020 to 3.2 hours in spring

280 2021. However, screen time was still higher than pre-pandemic levels (2.2 hours / day; Barbieri
281 et al., 202).

282 Our second study objective was to explore whether components of the COM-B model
283 would predict changes in recreational screen time behavior profile groups. Our findings partially
284 supported our hypothesis that components of the COM-B model significantly predicted the
285 recreational screen time profiles. Of the six COM-B constructs, automatic motivation, reflective
286 motivation, social opportunity, and psychological capabilities significantly predicted the screen
287 time profile. Specifically, individuals that Always Met Guidelines compared to those that
288 Increased Screen Time or Never Met Screen Time Guidelines showed greater levels of automatic
289 and reflection motivations. Automatic motivation was the strongest predictor of recreational
290 screen time profiles. This suggests that unconscious processes (e.g., automatic processes, habits,
291 attitude) may play a more prominent role than the conscious processes for limiting recreational
292 screen time behavior. The critical role in unconscious and automatic processes for sedentary-
293 based screen time and physical activity has been reported (Marchant et al., 2020; Rebar et al.,
294 2016).

295 Highlighting the role of automatic motivations is a strength of COM-B framework in
296 comparison to traditional social cognitive theories in understanding screen-based sedentary
297 behaviors (Rhodes and Dean 2009; Prapavessis et al. 2015). An important practical implication of
298 this finding is that sedentary-based screen time behavior is most likely reinforced by
299 environmental cues and routines (Spence et al. 2017; Marchant et al. 2020). Thus, decreasing
300 screen time may be achieved by eliminating any trigger in one's environment; for example,
301 removing smartphones from bedrooms or the dining room. One can also develop new habits in
302 support of an existing screen time behavior (Rhodes and Rebar 2018); for example, going for a

303 walk around the neighborhood immediately after one hour of sedentary screen time.
304 Alternatively, screen time interventions may aim to substitute screen time behavior with other
305 physically active behavior or alter behavior topography (e.g., from sitting to standing) while
306 continuing with screen time activity (Spence et al. 2017). However, the effectiveness of these
307 dual-hinged interventions still needs to be established. Early evidence suggests that behavior
308 topography types of intervention may be more effective than behavior substitution (Prince et al.,
309 2014; Spence et al., 2017). Future studies are warranted to determine optimal intervention
310 strategies.

311 In terms of capabilities to limit recreational screen time, we only observed that
312 psychological capability (e.g., self-regulation, knowledge, reasoning) was a significant predictor
313 of screen time profile. Individuals who always met the recreational screen time guidelines
314 reported higher levels of perceived psychological capabilities to limit screen time when
315 compared to those individuals in the other profile groups who did not meet the screen time
316 guidelines. Psychological capability has shown to be a significant predictor of sedentary
317 behavior (Owen et al. 2011; Ojo et al. 2019). It may not be surprising that physical capability
318 was not associated with the recreational screen time profiles since it requires minimal physical
319 skills to limit screen time. However, most participants were less likely to be motivated to do so.
320 This effect has been shown in other lifestyle behaviors, such as physical activity, where
321 capability and motivation are positively associated such that when motivation is accounted for,
322 capability becomes less predictive of behavior(Williams and Rhodes 2016). Thus, education-
323 based interventions that focus on improving self-discipline and behavioral awareness (e.g., a
324 priori plans, self-monitoring, stop clock) while building motivation may be necessary to create
325 effective interventions to limit recreational screen time behavior.

326 Finally, social opportunity was also a significant predictor of recreational screen-time
327 profile groups. Specifically, if people perceived they had the social support (e.g., from family
328 and friends) to limit screen time, they were also more likely to meet the recreational screen time
329 guidelines. This finding was consistent with previous studies examining sedentary-based screen
330 time (Garcia et al. 2017; Ojo et al. 2019). It is important to note that social opportunity showed a
331 small effect in predicting screen time profile compared with the other COM-B constructs. Due to
332 the COVID-19 physical distance measure, it could possible that a strong social network would
333 have created increased opportunities for screen time behaviors to connect with family and
334 friends. Interestingly, physical opportunity has been previously shown to be a significant
335 predictor of sedentary behavior(Owen et al. 2011). The lack of significance observed in this
336 study may be attributed to the pandemic lockdown (e.g., working from home, socializing via
337 video calls). Even though all pandemic restrictions were lifted at the time of the study,
338 individuals may not have had adequate time or the opportunity to adjust their physical
339 environment to be conducive to limiting recreational screen time.

340 Despite the strengths of this study, there are noteworthy limitations. Due to the use of a
341 retrospective cross-sectional design, it is not possible to determine causality. Second, participants
342 were asked to recall their screen time behavior, which can introduce potential bias. Currently,
343 there is limited research on the validity and reliability of recalling screen time use over a long
344 period of time. Most studies investigating screen time use rely on self-reports over shorter
345 periods (e.g., weeks). Self-report of screen time can introduce both overestimate and
346 underestimate actual screen time use, depending on several factors such as the type of screen
347 time activity and ways individuals interact with their screens (e.g., habitual or occur in short
348 bursts throughout the day)(Ohme et al. 2021; Muench et al. 2022). A recent study suggested that

349 a self-report screen time questionnaire may be used to successfully classify individuals into
350 different categories of screen time use (e.g., high vs. low), suggesting a pattern of longstanding
351 behaviour; however, it is likely that objective measures and more frequent prospective
352 assessments are needed to increase the precision of screen time assessment (Vizcaino et al.
353 2019). Thus, caution is required when interpreting study results. Third, the screen time
354 assessment was self-report, thus this may introduce potential bias. Fourth, even though the
355 sample was representative of the Canadian population, it may not represent all aspects.
356 Individuals willing to participate in online surveys via a third-party company may differ from the
357 general population. Francophone populations were not included in this sample. Thus, the
358 generalizability of our findings needs to be interpreted with caution. Finally, COM-B measures
359 was a single-item adapted from physical activity measures. Although it does seem that we were
360 able to generate prediction from these items. Complex constructs such as the automatic
361 motivation may require more nuanced measures. Future studies are warranted.

362

363 **CONCLUSION**

364 This study is among the first to evaluate changes in recreational screen time behaviors
365 among Canadian adults from pre-COVID to two years post-COVID-19 pandemic and explore
366 whether components of the COM-B model were associated with recreational screen-time profile
367 groups. Our results suggest that recreational screen time was higher following the pandemic than
368 pre-pandemic. The majority of the Canadian adults in this study were not meeting the screen
369 time guidelines. Automatic motivation, reflective motivation, psychological capability, and
370 social opportunity were significant predictors of recreational screen-time profile. In particular,
371 automatic motivation was the strongest predictor. Future interventions may need to consider

372 building motivations (e.g., habit formation, cues, planning) and facilitate opportunities for
373 individuals to limit screen time.

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382 **Author statements**

383 **Competing interests statement**

384 The authors declare there are no competing interests.

385

386 **Author contribution statement**

387 **SL:** Conceptualization, Formal Analysis, Methodology, Writing – original draft, Writing –

388 review & editing; **RC:** Formal Analysis,, Writing – original draft, Writing – review & editing

389 **WS:** Conceptualization, Project administration, Methodology; Writing – review & editing

390 **KN:** Conceptualization, Project administration, Methodology; Writing – review & editing

391 **RR:** Conceptualization, Formal Analysis, Methodology, Writing – review & editing.

392

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395

396 **Data availability statement**

397 Data generated or analyzed during this study are available from the corresponding author upon
398 reasonable request.

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Table 1: Recreational Screen Time Behavior Profiles with Demographic variables.

| | Always Met Screen Time Guidelines (n = 454) | Increased Screen Time (n = 96) | Never met Screen Time Guidelines (n = 399) | p-value |
|--------------------------------------|--|---|---|----------------|
| Age | 45.67 (14.62) | 48.30 (15.30) | 48.06 (15.73) | .047 |
| Sex | | | | |
| Male | 232 [51.1%] | 38[39.6%] | 198 [49.6%] | .11 |
| Female | 220 [48.5%] | 58 [60.4%] | 199 [49.9%] | |
| Education | | | | |
| Grade school/High School | 84 [18.8%] | 14 [14.9%] | 91 [22.9%] | .50 |
| College/Diploma Degree/ Trade Degree | 146 [32.6%] | 30 [31.9%] | 119 [30.0%] | |
| University Bachelor's degree | 138 [30.9%] | 35 [37.2%] | 126 [31.7%] | |
| Professional or Graduate Degree | 79 [17.7%] | 15 [16.0%] | 61 [15.4%] | |
| Employment | | | | |
| Unemployed | 113 [25.6%] | 35 [36.8%] | 155 [39.3%] | .009 |
| Employed | 329 [74.4%] | 60 [63.2%] | 239 [60.1%] | |
| Family Income (CAD) | | | | |
| <\$39,000 | 55 [13.9%] | 17 [20.2%] | 80 [23.2%] | .06 |
| \$40,000 - \$59,999 | 66 [16.7%] | 12 [14.3%] | 51 [14.8%] | |
| \$60,000 - \$79,999 | 55 [13.9%] | 9 [10.7%] | 57 [16.5%] | |
| \$80,000 – \$99,999 | 72 [18.2%] | 11 [13.1%] | 45 [13.0%] | |
| \$100,000 – \$139,000 | 79 [20.0%] | 16 [19.0%] | 60 [17.4 %] | |
| >\$140,000 | 68 [17.2%] | 19 [22.6%] | 52 [15.1%] | |
| Ethnicity | | | | |

| | | | | |
|--|-------------|------------|-------------|-----|
| North American Aboriginal origins | 13 [2.9%] | 1 [1%] | 4 [1.0%] | |
| Other North American origins | 161 [35.5%] | 33 [34.3%] | 157 [39.3%] | |
| European origins | 187 [41.2%] | 44 [45.8%] | 155 [38.8%] | |
| Caribbean origins | 7 [1.5%] | 2 [2.0%] | 6 [1.5%] | .62 |
| Latin, Central, and South American origins | 3 [0.6%] | 0 [0%] | 5 [1.3%] | |
| African origins | 4 [0.8%] | 0 [0%] | 1[0.3%] | |
| Asian origins | 58 [12.8%] | 9 [9.4%] | 51 [12.8%] | |
| Oceania origins (Australia, New Zealand, Pacific Islands) | 1 [0.2%] | 0 [0%] | 2 [0.5%] | |

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Table 2: Hours of Screen Time and Screen Time Behavior Profiles.

| | Always Met Screen Time Guidelines (<i>n</i> = 454) | Increased Screen Time (<i>n</i> = 96) | Never met Screen Time Guidelines (<i>n</i> = 399) | P- Value | Post-hoc |
|--|---|--|--|---------------------|----------------------|
| Recreational screen time pre-pandemic (h/day) | 1.72 (0.93) | 2.32 (0.73) | 5.71 (2.32) | <.001 | AMST<all; IST< NMST |
| Recreational screen time post pandemic (h/day) | 1.71 (0.96) | 4.9 (1.97) | 6.27 (2.54) | <.001 | AMST <all; IST< NMST |
| Δ Recreational Screen time pre to post pandemic (h/day) | -0.01 (0.59) | 2.58 (2.18) | 0.56 (1.47) | <.001 | AMST <all; IS<NMS |

Note: AMST: Always Met Screen Time; IST: Increased Screen Time; NMST: Never met Screen Time

Table 3: Predictors of Recreational Screen Time Profiles Using COM-B.

| | Screen time profiles | | | Correlation with discriminant function | Univariate Follow-up F | Post Hoc |
|---|--|--|---|---|------------------------------|---------------|
| | Always Met Screen Time Guidelines (<i>n</i> = 454) | Increased Screen Time (<i>n</i> = 96) | Never met Screen Time guidelines (<i>n</i> = 399) | | | |
| Employment | 1.74 (0.43) | 1.63 (0.48) | 1.61 (0.49) | .42 | 9.6* | AMST>NMST |
| Perceived physical opportunity | 3.49 (0.95) | 3.43(1.0) | 3.37 (1.09) | -.07 | 1.34 | n/a |
| Social opportunity | 3.40 (0.97) | 3.12(1.19)* | 3.17 (1.13) | .18 | 5.97* | AMST>IST |
| Reflective motivation | 3.19 (0.98) | 3.00 (1.07) | 2.80 (1.07) | .25 | 14.56* | AMST>NMST |
| Automatic motivation | 3.12 (1.02) | 2.71 (1.12)* | 2.59 (1.1) | .63 | 27.94* | AMST>IST>NMST |
| Physical capability | 3.86 (0.86) | 3.92 (0.97) | 3.97 (0.81) | -.49 | 1.76 | n/a |
| Psychological capability | 3.65 (0.93) | 3.47 (1.05) | 3.43 (1.04) | .21 | 5.31* | AMST>NMST |

Note: *= $p < .01$; AMST: Always Met Screen Time; IST: Increased Screen Time; NMST: Never met Screen Time

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