A Longitudinal Study of Gaming Patterns during the First Nine Months of the COVID-19 Pandemic

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Abstract

The current longitudinal study explored the gaming behaviours of Canadians during the COVID-19 pandemic. A total of 332 people (M_{age} = 33.79, 60.8% men) who played video games responded to four waves of surveys (spaced 3 months apart) on the crowdsourcing platform Prolific from March 2020 to February 2021. The main outcome of interest was time spent gaming, measured in hours spent gaming in the past 30 days prior to each assessment wave. Latent growth curve modelling showed that participants reported high initial levels of gaming, but progressively declined in gaming activity across the subsequent waves. Several sociodemographic, COVID-19-specific, and gaming-related measures were significant predictors of increased gaming at the outset of the pandemic, but these factors were not related to longer-term declines in gaming during the pandemic. The findings of this study indicate that gaming may have been an adaptive, rather than maladaptive, behaviour during the pandemic.

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COVID-19 was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (WHO, 2020). Strict public health measures were implemented worldwide to curb the spread of COVID-19 (Haug et al., 2020). In Canada, all provinces and territories declared public states of emergency in March 2020 (Dawson, 2020). Public health restrictions varied across provinces, but commonly included work-from-home mandates, the closure of non-essential businesses to the public, online schooling, and social distancing and masking requirements (Breton et al., 2021). These restrictions have been associated with increased levels of loneliness, stress, depression, and anxiety (Dozois & Mental Health Research Canada, 2021). Furthermore, recreational activities were limited to those that could be completed at home or outside (Higuchi et al., 2020; King et al, 2020). Subsequently, mainstream news outlets have reported that video games and online gaming surged in popularity, particularly at the beginning of the pandemic (Perez, 2020; Shanley, 2020; Stephen, 2020). For example, in their 2021 annual report, the Entertainment Software Association of Canada (ESAC), an industry trade association that represents Canadian video game companies, reported that video game sales increased by 29% in 2020 compared to the same period in 2019 (ESAC, 2021).

The increase in video game sales during the pandemic, and subsequent increase in actual video game play, could be driven by several factors. Barr and Copeland-Stewart (2021) surveyed nearly 800 people who played video games from internet forums such as Reddit. Participants were asked their frequency of video game play before the COVID-19 pandemic and their frequency currently, which at the time of the study was June 2020. If they indicated that the frequency had changed, they were asked to explain why it had changed. Approximately 71% of

respondents answered that their video game habits had changed during the pandemic and the majority indicated that they increased the amount they were gaming. For instance, the proportion of people who played several times a day increased from 10.5% pre-pandemic to 40% during the pandemic in June 2020. Three themes were identified in the responses for why their video game habits had changed: socializing, time, and coping. Participants reported that video games were a way for them to socialize, that they had more time to play video games, and that video games were a way to cope with the stressful circumstances of living through a worldwide pandemic.

The researchers also asked participants to report on the effect that video games had on their well-being. They found that video games were largely viewed as having a positive impact on well-being, with more than 10 times more "positive" codes in terms of the impact of video games on well-being than "negative" codes. Participants explained that video games helped with their mental health (e.g., decreased anxiety levels), relieved stress, provided a means to escape or distract from the circumstances, were cognitively stimulating (and thus eased boredom), gave participants a sense of control over something, helped bring a sense of normality to everyday life, and provided a means of socialization. However, some participants noted negative effects of video games on well-being, reporting that video games were used to "waste time" and that playing more often decreased productivity levels.

It appears likely that video games fulfilled several needs for individuals during the COVID-19 pandemic. People turned to video games to socialize, improve their mental health, and cope with the difficult circumstances of lockdowns and living through a pandemic. However, while video games are typically experienced as an enjoyable recreational activity, it can become a problematic behaviour for individuals with certain vulnerabilities and risk factors. The WHO recognized gaming disorder (GD) as a diagnosable mental health condition in the 11th

edition of the International Classification of Diseases (ICD-11) (WHO, 2019). According to the ICD-11, GD can be diagnosed in individuals who struggle to control their gaming behaviour, prioritize gaming over other activities, and continue or escalate their gaming despite the negative consequences stemming from it (WHO, 2019; Jo et al., 2019). The estimated worldwide prevalence rate of GD is 3.05% (Stevens et al., 2021). There is little data on the prevalence rate of GD in Canada specifically, although some research suggests that it is close to the worldwide rate. A recent survey of 1238 adult Canadians found that 3.2% met criteria for GD, which accounted for 7.20% of participants who regularly gamed (Sanders et al., 2017). Another study that surveyed young adults in Canada, the United States, the United Kingdom, and Germany, found that 2.6% of respondents endorsed symptoms related to GD (Przybylski et al., 2017).

The Barr and Copeland-Stewart (2021) study discussed above is one of several studies that examined how gaming behaviours changed during the COVID-19 pandemic. For example, Teng et al. (2021) examined data from a longitudinal study on the mental health of Chinese children (classified as students in primary school) and adolescents (students in middle school). They compared scores on the Internet Gaming Disorder Scale-Short Form (IGDS9-SF; Pontes & Griffiths, 2015) and frequency of video game play before the pandemic (October to November 2019) and during the early stages of the pandemic (April to May 2020). Frequency of video game use increased overall between pre-pandemic and pandemic measures. They also found that adolescents endorsed more symptoms related to GD during the pandemic compared to before, a statistically significant difference. However, the effect size was relatively small (d = -0.07) and this change was only seen in the adolescents of the sample, not the children.

Other research has examined how young adults have been engaging in video games during the pandemic. A cross-sectional study by Balhara et al. (2020) surveyed Indian college

students during the first COVID-19-related lockdown, where approximately half of the participants (50.8%, *n* = 65) reported that their gaming had increased during lockdown. Furthermore, the group that increased reported that gaming helped them cope better with academic stress. In another cross-sectional study, Higuchi et al. (2020) examined 80 people who sought treatment for GD (70% of sample), excessive gaming that did not meet criteria for GD (20% of sample) and excessive online activity (10% of sample) at a facility in Japan during May–June 2020. This period was during a state of emergency and a time of strict public health measures. Participants were asked about their gaming behaviours and Internet usage in February 2020 and in the 30 days prior to the study. The researchers found that online gaming significantly increased from an average of 3.9 hours per day in February 2020 to 5.4 hours per day in May–June 2020. Furthermore, 52.5% of participants reported that they had increased the amount of time spent online gaming in May–June 2020 compared to February 2020.

Although informative, none of these studies gathered data beyond the first few months of the pandemic. As such, we do not know much about how people were gaming beyond the summer of 2020. Though it appears that individuals with and without problematic gaming behaviours tended to increase the amount of time spent gaming during the first few months of the pandemic, there is little data on how people were gaming beyond this timeframe. The pandemic is frequently described in terms of waves of COVID-19 infections. In Canada, new waves tended to result in tightened public health restrictions. Emerging research suggests that pandemic-related restrictions increased anxiety, stress, and distress, as well as exacerbating mental health issues (Murphy et al., 2021). As such, there may have been an increase in problematic gaming behaviours during times of heightened public health restrictions, but without longitudinal data, we do not know whether this was the case.

If gaming behaviours were fluctuating during the COVID-19 pandemic, what could relate to these patterns of change? First, since this is an unprecedented time in history, it is possible that there are factors specific to the COVID-19 pandemic that influenced changes in gaming behaviours. In one of the only studies currently available on predictors of disordered gaming during COVID-19, Oka et al. (2021) gathered data from nearly 4000 Japanese adults in December 2019 and again in July 2020. They conducted multiple logistic regressions analyses to determine which sociodemographic factors were associated with an increased likelihood of developing internet gaming disorder from December 2019 to July 2020. Factors that were associated with higher odds of developing GD included being male, being younger than 30, decreased face-to-face communication with family members, and testing positive for COVID-19.

Notably, Oka et al. (2021) also examined a multitude of sociodemographic factors, including having children, living alone versus with someone else, household income, and employment status. These sociodemographic factors are all things that could have been impacted by the pandemic and may have impacted how people coped with the stresses of the pandemic. For instance, in terms of employment status, the International Labour Organization (2021) reported that the equivalent of 255 million full-time jobs were lost worldwide in 2020. Loss of employment presumably led to a loss of income for millions of people; for instance, in Canada, nearly 9 million Canadians received monetary assistance from the Canada Emergency Response Benefit (CERB) (Press, 2021), which was created to help Canadians whose income was directly affected by the COVID-19 pandemic (Government of Canada, n.d.).

The findings from Oka et al. (2021) echoed consistent findings from research examining sociodemographic factors found that being male and being younger in age are important predictors of disordered gaming. Being male is a well-established predictor of elevated scores on

measures of GD symptoms (Liu et al., 2021; Holm et al., 2020; Wartberg et al., 2021; Coyne et al., 2020). Additionally, younger age has been shown to predict elevated scores on the IGDS in several studies (Beard et al., 2017; Bernaldo-de-Quiros et al., 2021; Oka et al., 2021). In summary, sociodemographic factors are one category of variables that could help to predict changes in gaming, particularly by understanding that COVID-19-specific factors could have had an impact on some sociodemographic factors, such as employment status.

There are also several mental health-related variables that could influence patterns of change in gaming behaviours. Depression is highly comorbid with disordered gaming. One systematic review identified 13 studies that found a full association (defined as a significant correlation between depression and gaming for both males and females) between depression and gaming; eight of these studies found large effect sizes, three found moderate effect sizes, and two found small effect sizes (González-Bueso et al., 2018). Depression has also been identified as a predictor for disordered gaming behaviours. In a longitudinal study of predictors of GD in adolescents, Liu et al. (2021) found that symptoms of depression were significantly associated with the incidence of internet gaming disorder over a one-year period. Research has indicated that depression is an important factor that may be involved in the development and/or maintenance of disordered gaming.

In terms of other mental health variables, symptoms of inattention and hyperactivity, or the formal diagnosis of attention deficit hyperactivity disorder (ADHD) may also be related to disordered gaming. González-Bueso et al. (2018) found a full association (using the same definition as above) between ADHD and disordered gaming in seven studies, of which four reported large effect sizes. A recent longitudinal study that examined predictors of problematic gaming in adolescents found that emotional distress and notable symptoms of inattention and

hyperactivity significantly predicted problematic video gaming a year later (Wartberg et al., 2021). Relatedly, being prone to boredom is commonly seen in people with ADHD (Malkovsky et al., 2012) and has been associated with an increased risk for addictive behaviours, including gaming (Lim, 2014). Personal distress was also found to be a significant predictor of problematic video gaming in a cross-sectional study of male and female gamers aged 18–30 (Cudo et al., 2019).

In terms of factors related to gaming specifically, preference for first-person shooter and massively multiplayer online roleplaying games (MMORPG) has been found to be a consistent predictor of GD. In a recent systematic review, Rehbein et al. (2021) identified 32 papers that examined the influence of game genre on symptoms of gaming disorder. The majority (23, or 71.88%) of these papers found that playing or preferring MMORPGs was associated with symptoms of gaming disorder. Twelve studies (some of which are included in the 23 studies that examined MMORPGs) found that people who preferred first-person shooter games were more likely to report symptoms of gaming disorder. Relatedly, primarily gaming alone (solitary gaming) versus primarily playing with others (social gaming) could potentially impact time spent gaming. As suggested by their name, MMORPGs are played online with other people. Gaming online for social reasons is an important motivator of gameplay (Cheah et al., 2022), and may have been particularly important during the pandemic when in-person social interactions were limited. One study found that becoming a member of an online gaming group and identification with that group was a significant motivation for continued game play in people with disordered gaming (Gong et al., 2019). As such, the extent to which someone plays alone versus with others may be related to the amount of video gaming that one does.

The sum of currrent research findings so far indicate that depressive symptoms, personal distress, boredom proneness, preference for MMORPG and/or first-person shooter games, and social gaming (over solitary gaming) are important predictors of problematic video gaming. It is also important to note that none of these studies were conducted within the context of the COVID-19 pandemic, and so these factors should be seen as predictors of problematic gaming more generally.

The Current Study

The objective of this study was to provide a longitudinal account of how a sample of Canadians engaged in video gaming throughout the first nine months of the COVID-19 pandemic using latent growth curve modeling. There are no other studies to our knowledge that have examined gaming beyond the first few months of the pandemic. Public health restrictions fluctuated in severity during these months of the pandemic in Canada and these changes impacted the activities Canadians could engage in and their mental health. It follows that gaming could likewise have been impacted by these changes. We also aimed to expand on research that examined predictors of pandemic-related changes in gaming. We examined sociodemographic variables, gaming-specific variables, and psychological factors. Crucially, we were also able to investigate factors specifically related to COVID-19, such as the risk of severe illness should one contract COVID-19 and the average amount of news consumed related to the pandemic.

We hypothesized that the amount of time spent gaming would be non-linear throughout the first nine months of pandemic. We also hypothesized that several factors would predict changes in gaming behaviours. In terms of sociodemographic and COVID-19 factors, age (being younger), sex (male), having children, living alone, having a higher risk of illness due to COVID-19, experiencing a decrease in income, and spending more time consuming news related

to COVID-19 would predict increased time spent gaming. For psychological variables, we anticipated that being depressed and being more prone to boredom would predict greater time spent gaming. Finally, in terms of gaming-related variables, we hypothesized that endorsing more symptoms related to gaming disorder, preferring MMORPG and/or first-person shooter games, and more time spent gaming socially would be associated with greater time spent gaming.

Method

Participants and Procedure

These data were part of a four-wave longitudinal study investigating the association between COVID-19 and multiple mental health variables and addictive behaviours (see Wardell et al., 2020; Vedelago et al., 2021; Baptist-Mohseni et al., 2022 for other studies published from this dataset). Participants were recruited from an online participant pool via the website Prolific. Prolific is crowdsourcing platform designed to be used by researchers for online studies (Palan & Schitter, 2018). Participants were eligible if they retrospectively reported gaming at least once in the three months prior to March 2020. Data were collected across four waves, with each wave approximately three months apart: April–May 2020, August 2020, November 2020, and February–March 2021. Participants were asked to complete several surveys online and were compensated $13 CAD for their participation at each wave. Sociodemographic measures were assessed at the first timepoint, and COVID-19-related, psychological, and gaming-related, measures were assessed at all four timepoints.

The sample consisted of 332 participants (M_{age} = 33.79 years, SD_{age} = 8.92), 60.8% male and 39.2% female. Approximately half of the participants were from Ontario (50.6%), with 14.2% from British Columbia, 11.1% from Alberta, 10.8% from Quebec, and the remainder from

Manitoba (2.4%), Saskatchewan (2.1%), Nova Scotia (3.6%), New Brunswick (1.8%), Newfoundland and Labrador (2.1%), Prince Edward Island (0.9%), and the Yukon (0.3%). Slightly more than half (52.4%) of participants had a college or university degree. The majority of participants (86.2%) reported being employed before the COVID-19 pandemic.

Measures

Sociodemographic & COVID-19 Measures

Participants were asked to report their age, biological sex (male = 0, female = 1), and ethnicity (non-white = 0, white = 1). Following the findings of Wardell et al. (2020) and Oka et al. (2021) we also included the following measures as potential predictors for gaming in our main analyses: having children under the age of 18 years (no = 0, yes = 1), living alone (0 = no, 1 = yes), increased risk of COVID-19 due to underlying illness (COVID Risk, coded as 0 = no, not at higher risk of COVID-19 due to underlying illness and 1 = yes, at higher risk), experienced a decrease in income due to COVID-19 (Income Change, coded as 0 = income stayed the same or increased and 1 = income decreased), and the amount of news related to COVID-19 consumed daily (News Amount, where 0 = none, 1 = 1–15 minutes, 2 = 15–30 minutes, 3 = 30 minutes–1 hour, 4 = 1–2 hours, 5 = 2–3 hours, 6 = 4+ hours).

Psychological Measures

Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 was used to assess the severity of symptoms associated with depression (Kroenke et al., 2001). The PHQ-9 contains nine items that each correspond to the criteria for major depressive disorder in the DSM-IV (American Psychiatric Association, 1994). Participants are asked how frequently they have experienced each item in the past 30 days. Sample items include “little interest of pleasure in doing things” and “feeling tired or having little energy”. Responses range from 0 (“not at all sure”) to 3

("nearly every day"). Total scores are calculated by summing responses to all items. A cut-off of 10 is generally used to indicate probable major depression. Severity can be indicated by the score as well (Kroenke et al., 2001). The PHQ-9 has been demonstrated to have excellent internal and test-retest reliability (Kroenke et al., 2001). In terms of construct validity, higher scores, indicating the prescence of more symptoms related to depression, have been shown to be associated with greater impairment and greater difficulty associated with symptoms (Kroenke et al., 2001). In the study's sample, Cronbach's alpha was 0.87 for Time 1, 0.90 for Time 2, 0.90 for Time 3, and 0.90 for Time 4.

Short Boredom Proneness Scale (SBPS). The SBPS (Struk et al., 2017) is an 8-item scale that assesses tendency to experience boredom. Participants are asked the extent to which they agree with each statement. Sample items include "I find it hard to entertain myself". Higher scores indicate higher levels of boredom proneness. The SBPS is positively and significantly correlated with other measures of boredom suspectibility, indicating that the SBPS demonstrates good construct validity (Struk et al., 2017). Cronbach's alpha for the SBPS in the present study was 0.81 for Time 1, 0.91 for Time 2, 0.91 for Time 3, and 0.93 for Time 4.

Gaming-Related Measures

Participants were asked which games they prefer to play from a list; they could select as many as applied to them. A variable was created to capture participants who preferred to play MMORPG and/or first-person shooter games and those who did not. Participants who indicated that one of their preferred games was either an MMORPG or a first-person shooter game were coded as 0, and participants who did not play either of those games were coded as 1. Participants were also asked how much time they spent gaming by themselves (solitary gaming) versus with other people, either in-person or virtually. This was coded so that higher scores on this measure

indicated more time spent gaming solitarily. For instance, a score of 0 would indicate that a participant only gamed with other people, whereas a score of 10 would indicate that a participant only gamed alone.

Internet Gaming Disorder Scale – Short Form (IGDS9-SF). The IGDS-SF9 (Pontes & Griffiths, 2015) is a 9-item self-report measure. Each item corresponds to one of the nine criteria proposed for Internet Gaming Disorder (IGD) in the DSM-5 (APA, 2013). Participants are asked how often in the past year they have experienced the symptom described. Sample items include "Do you feel preoccupied with your gaming behaviour?" and "Do you play in order to temporarily escape or relieve a negative mood?" Responses are anchored from 1 ("never") to 5 ("very often"). Total scores are calculated by summing all responses. Since IGD is still a disorder under consideration by the APA, no official cut-off scores are indicated for a diagnosis of IGD (Pontes & Griffiths, 2015; Stavropoulous et al., 2019). However, some authors have suggested using a cut-off score of 36, as this indicates that five out of nine criteria were answered with "very often" (Pontes & Griffiths, 2015). Higher scores suggest greater severity of symptoms associated with problematic gaming. A recent systematic review found that the IGDS9-SF excellent construct validity and test-retest reliability (Poon et al., 2021). In our sample, Cronbach's alpha was 0.90 for Time 1, 0.92 for Time 2, 0.91 for Time 3, and 0.89 for Time 4.

Gaming Timeline Follow-Back (G-TLFB). The G-TLFB was used to assess time spent gaming. This was the main outcome used in our study to track changes in gaming activity over time. It was used to estimate time spent gaming in the 30 days prior to COVID-19 being declared an emergency in the participant's area, as well as during the four assessment timepoints. Participants were asked to estimate how many hours they spent gaming on each day of the week for the past 30 days. The TLFB was initially created to estimate drinking frequency (Sobell &

Sobell, 1992), but has been adapted for use in gambling (Weinstock et al., 2004) and gaming (Park et al., 2020; Rapinda et al., 2021). Cronbach's alpha was 0.97 for Time 1, 0.95 for Time 2, 0.95 for Time 3, and 0.94 for Time 4.

Electronic Gaming Motives Questionnaire (EGMQ). The EGMQ (Myrseth et al., 2017) was used to assess motivations for gaming on four dimensions: coping, enhancement, self-gratification, and social. Participants are asked how often they participate in gaming because of a particular reason, where each reason is an item on the questionnaire. Sample items include "as a way to celebrate" and "because it's fun". Responses are anchored from 1 ("almost never/never") to 4 ("almost always"). The EGMQ has demonstrated good internal consistency and construct validity (Myrseth et al., 2017). Scores are calculated as an average for each dimension. Cronbach's alpha for this sample was 0.86 for Time 1, 0.86 for Time 2, 0.84 for Time 3, and 0.86 for Time 4.

Data Analysis Plan

First, data were screened for outliers prior to the main analyses. Outliers were classified as z-scores greater than 3.29 and were replaced with the highest acceptable value that fell within ± 3.29 SD (Tabachnick & Fidell, 2013). Multicollinearity was examined through bivariate correlations between the predictors as well as the dependent variables (all four timepoints of the G-TLFB), where multicollinearity was indicated by $r > 0.75$. Next, we ran unconditional growth models in order to determine the nature of growth in terms of hours spent gaming, as measured by the G-TLFB. Specifically, this involved testing an intercept-only model first, followed by sequentially testing models with linear and quadratic growth (slope) terms. The purpose of the unconditional growth model testing is to find out which pattern of growth best fits the data for gaming change during the pandemic. Once the nature of growth was determined, two conditional

latent growth curve models were estimated to examine predictors of initial (baseline) gaming, as well as changes (slope) in gaming during the first nine months of COVID-19. In Model 1, sociodemographic, COVID-19-specific, and psychological factors were specified as predictors of pandemic-related gaming and in Model 2, baseline gaming-related predictors were examined. We opted to run a latent growth model with a robust estimator given the nonnormality of the data. Model fit was evaluated using several indices that have well-established cut-offs for excellent fit. Fit of a latent growth model was considered excellent if the χ^2 statistic was non-significant; the comparative fit index (CFI) was > .95; the root mean square error of approximation (RMSEA) was < .06; and the square root mean residual (SRMR) was < .08 (Hu & Bentler, 1999). Based on the recommendation of Cheung and Rensvold (2002), improvement in fit with the iterative addition of slopes in the unconditional model was evalued using a CFI change of > .01. Outlier identification and bivariate correlations were conducted in SPSS 28.0.0. The latent growth curve modeling was conducted in Mplus Version 8.7 (Muthén & Muthén, 2017).

Results

Preliminary Analyses

One outlier was identified for the IGDS, four for the PHQ-9, and one for the G-TLFB. In terms of missing data, 181 (54.5%) participants had data for all four waves, and 151 (45.5%) participants were missing data for at least one wave. Participants who were missing data were compared to those who were not missing any data on all of the Time 1 predictor variables, as shown in Table 1. Participants with complete data were significantly older, spent less time gaming, had lower SBPS and IGDS scores, and were more likely to have had their income stay the same or increase due to COVID-19 when compared to participants with missing data.

Bivariate correlations are presented in Table 2; multicollinearity ($r > 0.75$) was not identified between any of the predictor variables. Descriptive statistics for the baseline predictors and all timepoints of the G-TLFB, including skewness and kurtosis, are presented in Table 3. Descriptive statistics for the continuous variables across all four timepoint are presented in Table 4.

Latent Growth Curve Modeling

The intercept-only model was a poor fit to the data ($\chi^2(8) = 41.67$, $p < .001$, CFI = 0.71, RMSEA = 0.11, 90% confidence interval (CI) [0.08, 0.15], SRMR = 0.14). A linear slope term was added, and the model was re-run. While it did lead to a CFI value change of greater than .01, the fit of the linear growth model was below established cut-offs for excellent fit ($\chi^2(7) = 16.33$, $p = .02$, CFI = 0.92, RMSEA = 0.06, 90% confidence interval (CI) [0.02, 0.10], SRMR = 0.10), meaning that linear change did not summarize the gaming behaviour data very well. Next, a quadratic slope term was added to the model. The CFI value change was greater than .01, and resulted in an excellent model fit ($\chi^2(6) = 8.73$, $p = .19$, CFI = 0.98, RMSEA = 0.04, 90% confidence interval (CI) [0.00, 0.09], SRMR = 0.08). The quadratic model was retained as the unconditional growth model. The trajectory is shown in Figure 1. Time spent gaming peaked at the first wave, then declined during the second and third waves. By the fourth wave, time spent gaming seemed to level out and did not increase or decrease in a significant way compared to the third wave.

Next, we examined predictors of decreasing quadratic growth in time spent gaming using conditional latent growth curve models. Predictors consisted of variables assessed at Time 1 and were organized into two models. Model 1 predictors included sociodemographic, psychological, and COVID-19-specific factors. This model fit the data well ($\chi^2(16) = 25.20$, $p = .07$, CFI = 0.97,

RMSEA = 0.04, 90% confidence interval (CI) [0.00, 0.08], SRMR = 0.06) (See Table 5). For Model 1, being male, living with others (versus living alone), and experiencing a decrease in income for reasons related to COVID-19 were associated with more time spent gaming at baseline. However, none of these predictors significantly predicted growth for the quadratic slope. Age was the only significant predictor for the quadratic slope, such older participants' gaming decreased at a more accelerated rate. Model 2 predictors included all gaming-related measures. This model provided excellent fit to the data ($\chi^2(13) = 21.91$, $p = .06$, CFI = 0.98, RMSEA = 0.05, 90% confidence interval (CI) [0.00, 0.08], SRMR = 0.04) (See Table 6). For Model 2, the IGDS, Game Preference (preferring MMORPG/first-person shooter games), and more social gaming were associated with more time spent gaming at baseline. However, none of these were significant predictors of the quadratic declines in gaming throughout the longer-term during the pandemic.

Discussion

The aim of this study was to provide a longitudinal account of the gaming behaviour of Canadians throughout the first nine months of the COVID-19 pandemic. Variables that could explain the observed patterns of change were also examined. Latent growth curve modelling revealed that the pattern of growth was best explained by declining (quadratic) growth. Participants in this sample spent the most time gaming at the beginning of the pandemic (April–May 2020). Time spent gaming decreased by the second timepoint (August 2020) and further decreased by the third timepoint (November 2020). Changes in time spent gaming plateaued by February 2021. This marks one of this the first studies to examined gaming behaviours beyond the first few months of the COVID-19 pandemic. These results suggest that time spent gaming

was at its peak earliest in the pandemic. As the pandemic continued, participants in our sample decreased the time they spent gaming.

The extent to which several potentially relevant variables, including sociodemographic variables, psychological factors, COVID-19-specific measures, and variables related to gaming, predicted the observed pattern of change were also examined. It was found that that being male, living with others (versus living alone), and experiencing a loss in income due to COVID-19 were associated with greater gaming at the outset of the pandemic. However, the only significant predictor of longitudinal growth was age, such that older participants tended to decrease the amount of time they spent gaming more quickly. In terms of gaming-specific predictors, preferring MMORPG or first-person shooter games, having higher IGDS scores, and spending more time gaming solitarily were associated with increased time gaming during the first month of the pandemic. However, none of these variables were significant predictors longitudinally. In fact, none of the variables examined except for age were significant predictors of longitudinal growth in gaming behaviours in the sample. Viewed another way, most of the significant predictors were significant predictors of baseline time spent gaming, which is when time spent gaming was at its highest. Since most of the predictors chosen in this study have been linked to increased gaming or symptoms of disordered gaming, and given that the results indicated that gaming decreased over time, it makes sense that there were largely null findings with respect to significant predictors longitudinally.

The finding that people decreased the amount of time they spent gaming throughout the pandemic is an interesting result in and of itself. If people were gaming the most at the beginning of the pandemic, when public health measures were strict, why did we not see gaming increase during November 2020 or February 2021, when public health measures were tightened again

across many places in Canada? The focus of this study was to examine whether baseline measures would predict changes in gaming longitudinally. However, an area for future exploration for this dataset could be to examine whether changes in gaming at each timepoint were more strongly related to other relevant measures from that same timepoint, such as depressive symptoms and boredom proneness.

It is also important to consider that changes in time spent gaming were examined, not symptoms of disordered gaming behaviours. Much of the research literature on predictors of gaming examine predictors of disordered gaming rather than gaming behaviour more generally. Related to this, the participants of the present study can be characterized as mostly recreational gamers. The mean IGDS score was relatively low at baseline (M = 15.10, SD = 6.28), and, using the cut-off score of 36 as an indication of potential IGD, only two participants met that threshold at baseline. None of the participants met this threshold at the subsequent timepoints. This suggests that few participants in our sample were gaming in a disordered way, if we only consider IGDS scores. In terms of time spent gaming, disordered gamers do tend to spend more time gaming; the APA (2013) noted that disordered gamers tend to spend at least 30 hours per week gaming. As shown in Table 3, few participants came close to that amount of gaming at any point during the study. It seems likely, then, that the predictors established in the research literature are predictors of disordered gaming and not recreational gaming behaviour.

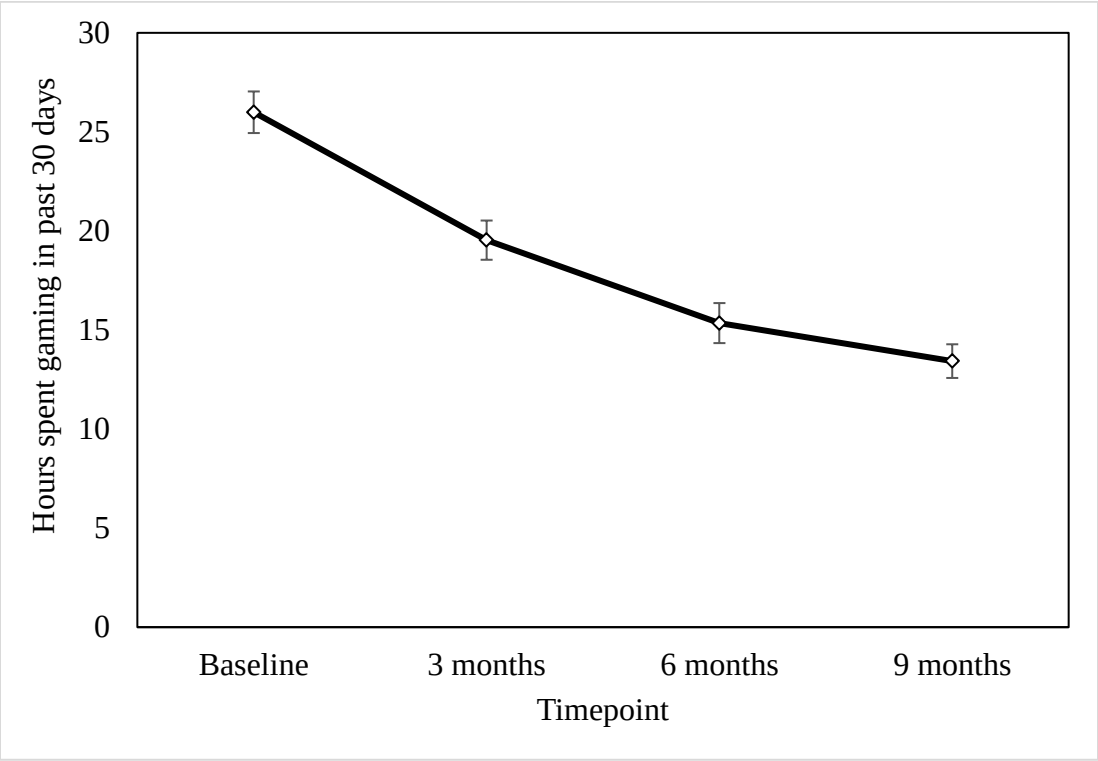
Finally, I approached this analysis anticipating that the stressors associated with the pandemic could have driven more people to use gaming as a way to cope. Using gaming to cope may be problematic if people who were vulnerable to developing disordered gaming did so under the strains of the pandemic. It may be the case that at the beginning of the pandemic, people were gaming as a way to cope. However, this may not necessarily have been a harmful coping

mechanism. Drawing on the conclusions from Barr and Copeland-Stewart (2021), the initial peak in time spent gaming could have been driven by simply having more time to spend gaming, as a way to socialize virtually with others, or as a means to relieve stress and boredom. None of these reasons for gaming are necessarily pathological. Additionally, as our results show, participants stayed at this level of gaming temporarily: they peaked at the beginning of pandemic, and did not reach the same levels at any point in the subsequent nine months.

This study had some limitations. Notably, this study did not capture many people who may have been struggling with disordered gaming. Few participants in this study met criteria for IGD at any of the data collection timepoints. As such, conclusions cannot be definitively drawn about the effect of the pandemic longitudinally on disordered gaming behaviours in Canadians. Additionally, the study's sample was not particularly diverse; the majority of participants were white males, which limits the generalizability of the results. We also relied exclusively on self-report measures and were not able to measure gaming behaviours directly (e.g., use of behavioural tracking data). However, there were also several important strengths of this study. By using a longitudinal design, changes in gaming behaviour over the first nine months of the pandemic were modeled, rather than capturing a single timepoint as with a cross-sectional design. Several important predictors were assessed, some of which were unique to the COVID-19 pandemic, which is a novel contribution to the literature. This was a unique opportunity to assess pandemic-related, as well as more general, factors that could explain changes in gaming in a recreational sample of Canadians who play video games.

Figure 1

Longitudinal trajectory of gaming during the first nine months of the COVID-19 pandemic in a sample of Canadian gamers (n = 332)



Note. Baseline data were collected in April–May 2020, 3 months in August 2020, 6 months in November 2020, and 9 months in February–March 2021. Error bars represent standard error.

Table 1

Baseline Missing Data Analysis and Descriptive Statistics

Measure	Participants with complete data (n = 181) *M* (*SD*) / *N* (%)	Participants with missing data (n = 151) *M* (*SD*) / *N* (%)	t / χ^2	p	Effect size *d* / Phi
Age	31.96 (8.45)	29.32 (9.30)	2.64	<.01*	0.30
PHQ-9	7.46 (5.29)	8.19 (5.25)	-1.26	.21	0.14
SBPS	27.37 (10.09)	29.79 (10.21)	-2.15	.03*	0.24
Hours spent gaming last 30 days (G-TLFB)	17.98 (14.18)	21.69 (14.21)	-2.37	.02*	0.26
IGDS	14.30 (6.04)	16.06 (6.45)	-2.56	.01*	0.28
EGMQ - Coping	2.36 (0.75)	2.39 (0.67)	-0.29	.77	0.04
EGMQ - Social	1.92 (0.93)	1.99 (0.91)	-0.74	.46	0.08
EGMQ - Enhancement	2.95 (0.77)	2.96 (0.72)	-0.02	.98	0.01
EGMQ – Self-gratification	1.61 (0.63)	1.70 (0.65)	-1.30	.20	0.14
Solitary Gaming	5.67 (3.08)	5.76 (3.00)	-0.28	.78	0.03
Sex					
Male	102 (56.35%)	100 (66.23%)	3.37	.07	-0.10
Female	79 (43.65%)	51 (33.77%)			
Has children?					
Yes	46 (25.41%)	44 (29.14%)	0.58	.45	0.04
No	135 (74.59%)	107 (70.86%)			
Lives alone?					
Yes	67 (37.00%)	44 (29.14%)	2.30	.13	0.08
No	114 (63.00%)	107 (70.86%)			
Ethnicity					
White	119 (65.75%)	95 (62.91%)	0.29	.59	0.03
Non-white	62 (34.25%)	56 (37.09%)			

Risk of serious illness from COVID					
Yes	18 (9.94%)	12 (7.95%)	0.40	.53	0.04
No	163 (90.06%)	139 (92.05%)			
Game Preference					
MMORPG/First Person	79 (43.65%)	80 (52.98%)	2.87	.09	0.09
Other	102 (56.35%)	71 (47.02%)			
Income Change					
Stayed the same or increased	114 (65.90%)	73 (48.67%)	9.78	.02*	0.17
Decreased	59 (34.10%)	77 (51.33%)			

Note. All variables in this table were from Time 1. PHQ-9 = Patient Health Questionnaire – 9; SBPS = Short Bordeom Proneness Scale; G-TLFB = Gaming Timeline Followback; IGDS = Internet Gaming Disorder Scale; EGMQ = Electronic Gaming Motivation Questionnaire; MMORPG = Massively multiplayer online role-playing games.

Table 2

Pearson Correlations for Predictor and Outcome Measures

	Age	Sex	Children	News	Ethnicity	Living sit.	Income	COVID risk	PHQ-9	SBPS	G-TLFB 1	G-TLFB 2	G-TLFB 3	G-TLFB 4	Coping	SGR	Social	Enhance	IGDS	Game Pref.	Sol. Gaming
Age	1.00	0.09	0.43*	0.28*	0.18*	0.12ǂ	-0.19ǂ	0.11	-0.11	-0.24*	-0.18ǂ	0.02	0.05	-0.08	-0.07	-0.16ǂ	-0.31*	-0.19*	-0.12ǂ	-0.19*	0.29*
Sex		1.00	-0.09	0.007	0.02	-0.02	-0.01	0.70	0.23*	0.07	-0.14ǂ	-0.11	-0.09	-0.20ǂ	0.01	-0.26*	-0.19*	-0.27*	-0.23*	-0.39*	0.10
Children			1.00	0.24*	0.03	-0.06	-0.16ǂ	-0.003	-0.12ǂ	-0.13ǂ	-0.09	0.009	-0.06	-0.10	0.06	0.12ǂ	-0.02	-0.02	0.12ǂ	-0.15ǂ	0.21*
News				1.00	-0.08	0.06	-0.02	-0.02	0.10	0.02	-0.01	0.14ǂ	0.04	-0.08	0.12ǂ	0.21*	0.03	-0.04	0.10	-0.09	0.12ǂ
Ethnicity					1.00	0.06	-0.008	-0.007	-0.08	-0.09	-0.05	0.007	0.007	0.02	-0.04	-0.16ǂ	-0.07	-0.02	-0.18ǂ	-0.16ǂ	0.07
Living sit.						1.00	-0.11ǂ	0.02	0.04	0.05	-0.09	-0.06	0.002	0.11	0.04	-0.005	0.03	-0.006	-0.02	-0.05	-0.07
Income							1.00	-0.01	0.11ǂ	0.05	0.16ǂ	0.16ǂ	0.09	0.11	0.08	0.03	0.05	0.11ǂ	0.12ǂ	0.02	-0.05
COVID risk								1.00	0.11	-0.03	-0.05	0.002	0.02	0.06	-0.08	-0.07	0.02	-0.05	-0.02	0.06	-0.09
PHQ-9									1.00	0.63*	0.15ǂ	0.13ǂ	0.05	0.11	0.32*	0.04	0.04	-0.07	0.29*	-0.03	-0.10
SBPS										1.00	0.17ǂ	0.06	0.001	-0.02	0.33*	0.10	0.07	-0.05	0.25*	-0.006	-0.08
G-TLFB 1											1.00	0.66*	0.63*	0.52*	0.33*	0.35*	0.29*	0.27*	0.50*	0.30*	-0.23*
G-TLFB 2												1.00	0.74*	0.53*	0.29*	0.32*	0.29*	0.26*	0.47*	0.22*	-0.22*
G-TLFB 3													1.00	0.59*	0.26*	0.27*	0.19*	0.24*	0.39*	0.30*	-0.22*
G-TLFB 4														1.00	0.22*	0.23*	0.34*	0.26*	0.34*	0.33*	-0.30*
Coping															1.00	0.49*	0.22*	0.45*	0.52*	0.11ǂ	-0.07
SGRǂ																1.00	0.55*	0.47*	0.53*	0.16ǂ	-0.14
Socialǂ																	1.00	0.37*	0.35*	0.23*	-0.50*
Enhanceǂ																		1.00	0.29*	0.32*	-0.17ǂ
IGDS																			1.00	0.21*	-0.12ǂ
Game Pref.																				1.00	-0.26*
Sol. Gaming																					1.00

Note. All variables in this table were from Time 1, except for the G-TLFB 2-4. The correlations were used to assess multicollinearity amongst the predictors (r > 0.75), although there were still many significant correlations, as noted by ǂ$p < .05$ and *$p < .001$. *Abbreviations*. News = News Amount (hours spent per day consuming news related to COVID-19); living sit. = living situation (alone or with others); PHQ-9 = Patient Health Questionnaire – 9; income = income change (experienced a decrease in income due to COVID-19); SBPS = Short Bordeom Proneness Scale; G-TLFB = Gaming Timeline Followback; IGDS = Internet Gaming Disorder Scale; Coping = Coping subscale of EGMQ; SGR = Self-Gratification subscale of EGMQ, Social = Social subscale of EGMQ; Enhance = Enhancement subscale of EGMQ. Coding for categorical variables were as follows: biological sex (male = 0, female = 1), ethnicity (non-white = 0, white = 1), having children under the age of 18 (no = 0, yes = 1), living situation (0 = lives with others, 1 = lives alone), COVID Risk (0 = no, not at higher risk of COVID-19 due to underlying illness and 1 = yes, at higher risk), Income (0 = income stayed the same or increased, 1 = income decreased), News Amount (0 = none, 1 = 1–15 minutes, 2 = 15–30 minutes, 3 = 30 minutes–1 hour, 4 = 1–2 hours, 5 = 2–3 hours, 6 = 4+ hours).

Table 3

Descriptive Statistics for the Predictors and Outcome Measures

	M (SD)	*n* (%)	Skew	Kurtosis	Range
Age	30.88 (8.92)	-	1.36	3.08	18-74
Sex	-		0.47	-1.78	-
Female		130 (39.2%)			
Male		202 (60.8%)			
Children	-		1.09	-0.82	-
Yes		242 (72.9%)			
No		90 (27.1%)			
COVID news per day	-		0.71	0.13	-
None		7 (2.1%)			
1-15 minutes		79 (23.8%)			
15-30 minutes		101 (30.4%)			
30-60 minutes		80 (24.4%)			
1-2 hours		37 (11.1%)			
2-3 hours		16 (4.8%)			
4+ hours		12 (3.6%)			
Ethnicity	-		-0.59	-1.66	-
White		214 (64.5%)			
Non-white		118 (35.5%)			
Live alone	-		2.15	2.62	-
No		221 (66.6%)			
Yes		111 (33.4%)			
Income	-		0.35	-1.89	-
Decreased due to COVID		136 (41.0%)			
Stayed the same or increased		187 (56.3%)			
At high risk from COVID	-		2.83	6.03	-
Yes		302 (91.0%)			
No		30 (9.0%)			
PHQ-9	7.77 (5.28)	-	0.61	-0.06	0-24
SBPS	28.43 (10.20)	-	0.19	-0.71	8-56
Solitary Gaming	5.71 (3.04)	-	-0.02	-1.05	0-10
EGMQ-Coping	2.38 (0.71)	-	0.28	-0.43	1-4
Social	1.95 (0.92)	-	0.55	-0.90	1-4
Enhancement	2.95 (0.75)	-	-0.39	-0.46	1-4
Self-Gratification	1.65 (0.64)	-	0.91	0.16	1-3.75
IGDS	15.10 (6.28)	-	1.26	0.86	9-36
Game Preference			0.08	-1.99	-
Shooter/MMOPRG	-	159 (47.9%)			
Others	-	173 (52.1%)			
G-TLFB 1	19.67 (14.29)	-	1.08	0.99	0-71
G-TLFB 2	14.38 (14.59)	-	2.38	9.07	0-111
G-TLFB 3	13.37 (14.58)	-	2.88	12.14	0-111
G-TLFB 4	12.93 (13.05)	-	2.17	6.85	0-84

Note. All variables in this table were from Time 1 except for G-TLFB 2-4. PHQ-9 = Patient Health Questionnaire – 9. SBPS = Short Bordeom Proneness Scale. G-TLFB = Gaming Timeline Followback. IGDS = Internet Gaming Disorder Scale. EGMQ = Electronic Gaming Motivation Questionnaire. MMORPG = Massively multiplayer online role-playing games.

Table 4

Means and Standard Deviations of Continuous Predictors For All Timepoints

	Time 1	Time 2	Time 3	Time 4
	M (SD)	*M* (SD)	*M* (SD)	*M* (SD)
EGMQ – Enhancement	2.95 (0.75)	2.90 (0.79)	2.88 (0.75)	2.97 (0.73)
EGMQ – Social	1.95 (0.92)	1.92 (0.86)	1.96 (0.85)	1.97 (0.89)
EGMQ – Coping	2.38 (0.71)	2.22 (0.74)	2.28 (0.68)	2.34 (0.72)
EGMQ – Self-Gratification	1.65 (0.64)	1.50 (0.61)	1.62 (0.59)	1.62 (0.64)
SBPS	28.47 (10.20)	27.87 (10.50)	28.03 (10.59)	28.99 (11.26)
PHQ-9	7.79 (5.28)	7.82 (5.34)	8.15 (5.72)	8.24 (5.88)
IGDS	15.10 (6.28)	14.10 (6.18)	14.03 (5.89)	13.33 (4.94)
Solitary Gaming	5.71 (3.04)	5.63 (3.00)	5.09 (2.97)	5.38 (3.17)

Note. EGMQ = Electronic Gaming Motivations Questionnaire. SBPS = Short Boredom Proneness Scale. PHQ-9 = Patient Health Questionnaire. IGDS = Internet Gaming Disorder Scale.

Table 5

Model 1 Predictor Results

	Estimate (*B*)	Standard Error	Est./S.E.	*p*-value
Intercept				
Age	-0.11	0.08	-1.35	0.18
Sex	-0.19	0.07	-2.58	0.01*
Children	-0.06	0.08	-0.81	0.42
Living Situation	-0.12	0.06	-2.04	0.04*
Income	0.14	0.07	2.15	0.03*
Ethnicity	0.02	0.07	0.29	0.77
COVID Risk	-0.04	0.06	-0.75	0.45
News	0.04	0.07	0.50	0.62
PHQ-9	0.08	0.09	0.90	0.37
SBPS	0.12	0.09	1.30	0.19
Linear Slope				
Age	0.83	0.23	3.67	<.001*
Sex	0.23	0.23	1.03	0.30
Children	-0.19	0.25	-0.75	0.46
Living Situation	0.02	0.25	0.07	0.94
Income	0.06	0.27	0.24	0.81
Ethnicity	-0.06	0.25	-0.24	0.81
COVID Risk	0.01	0.18	0.08	0.94
News	0.32	0.24	1.36	0.17
PHQ-9	-0.11	0.37	-0.30	0.76
SBPS	-0.16	0.34	-0.48	0.64
Quadratic Slope				
Age	-0.76	0.24	-3.10	<0.01
Sex	-0.27	0.23	-1.16	0.25
Children	0.16	0.27	0.59	0.56
Living Situation	0.15	0.27	0.56	0.58
Income	-0.20	0.27	-0.74	0.46
Ethnicity	0.01	0.27	0.04	0.97
COVID Risk	0.06	0.22	0.26	0.80
News	-0.49	0.27	-1.79	0.07
PHQ-9	0.22	0.40	0.56	0.57
SBPS	-0.03	0.36	-0.08	0.94

Note. PHQ-9 = Patient Health Questionnaire. SBPS = Short Boredom Proneness Scale.

Table 6

Model 2 Predictor Results

	Estimate (*B*)	Standard Error	Estimate/SE	*p*-value
Intercept				
IGDS	0.46	0.07	6.24	< .001
Game Preference	0.18	0.06	2.86	< 0.01
Solitary Gaming	-0.14	0.06	-2.20	0.03
EGMQ – Cope	0.07	0.08	0.90	0.37
EGMQ – SGR	0.04	0.09	0.47	0.64
EGMQ – Social	0.03	0.08	0.43	0.67
EGMQ – Enhance	0.05	0.06	0.90	0.37
Linear Slope				
IGDS	-0.06	1.10	-0.06	0.96
Game Preference	-0.85	0.35	-2.46	0.01
Solitary Gaming	-0.31	0.63	-0.50	0.62
EGMQ – Cope	-0.27	0.80	-0.33	0.74
EGMQ – SGR	0.46	0.78	0.59	0.56
EGMQ – Social	-0.61	0.77	-0.79	0.43
EGMQ – Enhance	0.02	0.56	0.03	0.97
Quadratic Slope				
IGDS	-0.44	0.82	-0.53	0.59
Game Preference	0.77	0.41	1.87	0.06
Solitary Gaming	0.33	0.62	0.53	0.60
EGMQ – Cope	0.14	0.70	0.19	0.85
EGMQ – SGR	-0.62	0.71	-0.87	0.38
EGMQ – Social	0.75	0.64	1.18	0.24
EGMQ – Enhance	-0.005	0.51	-0.01	0.99

Note. IGDS = Internet Gaming Disorder Scale. EGMQ = Electronic Gaming Motivation Questionnaire. Cope = Coping subscale of EGMQ. SGR = Self-gratification subscale of EGMQ. Social = Social subscale of EGMQ. Enhance = enhancement subscale of EGMQ.

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