Pathological Video Game Use Among Youths: A Two-Year Longitudinal Study

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KEY WORDS
pathological video game use, video game addiction, depression, longitudinal, impulse control

ABBREVIATION
LAN—local area network

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WHAT'S KNOWN ON THIS SUBJECT: Several correlational studies documented that participants who would be classified as "pathological" video gamers demonstrate a pattern of correlations with other variables that are comorbid (eg, depression) or occur with (eg, poorer grades and increased hostility) other addictions.

WHAT THIS STUDY ADDS: Following a large sample across 2 years, this study provides needed data on risk factors for becoming a pathological gamer, how long pathological gaming lasts, outcomes, and whether it is a primary problem or is a symptom of comorbid problems.

abstract

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OBJECTIVES: We aimed to measure the prevalence and length of the problem of pathological video gaming or Internet use, to identify risk and protective factors, to determine whether pathological gaming is a primary or secondary problem, and to identify outcomes for individuals who become or stop being pathological gamers.

METHODS: A 2-year, longitudinal, panel study was performed with a general elementary and secondary school population in Singapore, including 3034 children in grades 3 ($N = 743$), 4 ($N = 711$), 7 ($N = 916$), and 8 ($N = 664$). Several hypothesized risk and protective factors for developing or overcoming pathological gaming were measured, including weekly amount of game play, impulsivity, social competence, depression, social phobia, anxiety, and school performance.

RESULTS: The prevalence of pathological gaming was similar to that in other countries (~9%). Greater amounts of gaming, lower social competence, and greater impulsivity seemed to act as risk factors for becoming pathological gamers, whereas depression, anxiety, social phobias, and lower school performance seemed to act as outcomes of pathological gaming.

CONCLUSION: This study adds important information to the discussion about whether video game "addiction" is similar to other addictive behaviors, demonstrating that it can last for years and is not solely a symptom of comorbid disorders. *Pediatrics* 2011;127:e319–e329

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Several researchers have begun testing scientifically the concept of pathological video game use, commonly called video game "addiction."[1–17] The American Medical Association recognized that it is worthy of study, and the American Psychiatric Association considered it for inclusion in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, but decided there was not yet sufficient research.[18] Most researchers have assumed that it would be similar to pathological gambling. The parallel seems justifiable, because both are assumed to be behavioral addictions that begin as entertainment that can stimulate emotional responses and dopamine release.[14,19] People gamble or play video games for many reasons, including relaxation, competence, autonomy, and escape from daily concerns.[20,21] Playing can produce "flow" states, in which the player is focused, has a sense of control, may lose a sense of time and place, and finds playing intrinsically rewarding.[22] Playing is not pathological initially but becomes pathological for some individuals when the activity becomes dysfunctional, harming the individual's social, occupational, family, school, and psychological functioning. There is by no means a consensus on this issue, however. There still is heated debate about how best to define addictions, including behavioral addictions.[23–25] The purpose of this article is not to answer that debate but to provide new data that may be useful.

A majority of studies have based a screening tool for pathological video game or Internet use on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, criteria for pathological gambling.[5,7,8,14,26] Although the existing studies involve different populations and measures, they are beginning to yield fairly consistent evidence for construct validity, that is, cases that would be classified as "pathological" demonstrate a pattern of correlations with other variables that cooccur (eg, poorer grades and increased hostility) or are comorbid (eg, depression and attention-deficit/hyperactivity disorder) with other addictions.[5,16,27–29] A national weighted sample of 1178 US youths found that 8.5% of gamers were classified as pathological gamers.[5] Other samples in other countries yielded similar proportions, including 10.3% in China,[30] 8.0% in Australia,[31] 11.9% in Germany,[32] and 7.5% in Taiwan.[33] This burgeoning consistency notwithstanding, it is unclear whether this dichotomous approach is the best for screening, because most clinicians tend to focus also on the severity of symptoms. As an introductory approach to a new phenomenon, however, it is a reasonable starting place. It is critical not to pathologize behaviors needlessly; therefore, the weight of evidence would need to be strong as well as consistent. The evidence has not yet met these criteria.

Specifically, there are many issues that we need to understand before it would be reasonable to consider pathological video game use as a diagnosis in any revision to the *Diagnostic and Statistical Manual of Mental Disorders*. These issues include (but are not limited to) the following. (1) We need to be able to define risk and protective factors for becoming a pathological gamer and its etiology. (2) We need to understand the pattern of comorbidity with pathological gaming. Is pathological gaming a primary or a secondary problem? For example, if it is comorbid with depression, does depression increase the risk for a child to become a pathological gamer, or does pathological gaming increase the risk for depression? (It is worth noting that this is something of a false dichotomy, given that comorbid mental health issues often reinforce each other and simply treating the "first" issue does not solve the total problem.) (3) We need to understand the course of the problem. How long does it last? Is it simply a transitory (although perhaps acute) problem, or does it last for years? (4) We need to understand the typical outcomes of the problem. (5) We need to know how easily it can be overcome. If help is needed, what type of help would be most effective?

Almost all of the studies that have been conducted to date have relied on measurements at a single time point or on case studies. Unfortunately, most of the questions noted above cannot be answered with these research designs but require longitudinal studies. Furthermore, because extreme behaviors and conditions by definition affect only small proportions of the population, large samples are needed.

The present study monitored 3000 youths for 2 years, to begin to answer several of the unanswered questions. Specifically, we report on the prevalence and length of the problem, empirically identified risk and protective factors, whether the problem seems to be primary or secondary, and outcomes of both beginning and overcoming the problem.

METHODS

Participants

A total of 3034 children and adolescents in grades 3 ($N = 743$), 4 ($N = 711$), 7 ($N = 916$), and 8 ($N = 664$) in 6 primary schools and 6 secondary schools participated; 5 schools were boys' schools. These students were surveyed annually between 2007 and 2009. Parental consent was gathered by the schools. The overall participation rate was 99%. Surveys were conducted in classrooms by teachers who had been trained by the research team. Detailed procedures and demographic features are described elsewhere.[34]

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Of the participants who provided consent, 2998 completed a survey at time 1 (2179 boys and 819 girls; 72.6% Chinese, 14.2% Malay, 8.8% Indian, and 4.3% other races). Sixty students did not provide identifying information and were lost to follow-up monitoring (which left 2974 participants); 2605 and 2532 questionnaires were collected in years 2 and 3, respectively, which yielded attrition rates of 12.3% by time 2 and 14.7% by time 3. Comparisons of dropouts with remaining participants at time 3 showed no differences in their time 1 and time 2 levels of pathological gaming symptoms. Attrition was mainly attributable to administrative reasons, rather than students' refusal to participate. At time 1, 4 classes at each educational level were selected to participate. The students were reassigned to different classes each year, which made tracking of students difficult. Most students, however, stayed within the same schools across all 3 years.

Measures

The appendix describes the measures used. Pathological gaming was defined similarly to other American Psychiatric Association disorders, such that at least one-half of the items (5 of the 10 items) needed to be endorsed for a case to be considered pathological.[5,7,8,14,26] We were interested in examining how pathological gaming was related to several potential predictor or outcome variables, including amount of gaming, social competence, impulsivity, social phobia, depression, anxiety, parent-child relationship quality, and school performance. The questionnaires were administered in counterbalanced order.

Data Analyses

Latent growth mixture modeling was used to determine groups of students who were similar with respect to their growth trajectories in pathological gaming. Comparisons were made between the latent classes with respect to risk factors and outcome variables.

TABLE 1 Differences Between Boys and Girls in Weekly Amounts of Game Play and Numbers of Pathological Gaming Symptoms Reported

	Overall	Boys	Girls	*t*	*df*	*P*
Weekly amount of game play, mean ± SD, h						
Time 1	20.53 ± 25.78	21.54 ± 26.46	18.28 ± 23.89	3.08	3010	.002
Time 2	22.52 ± 24.15	23.47 ± 24.66	19.88 ± 22.50	3.19	2358	.001
Time 3	20.95 ± 22.72	21.44 ± 23.07	19.51 ± 21.63	1.75	2230	.081
No. of pathological gaming symptoms, mean ± SD						
Time 1	2.28 ± 1.78	2.49 ± 1.83	1.76 ± 1.55	9.63	2695	.001
Time 2	2.05 ± 1.86	2.29 ± 1.93	1.45 ± 1.48	10.14	2455	.001
Time 3	1.78 ± 1.80	1.97 ± 1.86	1.25 ± 1.51	8.75	2342	.001

RESULTS

Most (83%) of our subjects reported playing video games at least occasionally, with an additional 10% reporting that they used to play. The average amount of time playing was 20.5 hours per week (SD: 25.8 hours per week) at time 1, 22.5 hours per week (SD: 24.2 hours per week) at time 2, and 20.9 hours per week (SD: 22.7 hours per week) at time 3. Boys played more at each wave (Table 1).

The average numbers of pathological gaming symptoms reported (mean ± SD) were small, that is, 2.28 ± 1.78 at time 1, 2.05 ± 1.86 at time 2, and 1.78 ± 1.80 at time 3. The number of symptoms reported was correlated moderately with the amount of playing time at each wave ($r = 0.33$ at time 1, $r = 0.35$ at time 2, and $r = 0.37$ at time 3). Boys were more likely to play video games and to endorse more symptoms at each time (Table 1). Overall, the proportions of students in our sample who would meet the 5-symptom requirement to be considered pathological gamers were 9.9% at time 1, 8.8% at time 2, and 7.6% at time 3. Boys were more likely than girls to meet this requirement at all 3 times (time 1: boys, 12.0%; girls, 4.6%; time 2: boys, 11.2%; girls, 2.6%; time 3: boys, 9.2%; girls, 3.3%; all χ^2 $P < .001$).

Longitudinal latent class analysis was conducted by using the growth mixture model analysis in Mplus 5.21 (Muthén & Muthén, Los Angeles, CA). This analyzes each child's changes across time and groups together children who change similarly. Six classes were found that fit with theoretical predictions. Multiple criteria were used to choose the 6-class model as the best fit. First, classification quality is assessed on the basis of entropy, which is a standardized summary measure, with higher values indicating more-accurate classification. Entropy continued improving with additional classes. Second, the Bayesian Information Criterion statistic becomes smaller with improved fit, and 6 classes were better than 5. Third, the bootstrap Lo-Mendell-Rubin test compares the fit with k classes and the fit with $k - 1$ classes, providing a P value to determine whether there is a statistically significant improvement in fit with more classes. The Bootstrap likelihood ratio test yielded nonsignificant results for both 5 and 6 classes. Fourth, the classes need to fit theoretical predictions, and each of the 6 classes was theoretically sensible.

One latent class of children fit the definition of being pathological video game players (by endorsing at least one-half [ie, 5] of the symptoms) at time 1 but dropped below that threshold by time 3 (hereafter called the

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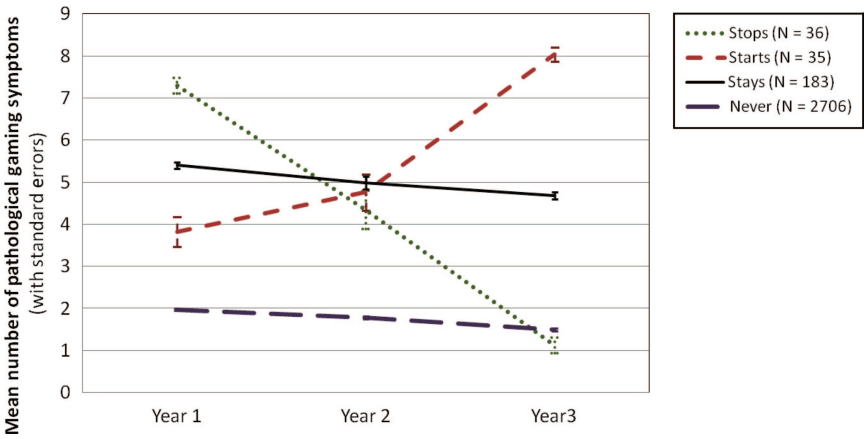

FIGURE 1
Mean trajectories of pathological gaming symptoms for 4 distinct groups identified through latent class analysis.

stops group). One latent class began the study below the 5-symptom line but increased to be over it by time 3 (the starts group). One latent class began the study above the 5-symptom line and held fairly constant across 2 years (the stays group). Finally, 3 latent classes stayed below the 5-symptom line (1 remaining stable across time, 1 increasing in symptoms, and 1 decreasing in symptoms), and these 3 classes were combined (the never pathological group). Figure 1 shows the trajectories of these 4 groups.

The 4 latent classes allowed us to estimate what proportions of youths stopped or started being pathological gamers over 2 years. Of 219 youths who were pathological gamers at time 1, 16.4% (36 youths) had significantly decreased symptoms within 2 years. Of 2741 youths who were not pathological gamers at time 1, 1.3% (35 youths) became pathological gamers within 2 years. This answers one critical question, namely, whether pathological gaming is a condition that is transient or stable. Most (84%) of the youths who were pathological gamers at time 1 were still pathological gamers 2 years later.

These longitudinal data also allowed us to begin to answer questions about whether some variables act as risk factors for becoming a pathological gamer and what the outcomes are for starting or stopping pathological gaming. A series of planned comparison analyses of covariance compared these 2 groups, controlling for race and gender (Table 2). Table 2 presents significant differences that seem to indicate risk factors for becoming a pathological gamer by virtue of being different particularly at time 1 and significant differences that seem to indicate outcomes of becoming a pathological gamer by virtue of being different particularly at times 2 and 3 and not at time 1.

A second series of planned comparisons were conducted for 2 groups of youths who began the study as pathological gamers, that is, those who stayed and those who stopped being pathological gamers. Table 3 presents differences that were seen between these 2 groups at time 1, which may give some hint regarding why some youths were able to stop, and differences that were seen between these 2 groups only later, which suggest outcomes of stopping pathological gaming.

The planned comparisons provide longitudinal data on risk factors, outcomes, and comorbidity and suggest some intriguing hypotheses. The patterns of results in Tables 2 and 3 demonstrate that many of the relationships between pathological gaming and other variables are not as simple as first imagined. For example, although impulsivity is a risk factor for becoming a pathological gamer, impulsivity worsens after a youth becomes a pathological gamer. Furthermore, depression, anxiety, and social phobias worsen after a youth becomes a pathological gamer and improves if an individual stops being a pathological gamer. These findings suggest that pathological gaming is not simply a symptom of other problems but contributes to those problems. To test this hypothesis, a longitudinal growth model, in which several risk factors at time 1 (weekly amount of video game play, social competence, and impulsivity) were hypothesized to predict changes in pathological gaming symptoms, which in turn were hypothesized to predict time 3 outcomes (depression, anxiety, social phobia, and school performance), with controlling for gender, was tested. Figure 2 presents the results of this hypothesized model. The model shows that amount of gaming and impulsivity significantly predict the number of pathological gaming symptoms at time 1 (pathological gaming intercept), such that more time gaming and higher impulsivity predict greater tendency to be a pathological gamer. Time 1 social competence and impulsivity also predict who changes to have more pathological gaming symptoms (pathological gaming change), such that children with lower social competence and greater impulsivity exhibit increases in their pathological gaming symptoms. Children who begin with more pathological gaming symptoms at time 1 demonstrate higher levels of depression, anxiety, and social phobia and lower grades at time 3. If they change to exhibit more pathological gaming symptoms, then this further increases their

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TABLE 2 Significant Differences Between Latent Classes of Gamers Who Became Pathological Gamers and Those Who Never Were Pathological Gamers

Variable	Mean ± SE		F	*df*	*P*	Partial η^2
	Starts Group	Never Group				
Potential risk factors						
Impulsivity score						
Time 1	2.49 ± 0.09	2.25 ± 0.01	7.63	1,2427	.006	.003
Time 2	2.58 ± 0.09	2.24 ± 0.01	15.61	1,2234	.001	.007
Time 3	2.69 ± 0.09	2.22 ± 0.01	29.41	1,2167	.001	.013
Social competence score						
Time 1	2.58 ± 0.12	2.96 ± 0.01	10.54	1,2418	.001	.004
Time 2	2.76 ± 0.10	2.97 ± 0.01	4.09	1,2244	.043	.002
Time 3	2.76 ± 0.10	3.06 ± 0.01	8.20	1,2154	.004	.004
Emotional regulation score						
Time 1	2.53 ± 0.11	2.77 ± 0.01	5.39	1,2421	.020	.002
Time 2	2.41 ± 0.09	2.81 ± 0.01	17.45	1,2249	.000	.008
Time 3	2.55 ± 0.09	2.87 ± 0.01	11.57	1,2156	.001	.005
Empathy score						
Time 1	2.20 ± 0.07	2.34 ± 0.01	3.90	1,2507	.048	.002
Time 2	2.16 ± 0.07	2.34 ± 0.01	7.38	1,2265	.007	.003
Time 3	2.15 ± 0.07	2.34 ± 0.01	7.57	1,2172	.006	.003
Weekly amount of video game play, h						
Time 1	31.12 ± 4.19	19.28 ± 0.48	7.90	1,2730	.005	.003
Time 2	37.10 ± 4.21	20.98 ± 0.51	14.47	1,2166	.001	.007
Time 3	40.66 ± 3.76	19.19 ± 0.47	32.06	1,2050	.001	.015
LAN center frequency score						
Time 1	1.00 ± 0.07	0.84 ± 0.01	5.23	1,2559	.020	.002
Time 2	1.09 ± 0.06	0.78 ± 0.01	27.10	1,2287	.001	.012
Time 3	1.02 ± 0.05	0.73 ± 0.01	31.51	1,2195	.001	.014
Problematic gaming symptoms score						
Time 1	3.44 ± 0.34	1.44 ± 0.04	33.51	1,2481	.001	.013
Time 2	3.61 ± 0.26	1.01 ± 0.03	99.22	1,2242	.001	.042
Time 3	5.72 ± 0.23	0.83 ± 0.03	452.97	1,2155	.001	.174
Identification with game characters score						
Time 1	2.25 ± 0.17	1.96 ± 0.02	2.85	1,2131	.091	.001
Time 2	2.15 ± 0.15	1.77 ± 0.02	6.862	1,1980	.009	.003
Time 3	2.30 ± 0.13	1.67 ± 0.02	22.07	1,1802	.001	.012
Potential outcomes						
School performance score						
Time 2	2.76 ± 0.22	3.24 ± 0.03	4.76	1,2309	.030	.002
Time 3	2.69 ± 0.22	3.10 ± 0.03	3.46	1,2242	.060	.002
Goal-setting score at time 2	2.73 ± 0.10	2.93 ± 0.01	3.90	1,2250	.050	.002
Parent-child relationship score at time 3	3.00 ± 0.11	3.46 ± 0.01	18.88	1,2143	.001	.009
Violent game exposure score						
Time 2	7.40 ± 0.76	3.94 ± 0.09	20.54	1,2002	.001	.010
Time 3	7.34 ± 0.68	3.38 ± 0.09	33.85	1,1816	.001	.018
Normative beliefs about aggression score						
Time 2	2.21 ± 0.12	1.82 ± 0.01	10.46	1,2282	.001	.005
Time 3	2.44 ± 0.11	1.79 ± 0.01	35.08	1,2152	.001	.016
Aggressive fantasies score						
Time 2	2.45 ± 0.12	1.85 ± 0.01	26.29	1,2277	.001	.011
Time 3	2.48 ± 0.11	1.80 ± 0.01	35.78	1,2168	.001	.016
Hostile attribution bias score at time 3	0.47 ± 0.04	0.29 ± 0.01	18.06	1,2231	.001	.008
Physically aggressive behavior score						
Time 2	2.17 ± 0.11	1.59 ± 0.01	29.71	1,2283	.001	.013
Time 3	2.35 ± 0.10	1.49 ± 0.01	75.08	1,2175	.001	.033
Relationally aggressive behavior score						
Time 2	2.28 ± 0.10	1.73 ± 0.01	27.21	1,2282	.001	.012
Time 3	2.41 ± 0.10	1.64 ± 0.01	56.64	1,2174	.001	.025
Physical victimization score						
Time 2	2.08 ± 0.13	1.63 ± 0.02	11.52	1,2281	.001	.005
Time 3	2.10 ± 0.12	1.49 ± 0.02	24.09	1,2171	.001	.011
Relational victimization score						
Time 2	2.19 ± 0.12	1.78 ± 0.02	11.32	1,2281	.001	.005
Time 3	2.29 ± 0.12	1.70 ± 0.02	22.77	1,2171	.001	.010

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TABLE 2 Continued

Variable	Mean ± SE		F	*df*	*P*	Partial η^2
	Starts Group	Never Group				
Online game play score						
Time 2	2.70 ± 0.20	2.32 ± 0.02	3.80	1,1989	.051	.002
Time 3	2.96 ± 0.20	2.37 ± 0.03	9.16	1,1804	.003	.005
ADHD symptoms score						
Time 2	2.28 ± 0.09	1.74 ± 0.01	34.40	1,2261	.001	.015
Time 3	2.65 ± 0.09	1.69 ± 0.01	117.74	1,2207	.001	.051
Anxiety score						
Time 2	0.84 ± 0.07	0.65 ± 0.01	8.04	1,2241	.005	.004
Time 3	0.95 ± 0.07	0.63 ± 0.01	21.21	1,2203	.001	.010
Social phobia score						
Time 2	2.60 ± 0.14	2.27 ± 0.02	5.14	1,2216	.023	.002
Time 3	2.46 ± 0.13	2.19 ± 0.02	4.09	1,2164	.043	.002
Depression score						
Time 2	3.17 ± 0.14	2.24 ± 0.02	43.56	1,2295	.001	.019
Time 3	2.85 ± 0.14	2.17 ± 0.02	25.26	1,2188	.001	.011

ADHD indicates attention-deficit/hyperactivity disorder.

TABLE 3 Significant Differences Between Latent Classes of Gamers Who Stopped Being Pathological Gamers and Those Who Stayed Pathological Gamers

Variable	Mean ± SE		F	*df*	*P*	Partial η^2
	Stops Group	Stays Group				
Potential protective factors						
School performance score at time 1	2.52 ± 0..23	3.10 ± 0.10	5.39	1,186	.021	.028
Goal-setting score						
Time 1	2.99 ± 0.11	2.70 ± 0.05	5.97	1,179	.016	.032
Time 2	2.75 ± 0.10	2.76 ± 0.05	<1	1,176	NS	.000
Time 3	3.02 ± 0.10	2.77 ± 0.04	5.40	1,167	.021	.031
Problematic gaming symptoms score						
Time 1	6.05 ± 0.42	4.95 ± 0.19	5.52	1,198	.020	.027
Time 3	0.66 ± 0.32	3.02 ± 0.14	46.10	1,168	.001	.215
Potential outcomes						
Empathy score at time 3	3.13 ± 0.09	2.89 ± 0.04	5.78	1,167	.017	.033
Impulsivity score at time 3	2.35 ± 0.07	2.55 ± 0.03	6.19	1,168	.014	.036
Violent game exposure score at time 3	4.43 ± 1.07	6.72 ± 0.46	3.79	1,165	.053	.022
Aggressive fantasies score at time 3	1.99 ± 0.13	2.33 ± 0.06	5.30	1,172	.022	.030
Physically aggressive behavior score at time 3	1.56 ± 0.12	1.86 ± 0.05	5.12	1,173	.025	.029
Relationally aggressive behavior score at time 3	1.77 ± 0.12	2.02 ± 0.05	3.73	1,173	.055	.021
Anxiety score at time 3	0.58 ± 0.08	0.89 ± 0.04	12.98	1,175	.001	.069
Social phobia score						
Time 2	2.33 ± 0.16	2.73 ± 0.07	5.42	1,181	.021	.029
Time 3	2.21 ± 0.13	2.70 ± 0.06	11.16	1,168	.001	.062
Depression score at time 3	2.28 ± 0.15	2.71 ± 0.07	6.88	1,175	.009	.038

NS indicates not significant.

time 3 depression, anxiety, and social phobia levels and poor school performance. Overall, this model fits the data extremely well ($\chi^2 = 70.4$, $P < .001$; comparative fit index = 0.99, Tucker-Lewis index = 0.96, root mean square error of approximation = 0.04, standardized root mean square residual = 0.02). This model accounted for a significant amount of variance for each of the outcome variables (depression, $R^2 = 0.49$; anxiety, $R^2 = 0.29$; social phobia, $R^2 = 0.20$; grades, $R^2 = 0.14$; all $P < .001$).

DISCUSSION

Although many studies have described correlates of pathological video game play, the present study provides needed data on risk factors for becoming a pathological gamer, how long pathological gaming lasts, what the outcomes are, and whether it is a primary problem or is simply a symptom of other comorbid problems. With a *Diagnostic and Statistical Manual of Mental Disorders*-style approach to definition, in which people exhibiting at least one-half of the symptoms are considered to be pathological gamers, between 7.6% and 9.9% of our sample would be classified as pathological gamers at any point in time. This range is similar to those for samples from other countries.[5,30–33] Knowing the

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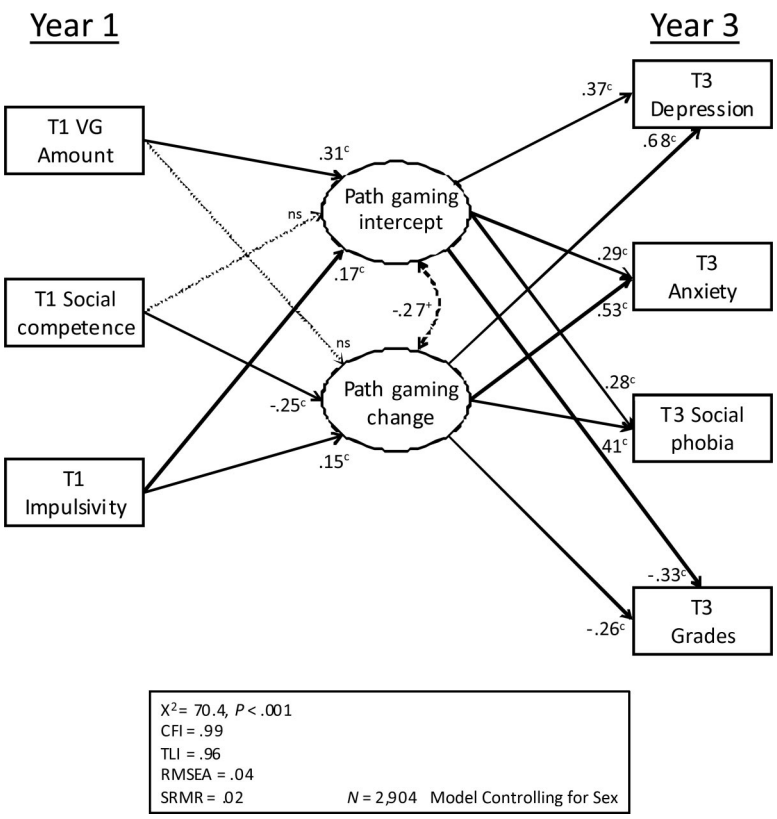

FIGURE 2
Longitudinal growth curve model, testing risk factors and outcomes of pathological gaming. VG indicates video gaming; T1, time 1; T3, time 3; ns, not significant; CFI, comparative fit index; TLI, Tucker-Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual. + indicates $P < .10$; a, $P < .05$; b, $P < .01$; C, $P < .001$.

prevalence, however, only tells us what proportion of children are experiencing dysfunction at a single point in time. This is not necessarily important if pathological gaming is a transient problem. The data here demonstrate, however, that most pathological gamers (84%) are still pathological gamers 2 years later. Furthermore, in the same 2-year window, only 1% of children became pathological gamers. Therefore, pathological gaming is not simply a "phase" that most children go through.

In examination of what early predictors discriminate between those who become pathological gamers and those who do not (Table 2), several personal characteristics and gaming habits seem to act as risk factors. Youths who are more impulsive, have lower social competence and empathy, and have poorer emotional regulation skills are more likely to become pathological gamers. This pattern fits with theoretical predictions, given that, if pathological gaming were to be classified as a disorder, it probably would be considered an impulse control disorder. Although the amount of gaming is not sufficient to define pathological gaming,[5,35,36] several variables related to the amount of gaming clearly differentiate individuals who are at risk of becoming pathological gamers. Youths who became pathological gamers started with an average of 31 hours of play per week, compared with 19 hours per week for those who never became pathological gamers. Going to local area network (LAN) computer centers (which are popular in Singapore) more frequently was a risk factor. These issues differentiated becoming a pathological gamer but also tended to become more discrepant over time. Furthermore, greater time 1 identification with game characters predicted becoming a pathological gamer but online gaming did not (although online gaming levels were significantly greater at time 2 and time 3).

Once players became pathological gamers, they began to have poorer grades and poorer relationships with their parents and to be exposed to more violent games (Table 2). This is of concern, given that several studies have demonstrated both short-term and long-term effects of violent games on aggression.[37–54] In this study, children who began consuming more violent games also began to have more normative beliefs about aggression, hostile attribution biases, and aggressive fantasies and to engage in more physically and relationally aggressive behaviors (they also became more likely to be victims of aggression). This pattern is mirrored for those who stop being pathological gamers; they end up with lower levels of violent game exposure (marginally significant), aggressive fantasies, and aggressive behaviors (Table 3).

Of particular note, however, are the results regarding other mental health variables. Many clinicians think that pathological gaming is not a serious concern because it has been assumed that gaming either is a symptom of other issues or is a secondary issue. That is, many clinicians assume that children may be depressed or anxious and therefore retreat into games as a coping strategy. Our data demonstrate that this assumption is overly simplistic. Although children do use games as a coping mechanism, it is not simply a symptom of other problems. Youths who became pathological gamers ended up with increased levels of depression, anxiety, and social phobia (Table 2). Conversely, those who

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stopped being pathological gamers ended up with lower levels of depression, anxiety, and social phobia than did those who remained pathological gamers. To our knowledge, these are the first data to demonstrate that gaming predicts other mental health disorders longitudinally, rather than simply being correlated with them. Figure 2 demonstrates that these empirically defined risk factors and outcomes fit together as hypothesized; early amounts of gaming, social competence (a protective factor that is negatively related), and impulsivity predict initial pathological gaming symptoms and increases in pathological gaming, which in turn predict increased levels of depression, anxiety, and social phobia and poorer grades.

Although these data provide evidence that pathological gaming can influence other mental health issues, we expect that many of the relationships between variables are in fact reciprocal, given that many mental health disorders tend to be comorbid and mutually reinforcing.[55] That is, although children who are depressed may retreat into gaming, the gaming increases the depression, and vice versa. Longer longitudinal studies are needed to test this.

Although this study identified several risk factors for becoming a pathological gamer, we did not find a systematic pattern of protective factors that helped some pathological gamers overcome their dysfunction (Table 3). It may be that other variables will need to be measured, or larger samples may be required to yield sufficient statistical power. Furthermore, these results will need to be replicated in other samples. It is unclear whether cultural differences limit the generalizeability of the results. The prevalence of pathological gaming is similar to that in other countries. The effects of prosocial and violent gaming are similar to those in other countries.[46,55] There seems to be no specific reason to assume that the relationships between variables would be different in other countries, but additional studies are needed. For example, LAN computer centers are more prevalent in Asia than in the West, and they were related to pathological gaming. It is likely that this relationship signifies increased access and not some risks unique to Singapore, but this remains to be tested. This study also would have been improved by gathering information from additional sources, such as teachers and parents.

This study begins to provide data to answer questions about the risk factors, cause, course, and outcomes of pathological gaming. Pathological gaming seems not to be simply secondary to other disorders but to predict poorer functioning longitudinally, and it can last for several years. Several important questions remain to be answered, including information on protective factors, how children can be helped, and what types of help might be most effective.

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APPENDIX Measures Used in Study

Name of Measure	Variables Measured	Items	Sample Items	Response Options and Scores	Reliability		
					Wave 1	Wave 2	Wave 3
General Media Habits Questionnaire[38,45]	Weekly amount of video game play	6	On a usual school day, how many hours do you play computer/video games in the morning?	Hours	NA	NA	NA
	Frequency of visiting LAN center	2	How often do you visit game arcades or gaming centers on weekdays/weekends?	Never (1) to almost always (4)	NA	NA	NA
	Violent game exposure	4 (for each of 3 games)	How often do you shoot or kill other players in this game?	Never (1) to almost always (4)	NA	NA	NA
	Identification with game characters	2 (for each of 3 games)	How much is your in-game character like you in real life?	Never (1) to almost always (4)	NA	NA	NA
	Online game play	1 (for each of 3 games)	Is the game played online with other people?	Never (1) to almost always (4)	NA	NA	NA
Barratt Impulsiveness Scale[56]	Impulsivity	14	I talk even when I know I shouldn't.	Strongly disagree (1) to strongly agree (4)	0.69	0.77	0.78
Personal Strengths Inventory II[57]	Social competence	4	I get along well with other people.	Strongly disagree (1) to strongly agree (4)	0.73	0.78	0.80
	Emotional regulation	6	I know how to deal with stress.	Strongly disagree (1) to strongly agree (4)	0.62	0.71	0.73
	Goal-setting	5	I set goals and plan how to reach those goals.	Strongly disagree (1) to strongly agree (4)	0.71	0.76	0.76
Children's Empathic Attitudes Questionnaire[58]	Empathy	15	I understand how other students feel.	No, maybe, or yes	0.86	0.87	0.86
Normative beliefs about aggression[59]	Normative beliefs about aggression	20	In general, it is OK to hit other people.	It's perfectly OK (1) to it's really wrong (4)	0.94	0.95	0.95
Hostile attribution bias[60]	Hostile attribution bias	12	6 scenarios		0.79	0.81	0.83
Aggressive fantasies[61,62]	Aggressive fantasies	6	Do you ever daydream about people getting killed?	Never (1) to almost always (4)	0.78	0.82	0.84
Self-report of aggression[63]	Physically aggressive behavior	6	When someone has angered or provoked me in some way, I have reacted by hitting that person.	Not true at all (1) to very true (4)	NA	0.86	0.87
	Relationally aggressive behavior	6	I have spread rumors about a person just to be unkind.	Not true at all (1) to very true (4)	NA	0.78	0.80
	Physical victimization	3	I often get hit or kicked by others.	Not true at all (1) to very true (4)	NA	0.84	0.85
	Relational victimization	3	I get ignored by others when they are angry with me.	Not true at all (1) to very true (4)	NA	0.64	0.69
Parent-family connectedness[64]	Parent-child relationship	6	I feel close to my mother.	Strongly disagree (1) to strongly agree (4)	0.90	NA	0.89
Pathological video game use[5]	Pathological gaming	10	In the past year, has your schoolwork suffered because you spent too much time playing computer/video games?	Yes, no, or sometimes	0.71	0.77	0.79
Problematic gaming[1]	Problematic gaming	10	Have you skipped meals, baths, or sleep so you could play more computer/video games?	Yes, no, or sometimes	0.85	0.83	0.84
ADHD screen[65]	ADHD	18	I feel restless.	Never or rarely (1) to very often (4)	NA	0.92	0.93
Asian adolescent depression scale[66]	Depression	22	I often feel like crying.	Strongly disagree (1) to strongly agree (5)	NA	0.95	0.96
Anxiety[67]	Anxiety	20	I am scared to go to school.	Not true or hardly ever true (0) to very true or often true (2)	NA	0.90	0.92
Social phobia[68]	Social phobia	17	I avoid speaking to anyone in authority.	Not at all (1) to extremely (5)	NA	0.93	0.92
School performance	School performance	4	What marks did you get for your last exam for the following subjects?	<50 (1) to >90 (6)	NA	NA	NA

ADHD indicates attention-deficit/hyperactivity disorder; NA, not applicable.

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