Video-Gaming Among High School Students: Health Correlates, Gender Differences, and Problematic Gaming

WHAT'S KNOWN ON THIS SUBJECT: The effects of video-gaming have been found to be mixed. There is little evidence that recreational play has poor consequences; however, problematic gaming has been recognized as a potential area of concern.

WHAT THIS STUDY ADDS: This study examined the correlates of recreational gaming and revealed few poor consequences but important health consequences of problematic gaming, particularly externalizing behaviors such as smoking, drug use, and fighting.

abstract

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OBJECTIVE: Video game playing may negatively impact youth. However, the existing literature on gaming is inconsistent and often has focused on aggression rather than the health correlates of gaming and the prevalence and correlates of problematic gaming.

METHODS: We anonymously surveyed 4028 adolescents about gaming and reported problems with gaming and other health behaviors. A total of 51.2% of the sample reported gaming (76.3% of boys and 29.2% of girls).

RESULTS: There were no negative health correlates of gaming in boys and lower odds of smoking regularly; however, girls who reported gaming were less likely to report depression and more likely to report getting into serious fights and carrying a weapon to school. Among gamers, 4.9% reported problematic gaming, defined as reporting trying to cut back, experiencing an irresistible urge to play, and experiencing a growing tension that could only be relieved by playing. Boys were more likely to report these problems (5.8%) than girls (3.0%). Correlates of problematic gaming included regular cigarette smoking, drug use, depression, and serious fights. Results suggest that gaming is largely normative in boys and not associated with many health factors. In girls, however, gaming seems to be associated with more externalizing behaviors and fewer internalizing symptoms.

CONCLUSIONS: The prevalence of problematic gaming is low but not insignificant, and problematic gaming may be contained within a larger spectrum of externalizing behaviors. More research is needed to define safe levels of gaming, refine the definition of problematic gaming, and evaluate effective prevention and intervention strategies. *Pediatrics* 2010;126:e1414–e1424

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ABBREVIATIONS
ICD—impulse-control disorder
OR—odds ratio

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The popularity of video, computer, online, and virtual reality games has raised concern in both the popular media[1] and the research community regarding the potential for negative health effects of gaming, including the potential for addiction.[2–10] Gaming has been associated with both positive and negative clinical correlates; however, the evidence for a negative impact of gaming has been inconsistent. Experienced gamers may exhibit superior visual, spatial, and attention skills,[11–13] and video-game formats have been successfully used to deliver health interventions to children and adolescents.[14] Depending on the specific game, high levels of motor skill and often problem-solving are required to advance through levels of play.[15] Survey research has indicated that children who play video games often do so in social groups, such as with friends or family members,[16,17] and that frequency of gaming is positively associated with more peer interaction outside of school,[16] although there is not enough evidence to conclude that gaming is a positive contributor to social development in children.[18] Research on the association between gaming and aggression, in both laboratory[19–21] and survey[22–25] settings, and several meta-analyses,[26,27] has generally indicated a lack of a strong association between playing games (even violent ones) and aggressive behavior,[18] although some studies have revealed such an association.[4,24,28–37]

Although the research to support concern about gaming as a negative health behavior in general remains controversial, there is clear evidence that some individuals develop a pattern of gaming behavior that is problematic.[1,5,6,8,38–42] Because videogaming is a nondrug behavior with hedonic components, problematic gaming might be best conceptualized as a nonsubstance addiction or an impulse-control disorder (ICD). The formal ICDs, such as pathologic gambling, are characterized by appetitive urges or growing tension before participation, relief or pleasure after engagement in the behavior, and repeated behavioral engagement despite negative consequences.[43] It is important to note that they are not defined by concern or complaints about the behavior from family, which is important when evaluating behaviors in adolescents who may be in conflict with parents around a wide variety of issues. Problematic gaming has typically been defined in the literature on the basis of measures of pathologic gambling[5,6,40,44,45]; however, a variety of definitions and criteria have been used, which has led to inconsistent estimates of the prevalence of problematic gaming.

Individuals with problematic gaming behavior have been shown to exhibit inattention, hyperactivity, and poor self-control[46,47]; experience time distortion while playing[48]; and demonstrate increased aggression and diminished empathy if their games of choice contain aggressive content.[28–30,32,37] Those with gaming problems who are engaged primarily in large online gaming communities often are shy,[49] have an external locus of control,[49] and use gaming to deal with negative emotions.[50]

Multiple research gaps presently exist. First, not all adolescents play video games, and the health correlates of gaming (eg, relationships with drug and alcohol use or depression) are incompletely understood, because much of the published research has focused on school performance, obesity, and aggression. Second, the likelihood of gaming, and the clinical correlates thereof, are likely to differ by gender, and gender differences in gaming and its health correlates are poorly understood. Third, much of the research on gaming has used online samples of gamers or small groups of individuals identified as having problematic gaming behaviors, which presents problems for generalizability. This study used survey data from a large sample of adolescents and examined the prevalence and clinical correlates of gaming, reported problems associated with video games, and the prevalence and correlates of problematic gaming.

METHODS

Sampling

Data were derived from a cross-sectional anonymous survey of students in public high schools, as described previously.[51] Schools were first recruited into the study, and then students at each enrolled school were invited to participate. Invitation letters were sent to all public 4-year and nonvocational or special-education high schools in the state of Connecticut. After the initial round of letters were mailed, the response from schools was not yet sufficient to ensure that all geographic regions of the state were sufficiently represented. Therefore, targeted contacts were made to schools that were in areas that would ensure a more representative sample. The final sample was representative of 14- to 18-year-old adolescents in Connecticut according to the most recent US census.[51]

Survey Procedures

In most cases, the entire student body was targeted for administration of the survey. Students were told that they could voluntarily refuse to complete the survey if they wished and were reminded to keep surveys anonymous. The survey took ~50 minutes to complete.

Measures

The measures used in this analysis included self-reported gender, race, eth-

nicity, grade, and family structure (living with 1 parent, living with 2 parents, or other family structure).

Health and functioning measures were categorized as presented in the tables and included grade average; extracurricular activities; lifetime smoking history; lifetime marijuana use; lifetime history of a sip of alcohol; current alcohol use among those with a history of any alcohol consumption, categorized as none, light (1–2 days of drinking in a month), moderate (3–9 days of drinking in a month), and heavy (≥10 days of drinking in a month); lifetime use of other drugs; caffeine use; report of being sad or hopeless for 2 weeks or more in the previous year; getting into fights and requiring medical attention in the previous year; carrying a weapon such as a knife, club, or gun to school in the previous year; and BMI calculated from self-reported height and weight.

Respondents were asked to report how much time they spent playing video or computer games in a typical week. Respondents who reported "none" were classified as non–game players. For those who played games, the frequency of play was categorized as less than 7, 7 to 14, 15 to 20, and 21 or more hours/week.

Those who played any video or computer games were asked if they had ever tried to cut back on playing; whether a family member had expressed concern about the amount of time they spend playing games; whether they missed school, work, or an important social activity because they were playing video or computer games; whether they thought they had a problem with excessive video or computer game use; whether they experienced an irresistible urge or uncontrollable need to play video or computer games; and whether they experienced a growing tension or anxiety that could only be relieved by playing video or computer games. The 3 items of unsuccessfully trying to cut back, experiencing an irresistible urge to play, and experiencing growing tension only relieved by playing were modeled after the Minnesota Impulse Disorder Inventory[52] and are considered the core features of an ICD. Students who endorsed all 3 items were categorized as "problematic video gamers." The coefficient α value for these items was .76.

Data Analysis

First, demographic characteristics and health correlates were compared between respondents who played video or computer games and those who did not, stratified according to gender, by using χ^2 tests for categorical variables and *t* tests for continuous variables. Second, logistic regression models were fit to assess the association between each health correlate and playing video games, adjusting for demographic differences. Interaction terms between gender and health correlates determined whether the associations were significantly different for girls and boys.

Next, among the subsample of respondents who reported any game-playing, those with problematic game-playing were compared with those with nonproblematic gaming, stratified according to gender for bivariate analyses. Logistic regression models were fit to examine associations between health correlates and problematic gaming, adjusting for gender and race. There was insufficient statistical power to test gender interactions in multivariable models.

RESULTS

Of 4028 respondents with data on video-gaming, 2064 (51.2%) reported playing at least 1 hour of video games per week. This proportion was higher in boys (76.3%) than in girls (29.2%) ($P < .0001$) (Table 1). In the total sample, gaming was significantly more prevalent in Asian students and lower grades. Among boys, playing video or computer games was associated with lower grades and with living in a 2-parent household. Among girls, significant positive associations were found with Asian race and lower grades.

Among boys, gaming was associated with higher grade average, never smoking, never having used marijuana, and high caffeine consumption (Table 2). In girls, gaming was associated with occasional smoking, never having used marijuana, never having a sip of alcohol, high caffeine use, no history of depression, getting into serious fights, and carrying a weapon. Gaming was associated with slightly higher BMI in girls (mean [SD] BMI: 22.35 [4.44] for gamers, 21.94 [3.61] for nongamers; $P = .03$) but not in boys.

Table 3 presents results of adjusted logistic regression analyses with interaction terms to identify significant differences across gender groups. Boys who reported gaming were less likely to be regular smokers, whereas there was no association between smoking and gaming in girls. Boys were also more likely to drink 1 to 2 servings of caffeinated drinks per day, whereas girls who reported gaming were more likely to drink 3 or more caffeine drinks per day. Girls who reported gaming were less likely to report depression, whereas there was no such association among boys. Similarly, girls were more likely to get into serious fights and carry a weapon, but no such association was seen among the boys. Finally, girls who reported gaming had slightly higher average BMI measures (odds ratio [OR]: 1.03; $P = .01$), whereas there was no association in boys (OR: 1.0001; $P = .98$).

Table 4 lists the frequency of gaming, along with reported problems associ-

TABLE 1 Demographic Characteristics of the High School Student Sample and Association With Video-Game Playing, According to Gender

Variable	Total Sample					Boys ($N = 1845$)					Girls ($N = 2139$)				
	n	%	Played Video Games Ever, %	χ^2	*P*	*n*	%	Played Video Games Ever, %	χ^2	*P*	*n*	%	Played Video Games Ever, %	χ^2	*P*
Black															
Yes	399	9.91	51.38	0.0033	.954	186	10.08	74.19	0.51	.4731	205	9.58	28.78	0.02	.8845
No	3629	90.09	51.23			1659	89.92	76.55			1934	90.42	29.27		
White															
Yes	3090	76.71	50.84	0.8493	.3568	1399	75.83	76.05	0.22	.6417	1666	77.89	29.47	0.23	.6298
No	938	23.29	52.56			446	24.17	77.13			473	22.11	28.33		
Asian															
Yes	159	3.95	65.41	13.3	.0003	83	4.50	81.93	1.52	.2184	67	3.13	43.28	6.62	.0101
No	3869	96.05	50.66			1762	95.5	76.05			2072	96.87	28.76		
Other race															
Yes	568	14.1	50.70	0.076	.7823	250	13.55	79.20	1.33	.2484	309	14.45	26.86	0.97	.3243
No	3460	85.9	51.33			1595	86.45	75.86			1830	85.55	29.62		
Hispanic															
Yes	519	13.43	52.41	0.31	.5806	232	13.15	76.72	0.01	.9232	273	13.23	30.40	0.14	.7129
No	3346	86.57	51.11			1532	86.85	76.44			1791	86.77	29.31		
Grade															
9th	1245	30.99	57.11	29.01	<.0001	571	30.98	78.63	10.40	.0155	654	30.65	37.92	35.23	<.0001
10th	1108	27.58	50.90			505	27.40	79.01			592	27.74	26.35		
11th	1055	26.26	47.39			477	25.88	74.42			571	26.76	24.69		
12th	609	15.16	46.47			290	15.74	70.34			317	14.85	24.61		
Family structure															
1 parent	910	22.9	48.02	5.29	.0711	386	21.15	70.98	10.33	.0057	515	24.45	30.49	1.77	.4133
2 parents	2865	72.09	52.32			1353	74.14	78.27			1484	70.47	28.17		
Other	199	5.01	49.75			86	4.71	70.93			107	5.08	32.71		

ated with gaming, among the sample of 2196 gamers. In the total sample, the majority of respondents reported playing less than 7 hours/week (61.1%); however, 10.9% reported playing 20 hours or more in a typical week. The most commonly endorsed items related to problems with gaming were family members expressing concern about gaming, trying to cut back on gaming, and experiencing an irresistible urge to play. Although the majority of respondents endorsed none of the problematic symptoms, 4.9% endorsed all 3 of the items indicative of an ICD.

There were significant gender differences in patterns of gaming and problems with gaming as well. Girls, compared with boys, more frequently reported playing fewer than 7 hours/week, and 14% of boys reported playing 20 or more hours/week. Girls also reported problematic gaming less often than boys. There were 84 (5.9%) boys who endorsed the 3 problem measures, whereas only 22 (3.0%) girls did so.

Table 5 compares demographic characteristics of those in the problematic gaming group with all others who reported gaming, stratified according to gender. Among boys, problematic gaming was associated with nonwhite and Asian race. There were no significant associations among girls.

Among health correlates (Table 6), problematic gaming was associated with boys who smoked regularly, were depressed, and got into serious fights or carried a weapon. Among girls, problematic gaming was associated with other drug use, depression, and serious fights. There was no association with BMI in either boys ($P = .20$) or girls ($P = .33$).

Logistic regression models presented in Table 7 indicated that, adjusted for race and gender, problematic gaming was associated with higher odds of smoking regularly, other drug use, lower caffeine consumption, depression, serious fights, and carrying a weapon to school. However, given effect sizes and the number of models, the most robust of these findings are for an increase in regular smoking (OR: 2.12; $P = .007$), depression (OR: 3.62; $P < .0001$), and serious fights (OR: 2.97; $P < .0001$).

DISCUSSION

This study is among the first and largest to examine clinical correlates of video-gaming and problematic gaming in a community sample of adolescents. We found that approximately half of the students reported gaming, concentrated among younger students and more common in boys.

There were no significant negative health correlates of gaming in boys, which likely reflects the popularity and normative nature of such games for this group. In addition, boys who reported gaming were significantly less likely to report being a regular

TABLE 2 Health and Functioning Measures and Association With Lifetime Video-Game Playing, According to Gender

Variable	Total Sample					Boys					Girls				
	n	%	Played Video Games Ever, %	χ^2	*P*	*n*	%	Played Video Games Ever, %	χ^2	*P*	*n*	%	Played Video Games Ever, %	χ^2	*P*
Grade average															
As and Bs	2319	59.11	48.68	15.48	.0004	941	52.05	78.21	6.7393	.0344	1361	65.50	28.14	2.5883	.2741
Cs	1157	29.49	54.80			594	32.85	75.76			549	26.42	31.51		
Ds and Fs	447	11.39	55.70			273	15.10	70.7			168	8.08	31.55		
Extracurricular activities															
Yes	3056	75.87	50.95	0.43	.5104	1382	74.91	76.48	0.087	.768	1642	76.76	29.05	0.098	.7543
No	972	24.13	52.16			463	25.09	75.81			497	23.24	29.78		
Smoking, lifetime															
Never	2441	62.41	54.40	34.34	<.0001	1146	64.53	79.58	29.91	<.0001	1268	60.53	31.39	12.42	.002
Occasionally	949	24.26	43.73			397	22.35	71.54			546	26.06	23.26		
Regularly	521	13.32	47.22			233	13.12	66.52			281	13.41	30.25		
Marijuana, lifetime															
Yes	1476	39.07	47.29	11.72	.0006	689	40.39	70.68	16.85	<.0001	772	25.78	25.78	7.11	.0077
No	2302	60.93	53.00			1017	59.61	79.35			1259	61.97	31.32		
Sip of alcohol, lifetime															
Yes	3312	86.72	49.34	21.36	<.0001	1444	84.00	75.48	1.49	.2228	1833	89.07	28.31	7.87	.005
No	507	13.28	60.36			275	16.00	78.91			225	37.33	37.33		
Current alcohol frequency															
Never regular	756	31.01	48.81	2.81	.4233	338	32.10	75.74	4.19	.2419	412	30.18	26.46	5.74	.1249
Light	704	28.88	48.15			295	28.02	72.54			402	29.45	30.35		
Moderate	697	28.59	44.76			286	27.16	75.17			406	29.74	22.91		
Heavy	281	11.53	46.26			134	12.73	67.16			145	10.62	26.90		
Other drug use, lifetime															
Yes	305	9.17	54.43	1.33	.2483	156	10.30	71.79	1.66	.1971	144	8.09	34.03	1.28	.2576
No	3022	90.83	50.96			1359	89.70	76.45			1636	91.91	29.52		
Caffeine use															
None	785	20.03	46.11	13.58	.0011	390	21.87	66.41	26.74	<.0001	381	18.20	24.67	8.83	.0121
1–2 drinks per d	2134	54.45	50.98			922	51.71	79.61			1195	57.10	28.79		
≥2 drinks per d	1000	25.52	54.90			471	26.42	77.28			517	24.70	33.66		
Sad or hopeless ≥2 wk															
Yes	835	21.78	47.19	6.27	.0123	269	15.57	76.97	1.13	.2874	556	26.90	27.66	7.85	.0051
No	2999	78.22	52.08			1459	84.43	73.98			1511	73.10	33.99		
Serious fights															
Yes	265	6.75	61.13	11.95	.0005	166	9.33	71.69	2.02	.1548	91	4.32	39.56	4.97	.0258
No	3660	93.25	50.14			1613	90.67	76.63			2014	95.68	28.70		
Carry a weapon															
Yes	742	18.81	67.65	101.58	<.0001	552	30.79	74.46	1.49	.2217	176	8.35	44.32	21.51	<.0001
No	3202	81.19	47.13			1241	69.21	77.12			1933	91.65	27.73		

smoker. However, among the girls, gaming was associated with modestly lower risk of depression and moderate increases in serious fights (OR: 1.7) and carrying a weapon (OR: 2.1).

We also found that among boys who reported gaming, 5.9% endorsed problematic gaming, compared with 3.0% of girls who reported gaming, which suggests that male gamers may be at higher risk for developing a gaming problem but that overall the risk of developing a problem is relatively low. Problematic gaming was associated with some important risk behaviors (moderate effect sizes were found for depression [OR: 3.6] and fighting [OR: 3.0]) but was not associated with grade averages, extracurricular activities, marijuana use, or alcohol use.

Gender Differences in Correlates of Gaming

The gender differences observed between gamers and nongamers, coupled with the contrast in frequencies of gaming across gender, are suggestive of a gender-specific self-selection process. That is, whereas gaming may be more appealing to boys in general, it may be particularly attractive to

TABLE 3 Association Between Lifetime Video-Game Playing and Other Health Factors, Adjusting for Grade and Stratified According to Gender

Variable	Total Sample		Boys		Girls		Gender Interaction[a]
	OR	*P*	OR	*P*	OR	*P*	*P*
Grade average (reference: As and Bs)							
Cs	0.66	.8586	0.868	.6483	1.140	.458	.0623
Ds and Fs	0.84	.1422	0.673	.0278	1.080	.9568	
Extracurricular activities: yes	0.97	.6836	0.99	.9351	0.961	.7263	
Smoking, lifetime (reference: never)							
Occasionally	0.76	.0144	0.656	.4695	0.710	.003	.1408
Regularly	0.69	<.0001	0.524	.0046	1.070	.1004	.0028
Marijuana, lifetime: yes	0.75	.0002	0.653	.0002	0.834	.0854	.1984
Sip of alcohol, lifetime: yes	0.78	.0239	0.856	.3362	0.715	.0245	.3239
Current alcohol frequency (reference: never regular)							
Light	1.05	.7099	0.846	.8659	1.243	.1	
Moderate	0.90	.4022	0.978	.3059	0.863	.0716	
Heavy	0.87	.3964	0.671	.0965	1.127	.6305	
Other drug use, lifetime: yes	1.04	.7675	0.832	.3376	1.292	.1758	
Caffeine use (reference: none)							
1–2 drinks per d	1.51	<.0001	1.929	.0004	1.190	.7481	.0049
≥2 drinks per d	1.65	<.0001	1.684	.1366	1.510	.0052	.5075
Sad or hopeless ≥2 wk: yes	1.19	.0549	1.154	.3499	0.721	.0024	.0149
Serious fights: yes	1.05	.7501	0.778	.1725	1.668	.0218	.008
Carry a weapon: yes	1.17	.1109	0.860	.2056	2.095	<.0001	<.0001

[a] Interaction term tests whether the OR for boys and girls are significantly different from each other.

TABLE 4 Characteristics of Video-Game Playing Among Those Who Have Played Video Games

Characteristic	Level	Total Sample		Boys		Girls		χ^2	*P*
		n	%	*n*	%	*n*	%		
Frequency of game playing in a typical week, h									
<7		1262	61.14	739	52.49	511	81.76	160.22	<.0001
7–14		385	18.65	314	22.30	65	10.40		
15–20		192	9.30	160	11.36	28	4.48		
≥20		225	10.90	195	13.85	21	3.40		
Ever tried to cut back?		408	20.20	302	22.00	96	15.60	10.87	.001
Family expressed concern?		560	27.79	466	33.92	84	13.73	86.19	<.0001
Missed activities to play?		289	14.37	238	17.33	41	6.73	39.21	<.0001
Do you think you have a problem?		175	8.76	134	9.84	33	5.44	10.48	.0012
Experienced irresistible urge to play?		395	19.72	318	23.28	68	11.18	39.13	<.0001
Experienced growing tension only relieved by playing?		319	15.91	253	18.51	56	9.20	27.69	<.0001
3 key symptoms endorsed[a]		106	4.90	84	5.85	22	3.02	8.34	.0039
Total No. of items endorsed									
0		1094	53.92	650	47.03	429	69.53	97.30	<.0001
1		366	18.04	269	19.46	95	15.40		
2		243	11.98	197	14.25	42	6.81		
3		131	6.46	106	7.67	24	3.89		
4		109	5.37	94	6.80	13	2.11		
5		51	2.51	42	3.04	9	1.46		
6		35	1.72	24	1.74	5	0.81		

[a] Unsuccessfully tried to cut back, experience irresistible urge, experience growing tension only relieved by playing.

girls with certain characteristics. Although causality cannot be examined in these cross-sectional data and competing hypotheses cannot be eliminated, this finding may suggest not that gaming leads to aggression but that more aggressive girls are attracted to gaming as a recreational activity. The finding also may reflect cultural differences in socioeconomic conditions at home and in their communities: it is possible that girls who live in more violent neighborhoods, where they are more likely to experience fights and to carry a weapon for protection, also are more likely to be attracted to gaming, may be more likely to spend time with male peers who are themselves gaming, or may prefer to stay home and play games rather than be outside in dangerous communities.

The finding also may be reflective of personality characteristics that are more externalizing; girls who reported gaming were not only more likely to get into fights and carry weapons, behaviors generally considered to be externalizing, but also were somewhat less likely to report feelings of depression, which would reflect more internalizing patterns. An additional possibility is that gaming may exert a positive effect on mood in girls; however, this hypothesis and the precise nature of the relationship warrant additional study in longitudinal investigations.

Among boys, the finding that gaming is associated with more prosocial or beneficial behaviors, such as less cigarette use, may reflect a different peer group among gamers. As noted above, the general lack of associations between health behaviors and gaming in boys also may reflect the normative nature of gaming for boys in the current US culture.

Problematic Gaming

Although there are no uniformly agreed-on thresholds for excessive game playing, we found higher frequencies of playing among boys than girls, and ~14% of the boys reported playing an average of 3 hours/day or more. This, coupled with the possibility that frequencies may be underreported because of the known phenom-

TABLE 5 Demographic Characteristics of Those Who Report Video-Game Playing and Association With Problematic Gaming

Variable	Total Sample					Boys					Girls				
	n	%	Problematic Gamers, %	χ^2	*P*	*n*	%	Problematic Gamers, %	χ^2	*P*	*n*	%	Problematic Gamers, %	χ^2	*P*
Black															
Yes	219	9.97	7.76	3.56	.0591	141	9.83	7.80	1.08	.2995	71	9.74	2.82	0.0109	.917
No	1977	90.03	4.81			1294	90.17	5.64			658	90.26	3.04		
White															
Yes	1656	75.41	4.47	5.55	.0185	1079	75.19	4.91	6.99	.0082	561	76.95	3.21	0.3020	.5823
No	540	24.59	7.04			356	24.81	8.71			168	23.05	2.38		
Asian															
Yes	109	4.96	7.34	1.19	.2757	70	4.88	11.43	4.15	.0416	31	4.25	0.00	1.01	.3155
No	2087	95.04	4.98			1365	95.12	5.57			698	95.75	3.15		
Other race															
Yes	314	14.30	5.1	0.0001	.9968	200	13.94	6.50	0.18	.6747	107	14.68	2.80	0.02	.8885
No	1882	85.70	5.1			1235	86.06	5.75			622	85.32	3.05		
Hispanic															
Yes	296	14.02	7.43	4.63	.0315	184	13.37	8.70	3.64	.0564	102	14.35	3.92	0.27	.6021
No	1816	85.98	4.52			1192	86.63	5.20			609	85.65	2.96		
Grade															
9th	743	33.97	4.31	3.18	.3651	452	31.54	4.42	4.07	.2538	277	38.15	2.89	0.47	.9256
10th	601	27.48	5.16			400	27.91	6.00			192	26.45	3.13		
11th	525	24.01	4.95			364	25.40	5.77			157	21.63	2.55		
12th	318	14.54	6.92			217	15.14	8.29			100	13.77	4.00		
Family structure															
1 parent	478	22.12	5.02	.84	0.6573	290	20.45	5.52	0.408	.8154	183	25.74	3.83	0.502	.7781
2 parents	1566	72.47	4.92			1061	74.82	5.66			483	67.93	2.90		
Other	117	5.41	6.84			67	4.72	7.46			45	6.33	2.22		

enon of time lapse,[48] in which gamers seem unaware of how much time has elapsed while playing, may reflect a strong appeal of these games, particularly to boys. However, it also suggests a need to further characterize the potential risks and benefits associated with high-frequency play and to balance such risks and benefits against those of other activities favored by adolescents, including watching television or experimenting with substances.[53]

Boys were significantly more likely than girls to report problems with gaming. When examining the 3 measures of an ICD, a relatively low but important proportion of both boys and girls have gaming problems. Additional research is needed to examine the accuracy of self-reports of such problems and whether these or other questions are the best way to assess impairment related to gaming. It is possible, for example, that some of the items may be endorsed as a "badge of honor" (eg, claiming to have a problem or an irresistible urge to play as a sign of a serious or experienced player).

The results of this study suggest that adolescents with problematic gaming are more likely to also be engaging in other risk behaviors such as smoking, drug use, and violence and are more likely to report depression. It is not possible with these data to determine whether problematic gaming leads to experimentation, aggression, or depression or vice versa, or the factors develop in conjunction, perhaps related to common etiologic factors such as the violence content in games or other common underlying traits such as introversion/extraversion, impulsivity, or sensation-seeking. Future longitudinal research is needed to examine the onset of risk behaviors in temporal relation to gaming and their potential roles in the development of health problems.

Those who reported problems with gaming also were significantly more likely to report depression. Additional research is needed to understand the role that video games play in brain function,[54–56] including those pathways also associated with depression. However, some research has suggested that adolescents who play excessive amounts of video games, in part, do so to deal with negative affect.[50,57] Conversely, excessive playing may alter brain function in such a way as to increase depressed affect and the risk of depression.

Strengths and Limitations

This study is among the largest to examine gaming in high school students, and this sample size allowed for the examination of gender differences in health correlates. Data were examined by using regression models in a manner consistent with previous work that investigated youth impulse-control behaviors, which allows for comparabil-

TABLE 6 Health and Functioning Measures and Association With Problematic Gaming, According to Gender

Variable	Total Sample					Boys					Girls				
	n	%	Problematic Gamers, %	χ^2	*P*	*n*	%	Problematic Gamers, %	χ^2	*P*	*n*	%	Problematic Gamers, %	χ^2	*P*
Grade average															0.7521
As and Bs	1189	55.64	4.63	1.07	.5847	748	53.24	5.61	0.2313	.8908	431	61.05	2.78	0.569	
Cs	674	31.54	5.49			457	32.53	5.91			206	29.18	3.88		
Ds and Fs	274	12.82	5.84			200	14.23	6.50			69	9.77	2.90		
Extracurricular activities															0.1795
Yes	1646	74.95	4.68	2.42	.1198	1072	74.70	5.41	1.51	.2191	552	75.72	2.54	1.81	
No	550	25.05	6.36			363	25.30	7.16			177	24.28	4.52		
Smoking, lifetime															
Never	1363	64.35	3.96	10.28	.0058	911	66.06	4.39	9.91	.0071	434	61.13	2.76	2.08	0.353
Occasionally	467	22.05	5.57			302	21.90	6.62			161	22.68	2.48		
Regularly	288	13.60	8.33			166	12.04	10.24			115	16.20	5.22		
Marijuana, lifetime															0.0831
Yes	776	37.91	6.19	2.86	.0906	507	38.32	6.31	0.36	.5472	256	36.99	4.69	3	
No	1271	62.09	4.48			816	61.68	5.51			436	63.01	2.29		
Sip of alcohol, lifetime															0.6313
Yes	1758	85.05	4.95	0.78	.3778	1118	83.75	5.64	0.99	.3207	614	87.59	3.26	0.23	
No	309	14.95	6.15			217	16.25	7.37			87	12.41	2.30		
Current alcohol frequency															0.0751
Never regular	396	31.50	5.30	2.44	.4867	255	31.99	5.49	1.01	.7984	138	30.80	5.07	6.91	
Light	366	29.12	3.28			221	27.73	4.52			142	31.70	1.41		
Moderate	344	27.37	3.49			222	27.85	4.50			118	26.34	0.85		
Heavy	151	12.01	3.97			99	12.42	3.03			50	11.16	6.01		
Other drug use, lifetime															0.001
Yes	183	10.13	10.38	12.53	.0004	120	10.17	9.17	3.03	.0814	58	9.63	10.34	10.85	
No	1623	89.87	1.37			1060	89.83	5.28			544	90.37	2.39		
Caffeine use															0.0666
None	403	18.88	7.69	9.44	.0089	279	20.04	7.89	4.18	.1236	112	15.75	6.25	5.42	
1–2 drinks per d	1142	53.49	3.85			738	53.02	4.61			394	55.41	2.03		
≥2 drinks per d	590	27.63	5.08			375	26.94	5.87			205	28.83	2.93		
Sad or hopeless ≥2 wk														21.62	<0.0001
Yes	431	20.66	10.21	36.85	<.0001	211	15.62	11.37	17.44	<.0001	214	30.27	7.48		
No	1655	79.34	3.26			1140	84.38	4.30			493	69.73	1.01		
Serious fights														6.52	0.0106
Yes	177	8.30	14.12	35.56	<.0001	129	9.31	13.95	19.12	<.0001	41	5.73	9.76		
No	1955	91.70	4.04			1257	90.69	4.69			675	94.27	2.67		
Carry a weapon															0.369
Yes	530	24.75	7.74	12.63	.0004	431	30.85	7.66	5.51	.019	86	12.04	4.65	0.81	
No	1611	75.25	3.91			966	69.15	4.55			628	87.96	2.87		

ity across studies.[58] However, the data are cross-sectional, so that temporal associations cannot be elucidated, and this limits our ability to suggest causal pathways or theoretical models for problematic gaming. Also, the data were self-reported and the psychometric properties of the questions have not been directly evaluated, although they were based on validated questions used to assess other impulsive behaviors in the Minnesota Impulse Disorder Inventory.[52] Additional research is needed to determine whether these questions are accurate, reliable, and appropriate for assessing problem gaming. We selected a relatively stringent threshold for defining problematic gaming, and additional research is needed to determine the optimal threshold for this definition. Despite a substantial sample size, the low prevalence of problematic gaming did not allow us to fully investigate gender interactions in multivariable models. Given the suggestion of differences in bivariate analyses, future research should examine potential gender differences in the correlates of problematic gaming. In addition, other factors, such as depression, that are found in association with other impulse-control behaviors, may represent important variables of consequence (perhaps particularly for girls[59,60]) in the development of problematic video-gaming, and future studies should investigate directly and systematically the relationships between gender, mood, and problematic video-gaming. Additional factors such as temperament warrant similar consideration as potential vulnerability factors.[61] Such analyses could help identify how additional factors might be mediating the relationship between problem video-game playing and negative measures of health and functioning. Finally, we

TABLE 7 Adjusted Odds of Reporting Problematic Gaming, Adjusted for Race and Gender, Among Video Game Players

Variable	OR	95% CI	*P*
Grade average (reference: As and Bs)			
Cs	1.08	(0.69–1.71)	.7383
Ds and Fs	1.14	(0.62–2.08)	.6821
Extracurricular activities: yes	0.68	(0.44–1.05)	.0795
Smoking, lifetime (reference: never)			
Occasionally	1.36	(0.82–2.26)	.2369
Regularly	2.12	(1.23–3.64)	.0066
Marijuana, lifetime: yes	1.26	(0.82–1.92)	.2905
Sip of alcohol, lifetime: yes	0.93	(0.53–1.63)	.7945
Current alcohol frequency (reference: never regular)			
Light	0.76	(0.36–1.61)	.4701
Moderate	0.76	(0.35–1.63)	.4745
Heavy	0.97	(0.37–2.51)	.9449
Other drug use, lifetime: yes	2.25	(1.26–4.02)	.0064
Caffeine use (reference: none)			
1–2 drinks per d	0.51	(0.31–0.85)	.0094
≥2 drinks per d	0.70	(0.40–1.21)	.198
Sad or hopeless ≥2 wk: yes	3.62	(2.31–5.65)	<.0001
Serious fights: yes	2.97	(1.74–5.07)	<.0001
Carry a weapon: yes	1.65	(1.06–2.58)	.0262

were unable to distinguish between computer games, handheld video games, physically active games such as Wii, and online gaming. It is possible that each of these types of games attracts different types of players and correlates differentially with specific health measures, particularly because the types of games played may be directly associated with socioeconomic status, which we were unable to assess reliably.

CONCLUSIONS

We found no significant negative health correlates of video game use in boys, modest correlations with higher aggression and reduced depression in girls, a relatively low but important percentage of reported problems with gaming, and important associations between problematic gaming and smoking, drug use, aggressive behavior and depression, although there were no associations with grade averages, extracurricular activities, marijuana use, or alcohol use. Additional research is needed to examine recreational and problematic levels of video-gaming, to determine safe levels of gaming, and to identify risk factors and potential points of intervention and prevention. In addition, more research is needed into beneficial uses of video games given their popularity among youth.[62]

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REFERENCES

1. Wagner JS. When play turns to trouble: many parents are now wondering: how much is too much? *US News World Rep*. 2008;144(14):51–53
2. Dejoie JF. Internet addiction: a different kind of addiction [in French]? *Rev Med Liege*. 2001;56(7):523–530
3. Fitzpatrick JJ. Internet addiction: recognition and interventions. *Arch Psychiatr Nurs*. 2008;22(2):59–60
4. Grusser SM, Thalemann R, Griffiths MD. Excessive computer game playing: evidence for addiction and aggression? *Cyberpsychol Behav*. 2007;10(2):290–292
5. Meenan AL. Internet gaming: a hidden addiction. *Am Fam Physician*. 2007;76(8):1116–1117
6. Ng BD, Wiemer-Hastings P. Addiction to the internet and online gaming. *Cyberpsychol Behav*. 2005;8(2):110–113
7. Plusquellec M. Are virtual worlds a threat to the mental health of children and adolescents[in French]?. *Arch Pediatr* 2000;7(2):209–210
8. Sattar P, Ramaswamy S. Internet gaming addiction. *Can J Psychiatry*. 2004;49(12):869–870
9. Wan CS, Chiou WB. Why are adolescents addicted to online gaming? An interview study in Taiwan. *Cyberpsychol Behav*. 2006;9(6):762–766
10. Zyss T, Boron J. The world of computer games I: a new entertainment medium and new danger: description of a technique [in Polish]. *Psychiatr Pol*. 1996;30(2):255–266
11. Feng J, Spence I, Pratt J. Playing an action video game reduces gender differences in spatial cognition. *Psychol Sci*. 2007;18(10):850–855
12. Boot WR, Kramer AF, Simons DJ, Fabiani M, Gratton G. The effects of video game playing on attention, memory, and executive control. *Acta Psychol (Amst)*. 2008;129(3):387–398
13. Griffith JL, Voloschin P, Gibb GD, Bailey JR. Differences in eye-hand motor coordination of video-game users and non-users. *Percept Mot Skills*. 1983;57(1):155–158
14. Ferguson CJ. The good, the bad and the ugly: a meta-analytic review of positive and negative effects of violent video games. *Psychiatr Q*. 2007;78(4):309–316
15. Greenfield PM. Video games as cultural artifacts. *J Appl Dev Psychol*. 1994;15(1):3–12
16. Phillips CA, Rolls S, Rouse A, Griffiths MD. Home video game playing in schoolchildren: a study of incidence and patterns of play. *J Adolesc*. 1995;18:687–691

17. Kubey R, Larson R. The use and experience of the new video media among children and young adolescents. *Commun Res*. 1990; 17(1):107–130
18. Durkin K, Barber B. Not so doomed: computer game play and positive adolescent development. *J* Appl Dev Psychol. 2002;23(4): 373–392
19. Unsworth G, Devilly GJ, Ward T. The effect of playing violent video games on adolescents: should parents be quaking in their boots? *Psychol Crime Law*. 2007;13(4):383–394
20. Ferguson CJ, Rueda SM, Cruz AM, Ferguson DE, Fritz S, Smith SM. Violent video games and aggression: causal relationship or byproduct of family violence and intrinsic violence motivation? *Crim Justice Behav*. 2008; 35(3):311–332
21. Williams D, Skoric M. Internet fantasy violence: a test of aggression in an online game. *Commun Monogr*. 2005;72(2): 217–233
22. Ferguson CJ, San Miguel C, Hartley RD. A multivariate analysis of youth violence and aggression: the influence of family, peers, depression, and media violence. *J Pediatr*. 2009;155(6):904–908
23. Wiegman O, van Schie EG. Video game playing and its relations with aggressive and prosocial behaviour. *Br J Soc Psychol*. 1998; 37(Pt 3):367–378
24. Colwell J, Kato M. Investigation of the relationship between social isolation, self-esteem, aggression and computer game play in Japanese adolescents. *Asian J Soc Psychol*. 2003;6(2):149–158
25. Van Schie EG, Wiegman O. Children and videogames: leisure activities, aggression, social integration, and school performance. *J Appl Soc Psychol*. 1997;27(13):1175–1194
26. Ferguson CJ, Kilburn J. The public health risks of media violence: a meta-analytic review. *J Pediatr*. 2009;154(5):759–763
27. Savage J, Yancey C. The effects of media violence exposure on criminal aggression. *Crim Just Behav*. 2008;35(6);772–791
28. Anderson CA. An update on the effects of playing violent video games. *J Adolesc*. 2004;27(1):113–122
29. Anderson CA, Bushman BJ. Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: a meta-analytic review of the scientific literature. *Psychol Sci*. 2001;12(5):353–359
30. Anderson CA, Sakamoto A, Gentile DA, et al. Longitudinal effects of violent video games on aggression in Japan and the United States. *Pediatrics*. 2008;122(5) Available at: www.pediatrics.org/cgi/content/full/122/5/e1067
31. Colwell J, Payne J. Negative correlates of computer game play in adolescents. *Br J Psychol*. 2000;91(pt 3):295–310
32. Gentile DA, Lynch PJ, Linder JR, Walsh DA. The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *J Adolesc*. 2004; 27(1):5–22
33. Kim EJ, Namkoong K, Ku T, Kim SJ. The relationship between online game addiction and aggression, self-control and narcissistic personality traits. *Eur Psychiatry*. 2008; 23(3):212–218
34. Kutner LA, Olson CK. *Grand Theft Childhood: The Surprising Truth About Violent Video Games and What Parents Can Do*. New York, NY: Simon & Schuster; 2008
35. Lemmens JS, Bushman BJ, Konijn EA. The appeal of violent video games to lower educated aggressive adolescent boys from two countries. *Cyberpsychol Behav*. 2006;9(5): 638–641
36. Robinson TN, Wilde ML, Navracruz LC, Haydel KF, Varady A. Effects of reducing children's television and video game use on aggressive behavior: a randomized controlled trial. *Arch Pediatr Adolesc Med*. 2001; 155(1):17–23
37. Uhlmann E, Swanson J. Exposure to violent video games increases automatic aggressiveness. *J Adolesc*. 2004;27(1):41–52
38. Chiu SI, Lee JZ, Huang DH. Video game addiction in children and teenagers in Taiwan. *Cyberpsychol Behav*. 2004;7(5):571–581
39. Chou C. Internet heavy use and addiction among Taiwanese college students: an online interview study. *Cyberpsychol Behav*. 2001;4(5):573–585
40. Griffiths MD, Hunt N. Dependence on computer games by adolescents. *Psychol Rep*. 1998;82(2):475–480
41. Peters CS, Malesky LA. Problematic usage among highly-engaged players of massively multiplayer online role playing games. *Cyberpsychol Behav*. 2008;11(4):481–484
42. Tsai CC, Lin SS. Internet addiction of adolescents in Taiwan: an interview study. *Cyberpsychol Behav*. 2003;6(6):649–652
43. American Psychiatric Association. Impulse-control disorders not elsewhere classified. In: *Diagnostic and Statsitical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association; 1994: 609–621
44. Johansson A, Gotestam KG. Problems with computer games without monetary reward: similarity to pathological gambling. *Psychol Rep*. 2004;95(2):641–650
45. Tejeiro Salguero RA, Moran RM. Measuring problem video game playing in adolescents. *Addiction*. 2002;97(12):1601–1606
46. Bioulac S, Arfi L, Bouvard MP. Attention deficit/hyperactivity disorder and video games: a comparative study of hyperactive and control children. *Eur Psychiatry*. 2008; 23(2):134–141
47. Chan PA, Rabinowitz T. A cross-sectional analysis of video games and attention deficit hyperactivity disorder symptoms in adolescents. *Ann Gen Psychiatry*. 2006;5(5):16
48. Rau PL, Peng SY, Yang CC. Time distortion for expert and novice online game players. *Cyberpsychol Behav*. 2006;9(4):396–403
49. Chak K, Leung L. Shyness and locus of control as predictors of internet addiction and internet use. *Cyberpsychol Behav*. 2004; 7(5):559–570
50. Chumbley J, Griffiths M. Affect and the computer game player: the effect of gender, personality, and game reinforcement structure on affective responses to computer game-play. *Cyberpsychol Behav*. 2006;9(3): 308–316
51. Schepis T, Desai R, Smith A, Potenza M, Krishnan-Sarin S. Impulsive sensation seeking, parental history of alcohol problems, and current alcohol and tobacco use in adolescents. *J Addicti Med*. 2008; 2(4):185–193
52. Grant JE, Levine L, Kim D, Potenza MN. Impulse control disorders in adult psychiatric inpatients. *Am J Psychiatry*. 2005;162(11): 2184–2188
53. Cummings HM, Vandewater EA. Relation of adolescent video game play to time spent in other activities. *Arch Pediatr Adolesc Med*. 2007;161(7):684–689
54. Brewer JA, Potenza MN. The neurobiology and genetics of impulse control disorders: relationships to drug addictions. *Biochem Pharmacol*. 2008;75(1):63–75
55. Thalemann R, Wolfling K, Grusser SM. Specific cue reactivity on computer game-related cues in excessive gamers. *Behav Neurosci*. 2007;121(3):614–618
56. Grant JE, Brewer JA, Potenza MN. The neurobiology of substance and behavioral addictions. *CNS Spectr*. 2006;11(12): 924–930
57. Konijn EA, Bijvank MN, Bushman BJ. I wish I were a warrior: the role of wishful identification in the effects of violent video games on aggression in adolescent boys. *Dev Psychol*. 2007;43(4):1038–1044
58. Liu TC, Desai RA, Krishnan-Sarin S, Cavallo DA, Potenza MN. Problematic Internet use and health in adolescents: data from a high

school survey in Connecticut. *J Clin Psychiatry*. 2010; In press

59. Desai RA, Maciejewski PK, Pantalon MV, Potenza MN. Gender differences in adolescent gambling. *Ann Clin Psychiatry*. 2005;17(4):249–258
60. Olson CK. Children's motivations for video game play in the context of normal development. *Rev Gen Psychology*. 2010;14(2):180–187
61. Markey PM, Markey CN. Vulnerability to violent video games: a review and integration of personality research. *Rev Gen Psychology*. 2010;14(2):82–91
62. Barnett J, Coulson M. Virtually real: a psychological perspective on massively multiplayer online games. *Rev Gen Psychology*. 2010;14(2):167–179

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