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HOURS OF GAMING OR NON-ACADEMIC COMPUTER USE, SUBSTANCE USE, MENTAL HEALTH STATUS AND SCHOOL PERFORMANCE AMONG TEXAS ADOLESCENCE: FINDINGS FROM THE 2017 YRBS IN TEXAS

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Background

Literature Review / Introduction

Online gaming activities among adolescents and adults has increased exponentially in the last decade, and mental health issues associated with excessive gaming have drawn attention from health care professionals worldwide (Griffith, 2016). Recognizing this trend, American Psychiatric Association (APA) categorized gaming disorder/addiction as a mental health condition in 2013 in an effort to prevent the expansion of relevant mental health issues (American Psychiatric Association, 2013). Additionally, the World Health Organization (WHO) declared gaming disorder/addiction as a mental health disease, (World Health Organization, 2018). As a result of this declaration, *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) has established nine diagnostic criteria. One of the primary diagnostic criteria for gaming disorder from the DSM-5 is prolonged hours of gaming. Although prolonged hours of gaming are a necessary but not sufficient diagnostic criterion, one should not be diagnosed as having gaming disorder without spending prolonged period of time on gaming. Therefore, it is reasonable to consider prolonged hours of gaming as a major risk factor for gaming disorder/addiction, and those engaged in prolonged hours of gaming are among the population at risk. Estimating the size of the population at risk of gaming disorder/addiction is a step closer to the estimation of the prevalence of gaming disorder/addiction. There are prevalence estimates on the national level from a previous research (Lee, 2017), but there are no studies done on the prevalence estimates of population at risk in Texas yet.

Besides prolonged gaming hours, studies revealed that those who frequently use alcohol, marijuana, and/or tobacco tend to develop gaming addiction possibly due to the exposure to behavioral rewards can alter neural plasticity in brain areas that are influenced by substance use, and vice versa (Olsen, 2011). This conclusion motivates an exploration of how prolonged gaming, a prominent behavioral reward among adolescence, can interact with their substance use, including alcohol, marijuana, and/or tobacco. Grant's study in behavioral addictions also suggests that behavioral addictions overlap with substance addictions in domains such as genetics, neurobiological mechanisms, and treatment effects (Grant, 2010). Specifically, he discovered substantial similarities between behavioral addictions and substance addictions or dependence in terms of transmitter systems and genetics (Grant, 2006).

Finally, substance use among adolescence can also lead to lower academic performance (Santor, 2000). Panksepp argues that two distinct emotional systems, reward seeking and separation distress, dictate how emotions fluctuate depending on different stimuli, which imply that acquiring addictions is related to one's brain circuit activities, regardless the types of addictions (Panksepp, 2002). These findings have brought awareness on the connections between behavioral and substance addiction, as well as the risk factors that lead to either of them, such as the degree of substance use and/or the length of gaming hours. Therefore, leaving out substance use and disregarding the comorbidity of behavioral and substance addictions could bias the results of studies done on the relationship between prolonged hours of gaming and academic performance.

Public Health Significance

The fact that American Psychiatric Association and World Health Organization have categorized gaming disorder as a mental illness indicates that addiction to gaming has become a public health concern that deserves more attention from researchers (American Psychiatric Association, 2013). Griffiths' study points out that adolescents and adults use internet gaming as a common way of escape from reality or stress, and this explains why internet gaming has become prevalent among internet users since 2015 (Griffiths, 2016). According to Granic, about 91% of children between the ages of 2 and 17 play video games, 99% teenager boys and 94% teenage girls play video games; altogether, 97% of them play video games for at least one hour every day in the United States (Granic, 2014).

The high percentage of children and adolescents that play game daily nationwide leads to the question of what the percentage of prolonged gaming or non-academic computer use is locally, or in Texas, in this case. Knowing the size of the affected population should help researchers determine to what extend an intervention is necessary on the state level. This study endeavors to protect vulnerable population in Texas between age 12 to 18, which are critical years for school children to lay the foundation for their future academic or career success, as well as forming habits beneficial for their mental health.

Mechanisms

Impulsivity, lack of executive control, and addiction personality traits are common features among gaming disorder and substance use. The shared pathophysiological mechanism in both types of addictions indicates a strong neurobiological link between them. Structural brain imaging studies observed that gray matter volumes of orbitofrontal cortex, insula,

temporal gyrus, parietal cortex, postcentral gyrus, and occipital cortex decrease as one develops either type of addiction (Sook, 2018). Still, differences exist between the behavioral and substance addiction. Possibly due to active sensory and motor processing during gaming, individuals with gaming disorder were found with increased cortical thickness in the precuneus, and the precentral and middle temporal cortices, whereas individuals with excessive alcohol use showed negative functional connectivity in these areas (Yoon, 2017). These findings provide basis for researching the influence of the two types of addiction in a correlated manner instead of treating them separately.

Hypothesis, Research Question, Specific Aims or Objectives

This study aims to answer two research questions. First, what is the estimated prevalence of the adolescent population at risk of excessive gaming disorder in Texas. Second, what kinds of interactions exist between hours of gaming or non-academic computer use and substance use, and how academic performance differ on these habits that expose the users to various types of addictions. By answering these questions, this study should recommend corresponding interventions and future directions of research.

METHODS

This study will use data from the 2017 Texas adolescents' Youth Risk Behavior Survey (YRBS) provided by the Center for Disease Control and Prevention. The participants consist of both middle school and high school students age between 12 to 18. The survey questions focus on lifestyle factors, particularly those associated with health risks. Survey question used in this study will be relevant to mental health status, hours of daily gaming or non-academic computer use, and substance use including cigarette, tobacco, electronic vapor products (EVP),

alcohol, marijuana, and hard drugs. Unweighted prevalence is generated by SAS command PROC FREQ with a chi-square examining associations among the categorical variables. To discover how academic performance differs on multiple mental health risks including internet gaming and substance use, three-way ANOVAs are used to find the risks factors that are significant, and Bonferroni procedure is used for multiple comparisons within each group.

Data Analysis

To examine whether school performance differed based on mental health status, length of daily non-academic computer use, and six types of substance use including cigarette, other tobacco product, electronic vapor products (EVP), alcohol, marijuana, and hard drugs, three-way ANOVA tests in SAS will be used to analyze the YRBSS data. A study on gaming hours, personality and academic performance (Ventura, 2012) suggests the relationship between hours of gaming and GPA is not linear: students who do not spend any time on gaming or non-academic computer use and students who spend more than 5 hours on gaming or non-academic computer use both achieve less academically than those in the middle. Similarly, another study points out that gaming hours do not have a linear relationship with other conditions, such as mental health (Lee, 2017). Thus, it is appropriate to use hours of gaming or computer use as a categorical variable. The three-way ANOVA is performed one time on each type of substance use. The results from the Bonferroni procedure explain which subgroups differ from one another across the subgroups categorized by mental health status, daily non-academic computer use, and substance use.

Based on the independent variables mentioned above, participants are divided into two to five subgroups within each category of independent variable. Mental health status corresponds

to the survey question of "During the past 12 months, did you ever seriously consider attempting suicide?", which yields two options/groups—Yes or No. Number of hours of daily non-academic computer use is asked in the survey question "On an average school day, how many hours do you play video or computer games or use a computer for something that is not school work?". The answers are recoded into five groups: zero hours (I do not play video or computer games or use a computer for something that is not school work), one hour or less, two hours, three to four hours, and five hours or more per day. Among the answers to the questions asking for six types of substance use, cigarette and marijuana use are recoded and categorized into never used before, used before but not this month, used this month but rarely, used this month on a regular basis, and frequently used this month. Electronic vapor products (EVP) and alcohol use have four categories: never used before, used before but not this month, used this month infrequently, and frequently used this month. Tobacco use has three categories: never used before, used before but not this month, used this month. Since hard drug use is not prevalent among teenage population, the survey question asks about lifetime use, and the answer is categorized into never used before, use rarely, and use not rarely.

RESULTS

Summary Statistics

Among the 2113 high school students from Texas, 1122 of them are females and 991 of them are males. There are 470 of them have prolonged hours (5 hours per day or more) of gaming or non-academic computer use, with 289 (13.68%) females and 181 (8.57%) males. The distribution of students among the five categories of hours of non-academic computer use

hours are relatively even: 465 (22.01%) non-users, 437(20.68%) people use one hour or less, 305 (14.43%) people use about two hours, 436 (20.63%) people use around 3 or 4 hours, and 470 (22.24%) people use five hours or more on a daily basis.

The results of chi-square tests indicate that significant differences exist between hours of daily internet gaming or non-academic computer use and age (χ^2 = 39.13, p <0.0001), gender (χ^2 = 59.50, p < 0.001) , mental health status represented by whether suicidal or not (χ^2 = 19.2, p = 0.0007), hours of sleep (χ^2 =71.13 , p < 0.0001), other tobacco product use (χ^2 = 16.38 , p = 0.0373), and marijuana use (χ^2 = 29.99, p = 0.018). Based on the frequency distribution in table 1, students are less concentrated in the two-hour section, or the middle section of non-academically computer use, and more concentrated on the two opposite sides of the spectrum; female students use computer more for gaming or non-academic purposes than male students; students with suicidal thoughts spend much less time on computer for gaming or non-academic purposes, and they contribute more to the difference with a χ^2 of 15.8 than students without suicidal thoughts with a χ^2 of 3.4; those who sleep the most (χ^2 = 13.7) or the least (χ^2 = 34.7) have more significant differences than those who sleep 5 – 6 (χ^2 = 10.8) or 7 – 8 (χ^2 = 11.9) hours in their internet gaming or non-academic computer use hours. The use of other tobacco products and marijuana are not as significant as other categorical variables. Marijuana has “Not Recent” users, and other tobacco products has “Occasional” users contribute the most to their significant differences with a χ^2 of 12.9 and 12.1, respectively. Ethnicity represented by being Hispanic or not, average school performance, electronic vapor products (EVP), alcohol, and hard drugs are not associated with hours of daily internet gaming or non-academic computer use, in this case.

Table 1. Summary Statistics of Participants by Internet Gaming or Non-Academic Computer-Use Hours

	Hours of Daily Internet Gaming or Non-academic Computer Use						
	0 n(%)	≤ 1 n(%)	2 n(%)	3 – 4 n(%)	≥ 5[1] n(%)	χ^2	P Value
Age						39.13	< 0.0001
≤ 15	143(6.77)	183(8.66)	131(6.20)	199(9.42)	186(8.80)	14.5	
16-17	232(10.98)	200(9.47)	151(7.15)	185(8.76)	216(10.22)	3.4	
≥ 18	90(4.26)	54(2.56)	23(1.09)	52(2.46)	68(3.22)	21.2	
Gender						59.50	<0.001
F	293(13.87)	193(9.13)	133(6.29)	214(10.13)	289(13.68)	27.9	
M	172(8.14)	244(11.55)	172(8.14)	222(10.51)	181(8.57)	31.6	
Hispanic						4.81	0.7773
N	150(7.1)	153(7.24)	112(5.3)	152(7.19)	176(8.33)	2.0	
Y	303(14.34)	272(12.87)	185(8.76)	276(13.06)	287(13.54)	0.9	
N/A	12(0.57)	12(0.57)	8(0.38)	8(0.38)	8(0.38)	1.8	
Suicidal						19.12	0.0007
Y	95(4.5)	62(2.93)	37(1.75)	74(3.5)	104(4.92)	15.8	
N	370(17.51)	375(17.75)	268(12.68)	362(17.13)	366(17.32)	3.4	
Hours of Sleep						71.13	
≤ 4	78(3.69)	43(2.04)	12(0.57)	33(1.56)	57(2.7)	34.7	<0.0001
5 - 6	160(7.57)	135(6.39)	99(4.69)	175(8.28)	196(9.28)	10.8	
7 - 8	198(9.37)	211(9.99)	174(8.23)	196(9.28)	195(9.23)	11.9	
9 - 10	29(1.37)	48(2.27)	20(0.95)	32(1.51)	22(1.04)	13.7	
Average School Performance						26.09	0.0527
A	151(7.15)	135(6.39)	104(4.92)	133(6.29)	115(5.44)	7.5	
B	217(10.27)	206(9.75)	151(7.15)	206(9.75)	224(10.6)	0.3	
C	60(2.84)	67(3.17)	32(1.51)	64(3.03)	87(4.12)	9.5	
D/F	19(0.90)	11(0.52)	5(0.24)	12(0.57)	23(1.09)	8.2	
N/A	18(0.85)	18(0.85)	13(0.62)	21(0.99)	21(0.99)	0.5	
Cigarette Use						15.52	0.4870
Never	312(14.77)	305(14.43)	224(10.6)	315(14.91)	330(15.62)	1.4	
Not recent	93(4.4)	82(3.88)	53(2.51)	85(4.02)	103(4.87)	2.2	
Recent, rare	26(1.23)	25(1.18)	14(0.66)	18(0.85)	14(0.66)	5.1	
Recent, occasional	16(0.76)	13(0.62)	7(0.33)	12(0.57)	12(0.57)	1.1	
Recent, regular	18(0.85)	12(0.57)	7(0.33)	6(0.28)	11(0.52)	5.7	
Other Tobacco Products Use						16.38	0.0373
Never	421(19.92)	393(18.6)	274(12.97)	400(18.93)	444(21.01)	0.7	
Occasional	34(1.61)	41(1.94)	25(1.18)	29(1.37)	17(0.8)	12.1	

Regular	10(0.47)	3(0.14)	6(0.28)	7(0.33)	9(0.43)	3.5	
EVP Use						20.42	0.0596
Never	264(12.49)	239(11.31)	189(8.94)	275(13.01)	263(12.45)	4.0	
Not recent	167(7.9)	157(7.43)	89(4.21)	133(6.29)	169(8)	5.2	
Recent, occasional	17(0.80)	29(1.37)	21(0.99)	23(1.09)	26(1.23)	5.0	
Recent, frequent	17(0.80)	12(0.57)	6(0.28)	5(0.24)	12(0.57)	6.2	
Alcohol Use						17.78	0.1225
Never	212(10.03)	207(9.8)	147(6.96)	196(9.28)	182(8.61)	5.4	
Not recent	113(5.35)	119(5.63)	77(3.64)	121(5.73)	140(6.63)	3.1	
Recent, occasional	123(5.82)	101(4.78)	70(3.31)	113(5.35)	131(6.2)	3.0	
Recent, frequent	17(0.80)	10(0.47)	11(0.52)	6(0.28)	17(0.80)	6.4	
Marijuana Use						29.99	0.018
Never	277(13.11)	285(13.49)	209(9.89)	284(13.44)	285(13.49)	3.3	
Not recent	112(5.3)	74(3.5)	41(1.94)	77(3.64)	93(4.4)	12.9	
Recent, occasional	40(1.89)	45(2.13)	35(1.66)	55(2.6)	58(2.74)	4.5	
Recent, frequent	20(0.95)	24(1.14)	10(0.47)	14(0.66)	18(0.85)	3.6	
Recent, everyday	16(0.76)	9(0.43)	10(0.47)	6(0.28)	16(0.76)	5.7	
Hard Drugs Use[2]						10.38	0.2396
Never	396(18.74)	372(17.61)	276(13.06)	389(18.41)	412(19.50)	1.0	
Rare	51(2.41)	51(2.41)	25(1.18)	37(1.75)	42(1.99)	4.1	
Not Rare	18(0.85)	14(0.66)	4(0.19)	10(0.47)	16(0.76)	5.2	
Total	465(22.01)	437(20.68)	305(14.43)	436(20.63)	470(22.24)		

1 - Prolonged gaming or non-academic computer use hours; considered at risk of having Internet Gaming Disorder (IGD).

2 - **Hard Drug Use** includes the use of heroin, meth, ecstasy, cocaine, synthetic marijuana, or any combinations of them.

Values are n (%), unless otherwise indicated.

Three-way ANOVA Tests and Post Hoc Analyses

In the three-way ANOVA model, academic performance measured on a scale from 0 to 100 is used as dependent or outcome variable, and mental health status, hours of daily non-academic computer use, and a type of substance are used as independent variables. The interaction terms between the three independent variables are included in the model to account for compound impacts on the outcome variable. The three-way ANOVA is performed six times to account for the six substances found among high school populations.

Give the presence of mental health status and hours of daily non-academic computer use, significance differences in academic performance are identified for all the six substances with their p values all less than 0.0001, according to table 2. This means there are significant three-way interactions among the three independent variables for each type of substance use.

The Bonferroni correction has identified the differences within each group. Regardless of the types of substance, students with suicidal thoughts have a considerably lower average grade of 83.87 than students without suicidal thoughts with an average grade of 86.19. Students who use computer for gaming or non-academic purpose for 5 hours or more daily have significantly lower grades than all other categories.

For cigarette use, students who never use cigarette have higher grades than those who have, and those who have used before but not recently have significantly higher grades than those who smoke cigarettes frequently in the recent month; the combination with the lowest school performance (mean = 68.33, sd = 17.51) is smoking frequently with suicidal thoughts and 5 or more daily hours of gaming or non-academic computer use.

For other tobacco products use, those who never use tobacco products have significantly higher grades than those who have, regardless of being recent users or not; the combination with the lowest school performance (mean = 57.50, sd = 5.00) is recently using tobacco products with suicidal thoughts and having 5 or more daily hours of gaming or non-academic computer use.

For electronic vapor products use, students who never use EVP have significantly higher grades than those who have, and students who are not recent users have higher grades than recent users; the combination with the lowest school performance (mean = 71.00 sd =

8.9442719) is being recent, infrequent users with suicidal thoughts and having 5 or more daily hours of gaming or non-academic computer use.

For alcohol use, students who never use alcohol and who are not recent users have significantly better grades than those who use alcohol recently; the combination with the lowest school performance (mean =70.00 sd = 7.07) is being a recent and frequent user with suicidal thoughts and having 1 daily hours of gaming or non-academic computer use.

For marijuana use, never-users have significantly higher grades than those who have used marijuana; students who have not used recently have higher grades than recent users; the combination with the lowest school performance (mean = 60.00, sd = 10.00) is being recent and frequent users with suicidal thoughts and having 5 or more daily hours of gaming or non-academic computer use.

For hard drug use, students who never use hard drugs have the highest school scores, followed by student who use it rarely during their life time, and students who use hard drugs more during their life time have the lowest school scores; the combination with the lowest school performance (mean = 63.57, sd = 14.6385011) is using hard drugs more than rarely with suicidal thoughts and having 5 or more daily hours of gaming or non-academic computer use.

In summary, all six types of substance use, mental health status, and hours of daily non-academic computer use contribute to a significant three-way interaction. The conclusions from the Bonferroni procedures demonstrate that prolonged hours of daily non-academic computer use and mental health status can significantly influence school performance with presence of one or more types of substance use.

Table 2. Multiple Comparisons of Academic Performance Across Substance Use, Mental Health Status, and Hours of Non-academic Computer Use Hours Groups

Academic Performance		Suicidal		Hours of Daily Non-Academic Computer Use					Overall Statistics		Post hoc
		Y (n = 372)	N (n = 1741)	0^{a} (n = 465)	$\leq 1^{b}$ (n = 437)	2^{c} (n = 305)	$3—4^{d}$ (n = 436)	$\geq 5^{e}$ (n = 470)	F	P Value	
Cigarette Use[1]	Never[A] (n = 1486)	85.42 ± 8.80	86.92 ± 7.30	87.04 ± 7.74	86.75 ± 7.46	87.44 ± 7.05	87.24 ± 7.05	85.42 ± 8.03	3.66	< 0.0001	A > B, C, D, E; B > E
	Not Recent[B] (n = 416)	83.10 ± 9.07	84.80 ± 7.96	85.00 ± 8.03	84.62 ± 7.92	87.55 ± 6.27	84.15 ± 8.20	82.23 ± 9.18			
	Recent, rare[C] (n = 97)	83.40 ± 10.28	83.21 ± 9.20	83.80 ± 9.71	85.87 ± 9.00	84.29 ± 7.30	78.53 ± 9.31	82.69 ± 10.92			
	Recent, regular[D] (n = 60)	83.13 ± 6.55	81.51 ± 11.31	80.63 ± 12.63	81.15 ± 6.50	83.57 ± 10.69	79.55 ± 12.93	85.83 ± 6.69			
	Recent, frequent[E] (n = 54)	75.52 ± 12.24	83.75 ± 11.00	83.13 ± 9.11	84.17 ± 9.96	80.71 ± 12.72	81.67 ± 10.33	72.00 ± 16.36			
Tobacco Use[2]	Never[A] (n = 1932)	84.60 ± 8.87	86.50 ± 7.59	86.40 ± 7.90	86.35 ± 7.69	87.53 ± 6.89	86.52 ± 7.59	84.72 ± 8.44	5.03	< 0.0001	A > B, C
	Not Recent[B] (n = 146)	82.25 ± 9.87	81.90 ± 9.61	81.56 ± 11.81	82.95 ± 8.00	83.00 ± 10.00	80.71 ± 9.59	81.25 ± 8.85			
	Recent[C] (n = 35)	73.18 ± 13.28	84.09 ± 9.21	87.22 ± 6.67	88.33 ± 5.77	88.33 ± 4.08	76.67 ± 7.53	71.67 ± 16.58			
EVP	Never[A] (n = 1230)	85.71 ± 8.59	86.91 ± 7.55	87.04 ± 8.12	87.06 ± 7.13	87.64 ± 6.91	87.35 ± 7.23	84.96 ± 8.48	3.97	<	A > B, C, D;
	Not Recent[B] (n = 715)	83.68 ± 9.40	85.43 ± 7.83	85.56 ± 7.69	85.07 ± 8.52	86.95 ± 6.79	83.79 ± 8.80	84.44 ± 8.58			

Use[3]	Recent, infrequent[C] (n = 116)	81.18 ± 9.22	83.21 ± 9.08	80.63 ± 12.63	83.93 ± 8.32	84.52 ± 8.65	81.82 ± 7.16	81.40 ± 9.52		0.0001	B > C, D
	Recent, frequent[D] (n = 52)	79.09 ± 11.41	82.50 ± 9.28	81.00 ± 8.28	84.17 ± 5.15	80.00 ± 13.78	87.00 ± 8.37	75.83 ± 13.79			
Alcohol Use[4]	Never[A] (n = 944)	85.00 ± 9.83	86.64 ± 7.49	87.55 ± 7.50	86.46 ± 7.83	87.27 ± 7.20	85.56 ± 7.51	84.47 ± 84.44	3.05	< 0.0001	A, B > C, D
	Not Recent[B] (n = 570)	85.78 ± 7.80	86.69 ± 7.94	86.09 ± 8.28	85.95 ± 7.22	88.12 ± 6.74	88.01 ± 7.06	85.22 ± 9.14			
	Recent, infrequent[C] (n = 538)	83.01 ± 8.76	84.87 ± 8.04	84.09 ± 8.76	85.63 ± 7.69	85.72 ± 7.92	83.27 ± 8.66	83.98 ± 7.95			
	Recent, frequent [D] (n = 61)	76.05 ± 13.70	84.23 ± 9.00	82.50 ± 10.65	83.00 ± 12.29	85.00 ± 6.67	80.00 ± 8.37	78.13 ± 14.48			
Marijuana Use[5]	Never[A] (n = 1340)	85.90 ± 8.90	87.36 ± 7.18	87.25± 7.67	87.54 ± 7.12	87.88 ± 6.78	87.66 ± 7.07	85.74 ± 8.12	4.76	< 0.0001	A > B, C, D, E; B > D, E; C > E,
	Not Recent[B] (n = 397)	84.03 ± 8.22	84.62 ± 8.60	84.82 ± 8.46	84.72 ± 7.31	87.31 ± 7.06	83.77 ± 9.12	83.22 ± 9.31			
	Recent, rare[C] (n = 233)	83.03 ± 7.69	83.69 ± 8.10	85.00 ± 9.43	82.50 ± 8.11	84.71 ± 7.07	81.98 ± 7.99	83.94 ± 7.24			
	Recent, regular[D] (n = 86)	77.35 ± 13.00	82.54 ± 8.11	83.42 ± 8.98	81.36 ± 10.02	84.00 ± 11.00	81.92 ± 6.30	77.77 ±10.18			
	Recent, frequent[E] (n = 57)	76.18 ± 13.64	80.28 ± 9.10	80.00 ± 10.19	80.56 ± 8.82	81.00 ± 9.66	81.00 ± 11.40	75.00 ± 13.09			
Hard Drugs Use[6]	Never[A] (n = 1845)	85.04 ± 8.60	86.56 ± 7.57	86.57 ± 7.79	86.66 ± 7.45	87.21 ± 7.23	86.65 ± 7.56	84.92 ± 8.32	6.17	< 0.00	A > B > C
	Rare[B] (n = 206)	83.33 ±	83.07 ±	82.80 ±	84.18 ±	85.80 ±	81.29 ±	82.38 ±			

		8.15	8.33	10.36	6.40	6.40	8.08	8.28		01	
	Not Rare[C] (n = 62)	70.56 ± 13.38	82.81 ± 11.29	84.38 ± 10.63	77.14 ± 12.51	85.00 ± 14.14	78.00 ± 11.60	74.33 ± 15.80			
Post hoc		Y < N		a, b, c, d > e					* 2[C, Y, e] < 5[E, Y, e] < 6[C, Y, e] < 1[E, Y, e] < 4[D, Y, b] < 3[C, Y, e]		
* Ranking of the lowest school performance for each combination of substance use, mental health status (suicidal), and non-academic com											

DISCUSSION

Limitations and Strength

This study has multiple flaws. First, since data are only available from the aspects of risky behaviors and lifestyles, the result of this study could not distinguish whether the students' school performance is more attributable to other factors considered correlated to academic performance, such as parents' involvement in these students' education, or is more attributable to their length of gaming time. Second, this study does not provide an accurate account on the impact of gaming addiction on academic performance, because length of gaming time is only one of the nine criteria in DSM-5 diagnosis. Third, as a typical cross-sectional design, this study cannot explain whether participants with low academic performance were already having such grades prior to their gaming habits. Fourth, this study contradicts with other studies in terms of the role of gender in the amount of time spent on gaming or non-academic computer use. Other studies, for example, either discover that males with higher proportion of gaming or

non-academic computer use (Ko, 2005) or conclude that gender is not associated with internet gaming (Na, 2011). The contradiction should lead to an important question—what attributes to female students' longer hours of non-academic computer use and is it due to internet gaming or something else, such as social media. However, this question was not asked, and thus this study could not provide this useful piece of information that helps researchers to better understand the non-academic computer use among female students.

This study has three strengths. First, it provides an estimation of the population at risk of gaming disorder/addiction in Texas. The prevalence of spending 5 or more hours daily on non-academic computer use is 22.24%; female has a prevalence of 25.76% and male has a prevalence of 18.26%, and according to table one, gender is significantly associated with amount of time spent on gaming or non-academic computer use (χ^2= 39.13, p < 0.001). When compared with the overall IGD prevalence in North America (9.4%, 95% CI = 8.3%-10.5%), this may not necessarily be interpreted as Texas adolescents are more at risk, but public health professionals should be alarmed of this information. Second, the Bonferroni procedure reveals in table 2 that high school students with suicidal thoughts generally have a significantly lower school scores than those who do not have suicidal thoughts given the same level of substance use. This should bring awareness to the harmful compound effects of mental health status and substance use on high school students' academic performance. Third, this study examines a wide range of substance use, including electronic vapor products and hard drugs. Although hard drug use is not as prevalent as cigarette, marijuana, and alcohol use, providing an estimation of their prevalence can initiate efforts on lowering drop-out rates among high school students.

Future Recommendations

In terms of statistical method, multivariate logistic regression analyses can be used to evaluate the magnitude of the effects of predictor variables on academic performance with forward selection of the predictor variables. To improve the R squared for the models, other relevant variables such as social economic status of the participants' family or parents, and gender, should be included. The reported odds ratios can give directions of how the predictor variables influence the outcome variable other than simply showing whether they are associated with the outcome or not as in the ANOVA models. This should give more specific information on their relationships to the outcome variable. Comorbidity or overlap in substance use is not accounted for in this study, and there is a lack of distinction between computer use activities that this study could not distinguish between gaming and internet gaming.

Since Internet Gaming Disorder has nine diagnostic criteria established in DSM-5, and other psychometrically robust assessment tools have been developed to assist with the diagnosis based on DSM-5 (Pontes, 2014), researchers can design survey instruments with questions revolve around the unified criteria among these assessment tools. This could help narrow down the predictor variables that closely resemble the diagnostic criteria.

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