OXFORD

International Journal of Neuropsychopharmacology (2020) 23(6): 349–355

doi:10.1093/ijnp/pyaa010
Advance Access Publication: 12 February 2020
Regular Research Article

REGULAR RESEARCH ARTICLE

Treatment Efficacy of Internet Gaming Disorder With Attention Deficit Hyperactivity Disorder and Emotional Dysregulaton

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Abstract

Background: Recent youth with Attention Deficit Hyperactivity Disorder (ADHD) noticed emotional dysregulation if they had Internet Gaming Disorder (IGD). This study aims to understand the treatment efficacy of IGD with ADHD and emotional dysregulaton.
Method: A total of 101 ADHD youths were recruited. We used the Chen Internet Addiction Scale and IGD criteria of the diagnotsic statistical manual (DSM)-5 to confirm IGD. The Swanson, Nolan, and Pelham questionnaire Version IV was used for symptoms of ADHD and oppositional defiant disorder. Disruptive mood dysregulation disorder was assessed by psychiatrist.
Results: There is a new phenomenon that emotional dysregulation has been frequently noticed in severely gaming-addicted ADHD youth. Treatment efficacy of IGD is good when the underlying symptom of ADHD is controlled. Symptom scores of disruptive mood dysregulation (DMDD) were significantly reduced by 71.9%, 74.8%, and 84.4% at week 2, 3, and 4, respectively ($P \leq .001$) after adjusting baseline symptom severity.
Conclusion: IGD may strongly arouse emotional dysregulation. Future DSM criteria could consider these gaming-addicted youth as a specific subclass of ADHD.

Keywords: ADHD, IGD, treatment efficacy, DMDD

Introduction

The majority of modern youth play with computers for pleasure and spend excessive time on computer gaming or social media (Sriwilai and Charoensukmongkol, 2016). The internet brought great convenience and benefit to people. Although some studies have denied the concrete evidence of an association between pathological internet overuse and psychiatric disorders (Przybylski et al., 2017), while child and adolescent was falling into an internet-addicted state, indeed there is the complicated negative mood noticed or speeded over them (Jorgenson et al., 2016). The reported serious consequences of Internet Gaming Disorder (IGD) include cyber-bullying (Gamez-Guadix et al., 2016), disorganized behavior and compromised self-care (Sachdeva and Verma, 2015), unhealthy lifestyles and high-risk behavior (Durkee et al., 2016), internet criminality (Recupero,

Received: July 16, 2019; **Revised:** January 16, 2020; **Accepted:** February 10, 2020

Significance Statement

The number of youth with internet addiction is gradually increasing. Many are noticing the adverse influence of the Internet Gaming Disorder (IGD) toward children and adolescents. Children and adolescent psychiatrists highlight the lethal influence of self-injury, suicide, or comorbidity of gaming disorder. But no one, to our knowledge, has ever suggested the lethality of emotional dysregulation in the development of children. Clinically, we first noticed that IGD can cause disruptive mood dysregulation on children. Therefore, we must face the new adverse effects of IGD on children's development. Especially for those children and adolescents with Attention Deficit Hyperactivity Disorder (ADHD), they need earlier recognition and treatment of disruptive mood dysregulation disorder-like symptoms.

2008), social aggression or self-aggression (Bayraktar and Gun, 2007), and social withdrawal state or so-called "Hikikomori syndrome" (Stip et al., 2016).

Only because youth with IGD ultimately became increasingly aggressive, violent, or delinquent (Weissenberger et al., 2016), the American Psychiatric Association recently included IGD as a supplementary diagnosis in the new diagnostic statistical manual (DSM)-5 criteria (Yoo et al., 2004; Yen et al., 2007; Reinhardt and Reinhardt, 2013). Child mental health experts had started to notice many hazards caused by internet addiction (Nakayama et al., 2017) and focused more on treatment efficacy of IGD among clinical samples.

Despite many previous studies reporting IGD comorbid with various mental disorders (Young, 2008), depression and anxiety, higher degrees of impulsiveness and anger/aggression, higher levels of distress, poorer quality of life, and impaired inhibition response (Lim et al., 2016), the research on treatment efficacy of IGD among clinical samples is limited. While researcher studying the topic of treatment efficacy on IGD, the treatment effect of clinically comorbid other mental disorder of IGD should be explored appropriately. Clinically, Attention Deficit Hyperactivity Disorder (ADHD) mostly co-occurred with IGD among the child and adolescent population (Bozkurt et al., 2013) as also shown by a meta-analysis study conducted by Ho et al. (Ho et al., 2014). Therefore, the treatment efficacy of IGD should consider the treatment efficacy of underlying ADHD and other mental disorders.

Another new interesting mental consequence of gaming addiction is their severe irritability or emotional disruption toward their caregiver (Kaptsis et al., 2016). It might be imaginable that when parents force their children to quit using the internet, the majority of youth experienced withdrawal syndrome of internet addiction presented as emotional disruption, although 1 recent study indicated childhood emotion regulation deficits can predict symptoms of IGD at age 10 years (Wichstrom et al., 2019). Only a few reported emotional dysregulation after IGD, there is no study before to link IGD with emotional dysregulation before. So, there is no study to mention the treatment efficacy toward this phenomenon too. For youth with ADHD, such disruptive moods are dangerous and worthy of immediately exploring the association between IGD and disruptive mood. Therefore, ADHD youth's similar symptom presentation of Disruptive Mood Dysregulation Disorder (DMDD) after their withdrawal syndrome of internet addiction should be assessed and also treated earlier.

Reviewing the literature on treatment efficacy of IGD showed only the following treatment options were summarized: pharmacotherapy by methylphenidate (MPH) and atomoxetine both can reduce the symptom severity of children with IGD comorbid with ADHD (Park et al., 2016). Furthermore, Han et al. in Korea highlighted that MPH might play a significant role as a potential treatment drug for internet addiction (Han et al., 2009). Antidepressants such as bupropion and escitalopram were also found to be effective in treating symptoms of IGD comorbid with depressive symptom (Song et al., 2016). Otherwise, providing nonpharmacological intervention as cognitive behavioral therapy and family therapy to patients and their parents is also very important and effective treatment of IGD (Elsalhy et al., 2016). Treatment efficacy of IGD depends on how well the symptoms of ADHD (Chou et al., 2015) and the symptom severity of ADHD (Dalbudak and Evren, 2014) are being controlled. But to our knowledge, no study has previously explored the treatment effects of IGD with ADHD- and DMDD-like symptom.

This study used the clinical patient data from the out-patient department of psychiatry to study the proportion of emotional dysregulation presented as DMDD-like symptoms and to understand the treatment efficacy among gaming-addicted ADHD youth. Here, we hypothesized the impulsive or disruptive mood dysregulation may lead treatment efficacy of IGD to become poor. Moreover, we need to explore whether only controlling symptoms of ADHD would still be effective for those children co-occurring with ADHD, IGD, and DMDD. Results of this study may provide guidelines to child psychiatrists for diagnosing IGD and treating patients earlier considering a new phenomenon the emotional dysregulation might be noticed on ADHD youth as they became internet gaming disordered patient.

Methods

Participants and Data Collection

Patients were recruited from the Out-Patient Units of Mackay Memorial Hospital in Taipei, Taiwan, and the research protocol was approved by the hospital's institutional review board. Written informed consent was obtained from each patient consistent with the institutional review board guidelines. The inclusion criteria were males or females with ADHD from 7 to 18 years old. The exclusion criteria were as follows: pediatric patients or their parent(s)/caregiver(s) with known or suspected psychotic disease, mental retardation, or other mental conditions that would prevent them from completing the study. After obtaining signed consent from a legal guardian, all patients recruited for this study were invited to participate in the following programs and were interviewed to provide the following measurements.

Measurement

Chen Internet Addiction Scale (CIA)

The CIA is a self-reported questionnaire consisting of 26 questions on a 4-point scale that assesses with good reliability and validity (Chen et al., 2003) the 5 dimensions of internet use-related problems: compulsive use, withdrawal, tolerance, interpersonal and health problems, and time management problems. The internal reliability of the scale and the subscales in the original study ranged from 0.79 to 0.93. Higher CIA scores indicated increased severity of internet addiction. The CIA has good diagnostic accuracy

Table 1. Characteristics of Patients with ADHD (Categorical Variable)

		IA internet addiction (CIAS > 56)		
		No (n = 49)	Yes (n = 52)	P value[a]
Sex	Male	38 (77.6%)	31 (59.6%)	.058
	Female	11 (22.4%)	21 (40.4%)	
Performance	Middle	24 (50.0%)	23 (45.1%)	.689
	Worse	24 (50.0%)	28 (54.9%)	
Interpersonal	Good	36 (75.0%)	24 (47.1%)	.007
Relationship	Bad	12 (25.0%)	27 (52.9%)	
ODD	No	15 (30.6%)	8 (15.4%)	.096
	Yes	34 (69.4%)	44 (84.6%)	
DMDD	No	23 (46.9%)	11 (21.2%)	.011
	Yes	26 (53.1%)	41 (78.8%)	
Comorbidity	Yes	39 (79.6%)	52 (100.0%)	<.001
	No	10 (20.4%)	0 (0.0%)	
Subtype	Combined	35 (71.4%)	30 (57.7%)	.212
	Inattentive	14 (28.6%)	22 (42.3%)	
Family psychiatric	Yes	11 (22.4%)	10 (19.2%)	.807
history	No	38 (77.6%)	42 (80.8%)	
Sibling with ADHD	Yes	11 (22.4%)	9 (17.3%)	.620
	No	38 (77.6%)	43 (82.7%)	
Daily online	More than 1 h	23 (46.9%)	42 (80.8%)	<.001
Chatting or gaming	Less than 1 h	26 (53.1%)	10 (19.2%)	
Weekend online	More than 3 h	21 (42.9%)	44 (84.6%)	<.001
Chatting or gaming	Less than 3 h	28 (57.1%)	8 (15.4%)	
Treatment effect	Good	14 (50.0%)	11 (31.4%)	.195
	Bad	14 (50.0%)	24 (68.6%)	
Attend parent group	Yes	7 (23.3%)	8 (20.0%)	.775
Program	No	23 (76.7%)	32 (80.0%)	
Compliance	Good	13 (48.1%)	10 (27.8%)	.118
	Bad	14 (51.9%)	26 (72.2%)	
		IA internet addiction (CIAS ≥ 57)		
		No (n = 49)	Yes (n = 52)	P-value[b]
Height		138.80 ± 18.15	148.72 ± 18.80	.009
Weight		35.89 ± 15.06	45.94 ± 18.41	.003
Age		10.16 ± 3.06	12.28 ± 3.73	.002
Father's age		42.63 ± 6.30	46.94 ± 7.85	.003
Mother's age		40.22 ± 7.25	43.60 ± 7.03	.020
SNAP_1_9		20.02 ± 3.23	21.13 ± 3.72	.112
SNAP_10_18		13.98 ± 7.11	14.00 ± 7.04	.988
SNAP_19_26		12.20 ± 6.28	14.00 ± 4.66	.108
DMDD total		1.12 ± 1.15	1.92 ± 1.03	< .001
CIAS		42.00 ± 10.66	72.81 ± 9.84	< .001
IGD (DSM-5)		5.57 ± 4.59	14.77 ± 5.02	< .001

Abbreviations: ADHD, Attention Deficit Hyperactivity Disorder; CIAS, Chen's Internet Addiction Scale; DMDD, Disruptive Mood Deregulation Disorder; IA, internet addiction; IGD, Internet Gaming Disorder; ODD, Oppositional Defiant Disorder.
[a]Fisher's Exact test.
[b]Independent *t* test.

(89.6%). The screening cut-off point had high sensitivity (85.6%) and the diagnostic cut-off point had the highest diagnostic accuracy, classifying 87.6% of participants correctly.

Swanson, Nolan, and Pelham, Version IV Questionnaire (SNAP-IV)

The SNAP-IV consists of the following items: inattention, hyperactivity/impulsivity, and oppositional symptoms. These items reflect the core symptoms of ADHD and Oppositional Defiant Disorder as defined in the DSM-IV. The psychometric properties of SNAP-IV-Chinese in Taiwan showed the intra-class correlation coefficients for the 3 subscales of the Chinese SNAP-IV ranged from 0.59 to 0.72 for the parent form and from 0.60 to 0.84 for the teacher form. All subscales of both the parent and teacher forms showed excellent internal consistency with Cronbach's $\alpha > 0.88$ (Liu et al., 2006).

Statistical Analysis

Descriptive statistics were applied to show demographic characteristics. Differences of categorical variables between groups were compared by either chi-square tests or Fisher's exact tests (whichever is appropriate). Numerical variables were tested

by the Student's t test. All statistical analyses were analyzed using SPSS v22.0 (SPSS Inc., Chicago, IL). Furthermore, to take into account the within-patient dependency due to repeated measurements, the generalized estimating equations (GEE) method's multiple linear regression and/or logistic regression models were used to compare the differences of the treatment effects between internet addicted (IA) and non-IA groups after adjusting for the effects of baseline severity. All statistical tests were 2-sided and the significance level was set at $P < .05$.

Results

A total of 101 eligible ADHD children were enrolled in this study. They completed the baseline data of the 3 aforementioned evaluation forms. The results of the comparison of baseline characteristics of ADHD patients between the IA and non-IA groups are shown in Table 1. Among them, there were significant differences in interpersonal relationships, DMDD, comorbidity, daily and/or weekend online chatting or gaming, and age. Other factors of ADHD patients, such as height, weight, father's age, and mother's age, were also significantly different ($P < .05$). The scores of IA severity-related scales (DMDD, Chen's Internet Addiction Scale [CIAS], and DSM-5) were significantly different between these 2 groups at baseline ($P < .001$).

To compare the treatment effects between IA and non-IA groups, we analyzed the baseline score, group, treatment duration (in weeks), and their interaction by multiple linear regression using GEE's method. As shown in Table 2, after adjusting for the effect of baseline severity, the effect of treatment of inattention, hyperactivity/impulsivity, and symptoms of oppositional defiant disorder (ODD) in the non-IA group was significantly reduced (9.370, 6.477, and 2.947 units, respectively; $P < .001$, $< .001$, and .004, respectively). In contrast, the reduction in inattentive symptoms score in the IA groups was 5.269 (9.370–4.101) units, which was 4.101 units less in symptomatic reduction than the non-IA group ($P = .011$). However, in the IA group, the reduction in the other 2 symptom scores, hyperactivity/impulsivity and ODD, was similar to the non-IA group ($P = .303$ and 0.743, respectively). Similarly, the severity of DMDD (total score) was significantly reduced, on average, 0.595 units in the non-IA group ($P = .006$). In the IA group, the reduction of DMDD total score (from baseline to week 4) was almost similar to that of the non-IA group ($P = .953$) after adjusting for the effect of baseline severity.

The GEE method's multiple linear regression model was used to compare the differences of the treatment effects between these 2 groups according to CIAS and DSM-5 given the high correlation between these 2 scales (Pearson correlation = 0.864 and 0.856 at baseline and week 4, respectively). As shown in Table 2, 4 weeks later, the severity of internet addiction in the non-IA group was slightly increased (1.411 units) on the CIAS scale ($P = .482$). On the other hand, the reduction of the IA severity in the IA group was, on average, 4.540 (5.951–1.411) units, which was 5.951 units significantly higher than that of the non-IA group ($P = .031$). However, the severity of internet addiction in the DSM-5 scale remained almost the same at baseline and week 4 in both groups.

After 4 weeks' treatment, to evaluate the treatment effects on DMDD, we first defined a child to be comorbid with DMDD if his/her symptom scale was DMDD > 0 and then used the GEE method's multiple logistic regression to analyze the data. As shown in Table 3, compared with the baseline, the odds ratios of the risk of IGD patients comorbid with DMDD were 0.281, 0.252, and 0.156 at week 2, 3, and 4, respectively (all $P < .001$) after adjusting for the effect of baseline severity. In other words, compared with the risk at baseline, the risk (odds) of IGD patients comorbid with DMDD was significantly reduced (71.9%, 74.8%, and 84.4% at week 2, 3, and 4, respectively; $P \leq 0.001$) after adjusting for the effect of baseline severity. We further compared the difference of the treatment effects between IA and non-IA groups. As shown in Table 4, after adjusting for the effect of baseline severity, the odds ratio for IGD patients comorbid with DMDD for IA vs non-IA was 2.528 at baseline ($P = .020$). For the non-IA group, the odds ratio for IGD patients comorbid with DMDD was 0.085 for week 4 vs baseline ($P = .021$). Moreover, the odds ratio for IGD patients comorbid with DMDD for week 4 vs baseline in the IA group was 86.0% (1–0.140) less than the odds ratio of the non-IA group, although the result reached only borderline significance ($P = .095$).

Discussion

From the present study that included clinical patients from the out-patient department of psychiatry, we found that diagnosis of IGD based on DSM-5 criteria was not low (51.5%) among youth with ADHD. Interestingly, internet-addicted ADHD youths were more comorbid with DMDD like emotional dysregulation than ADHD youths without gaming disorder. The complicated irritable mood or emotional dysregulation was indeed noticed after IGD, and we should regard this phenomenon as a new complication of ADHD with IGD.

For the internet-addicted youth with ADHD, they were characterized as following: having poor interpersonal relationships, spending excessive time in online chatting or playing online games for more than 1 h/d and more than 3 hours per weekend day. Compared with ADHD youth without internet addiction, they did not differ in their gender or general appearances, but they were 2 years elder in age, had older fathers and mothers, were 10 cm taller, and weighed 10 kg more.

Overall treatment effect of IGD would be good when the underlying symptoms of inattention, hyperactivity/impulsivity, and oppositional defiant disorder were controlled by ADHD pharmacotherapy. Such results were in line with a Korean study that reported that MPH was effective in treatment of IGD. (Han et al., 2009; Park et al., 2016). Furthermore, this study indicated that even in the internet-addicted ADHD youth with symptoms of DMDD, psychostimulant-MPH, Atomoxetine (Strattera), MPH and Abilify, or Strattera and ABilify can be used as a satisfactory choice of drug on treating IGD. The degree of improvement on ADHD and DMDD scales determined the treatment efficacy of IGD. After 4 weeks of treatment, the odds ratios of DMDD were significantly reduced (54.2%, 59.1%, and 68.4% at week 2, 3, and 4, respectively). In summary, the treatment effect for IGD comorbid with ADHD and DMDD was good overall.

For a long time, many studies have demonstrated that addicted behavior may induce emotional dysregulation (Murphy et al., 2012). Why just a playful gaming behavior gradually appearing disruptive mood dysregulation? Here, we tried to employ a commonly used Research Domain Criteria (RDoC) dimensions model to explain this modern phenomenon of why the irritable ADHD child developed IGD with aggression. In the RDoC perspective, ADHD patients also have deficits in the domains of cognition (specifically in working memory) and positive valence (in rewarding anticipation/dalay/receipt) (Musser and Raiker, 2019). The substance use disordered patients exhibit problem on the domains of negative valence systems, positive valence systems, cognitive systems, systems for social processes, and arousal and regulatory systems (Zambrano-Vazquez et al., 2017). Indeed, IGD and ADHD have disordered brain function overlapping on domains of executive function, incentive salience, and negative emotionality (Kwako et al., 2016). As a result, deficits in

Table 2. Comparing Differences of Clinical Measures for the 4-Week Treatment Between IA and Non-IA Groups Using GEE Method

		Baseline	Week 4	Between-group difference in score changing rate, mean (SE)	95% CI	Wald x^2	*P*
SNAP_1_9	IA No	20.02 ± 3.23	10.87 ± 5.27	−9.370 (1.002)[a]	(−11.334, −7.406)	87.418	<.001
	Yes	21.13 ± 3.72	16.00 ± 5.67	4.101 (1.617)[b]	(0.932, 7.269)	6.434	.011
SNAP_10_18	IA No	13.98 ± 7.11	8.35 ± 6.53	−6.477 (0.996)[a]	(-8.430, −4.525)	42.283	<.001
	Yes	14.00 ± 7.04	9.80 ± 6.76	1.526 (1.480)[b]	(−1.375, 4.427)	1.063	.303
SNAP_19_26	IA No	12.20 ± 6.28	9.90 ± 4.59	−2.947 (1.036)[a]	(−4.977, −0.917)	8.099	.004
	Yes	14.00 ± 4.66	11.45 ± 6.22	−0.501 (1.531)[b]	(−3.502, 2.499)	0.107	.743
DMDD total	IA No	1.12 ± 1.15	0.77 ± 1.06	−0.595 (0.215)[a]	(−1.017, −0.173)	7.635	.006
	Yes	1.92 ± 1.03	1.20 ± 1.40	0.018 (0.304)[b]	(−0.579, 0.615)	0.004	.953
CIAS	IA No	42.00 ± 10.66	43.71 ± 11.06	1.411(2.008)[ac]	(−2.524, 5.347)	0.494	.482
	Yes	72.81 ± 9.84	68.65 ± 7.26	−5.951 (2.754)[bc]	(−11.349, −0.554)	4.670	.031
DSM-5	IA No	5.57 ± 4.59	6.65 ± 4.39	0.728 (0.916)[ac]	(−1.067, 2.524)	0.632	.427
	Yes	14.77 ± 5.02	13.95 ± 4.62	−1.768 (1.261)[bc]	(−4.421, 0.704)	1.966	.161

Abbreviations: CI, confidence interval; CIAS, Chen's internet addiction scale; DMDD, Disruptive Mood Deregulation Disorder; SE, standard error; SNAP-IV, Swanson, Nolan, and Pelham, Version IV Questionnaire.

[a]Treatment duration effect (week 4 vs baseline) using GEE method's multiple linear regression after controlling for baseline severity.

[b]Group-treatment duration (week) interaction effect between 2 groups (IA vs Non-IA) using GEE method's multiple linear regression after controlling for baseline severity.

[c]GEE method's multiple linear regression with group, treatment duration (in week), and their interaction terms in the model.

Table 3. Results of GEE Method Multiple Logistic Regression to Evaluate Treatment Effects in Reducing the Risk of DMDD After Adjusting Baseline Severity Effects

			Hypothesis test				95% Wald C.I. for OR	
Parameter	B	Std. error	Wald x^2	df	Sig.	OR	Lower	Upper
(Intercept)	−0.747	0.2572	8.429	1	0.004	0.474	0.286	0.785
DMDD_base	1.498	0.1835	66.634	1	<0.001	4.472	3.121	6.408
Week 4 vs baseline	−1.856	0.4073	20.766	1	<0.001	0.156	0.070	0.347
Week 3 vs baseline	−1.378	0.3493	15.568	1	<0.001	0.252	0.127	0.500
Week 2 vs baseline	−1.268	0.3892	10.613	1	0.001	0.281	0.131	0.603

Abbreviations: B, Baseline; C.I., confidence interval; df, standard deviation; DMDD, Disruptive mood deregulation disorder; OR, odds ratio; Sig., significance *P*-value.

Table 4. Results of GEE Method Multiple Logistic Regression to Compare Treatment Effects Between IA and Non-IA Groups in Reducing the Risk of DMDD After Adjusting for Effects of Baseline Severity

			Hypothesis test				95% Wald C.I. for OR	
Parameter	B		Wald x^2	df	Sig.	OR	Lower	Upper
(Intercept)	−1.717	0.3649	22.147	1	<0.001	0.180	0.088	0.367
DMDD_base	2.537	0.5259	23.268	Std. Error	<0.001	12.640	4.509	35.434
IA vs non-IA	0.928	0.3996	5.387	1	0.020	2.528	1.155	5.533
Week 4 vs baseline	−2.460	1.0642	5.345	1	0.021	0.085	0.011	0.688
IA × week 4	−1.969	1.1805	2.781	1	0.095	0.140	0.014	1.412

Abbreviations: B, Baseline; C.I., confidence interval; df, standard deviation; DMDD, Disruptive mood deregulation disorder; IA, internet addiction; OR, odds ratio; Sig., significance *P*-value.

the domains of cognitive system and negative emotionality are interactively increasing symptoms of ADHD and IGD.

Firstly, children with ADHD generally avoid the complicated task because they really have executive function impairment. According to the psychopathology explained by the RDoC dimensions model, children's inattentive symptom closely corelated with symptoms of irritability and aggression, which represented brain deficit in the domain of negative affect. In addition, because inattentive ADHD children are over-involved in the internet gaming world, usually they tend to overplay, then become habitually play gaming representing kind of disturbance on the domain of incentive salience (Kwako et al., 2016) caused by internet gaming. Intermixed brain disturbance on the domain of negative affect by ADHD and disturbance on the domain of incentive salience by gaming disorder eventually lead ADHD children to develop the symptoms of distorted liking or wanting gaming first. Then they develop the withdrawal-negative affect as they were stopped from playing games. Such DMDD-like withdrawal emotional disturbance represents a more disturbed negative emotionality domain on the RDoC domain model. From impairment in executive function from ADHD to mood dysregulation, and finally progressing to

the more withdrawal-negative effects on ADHD children, this is a vicious cycle caused by the effects of IGD added to the effects of ADHD. IGD is an aggravating coping mechanism for ADHD from this clinical sample. Therefore, it is understandable that IGD may increase the symptom severity of ADHD with more symptoms of irritability, and finally patients experience aggressive, loss of control, and craving/withdrawal from addiction to gaming (Lee et al., 2017b). Our study result indicated the ADHD children with irritability and aggression may experience more severe disruptive emotional symptoms because the symptoms of IGD aggravate the symptoms of ADHD.

Why do gaming-addicted ADHD youth experience emotional dysregulation or transiently presented symptoms like DMDD? From these study results, we provide the following explanation: IGD is a superficial mental problem outside their unresolved underlying psychiatric mental disorder (Eichenberg et al., 2017). The longer time playing games featuring aggressive content may aggravate underlying a mental disorder through a long process of social interaction deprivation or stimulation deprivation. This has been explained by many studies on aggressive behavior in youth with IGD (Ybarra et al., 2008). IGD is not only a superficial symptom to avoid social interaction and complicated learning tasks. Worse for these gaming-addicted ADHD youth with emotional dysregulation is that they belong to the so-called subtypes of IGD of "impulsive/aggressive" and "emotionally vulnerable" (Lee et al., 2017a). Their lives featured poorer interpersonal relationship or unhealthy lifestyles first, which gradually led ADHD youth to develop unhealthy psychologically disruptive mood dysregulation. When they became gaming addicted with withdrawal symptoms, their hidden emotional disruption and impulsive behavior problem burst out. Here, we suggest that child mental health experts consider internet addiction as a formal diagnosis earlier and start to treat patients as early as possible to prevent further disruptive mood dysregulation. The consequences of DMDD in children and adolescents include adverse health outcomes; impoverishment; reported police contact; low educational attainment; higher rates of having official felony charges, physical fighting, and breaking into buildings illegally; and disrupted social function (violent relationships, poor parental relations, and no best friend) (Copeland et al., 2014).

Internet addiction should become a diagnostic reminder of the possibility of subsequent sequelae like disruptive emotionality (DMDD) in children and adolescents with ADHD. In future DSM diagnose system, DMDD may be a comorbid diagnosis of IGD as children with IGD who frequently present opposing resistance, bad temper, and negative emotions.

The limitation of this study was that we had only a small sample size from a medical center, so it does not represent IGD across the whole country. The diagnosis of this additional DMDD is based on DSM-5 diagnosis. We did not differentiate such emotional dysregulation after IGD appeared usually or only in the withdrawal period. However, after treatment, the symptom severity of DMDD was relatively reduced. Therefore, the stability of the diagnosis of DMDD may be questioned. Thus, DMDD in this study we should express them as DMDD like emotional disruptive symptom. Indeed, we had a tendency to confuse readers by using DMDD as a construct to express the withdrawal symptom of IGD. In this paper, there is only a psychiatrist's diagnosis instead of the structured measure for DMDD. Thus, DMDD may not equal withdrawal emotional dysregulation although we attempted to express the symptom severity of withdrawal emotional dysregulation as patients were stopped from game playing. Also, irritability is the chief symptom of ODD, so irritability in DMDD symptoms may overlap with the irritability symptom of ODD (Meyers et al., 2017). So DMDD and irritability-mood deregulation-aggression are used interchangeably here. Taken together, this is valuable information as clinicians struggle to understand the irritability and potential aggression that families experience when interrupting the behaviors. This symptom complex often interferes with the parent's ability to alter the gaming behaviors. Pharmacotherapies and behavioral interventions targeting this symptom complex could be very helpful to affected youths and their families. Also, this study result suggested that overplaying gaming might lead normal children to develop more regressive or impulsive behavior and gradually more dysregulation in mood. The explosive emotional outbreak during their addiction withdrawal period among these internet-addicted ADHD youth may be dangerous and should be diagnosed earlier during present child and adolescent outpatient clinical practicing. For children and adolescents with ADHD, we should regard IGD as an alert to a hazard of unhealthy growth, and IGD must be diagnosed and treated earlier to prevent the later disruptive mood dysregulation.

Acknowledgments

Chuan-Hsin Chang, Yue-Cune Chang, Helen Cheng, and Ruu-Fen Tzang designed the study and wrote the protocol. Yue-Cune Chang undertook the statistical analysis, and all authors contributed to and approved the final manuscript.

Statement of Interest

None.

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