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BRIEF REPORT



Between two worlds: Exploring esports betting in relation to problem gambling, gaming, and mental health problems

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ABSTRACT

Background and aims: Esports betting is an emerging gambling activity where individuals place bets on an organized video gaming competition. It represents only one of several gambling activities commonly endorsed by adolescents. To date, limited research has explored the relationship between esports betting and mental health among adolescents and its convergence with both problem gambling (PG) and problem video gaming (PVG). The present study examined the relation between esports betting, PG and PVG, and both externalizing and internalizing problems among adolescents while accounting for adolescents' video gaming intensity (i.e., how often they play 2 h or more in a day) and engagement in other gambling activities. **Methods:** Data was collected from 6,810 adolescents in Wood County, Ohio schools. A subset of 1,348 adolescents ($M_{\text{age}} = 14.67$ years, $SD = 1.73$, 64% male) who had gambled and played video games during the past year were included in the analyses. **Results:** Approximately 20% ($n = 263$) of the included sample had bet on esports during the past year. Esports betting was positively correlated with other forms of gambling, both PG and PVG, and externalizing behaviors. Mediation analyses revealed esports betting was associated to both internalizing and externalizing problems through PVG and not PG. **Conclusions:** Esports betting may be particularly appealing to adolescents who are enthusiastic video gamers. As such, regulators must be vigilant to ensure codes of best practices are applied to esports betting operators specifically for underaged individuals.

KEYWORDS

esports betting, adolescence, problem gambling, problem video gaming

INTRODUCTION

Esports are organized video gaming competitions where individuals or teams compete in leagues and/or tournaments to win monetary prizes (Greer, Rockloff, Browne, Hing, & King, 2019). Rather than betting on the outcome of traditional sports, esports betting involves bets placed on the outcomes of video gaming competitions (Abarbanel, Macey, Hamari, & Melton, 2020; Gainsbury, Abarbanel, & Blaszczynski, 2017a). The global esports market has grown dramatically, from revenues of \$124 million in 2014 to over \$900 million in 2018 (NewZoo, 2018). The growth in the esports market has been associated with the increases in

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esports betting advertising and participation (Abarbanel & Phung, 2019; Eilers & Krejčík, 2018; Juniper Research, 2018). Preliminary findings indicate that individuals betting on esports are younger, more likely to be male, report wagering on a greater number of activities, regularly play video games, and are more frequent esports spectators (Abarbanel et al., 2020; Gainsbury et al., 2017a, 2017b; Macey, Abarbanel, & Hamari, 2020; Macey & Hamari, 2019). The aim of the current study was to investigate the psychological factors associated with esports betting among adolescent youth including problem gambling, problem video gaming and youth mental health outcomes.

Problem Gambling and problem video gaming

Gambling and video gaming disorder are the two formally recognized non-substance related addictive disorders (i.e., behavioral addictions) according to the International Classification of Diseases – Eleventh Edition (ICD-11; WHO, 2019). Both disorders are defined as a persistent and recurrent engagement in the behavior (gambling or video gaming), leading to clinically significant impairment or distress. Recent research has shown that rates of problematic participation in both gambling and video gaming are higher among youth when compared to adults, with 0.2–12.3% reporting problem gambling (PG; Calado, Alexandre, & Griffiths, 2017; Emond & Griffiths, 2020) and 3–10% reporting problem video gaming (PVG; Fam, 2018; Paulus, Ohmann, von Gontard, & Popow, 2018; Stevens, Dorstyn, Delfabbro, & King, 2020). PG and PVG are comorbid with a number of mental health problems including depression, anxiety, impaired sleep, increased substance use and aggression (Lam, 2014; Männikkö et al., 2020; Mills et al., 2020; Myrseth & Notelaers, 2018). Perhaps unsurprising, both PG and PVG are associated with increased gambling and video gaming frequency, respectively (Carbonneau et al., 2015; Gentile et al., 2011). That is, those who participate more frequently and more intensely (i.e., larger bets, longer gaming sessions) in these activities are more likely to endorse symptoms of PG and PVG. Although both PG and PVG fall under the umbrella of behavioral addictions, mixed findings have been noted in the co-occurrence of PG and PVG, with some studies finding that individuals reporting symptoms of one disorder are more likely to endorse symptoms of the other (Derevensky, 2019; Floros, 2018; McBride & Derevensky, 2017) and other studies finding no direct association between PG and PVG (Delfabbro & King, 2020; Macey & Hamari, 2018) or between the frequency of involvement in gambling and gaming (Forrest, King, & Delfabbro, 2016).

Gamblification of video gaming and esports betting

Adolescents have been identified as being more likely to engage in novel forms of gambling via the Internet (Emond & Griffiths, 2020; Giralt et al., 2018; González-Roz, Fernández-Hermida, Weidberg, Martínez-Loredo, & Secades-Villa, 2017), and developers are increasingly introducing gambling-like elements into video games (Abarbanel, 2018). For instance, loot boxes, which offer the chance of obtaining rare items or in-game currency, have provided the

video gaming industry with a large revenue stream over the past 5+ years. However, the lottery-style manner of loot boxes has made numerous video gamers feel as though they are gambling while playing, with loot box purchasing being significantly correlated with PG severity (Brooks & Clark, 2019; Zendle & Meyer, 2019). Another recent trend is social casino games or gambling-themed video games, which have also been found to correlate with PG measures (Gainsbury, Russell, & Hing, 2014; King, Russell, Gainsbury, Delfabbro, & Hing, 2016; Li, Mills, & Nower, 2020; Wohl, Salmon, Hollingshead, & Kim, 2017). The *gamblification* of video gaming has led to the emergence of a number of studies on the risks posed by loot box purchases and social casino gaming to problem gambling. Further, some studies have intended to demonstrate a possible migration from early exposure to either loot box purchases or social casino gaming to gambling with real money (Hayer et al., 2018; Macey & Hamari, 2019; Zendle, 2020; Zendle & Meyer, 2019). While there is still a need for additional research on the validity of this gateway hypothesis of video gaming to gambling (see review by Delfabbro & King, 2020), there is also a paucity of research on esports betting, which may represent further concerns related to video gaming and gambling for mental health professionals.

Unlike in-game gambling-like activities (i.e., loot boxes, social casino gaming), esports betting is external to video gaming. Indeed, although esports betting may be appealing to gamers, it is important to note that gamers are not the only individuals who engage in this type of gambling. Of note, online gamblers appear to be attracted to various forms of online wagering including, but not limited to, video game-related gambling such as esports betting (Macey & Hamari, 2018; Lelonek-Kuleta & Bartczuk, 2021). Moreover, esports betting may share some similarities to sports betting, in that individuals can believe that they are able to develop a certain degree of skill, knowledge and analysis of in-game features which will give them a betting advantage (Lelonek-Kuleta & Bartczuk, 2021; Winters & Derevensky, 2019). Based on this, individuals who play video games, similar to casual sports players, may believe that they have better chances of gambling success due to their knowledge of the game. This claim is bolstered by research findings indicating that maladaptive or distorted cognitions are implicated in both problem gambling and gaming (Brooks & Clark, 2019; Macey & Hamari, 2020).

To date, research has found that more frequent esports betting is associated with greater PG symptoms (Gainsbury, Abarbanel, & Blaszczynski, 2017b; Macey & Hamari, 2019) and one study reported esports betting as being positively associated with both PG and PVG (Zendle, 2020). Nonetheless, the link between esports betting and mental health remains unexplored. The potential elevated risk for both PG and PVG suggests that esports betting may place adolescents at-risk for mental health symptoms found to be comorbid with PG and PVG including internalizing (e.g., depression, anxiety, and low self-esteem) and externalizing problems (e.g., conduct problems, and inattention/hyperactivity) (Derevensky, 2019; Dowling et al., 2017; Giralt et al., 2018;



Livazović & Bojčić, 2019; Richard, Fletcher, Boutin, Derevensky, & Temcheff, 2020). Further, given the expected growth in the esports betting market, research is needed on the potential risk esports betting represents for youth.

The present study sought to explore the effect of the frequency of participation in various gambling activities and video gaming intensity (i.e., how often do you play 2+ hours of video games in a day) onto both externalizing and internalizing problems among adolescents. Given the association between esports betting and both PG and PVG and previous research demonstrating an association between mental health outcomes and both PG and PVG (Derevensky, 2019; Richard et al., 2020), we hypothesized that increased gambling frequency and video gaming intensity would be associated with greater externalizing and internalizing problems and that these effects would be mediated by symptoms of PG and PVG. Within this broader objective, specific attention is brought to exploring the relationship between esports betting and symptoms of PG and PVG. Esports culture tends to replicate traditional sports cultures, involving elite athletes (gamers), teams, leagues, and championships. As such, similar to previous studies demonstrating that athletes (at the elite or non-elite/casual level) are more likely to engage in sports betting (Winters & Derevensky, 2019), it is hypothesized that video gamers will also be more likely to engage in esports betting, and that an increased frequency of esports betting contributes more to PVG severity in comparison to PG after accounting for other gambling activities.

METHODS

The current study employed data from the 2019 Alcohol, Drug Addiction and Mental Health Services (ADAMHS) Board/Wood County Educational Service Center Survey on Alcohol and Other Drug Use among adolescents in Wood County, Ohio.

Participants

Of a total 7,573 students from grades 7 through 12 who participated in the study, 763 were excluded due to suspected insincere responding (i.e., reporting engaging in all gambling activities at all times and providing inconsistent responses). Given the purpose of the study, the sample was reduced to those who had gambled in the previous year ($n = 1,752$). This subsample was further reduced to exclude adolescents who gambled but did not regularly play video games ($n = 404$). Therefore, the final sample consisted of 1,348 adolescents ($M_{age} = 14.67$ years, $SD = 1.73$, 64% male).

Measures

Gambling and Video Gaming Frequency. Frequency of participation in 11 common gambling activities (e.g., poker, bingo, sports betting, esports) over the previous 12 months (based on a 5-point scale ranging from “Not at All = 0” to

“Daily = 4”) was assessed. Using the same 5-point scale, video gaming intensity was measured by a single item (*Spent at least two hours daily playing games online or offline.*). This was used in lieu of an estimate of weekly video gaming frequency due to research demonstrating inaccurate estimations (Williams, Consalvo, Caplan, & Yee, 2009; Wood & Griffiths, 2007). Additionally, given the brevity of the survey, space did not allow for a more exhaustive measure of video gaming frequency (e.g., Gentile, Lynch, Linder, & Walsh, 2004). As such, it was believed this would be the most accurate and clear assessment of how frequently adolescents’ play video games intensely. Finally, the use 2+ hours daily versus 3+ or 4+ hours was based on prior research suggesting a long gaming session for both casual as well as excessive gamers would be in excess of 2 h (Kapalo, Dewar, Rupp, & Szalma, 2015; Neys, Jansz, & Tan, 2014). As such, how often they play 2+ hours (i.e., never, less than monthly, monthly, weekly, daily) would be a strong indicator of their video gaming intensity. Due to the exclusion criteria, the final sample did not include individuals who indicated “Not at all” for the video gaming intensity item meaning that the range was from 1 to 4. Item wording is provided in appendix.

NORC DSM-IV Screening for Gambling Problems (NODS-CLiP; Toce-Gerstein, Gerstein, & Volberg, 2009). The NODS-CLiP is a screening measure for gambling disorder (GD), containing three dichotomous (yes/no) questions based on the DSM-IV criteria for GD (loss of control, lying, and preoccupation). Participants who responded affirmatively to one or more items were identified as being at-risk for GD and may referred to as “problem gamblers” (PG). The NODS-CLiP has demonstrated excellent sensitivity, capturing 94% of problem gamblers identified by the NODS, while having a specificity level of 0.96 (Toce-Gerstein et al., 2009). Within the following sample, 214 participants had scores of one or higher. The internal consistency of the NODS-CLiP was 0.55 for the present sample. Item wording is provided in appendix.

Internet Gaming Disorder Scale-Short Form (IGDS-SF9; Pontes & Griffiths, 2015), is a 9-item measurement adapted from the nine core criteria that define IGD according to the DSM-5 (APA, 2013). Responses were based on a 5-point Likert scale “Never = 1” to “Very Often = 5”, with higher scores indicating greater severity of gaming disorder. In the following study the midpoint (a score of 30 or more) was considered at-risk for IGD (termed PVG) and 76 participants scored within this range. The internal consistency of the IGDS-SF9 was 0.89 for the present sample. Item wording is provided in appendix.

The Ohio Scales Youth Problem Severity Scale (PSS; Ogles, Melendez, Davis, & Lunnen, 2001). The PSS is a 20-item self-report measure that assesses internalizing and externalizing problems. Scores are calculated by summing the participants’ ratings of each item on a 6-point scale during the past 30 days, ranging from “Not at All = 0” to “All the Time = 5”. Within the present sample, the internal consistency of the PSS was 0.92 (internalizing) and 0.87 (externalizing) for each subscale. Item wording is provided in appendix.

Ethics

Ethical approval was granted by the ADAMNHS ethics committee. All parents of students signed a consent form to allow students to participate in the study. Further, all students provided assent to participate and were instructed that they could leave the study at any time.

RESULTS

Data analysis plan

Data was reviewed in SPSS version 26 (IBM Corp, 2019) with all subsequent analyses conducted in the *Mplus* version 8 (Muthén & Muthén, 2017). A primary objective of the present study was to assess the association between gambling frequency and video gaming intensity with both internalizing and externalizing problems, and the role either PG or PVG play in explaining this association (i.e., mediation). As such, structural equation modeling (SEM) was used to evaluate the fit of the data to the hypothesized full mediation model (Fig. 1). This assumed that the effect of gambling frequency and video gaming intensity onto both internalizing and externalizing problems would be fully accounted for by PG and PVG. Results would be reviewed to assess the need to add additional paths to improve model fit, thus relaxing the hypothesized full mediation. Given the complexity of the model, four item parcels were used to indicate the externalizing and internalizing problem latent variables (Bandalos, 2002; Little, Cunningham, Shahar, &

Widaman, 2002). Finally, parameters were estimated using robust maximum likelihood as it is more robust against issues of non-normality. Missing values were estimated using full information maximum likelihood. Goodness-of-fit was assessed across several indices including the root mean square error of approximation (RMSEA; ≤ 0.05), comparative fit index (CFI; ≥ 0.95), Tucker-Lewis Index (TLI; ≥ 0.95), and standardized root mean squared residual (SRMR; ≤ 0.06) (Byrne, 2013; Kline, 2016).

Analyses

The data was reviewed for violations of normality with no issues detected. Results from the initial measurement model revealed high correlations between frequency of purchasing lottery and scratch tickets ($r = 0.796$) and frequency of engagement in fantasy sports and daily fantasy sports ($r = 0.756$). Two unplanned latent variables were created for ticket betting and fantasy sports betting frequency to account for these correlations. Additionally, the errors from preoccupation with video gaming and increased time playing video games were allowed to correlate based on modification indices. Results revealed an adequate fit of the data to the measurement model ($\chi^2(362) = 1,096.631, P < 0.001$; RMSEA = 0.039 90% (0.036, 0.041); CFI = 0.949; TLI = 0.935; SRMR = 0.039). Aside for one of the NODS-CLiP items (*lied about gambling*), all loadings exceeded 0.58 on their respective factor.

Bivariate correlations drawn from the measurement model were consistent with expectations. The frequency of all gambling activities was positively associated with PG (r 's

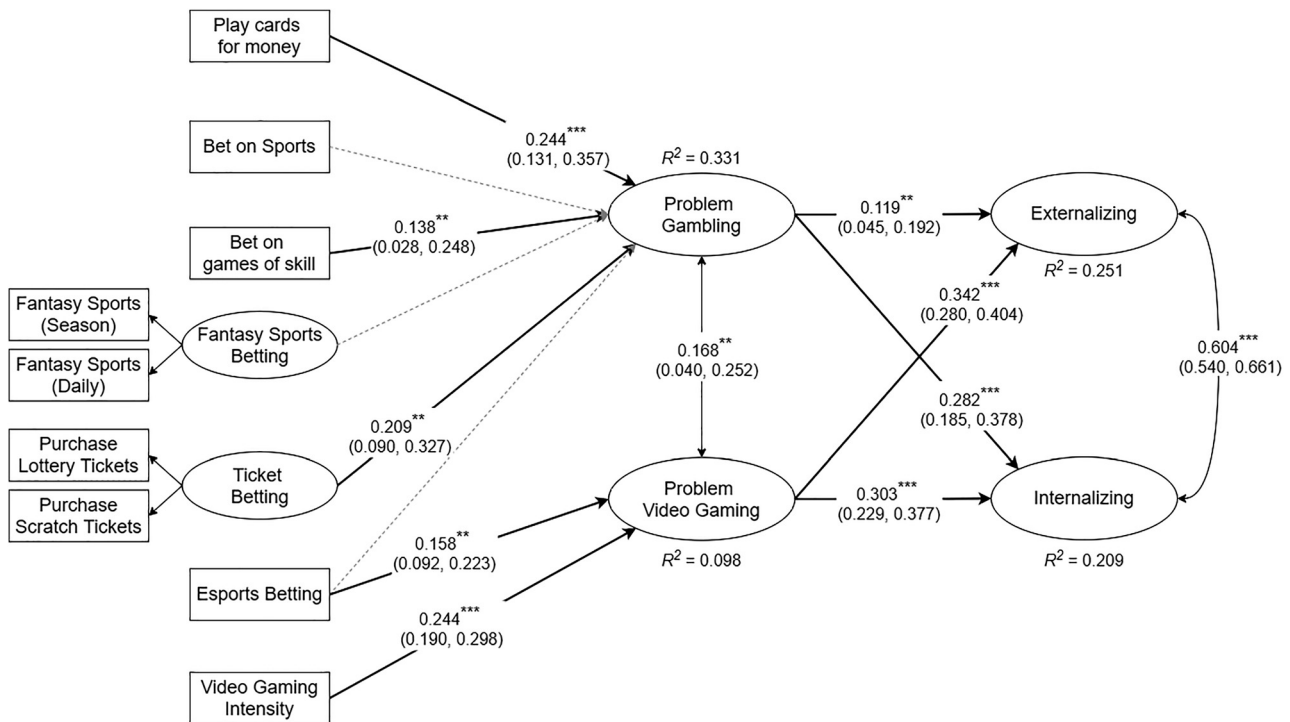


Fig. 1. Results from the hypothesized mediation model. All estimates are standardized with 95% confidence intervals in parentheses. Dashed lines were estimated but not significant ($P > 0.05$). * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$



Table 1. Indirect Effects from Mediation Model

Indirect Effect	β	P
Playing Cards for Money → Problem Gambling		
→ Externalizing Problems	0.029 (0.007, 0.051)	0.011
→ Internalizing Problems	0.069 (0.030, 0.108)	0.001
Betting on Games of Skill → Problem Gambling		
→ Externalizing Problems	0.016 (−0.002, 0.035)	0.078
→ Internalizing Problems	0.039 (0.003, 0.075)	0.035
Sports Betting → Problem Gambling		
→ Externalizing Problems	0.011 (−0.006, 0.027)	0.205
→ Internalizing Problems	0.025 (−0.013, 0.063)	0.196
Ticket Betting → Problem Gambling		
→ Externalizing Problems	0.025 (0.002, 0.047)	0.031
→ Internalizing Problems	0.059 (0.016, 0.102)	0.007
Fantasy Sports Betting → Problem Gambling		
→ Externalizing Problems	−0.003 (−0.024, 0.017)	0.751
→ Internalizing Problems	−0.008 (−0.057, 0.041)	0.748
Esports Betting → Problem Gambling		
→ Externalizing Problems	0.009 (−0.006, 0.025)	0.247
→ Internalizing Problems	0.022 (−0.015, 0.059)	0.244
Esports Betting → Problem Video Gaming		
→ Externalizing Problems	0.054 (0.031, 0.077)	<0.001
→ Internalizing Problems	0.048 (0.025, 0.071)	<0.001
Video Gaming Intensity → Problem Video Gaming		
→ Externalizing Problems	0.083 (0.057, 0.110)	<0.001
→ Internalizing Problems	0.074 (0.049, 0.099)	<0.001

range from 0.347 to 0.482). Video gaming intensity was positively associated with PVG ($r = 0.257$). PVG was also associated with playing cards for money ($r = 0.158$), betting on games of skill ($r = 0.158$), and esports betting ($r = 0.165$). Externalizing problems were positively associated with all gambling activities (r 's range from 0.178 to 0.253), video gaming intensity ($r = 0.112$), PG ($r = 0.292$), and PVG ($r = 0.347$). Internalizing problems were positively associated with ticket betting ($r = 0.122$), PG ($r = 0.158$) and PVG ($r = 0.323$).

Results revealed adequate fit of the data to the hypothesized full mediation model ($\chi^2(376) = 1,140.734$, $P < 0.001$; RMSEA = 0.039 90% (0.036, 0.041); CFI = 0.947; TLI = 0.935; SRMR = 0.042). A review of the modification indices did not suggest any direct paths to be added. Path estimates are in Fig. 1 with indirect effects present in Table 1. Gender and age were included as covariates. Model results indicate that frequency of participation in fantasy sports, games of skills, cards, and sports betting was significantly associated with internalizing and externalizing problems through PG, while esports betting and gaming intensity was significantly associated with internalizing and externalizing behaviors through PVG.

DISCUSSION

The current study is the first to examine the effect of adolescent participation in gambling and gaming onto externalizing and internalizing problems through PG and

PVG, with a specific emphasis on esports betting as a novel form of gambling. Mediation model results indicate that the frequency of participation in fantasy sports, games of skills, cards, and sports betting were significantly associated with internalizing and externalizing problems through PG, while esports betting and video gaming intensity were significantly associated with internalizing and externalizing behaviors through PVG. Specific to esports participation, results indicate that youth who engage in more frequent esports betting are more likely to report symptoms of PVG, which in turn, result in greater externalizing and internalizing problems. These results suggest that youth who do experience mental health symptoms as a result of esports betting are likely to experience these not as a direct result of their betting behaviors, but as a consequence of PVG symptoms. With similar relationships also being present for youth reporting engagement in a greater intensity of video gaming, these results suggest that it is the presence of symptoms such as feeling preoccupied with one's gaming, losing interest in hobbies or other activities, and needing to spend greater amounts of time gaming to achieve satisfaction, which result in greater externalizing and internalizing problems. Although additional longitudinal research is necessary to evaluate the temporal sequencing of these problems, these results would be in line with the network theory of psychopathological comorbidity (Borsboom & Cramer, 2013; Fried & Cramer, 2017) whereby symptoms of different mental health conditions emerge as a result of mutually interacting and reciprocally reinforcing symptom networks.

It is significant to emphasize that in the present study, esports betting was not associated with PG in the mediation model. These results are in contrast to studies finding a significant relationship between esports betting and PG among adults (Gainsbury et al., 2017b; Macey & Hamari, 2019; Zendle, 2020). In order to explain this finding, it is possible that this discrepancy is a result of investigating these betting behaviors among adolescents who report a lower frequency of engagement in esports betting. Alternatively, it is possible that this is a result of the present sample only including youth who engaged in both gambling and video gaming over the past year. Given that both PG and PVG were included in the mediation model and that these variables were significantly correlated, it is possible that there are interactions between PG and PVG symptoms that reduced the direct effect of esports betting on PG. More specifically, in the measures assessing PG and PVG, there are overlapping symptoms (i.e., preoccupation, attempts to reduce/control, lying/deception) that may have been endorsed for PVG but not for PG depending on how one's esports betting behaviors were conceptualized. Lastly, it is possible that there was significant overlap between the game one plays and the esports games one decides to bet on. This overlap may have blurred the distinction between problems related to gaming and gambling. Additional research is required to directly investigate these possible explanations, with the potential for qualitative research among gamers who wager on esports to yield significant insights into the interaction of these problems.

The findings related to video gaming intensity and esports betting is comparable to research indicating that athletes or individuals with additional knowledge about sports (i.e., recreational sports players) are at increased risk of engaging in sport betting (Winters & Derevensky, 2019). Although shown to be false, there is a perceived influence of domain specific knowledge which is suggested to contribute to feelings of competency and ability to win wagers based on the individual's sport-specific knowledge (Khazaal et al., 2012). As such, it is possible that high intensity video gamers (or problem video gamers) exhibit a similar form of cognitive distortions and erroneous beliefs around esports betting as athletes do when betting on sports. Further, with the rapid growth in the esports market (NewZoo, 2018) and research demonstrating that esports bettors are younger and are more likely to engage in regular video gaming themselves (Abarbanel et al., 2020), it is possible that adolescents are at an increased risk of engaging in esports betting and that esports bettors represent a specific subset of individuals with problems related to gaming. The present study provides preliminary evidence for this hypothesis by demonstrating that when accounting for other gambling activities, esports bettors are more likely to exhibit externalizing and internalizing problems through PVG, but not through PG.

Limitations

This study represents an initial attempt at understanding the convergent relationship between PG and PVG among esports bettors and the impact of the prior on adolescent mental

health. Nevertheless, several limitations should be noted. First, as the data is cross-sectional, it is impossible to assess causal relationships between the variables. Second, self-report data was utilized which allows for potential biases in responding. Given the sensitive nature of some of the survey questions (e.g., mental health symptoms, gambling among minors), it is possible that some individuals did not respond truthfully. A series of checks and filters were employed to confirm validity and sincerity of the responses; however, it is impossible to validate each respondent's true engagement. In a similar vein, the validity of the single item assessing video gaming intensity has not been fully explored. Nonetheless, the correlation between video gaming intensity and PVG is comparable to other studies using estimates of weekly video gaming (e.g., Lemmens et al., 2015; Pontes & Griffiths, 2015). Fourth, although the ADAMHS youth surveys are provided to all public schools within the Wood County district, selection biases may have occurred. For instance, this method of data collection may exclude adolescents who are home-schooled, go to private school, or may have dropped-out of school. Further, participation in the survey is still dependent on parent and adolescent consent. However, the large sample size and rate of public-school registration in the U.S. (89%) (National Center for Education Statistics, 2019) does allow for some level of generalizability. Finally, although a large sample size was used, the data was collected from one county in the U.S. As such, it may not be representative of adolescent behaviors more broadly. Future studies should examine this relationship longitudinally in order to better evaluate the temporal nature of these relationships.

CONCLUSIONS

Given the relationship between video gaming and esports, the appeal of betting on these events can be significant for adolescents who are already at increased risk of PVG and PG. Currently, there is an influx of advertisement and content related to esports betting with little enacted regulation (Emond & Griffiths, 2020). For instance, a report in the United Kingdom found that 17% of adolescents under the age of 16 followed Twitter accounts focused on esports betting (Smith & Rossi, 2019). Regulators must be vigilant to ensure codes of best practices are applied to esports betting operators and that appropriate regulations are in place for underaged individuals, as youth esports bettors appear to be at an increased risk of PVG and both internalizing and externalizing problems. Additionally, given the results demonstrating that esports betting was related to mental health problems through PVG, it will be important for researchers and clinicians working with gamers to not only assess for gaming frequency (and potential problematic gaming behaviors) but also for the individuals level of involvement in gaming-related gambling activities including esports betting. Further, consistent with research indicating that gambling-like behaviors within video games (e.g., loot box expenditure) are more strongly associated with PVG than PG (Li, Mills, & Nower, 2019) individuals who identify



esports as their main gambling activity may require assessment and treatments that are tailored more towards problem video gaming compared to problem gambling.

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Authors' contribution: LM: Study concept and design, methods, discussion, and editing. JR: literature review and editing. DM: Statistical analysis and editing. WI: Final editing. JD: Study supervision and final editing. All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of interest: The authors have no conflict of interest to disclose.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1556/2006.2021.00045>.

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