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FULL-LENGTH REPORT

Loot box purchasing is linked to problem gambling in adolescents when controlling for monetary gambling participation

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ABSTRACT

Background and aims: Purchasing loot boxes in digital games is akin to gambling as it involves risking money for a chance-based reward of uncertain value. Research has linked buying loot boxes to problem gambling amongst adolescents, but has not examined co-occurring gambling participation. This study examined links between loot box purchasing and problem gambling amongst adolescents while controlling for monetary gambling participation. *Methods:* Two survey samples of Australians aged 12–17 years were recruited through advertisements (n = 843) and online panels (n = 826). They included n = 421 and n = 128 adolescents, respectively, who met criteria for problem gambling. *Results:* Past-month loot box purchasing was significantly related to gambling problems in bivariate analyses. When including age, gender and past-month monetary gambling, loot box purchases were still associated with at-risk and problem gambling in both samples. As expected, these other predictors attenuated the predictive value of recent loot box purchases in relation to gambling problems. The odds-ratios, nevertheless, were still in the predicted direction and remained significant. When controlling for monetary gambling, age and gender, recent loot box purchasing increased the odds of problem gambling 3.7 to 6.0 times, and at-risk gambling 2.8 to 4.3 times. *Discussion and conclusions:* While causal relationships between loot box purchasing and problem gambling remain unclear, the results indicate that loot boxes disproportionately attract adolescents experiencing gambling problems, adding to the financial stress already caused by gambling. Consumer protection measures, youth and parental education, and age restrictions on loot box games are needed to protect young people.

KEYWORDS

gambling, gambling disorder, loot box, video games, youth

INTRODUCTION

Loot boxes are digital containers that can be purchased or won within the majority of popular video games (Rockloff et al., 2020; Zendle et al., 2020a). When opened, loot boxes reveal virtual items such as weapons or special abilities that can enhance game-play performance and progression in games (Drummond & Sauer, 2018; Parent Zone, 2019). Loot boxes can also contain skins (cosmetic items) that have aesthetic or prestige value, and can sometimes be sold for real money, traded or gambled on third-party websites (Greer, Rockloff, Browne, Hing, & King, 2019; Parent Zone, 2019). Some loot boxes yield in-game currency that can be spent in the game to progress or purchase in-game items. In essence, loot boxes are like lucky dips where a prize is guaranteed but its value is unknown in advance of opening (Rockloff et al., 2021).

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Purchasing loot boxes has similar structural characteristics to gambling because it involves spending money on a chance-based reward of uncertain value (Greer et al., 2019; Zendle, Meyer, & Over, 2019, 2020a, 2020b). Many loot boxes meet the legal criteria for gambling and are thought to have similar psychological drivers (Drummond, Sauer, Hall, Zendle, & Loudon, 2020). The random allocation of rewards of varying value means that players do not know how many loot boxes they need to purchase to obtain a desirable item (Drummond & Sauer, 2018). This variable ratio reinforcement schedule is similar to that used in electronic gaming machines (EGMs) and is known to encourage rapid uptake and persistent repetitive behaviour in the hope of being rewarded (Ferster & Skinner, 1957; Griffiths, 2018). Loot boxes in games use other psychological techniques drawn from gambling to induce spending and persistence, including continual availability, in-game promotions, auditory and visual cues, and the use of electronic money over multiple micro-transactions that make expenditure difficult to track (Hing, Russell, Browne, et al., 2021a; Larche, Chini, Lee, Dixon, & Fernandes, 2019; Parent Zone, 2019). Given that loot boxes are not regulated as gambling in most jurisdictions, they typically lack consumer protections (King & Delfabbro, 2019a), such as age restrictions, clear information on the odds of winning (Xiao, Henderson, Yuhan, & Newall, 2021), and safer gambling tools.

Of key concern is the link between loot box purchasing and problem gambling. All 16 studies reviewed in a recent scoping study corroborated this relationship (Montiel, Basterra-González, Machimbarrena, Ortega-Barón, & González-Cabrera, 2022). Two meta-analyses of 13 studies (Spicer et al., 2021) and 15 studies (Garea, Drummond, Sauer, Hall, & Williams, 2021) found significant small-to-moderate, but clinically relevant, positive correlations of 0.27 and 0.26, respectively, between loot box spending and problem gambling symptomatology. All studies to date have been cross-sectional and cannot identify causal directions between loot box purchasing and problem gambling or if there is a third variable explanation instead. Nevertheless, these findings suggest that either loot boxes are increasing problem gambling symptoms, or they disproportionately attract vulnerable players (Close et al., 2021; Garea et al., 2021; Zendle & Cairns, 2018, 2019). Experimental studies have examined the psychological effects of loot boxes, finding these are similar to the effects of gambling in triggering arousal, reward responses and urges to continue the activity that could lead to problematic use (Brady and Prentice, 2021; Larche et al., 2019). Further, survey data from 7,767 loot box purchasers showed that the top 5% of spenders generated half of loot box revenue (Close et al., 2021). Since higher loot box expenditure is associated with problem gambling, profits are disproportionately derived from higher-risk gamblers.

The association of loot box purchasing with problem gambling is particularly concerning in relation to adolescents. Most adolescents play video games (Brand, Jervis, Huggins, & Wilson, 2019) and purchasing loot boxes is a popular activity. In population studies in North America (DeCamp, 2021) and the UK (Gambling Commission, 2019), between one-sixth and one-quarter of adolescents reported purchasing loot boxes in the previous 12 months. Loot box purchasers are mostly male (Gambling Commission, 2019; Kristiansen & Severin, 2020) and the activity appears most popular amongst adolescents younger than 15 years (DeCamp, 2021; Hing, Russell, King, et al., 2021b). Adolescents report purchasing loot boxes mainly to gain in-game items, to obtain virtual in-game currency, or for in-game progress or competitive advantage (Hing, Russell, King, et al., 2021b; Rockloff et al., 2020). Other motivations include thrill and excitement, for prestige and appearance, to support game developers, to profit by selling or betting with loot box items, and because loot boxes may be perceived as good value (Zendle et al., 2019). Qualitative research is needed to gain a richer understanding of adolescents' motivations for purchasing loot boxes, similar to a detailed analysis of adult motivations which identified seven themes: opening experience; value of box contents; game-related elements; social influences; emotive/impulsive influences; fear of missing out; triggers/facilitators (Nicklin et al., 2021).

Despite the popularity of purchasing loot boxes amongst youth, and the consistent link found between loot box purchasing and problem gambling in adults, only three studies have specifically examined this relationship in adolescents (Kristiansen & Severin, 2020; Rockloff et al., 2021; Zendle et al., 2019). In a representative sample of 1,137 Danes aged 12–16 years, loot box engagement was positively correlated with problem gambling severity when controlling for demographics, with a stronger relationship amongst those who had purchased or sold loot boxes (Kristiansen & Severin, 2020). In a panel sample of 911 Australians aged 12–17 years, loot box purchasing was similarly associated with gambling problems amongst both boys and girls when controlling for age (Rockloff et al., 2021). A survey of 1,155 older adolescents aged 16–18 years, recruited through online advertising, also found a moderate-to-large positive association between problem gambling and spending money on loot boxes, as well as past-month expenditure (Zendle et al., 2019).

Overall, the few studies conducted indicate a relationship between buying loot boxes and problem gambling amongst adolescents. However, only two studies have included adolescents younger than 16 years (Kristiansen & Severin, 2020; Rockloff et al., 2021), even though purchasing loot boxes appears to be most popular amongst younger adolescents (DeCamp, 2021; Hing, Russell, King, et al., 2021b). Further, these studies have not controlled for gambling on other activities, even though numerous studies have found that engaging in a wider range of gambling activities is one of the strongest predictors of problem gambling (Baggio, Gainsbury, Berchtold, & Iglesias, 2016; Gainsbury, Russell, Wood, Hing, & Blaszczynski, 2015; LaPlante, Nelson, & Gray, 2014; Philander & MacKay, 2014). Controlling for participation in other forms provides valuable insight into whether there is a direct impact of loot box play on problems, or whether the association is due to concomitant play on other forms. This approach was taken by Wardle and Zendle (2021) who

analysed data from a weighted sample of 3,549 emerging adults aged 16–24 years in Great Britain. Those who purchased loot boxes were 11.4 times more likely to experience problem gambling than non-purchasers. Importantly, this relationship remained significant with odds of 4.5 after controlling for monetary gambling participation.

The current study uses a similar approach to Wardle and Zendle (2021) but in samples of Australian adolescents aged 12–17 years. The aim is to examine the association between loot box purchasing and gambling problems when controlling for socio-demographic factors and gambling participation. Based on the literature reviewed above, we hypothesise that loot box purchasing will predict problem and at-risk gambling when controlling for participation in monetary gambling. To our knowledge, this is the first adolescent-specific study to examine links between loot box purchasing and problem gambling in the context of adolescents' monetary gambling activities.

METHODS

Recruitment

Teenagers aged 12–17 years were recruited as the research focused on adolescents below the legal age of gambling (18 years in Australia). Participation required parental/guardian permission and the adolescent's informed consent. Only residents of the Australian state of New South Wales (NSW) were eligible to participate as this was the funding agency's jurisdiction.

To ensure robust numbers of participants in sub-populations of interest (problem and at-risk gamblers, loot box purchasers), we recruited two non-probability samples likely to have higher gambling involvement than general population samples. While representative samples are not essential to test relationships between variables (Russell, Browne, Hing, Rockloff, & Newall, 2021), we analysed all relationships separately in the two samples to enhance confidence in the results. The two samples were obtained using different recruitment methods to lessen the likelihood that results were an artefact of a particular recruitment method.

The first sample (*Advertisements sample*, $N = 843$) was recruited through email and online advertisements. Adults in NSW who had previously participated in studies by our research laboratory were emailed to invite any eligible adolescents in their household to complete the survey. Advertisements were also posted on Facebook, Instagram and Twitter, and in the funding agency's online communications. To incentivise participation, respondents could enter a draw to win an AU$100 shopping voucher. The second sample (*Qualtrics sample*, $N = 826$) was recruited through Qualtrics, a commercial panel provider who sources participants from several panels and compensates participants based on each panel's rewards system. Any duplicate responses within and between samples, identified through the email addresses and unique codes for follow-up that respondents provided, were deleted.

Procedure

Cognitive testing of the draft survey instrument was conducted with 12 adolescents aged 12–17 years who had engaged in simulated gambling, made microtransactions in video games, and/or seen gambling advertisements on social media. The interviewer encouraged participants to articulate their thinking process as they were answering the questions, with retrospective probes after each question to obtain further detail. Participants were also asked to highlight any confusion and uncertainty. Minor adjustments were made to some terminology (e.g., "money" was replaced with "real money"), question phrasing (to reduce length where possible), response options (e.g., adding a "don't know" option) and survey flow, but standard scales remained unchanged. After being presented with a participant information sheet and informed consent preamble, participants completed a 15-min online survey between 16 April and 23 May 2020. The survey for both samples was deployed on the Qualtrics survey software platform.

Participants

The two samples gained 1,669 usable survey responses.

Advertisements sample. The Advertisements sample questionnaire was initiated by 1,473 participants. Nine did not give informed consent and 60 did not meet the age and location criteria. Of the remaining 1,404 participants, 561 did not complete the survey. There were no data integrity issues detected with the remaining responses, giving a total sample of 843 (60.0% completion rate). The Advertisements sample (30.6% female) had a mean age of 14 years. As expected, the Advertisements sample had higher rates of gambling problems than found in population studies: 31.0% were non-gamblers, 10.9% non-problem gamblers, 8.2% at-risk gamblers and 49.9% in the problem gambling category. Adolescents in the households of our previous gambling research participants were expected to have elevated rates of problem gambling, given the strong link between parental and youth gambling problems (Dowling et al., 2017; McComb & Sabiston, 2010).

Qualtrics sample. The Qualtrics sample questionnaire was initiated by 4,101 participants, but 2,364 did not indicate parental consent, 119 did not give their own consent, 520 did not meet the age and location criteria, and 42 failed data quality checks (completed the survey too rapidly or failed an attention check). Of the remaining 1,056 participants, 230 did not complete the survey, giving a total of 826 responses (78.2% completion rate). Checks were also performed to assess data quality, such as tests for straightlining or inappropriate responses, that would indicate a non-serious attempt. In this particular dataset, no such issues were found, and thus no further exclusions were made. The Qualtrics sample (44.8% female) had a mean age of 14 years. As expected, the Qualtrics sample had higher rates of gambling problems than found in population studies: 50.7% were non-

gamblers, 24.6% non-problem gamblers, 9.2% at-risk gamblers and 15.5% in the problem gambling category.

Prior studies using online panels, like the Qualtrics sample, have also found elevated rates of problem gambling (Russell et al., 2021; Williams and Volberg, 2012).

Measures

Dependent variable. *Past-year problematic gambling* was assessed with the 9-item DSM-IV-MR-J which has been validated amongst youth (Fisher, 2000) and is the most widely used measure of youth problematic gambling in Australian and recent UK prevalence studies (Hing, Russell, King, et al., 2021b). Respondents who endorsed 4 or more items were classified as experiencing problem gambling; those with 2–3 endorsed items were classified as at-risk.

Independent variables. *Loot box questions* were preceded by the following explanation and pictures of 18 loot boxes found in popular video games: "Many video games offer loot boxes. Loot boxes are in-game items which can be purchased with real money, in-game currency, or awarded for free. When opened, loot boxes contain a random selection of virtual items (e.g., weapons, cosmetic items known as skins, or in-game currency). Some loot boxes are shown below. As you can see, they don't always look like a box. They can also appear as chests, crates, caches, packs, cards, etc." Participants were asked when, if ever, they had last: 1) opened a free loot box during a game, 2) paid real money to get a loot box or key, and 3) used virtual currency that was purchased with real money to get a loot box. In line with the Young People and Gambling Survey 2019 in the UK (Gambling Commission, 2019), response options were: "In the last 7 days", "In the last 4 weeks", "In the last 12 months", "More than 12 months ago" and "Never". For the current analyses, a composite variable was created to capture last-4-week loot box purchasing by combining response options 2 and 3 for "In the last 7 days" and "In the last 4 weeks". This past-month timeframe was used to focus the analyses on recent loot box purchasers and follows the procedure of Wardle and Zendle (2021) in collapsing categories in this manner.

Participation in monetary gambling was asked for 11 activities (Table 1). Response options were: "In the last 7 days," "In the last 4 weeks," "In the last 12 months," "More than 12 months ago," and "Never", based on response options used by the Gambling Commission (2019). For each activity, only last-4-week gambling was included in the analyses which combined the first two response options into a composite variable for each activity. A further composite variable was created that summed the number of past-month gambling activities of each respondent. This past-month timeframe was used to focus the analyses on recent gamblers, and again follows the procedure of Wardle and Zendle (2021) in collapsing categories in this manner.

Demographic characteristics included age (in years) and gender (male, female, other).

Analyses

By virtue of the substantial differences in recruitment methods between the Advertisements and Qualtrics samples, all analyses were conducted separately for the two sources. Analyses were restricted to the subset of persons who gambled at least once in the past 12 months, since non-gamblers were necessarily not at risk for problem gambling. From the original 1,669 responses, 989 had gambled within the prior 12 months (59.3%).

The analyses shown in Table 1 used biserial correlation to examine the relationships between last-4-week loot box purchasing (0 = no, 1 = yes) and last-4-week participation in 11 forms of gambling drawn from the NSW Gambling Survey 2019 (0 = no, 1 = yes) (Browne et al., 2019). These analyses demonstrate the concordance between loot box purchasing and gambling participation. The principal purpose of the study was to examine the relationship between loot box purchasing and gambling problems, while controlling for

Table 1. Percentage of past 4-week loot box purchasers (LBP) who had gambled on each monetary form with the last 4 weeks AND biserial correlations^ of past 4-week loot box purchasing (y/n) with past 4-week gambling participation on each form (y/n)

	Advertisements, n = 389				Qualtrics, n = 143			
	Count	Percent	$r_{\text{LBP, form}^\wedge}$	P	Count	Percent	$r_{\text{LBP, form}^\wedge}$	P
Lottery games	161	41.4	0.095	0.02*	75	52.4%	0.218	>0.01**
Pokies#	216	55.5	0.108	>0.01**	41	28.7	0.230	>0.01**
Race betting	37	9.5	0.160	>0.01**	43	30.1	0.193	>0.01**
Keno	10	2.6	−0.055	0.18	37	25.9	0.238	>0.01**
Sport betting	14	3.6	0.027	0.52	36	25.2	0.173	>0.01**
Casino games	13	3.3	0.069	0.10	26	18.2	0.207	>0.01**
Bingo	157	40.4	0.070	0.09	48	33.6	0.198	>0.01**
Poker	15	3.9	0.033	0.43	30	21.0	0.210	>0.01**
Esports betting	216	55.5	0.157	>0.01**	50	35.0	0.278	>0.01**
Fantasy sports betting	227	58.4	0.145	>0.01**	39	27.3	0.215	>0.01**
Private betting	245	63.0	0.165	>0.01**	54	37.8	0.142	>0.01**

^ includes adolescents who gambled on any form within the last 12 months: Advertisements n = 582, Qualtrics n = 407. # "Pokies" is a commonly used name in Australia for electronic gaming machines. **significant at the 0.01 level (2-tailed). *significant at the 0.05 level (2-tailed).

participation in other forms of gambling. Correlation matrices, in Table 2, computed the univariate relationships between the dependent variable, gambling problems, and last-4-week loot box purchasing as well as covariates (age and gender). Multinomial regressions predicting at-risk gambling and problem gambling (DSM-IV-MR-J) status were computed in Table 3 based on past-4-week loot box purchasing as the sole predictor for the purposes of comparison with the results including covariates. Another set of multinomial regressions, again predicting at-risk and problem gambling, was computed for Tables 4 and 5 with the addition of covariates including number of gambling forms engaged in during the last 4 weeks, age and gender, for the Advertisements sample and Qualtrics sample, respectively.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of Central Queensland University approved the study. All subjects were informed about the study, and all provided informed consent. Parental consent was sought for those younger than 18 years of age.

RESULTS

Descriptive results for monetary gambling and gambling problems

Table 1 illustrates the percentage of past 4-week loot box purchasers (LBP) who gambled on each of 11 forms of monetary gambling also within the four weeks prior to survey administration. The results are split by sample: Advertisements and Qualtrics. In addition, Table 1 shows the biserial correlations between past 4-week LBP purchasing and past 4-week gambling participation on each form. In the Advertisements sample, past 4-week LBPs were more likely to have gambled in the last four weeks on lottery games, pokies (electronic gaming machines), races, esports, fantasy sports and private betting. In the Qualtrics sample, past 4-week LBPs were more likely to have gambled on all 11 forms.

Correlations

Shown in Table 2 are rank-order correlations between DSM-IV-MR-J problem gambling (scored 0 = not-PG, 1 = PG) and the predictor variables of loot box purchasing in last four weeks (0 = no, 1 = yes), total number of the 11 types of gambling engaged in within the last four weeks (detailed in Table 1), age and gender (m/f – "other" not analysed as there were too few respondents). Results are shown separately for the Advertisements and Qualtrics samples in Panels A and B, respectively. In the Advertisements sample, neither age nor gender were correlated with problem gambling as expected, although all other predictors were correlated with problem gambling. Only gender failed to correlate significantly with problem gambling within the Qualtrics sample. The failure of age (in the Advertisement sample) and gender (in both samples) to correlate with gambling problems may result from low power and a restricted range. All participants were young (i.e., 12–17 years old) and most were male. For both samples, loot box purchasing within the last four weeks correlated with a calculated total of monetary forms of gambling in the same period. Lastly, there were marginally younger-aged males relative to females in the Advertisements sample.

Table 2. Correlation Matrices

Panel A: Advertisements sample

	Problem gambling (DSM-IV-MR-J)	Paid for LB last 4 weeks	Monetary gambling last 4 weeks	Age (years)	Gender (male)
Problem gambling (DSM-IV-MR-J)	–				
Paid for LB last 4 weeks	0.23**	–			
Number of gambling forms last 4 weeks	0.45**	0.21**	–		
Age (years)	−0.02	−0.04	0.05	–	
Gender ($m = 1, f = 0$)	0.02	0.07	−0.01	−0.09*	–

Panel B: Qualtrics sample

	Problem gambling (DSM-IV-MR-J)	Paid for LB last 4 weeks	Monetary gambling last 4 weeks	Age (years)	Gender (male)
Gambling problems (DSM-IV-MR-J)	–				
Paid for LB last 4 weeks	0.39**	–			
Number of gambling forms last 4 weeks	0.47**	0.35**	–		
Age (years)	0.10*	−0.05	0.13*	–	
Gender ($m = 1, f = 0$)	0.09	0.09	−0.12*	−0.09	–

**significant at the 0.01 level (2-tailed). *significant at the 0.05 level (2-tailed).

Table 3. Multinomial logistic regression with loot box purchasing sole predictor of at-risk and problem gambling

Panel A: Advertisements sample								
	At-risk gambling				Problem gambling			
	B	SE	OR	Wald st	B	SE	OR	Wald st
(Intercept)	−1.326***	0.273		23.606	0.560***	0.157		12.755
Paid for LB in last 4 weeks	1.945***	0.360	6.992	29.228	1.842***	0.252	6.306	53.401
Panel B: Qualtrics sample								
	At-risk gambling				Problem gambling			
	B	SE	OR	Wald st	B	SE	OR	Wald st
(Intercept)	−1.280***	0.165		60.226	−1.259***	0.164		59.226
Paid for LB in last 4 weeks	1.121***	0.302	3.067	13.788	2.114***	0.262	8.284	65.109

Non problem gambling is the reference category for the model. ***significant at the $P < 0.001$ level.
Non problem gambling is the reference category for the model. ***significant at the $P < 0.001$ level (2-tailed).

Table 4. Multinomial logistic regression for the Advertisements sample (all predictors of at-risk and problem gambling)

	At-risk gambling^				Problem gambling^			
	B	SE	OR	Wald st	B	SE	OR	Wald st
(Intercept)	−5.271**	2.001		6.938	−2.717	1.719		2.497
Paid for LB in last 4 weeks (y/n)	1.452**	0.465	4.270	9.761	1.315**	0.399	3.725	10.882
Number of gambling forms last 4 weeks	1.819***	0.216	6.164	70.582	2.010***	0.205	7.465	96.413
Age (years)	0.066	0.129	1.068	0.263	−0.021	0.112	0.979	0.035
Gender ($m = 1, f = 0$)	0.167	0.487	1.182	0.122	0.154	0.425	1.167	0.132

^Non problem gambling is the reference category for the model. ***significant at the 0.001 level. **significant at the 0.01 level (2-tailed).

Loot box purchasing as a sole predictor of gambling problems

Multinomial logistic regressions were performed to predict both at-risk gambling and problem gambling relating to those who purchased loot boxes within the last four weeks. For the Advertisements sample, results are shown in Table 3 Panel A. The odds-ratios (OR) indicated that people who purchased loot boxes recently were 6.99 times as likely to be at-risk gamblers, and 6.31 times as likely to score as problem gamblers as opposed to gamblers without problems.

Results for the Qualtrics sample are shown in Table 3 Panel B. The odds-ratio (OR) revealed that people who recently purchased loot boxes were 3.07 times as likely to be at-risk gamblers, and 8.28 times as likely to score as problem gamblers as opposed to gamblers without problems. As can be determined from Table 3, the implied CIs around the beta weights show that there was no significant difference between these two OR ratios.

All predictors of at-risk and problem gambling

Multinomial regressions were calculated to predict at-risk and problem gambling from loot box purchasing within the last four weeks along with additional covariate predictors including a count of the number of 11 different monetary gambling activities undertaken within the last four weeks (detailed in Table 1), age and gender.

As shown in Table 4 for the analyses of the Advertisements sample, the odds ratio revealed that loot box purchases within the last four weeks were still predictive of at-risk gambling, $P < 0.01$ (OR = 4.27). Likewise, the odds ratio revealed that loot box purchases within the last four weeks was also predictive of gambling problems, $P < 0.01$ (OR = 3.73). Consistent with expectations, a count of the number of 11 real money forms of gambling participation was predictive of both at-risk (OR = 6.16) and problem gambling (OR = 7.47). Lastly, however, neither age nor gender were predictive of at-risk or problem gambling in the Advertisements sample, $P > 0.05$, ns.

Table 5 shows the results of the multinomial logistic regression calculations for all predictors in the Qualtrics sample. Consistent with our hypotheses, loot box purchases in the last four weeks were still predictive of both at-risk (OR = 2.76) and problem gambling (OR = 6.00) in the presence of the other predictor variables. Moreover, both a count of the number of 11 gambling forms participated in within the last four weeks predicted problem gambling (OR = 1.55). Gender (male) predicted at-risk gambling (OR = 1.88) although not (significantly) problem gambling. Older ages predicted problem gambling (1.26 odds for each 1+ year older), although not (significantly) at-risk gambling.

DISCUSSION

This study examined relationships between loot box purchasing, monetary gambling participation, and at-risk and problem gambling in two samples of adolescents. Consistent

Table 5. Multinomial logistic regression for Qualtrics sample (all predictors of at-risk and problem gambling)

	At-risk gambling^				Problem gambling^			
	B	SE	OR	Wald st	B	SE	OR	Wald st
(Intercept)	−3.657*	1.506		5.894	−5.853***	1.592		13.514
Paid for LB in last 4 weeks	1.015**	0.313	2.761	10.499	1.792***	0.296	6.000	36.732
Number of gambling forms last 4 weeks	0.151	0.078	1.163	3.758	0.439***	0.068	1.551	41.610
Age (years)	0.121	0.096	1.129	1.573	0.231*	0.100	1.259	5.315
Gender ($m = 1, f = 0$)	0.632*	0.291	1.882	4.736	0.434	0.287	1.543	2.277

^Non problem gambling is the reference category for the model. ***significant at the 0.001 level. **significant at the 0.01 level (2-tailed). *significant at the 0.05 level (2-tailed).

with previous research (Wardle & Zendle, 2021), recent loot box purchasing was significantly and positively associated with recent monetary gambling in the two samples, both for the total number of gambling forms as well as for most individual forms. These included pokies, race betting, lottery-type games, poker, sports betting, esports betting, fantasy sports betting and private gambling. These results indicate a convergence of behaviour between loot box purchasing and monetary gambling amongst adolescents but cannot clarify any causal directions. However, these results do indicate that a subset of adolescents is drawn to engaging in both activities. This is not surprising given the similarities between loot box purchasing and gambling that include wagering money on the chance to win a prize whose value is unknown in advance (Greer et al., 2019; Zendle et al., 2019, 2020a, 2020b).

As predicted and found in previous research with adolescents (Kristiansen & Severin, 2020; Rockloff et al., 2021; Zendle et al., 2019), recent loot box purchasing was significantly related to both at-risk and problem gambling in bivariate analyses for both samples. When including other predictors, such as age, gender and, most critically, recent (i.e., past-4-week) participation in monetary gambling forms, loot box purchasing was still associated with at-risk and problem gambling in both samples. As expected, the addition of other predictors attenuated the predictive value of recent loot box purchasing in relation to at-risk and problem gambling. The odds-ratios, nevertheless, were still in the predicted direction and remained significant. When controlling for monetary gambling, age, and gender, recent loot box purchasing increased the odds of problem gambling 3.7 to 6.0 times, and at-risk gambling 2.8 to 4.3 times. These odds are similar to those found in Wardle and Zendle's (2021) study of emerging adults, where loot box purchasing increased the odds of problem gambling 4.5 times when controlling for monetary gambling participation.

One interpretation of the current results is that loot box purchasing has a direct causal effect on risk for problem gambling symptoms in adolescents. Loot boxes operate with gambling-like mechanics where the award of prizes based on a variable reinforcement schedule may increase chasing and persistence (Drummond & Sauer, 2018; Ferster & Skinner, 1957; Griffiths, 2018). Opportunities for repetitive continuous play, auditory and visual reinforcement, and the difficulties in keeping track of multiple electronic microtransactions, may also increase impaired control over loot box spending (Hing, Russell, Browne, et al., 2021; Larche et al., 2019; Parent Zone, 2019). Experimental studies have found that loot box purchasing triggers arousal, reward responses and urges to persist (Brady and Prentice, 2021; Larche et al., 2019). Several researchers have argued that loot box purchasing should be categorised as a type of gambling, and that its structural characteristics and psychological effects increase the risk of problem gambling (Drummond et al., 2018, 2020; Rockloff et al., 2020; Zendle et al., 2019, 2020a, 2020b).

An alternative explanation for the results is that young people with gambling problems are disproportionately attracted to purchasing loot boxes. By controlling for the number of other forms played, this indirect association is rendered less plausible, but is not eliminated. Individuals experiencing problem gambling tend to gamble on a wider range of activities (Binde, Romild, & Volberg, 2017; LaPlante et al., 2014). The opportunity to purchase loot boxes presents an additional gambling-like activity that can be undertaken by these more involved gamblers. Future research could examine whether there is a third variable explanation for the convergence of loot box purchasing and problem gambling symptomatology. Interestingly, Wardle and Zendle (2021) found that impulsivity attenuated but did not negate the significance of this relationship in emerging adults. However, other factors, such as risk-taking propensity, mental health problems and family functioning, may be worth examining as potential third variable explanations given their association with youth problem gambling (Volberg, Gupta, Griffiths, Ólason, & Delfabbro, 2011).

Regardless of any causality or a third variable explanation, the results indicate that loot boxes disproportionately attract spending from vulnerable adolescents experiencing gambling problems. Opportunities to purchase loot boxes in games are therefore adding to the financial stress that gambling is already causing them. Like gambling, the gaming industry relies on vulnerable players for much of its revenue (Close et al., 2021). This is even more concerning when these players are minors who lack the cognitive maturity to assess risk, are susceptible to poor and impulsive decision-making, and have heightened sensitivity to marketing and peer pressure (Emond & Griffiths, 2020; King, Delfabbro, Kaptsis, & Zwaans, 2014; Volberg et al., 2011). Moreover, there was no correlation between purchasing loot boxes in the last 4 weeks and age, indicating that younger adolescents may be no less likely to engage in this activity. Previous studies have found higher annual prevalence of loot box purchasing amongst adult gamers compared to adolescent gamers, but the reverse

finding in general population studies (Montiel et al., 2022). Our results suggest that adolescents aged 12–17 years may be similar in their level of loot box engagement.

CONCLUSIONS

This study is the first to our knowledge to examine the relationship between loot box purchasing and gambling problems amongst adolescents, when controlling for monetary gambling participation. While limited by self-report data which may be subject to recall and social desirability biases, and its non-probability samples, the consistency of results for both samples strengthens the credibility of the findings. The main finding, that loot box purchasing independently predicts problem gambling and at-risk gambling amongst young people, supports the need for consumer protection tools in games with loot boxes. Noticeably absent from these games are the harm minimisation measures typically provided for online gambling (King & Delfabbro, 2019b; Drummond, Sauer, & Hall, 2019). These include limit-setting options, expenditure statements, clear information about the odds of winning, safer play messages, self-exclusion and time-out options, and links to help services. These measures could be required of digital games that allow loot box purchases. Public education targeting children, adolescents and parents could also raise awareness of the risk of harm from loot box purchasing. In the absence of these consumer protection measures, loot boxes can be considered potentially more harmful than online gambling, especially given they can be legally accessed by minors within the digital games that many young people play. Further, the consistent association between loot box purchasing and gambling problems found in this and other adolescent research (Kristiansen & Severin, 2020; Rockloff et al., 2021; Zendle et al., 2019) supports the desirability of restricting the sale of these games to those of legal gambling age.

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Authors' contribution: NH, AR, MR, MB, PN, NG and DK designed the study and the survey instrument. AR cleaned the data and computed scales. MR conducted the statistical analyses and compiled the results tables. NH completed the first draft of the manuscript. All authors refined and approved the submitted version of the manuscript.

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